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ABSTRACTS

CLIMATE SMART AGRICULTURE AND AGRIBUSINESS DEVELOPMENT IN NIGERIA

KEYNOTE PAPER

Food System Approach to Research, Extension and Agribusiness Linkages in Nigeria: Policy and Institutional Lessons[1]

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1. Introduction

Recent efforts to address the challenges of the poverty, food insecurity and malnutrition revolve around how to correct the poor function of the global and local food systems. The upcoming UN Food Systems Summit by the end of 2021 is aimed at finding opportunities for Food System approach calls for developing various sub-components of the food system. Such approach requires asking the following questions. How does various components of the food system is improved through policy, research, and institutional development interventions? How to map the sub-components of the food systems and compare with the current state of these components? How does policy and institutional interventions can be designed to and interventions to improve the sub-components? Finally, how to improve food system through improving linkages among the sub-components?

In the transformation process of the food system, the existing institutions and their linkages must be studies and developed further through policy and institutional interventions. It is largely clear that new institutions may not be created for the food system approach per se but will modify the approaches and synergies to create the conditions for the outcomes that is expected out of the food systems approach recently proposed. Recent efforts have focused on developing approaches to measuring and improving the sub-component linkages in the food systems. In this paper, we examine the research, extension and agribusiness subsystems in Nigerian agriculture and draw specific policy and institutional lessons.

The paper is organized as follows. In the next section we present a conceptual framework that identifies methodological understandings of studying sub-components of a food system for their continuation to the effective functioning of the food system as a whole. In section three we review these opportunities to improve these individual components and how such improvements could result in furthering the effectiveness and efficiency of the subcomponent under study. In section four we draw the implications from the review for policy and institutional development that can speed up the food system transformation. Final section summary and conclusions.

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[1] Keynote paper presented at the 54th Annual Conference of Agricultural Society of Nigeria (ASN) held from 31st January - 4th February 2021, at Alex Ekwueme Federal University, Ndufu-Alike, Ebonyi State, Nigeria

[2] Senior Research Fellow and Head, Capacity Strengthening Program. The author thanks collaborators of the studies conducted in Nigeria that are used to draw insights for this paper.

2. The Conceptual Framework

Studying food systems has several dimensions. Not every scientist will be able to see the whole picture as it is projected by the conceptual framework presented so far, albeit they are comprehensive. However, food system approach requires each of these scientists to do their best and go beyond to connect with other subsystems to make impact of their work more synergistic. Yet, such method requires new set of skills that go beyond the individual disciplines to create a multidisciplinary and multisectoral approach to food system transformation. Similar approaches have been explored in the past. The farming system research, for example, in that began in the late 1970s and was pursued until late 1990s as an agricultural intervention strategy attempted such system approach at the farm level. Along the way it became tiresome to keep all the scientists working together to conduct experiments at the farm level. Partly because for individual single disciplinary scientists, it was not professionally rewarding to do joint research with other disciplines. And yet, the call for multidisciplinary research for solving food systems problems continues, as it now believed that we have developed multidisciplinary capacity for solving food system challenges not just at the farm level but at the market and at the macro levels. What have we learned from the experience of applying systems approach to developing practical solutions a t the farm level? Could such lessons be applied to food system transformation process? Even more challenging now is not only to go beyond the farm level to market and value chins but also to go beyond agriculture sector to other related sectors such as commerce, trade, health, environment, and related sectors.

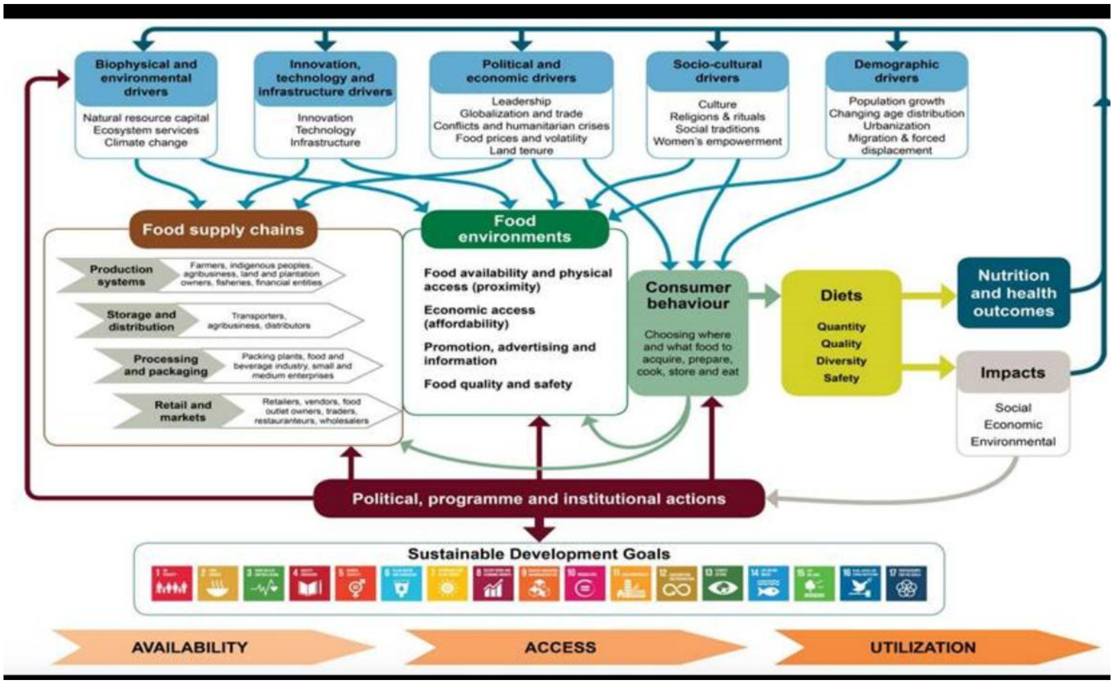
In this paper we try a develop a methodological approach that takes subsystems of research and innovation to connect with the productivity outcomes of the farmers and further link them to the post-harvest processing and value additions though emerging agribusinesses. This subsystem components and their revitalization could be considered as an experiment to see if the food systems approach would work. Operating with a smaller set of the components of a food system to deliver efficient and effective outcomes that we are seeking to achieve, it should be possible to improve these subsystem to reach their maximum potential towards their contribution to food system transformation. In this section, a conceptual framework for implementing a food system approach to research, extension and agribusiness linkages.

We begin with drivers of the food system and its relationship to the individual subsystems of research, extension and agribusiness for their constraints and opportunities for improving their efficiency and effectiveness to reach their full potential. Then we examine the opportunities for their contribution towards the synergistic interventions that could improve the food system functioning towards its final goals. Then we ask what policy and institutional solutions could help to improve the individual subsystems and their linkages to contribute towards food system transformation.

The recent approach to food system transformation identifies specific drivers of food systems (Figure 1). An approach to reviewing food systems in any country will begin with studying the drivers of food systems from a food supply chain perspective. This considers the multiple aspects of biophysical and environmental drivers, the innovation, technology and infrastructure drivers, the political and economic drivers, the socio-cultural and demographic drivers. Managing the biophysical and environmental drivers, and the innovation and technology drivers in figure 1, have direct implication for shaping sustainable food supply system. In the next step, we look at the research, extension and agribusiness subsystems that contribute to productivity of food supply system through the Analysis, identify the gap, and track the progress (AIT) operational framework (Babu, 2019). This framework has three steps. First, we analyze gaps in the current policy and institutional framework implemented in various subsystems. In the second step, we identify priority investment areas for food system transformation from the subsystem perspective. This is done with the help of the policy and strategy diagnose. On the last step, we track the progress to ensure that the strategy being implemented will reach the full potential needed for the food system transformation. Figure 2 presents the AIT operational framework. Repeating this framework across different subsystems and sectors / policies can help identify the policy and institutional gaps that could be addressed to improve the process of food system transformation.

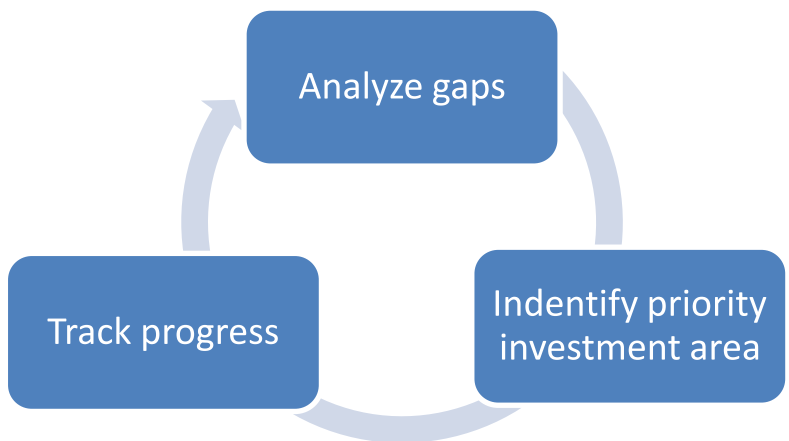
In this paper, we use the AIT framework to assess research, extension, and agribusiness linkages in Nigeria. We begin with individual system reviews and bring them all together with The research system review was conducted between 2014-2018. the Extension policy review of the Nigerian extension system was conducted between 2018-2020. During 2019-2020 we also conducted field case studies of young entrepreneurs to identify their agribusiness opportunities and constraints and how they synergize their activities with the research and extension. We bring these findings together in this paper to identify policy and institutional interventions from a food system perspective.

Figure 1: Drivers of Food Systems:



Source: HLPE (2017)

Figure 2. AIT Framework



3. The case of Nigerian research, extension, and agribusiness Linkages

Studying the research, extension , agribusiness subsystem in Nigeria gives unique opportunity to test the food system approach. Nigeria is also a federal state where decentralized decisions are made at the state level and this has implications for the food system approach to function at the local levels. Nigeria plays a crucial role in driving research and innovation in major crops in the Africa continent and in the west Africa region. Systematic study of research, extension and agribusiness components could be useful for the countries of Africa which face similar challenges. In this section we review these subsystems and draw insights for their linkages to improve their effectiveness, efficiency and their collective impact on the food system.

3.1 State of Research System and potential improvements:

Nigerian Agricultural research system is one of the largest in Africa in terms of the number of research institutions and the human resources. In a country in which agriculture remains a major driver for the national economic growth, poverty reduction, and food security, increasing productivity through research investments becomes a fundamental strategy. Yet, Nigerian agricultural sector has not performed to meet its potential. Several factors militate against Nigeria's efforts to reach its full potential in agriculture. Among them, unfavorable policy environment, organizational and institutional failures, and the human capacity to meet the research and innovation needs of diverse agro-ecological zones remain major contributing factors. Revitalizing agricultural research system and their linkages to extension and agribusinesses could be an effective way to overcome these constraints.

Recent policy initiatives such as , the Agricultural Transformation Agenda (ATA) and APP has focused on reforming the research and extension systems in Nigeria to meet the needs of the smallholder farmers. However, the linkages of the research, extension and other related institutions to work towards developing a food system that is inclusive and resulting in its transformation has remained a challenge. The recent reform strategy of the Agricultural Research Council of Nigeria (ARCN) outlines potential improvement that could help in overcoming such challenges (Babu et al., 2017). We review and reiterate them below.

Nigerian agricultural research system could attain its full potential if the following policy and institutional mechanisms could be improved. First, the overall governance and organizational structures should be revamped with an objective to increase the accountability and transparency of priority setting, planning funding and execution of research activities, and performance appraisals of the research staff in all these institutions. Second, the institutional and human capacity to conduct research and to manage research projects must be improved. With the existing capacity which has not been retrained for a long time, there is little chance for the researcher to be on the cutting edge in all the new emerging areas of agricultural research such capacity has implications for the research and innovation outputs and outcomes and further on the productivity of the agricultural sector as a whole in Nigeria.

Third, while the funding for research could be increased to meet the standards of the emerging economies, the current use of funds in the research systems requires better accountability and transparency in allocation. Mobilization of funds and the allocation of resources towards most rewarding research enterprises on a competitive basis will improve the effective utilization of the funds for research. Fourth, several institutions repat the research activities for want of coordination. While federal universities take up research in frontier areas, federal colleges of agriculture should be encouraged to do adaptive research to meet the research and innovation needs of the local farmers. Such adaptive research system is yet to be full developed in Nigeria, despite having federal collages and institutions spread throughout the country for various fields of enquiry. National agricultural research system needs to be strengthened further as an independent body that regulates the flow of resources as well as provides guidance for national priorities of research and innovation.

3.2 State of Extension system and potential improvements:

Agricultural innovations will remain on the shelves of the research laboratories unless they are translated into technologies and knowledge that is useful for farmers to increase their productivity and incomes. Nigerian agricultural system is no exception. While the productivity of the Agricultrual system is already lower than its potential in Nigeria, the poor functioning of the extension systems over the years adds to the inefficiency in translating research into productivity of farmers. The recently developed National Extension Policy (NEP) of the government of Nigeria provides opportunity to revamp the extension system in the country and to revitalize the research – extension- and farmer linkages. The NEP has 11 strategic elements that have been carefully identified to meet the local needs for extension system and could be applied to all the states of Nigeria with a common framework. However, the uptake of these ideas presented in the NEP has been slow.

National and state level consultations on the key policy and institutional innovation in this new agricultural extension policy include the following. First, as the extension system is becoming pluralistic, it is important to explore *Sustainable Funding Options and guidance towards partial privatization.* Not only such guidance is needed at the national level, it is also required at the state levels. Second, *National Monitoring, Evaluation, and Learning System* is an immediate institutional development priority where the investments in the extension system in terms of inputs, outputs, outcomes, and impact of the investment are tracked at the state and LGA levels for managing extension programs. Third, there is a need to establish *Agricultural Knowledge and Information Management (AKIM) system* for content management in extension programs. Such knowledge management system will improve the research and extension linkages at all levels.

Finally, investment in the institutional capacity to manage the quality control and regulation of emerging extension activities by the private sector, and the NGO sector would further help in streamlining the extension process with the national and state level agricultural development priorities. Guidance to the states on extension management that is in line with the national agricultural development strategies is crucial to holding the states level extension program accountable for their delivery on the ground.

3.3 State of Agribusiness and the potential improvements

Agribusiness and value chain development begin with the farm level productivity discussed above. From the food supply perspective increasing the productivity of the food production system can have implications of the productivity and competitiveness of the agribusiness and value chains. In the context of Nigeria, increasing income of the farmers and their livelihoods crucially depends on their participation in their domestic and in international markets. Agribusiness development which connects formers to their input needs and the output marketing help generate employment in the food system. While Nigeria has been able to develop some value chains that are internationally competitive, there is large potential to harness the agribusiness opportunities through increasing the competitiveness of their value chains and though better connection of research and innovation systems to the agribusiness opportunities. Value addition provides tremendous scope of the Nigeria agriculture sector, although it is constrained by several factors. As the farm sizes are small and fragmented, the productivity of farming system is further hamstrung by the limited mechanization, poor market infrastructure, and unfavorable pricing policies.

In addition to focusing on the productivity gains, agricultural policies and institutions must aim at increasing the agribusiness competitiveness of the value chains. In addition to achieving food security through productivity, sustainable food system transformation requires addressing the continued investments in productivity increasing technologies and improved agribusiness competitiveness. Thus, the interplay between agribusiness competitiveness, food security, and agricultural productivity, through the linkages of research, extension and agribusiness systems becomes crucial.

In the context of Nigerian agriculture, one can identify three sets of factors that need attention in increasing the competitiveness of the agribusiness and value chains. The first set includes the underlying factors which require relatively long time to change. These factors include political economy, governance system, legal system, and the legislative system all should support the development of the agricultural businesses. The second set of factors include the so-called intermediary factors. They take five to ten years to change and include development of input and output market, ease of doing business in these markets, tax system, investment in research and innovation, and development of relevant market infrastructure. The third category of factors are immediate factors that could have significant implications for competitiveness and are related to specific skill development, information exchange among the actors and players in the market systems, innovation in competing markets, developing functioning regulatory system, and increasing access to financing agribusiness (Jambor and Babu, 2016).

Nigerian farming system are constrained by continued low agricultural yields resulting from the use of traditional technology which results in low standard of living and subsistence nature of agriculture in most part of the country. Yet, recent policy and institutional reforms show opportunities for increasing specialization and move towards commercial farming practices though development of the value chains that use comparative advantage principles. however, agricultural transformation in Nigeria further requires policy institutional development that would help in efficient allocation of resources, making processing industries competitive, enabling technological innovation that results in structural transformation.

Nigerian policies and strategies in agriculture recognize the importance of increasing the competitiveness of agribusiness. However, a robust and enabling policy framework is needed to overcome the existing constraints on agro-industrialization and encourage private investment. Nigeria also requires an optimal combination of trade, industrial and agricultural policies that encourages value addition of agricultural processed products for domestic and international markets. Further, investments are needed to build the needed market infrastructure to convert the opportunities were Nigeria has a comparative advantage. Such policies should go hand in hand with regulatory mechanisms for food safety standards and rights to ownership of natural resources including land. In addition, the business environment needs improvement to increase private sector investment and trust in the system. Finally, development of skills and capacity at individual, institutional and system levels are needed to improve agricultural competitiveness.

3.4 Improving Research, extension and agribusiness sub system and its linkages:

Several efforts have been made to revitalize the research , extension and agribusiness systems through recent strategies including ATA and the APP. These strategies have implications for how the research, extension and agribusiness systems are shaped up in Nigeria.

Under the ATA the research strategy has been to develop a set of 30 value chains to achieve specific production targets primarily through productivity gains. This strategy called for restructuring of the ARCN and further develop a research system that responds to the needs of the smallholder farmers. While it borrowed several key best practices of the world's emerging economies such as Brazil, China, and India, implementation of these practices remains a challenge for several reasons. First, The reforms undertaken as part of the ATA and later as part of the APP are yet to bear fruit, as the needed institutional capacity to implement the best practices are lacking at various levels. Second, The federal institutions that are in various parts of the country are yet to be linked to the state and local government through formal mechanisms. Third, the benefits of the research conducted by the federal universities, federal colleges, and the federal research institutions are not fully taken up by the extension system of the states where they are located. This is partly due to the lack of institutional support that could do adaptive research in various Local Government Areas for the adoption of such technologies and innovation coming out of the research. Fourth, the research system is not fully aligned to the extension needs of the farming systems in the states. However, there are opportunities to connect the research emerging out of the research system to the needs of the smallholder farmers if the innovations are connected to the value chains and the agribusinesses of the states. We discuss these opportunities in the next section below.

In Nigeria the implementation of extension programs that reach out to farmers to provide them with knowledge and inputs are managed by the State governments. In countries such as India, china, and Brazil, where a similar federal system of governance exists, there is a strong research and extension linkage established over the years which Nigeria could adopt to its conditions. However, from the perspectives of the extension system, the federal extension policies and strategies are yet to be absorbed and translated into strategies at the local extension system. There is huge scope to change this. For example, the Indian system developed an effective platform for fostering close research-extension-farmer linkages. The Farm science centers in each district called Krishi Vigyan Kendra's (KVKs) established with the federal – state partnerships (operated by the state Agricultrual universities and local NGOs) provide one stop solution to agricultural knowledge that is relevant for the local farmers.

In the context of Nigeria, the Extension system currently operated by the LGAs should be converted to become the Farm science centers and its staff should be regularly trained to meet the knowledge needs of farmers in the LGAs. These extension workers will provide demonstration of the technologies relevant for th e farmers and agribusinesses in that area complementing the work done by the state extension system. The federal colleges of Agriculture and the Federal universities and faculties of agriculture should be linked to these farm science centers for research and knowledge exchange on a regular basis.

4. Implications of policy and Institutional development for Food System Transformation.

In Nigeria, a major challenge is the implementation of the policies and strategies that are already in paper. For example, a recent high- level committee came up with several recommendations. They relate to the following. The national policy on agricultural extension still needs final approval by the Federal Executive Council. This process needs to be expediated for the development of further institutional and funding arrangements that can link research-extension-agribusiness subsystems towards food system transformation.

The committee recommended the following: Sustainable funding mechanisms for the implementation of the national extension policy needs to be secured. The committee has recommended several funding strategies including the cost sharing among the federal, state, local governments, and farmer communities. A major emphasis is placed on retraining 75,000 extension workers, agribusiness entrepreneurs, and technical experts at the state and LGA levels. Recognizing the community-based approaches to extension, moving to a pluralistic extension service approach involving a value chain approach that includes demand driven, market oriented, and ICT-enable extension system is also emphasized. Revival of the ADPs that is moribund in many states through and establishment of the state level and LGA level information centers are recommended to strengthen knowledge access of the farmers and to demonstrate the innovations.

The committee also recognized the following: Revitalization of the REFILS requires strengthening the capacity of the famer-based organizations. While there is full recognition that the insecurity situation in the country affects the functioning of the extension system and collaboration of the federal, state, and LGA stakeholders, establishment of the agricultural extension steering committees at all levels. In the meantime, there are several extension approaches have shown isolated successes including the FADAMA system, farmers field schools, and other NGO based approaches. Scaling up these approaches will require institutional and human capacity that is lacking at all levels. Investments in such capacity development will also require bringing the research system to work with extension system on a collaborative, adaptive and learning approach. establishing 800 farm science centers with the help of the LGA level agricultural extension institutions and guiding them to work with the federal level monitoring system and the state level ADPs would help in quick revitalization of functioning extension system in Nigeria.

While the research, extension and agribusiness subsystems are moving in the right direction, we further need policy and institutional reforms to help the system to attain its full potential for the food system transformation.

5. Concluding remarks

In this paper we looked at a subset of the Nigerian food system to identify opportunities for policy and institutional interventions to improve their potential contribution towards food system perspective. Using Nigeria as a case study we have looked at the possible synergies that could be related through developing linkages in the subcomponents of a food system. Here we have looked at how these subcomponents are operating independently and how such disjointed efforts do not contribute to the food system transformation that development community is aiming at though the multidisciplinary and multisectoral approach that is proposed. Then the question becomes what kinds of policy and institutional development is needed to revitalize the research-extension- agribusiness linkages in the context of the food system transformation.

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SUB-THEME A

AGRICULTURAL PRODUCTION, POLICY AND EXTENSION

The need for sustainable agricultural mechanization in developing countries: an overview

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Abstract

It is a general believe that agricultural mechanization enhances labour and land productivity. It also ensures timeliness of operation and precision agriculture. Agricultural activities are time dependent and are being achieved with the help of mechanization. Agricultural mechanization covers all levels of farming and processing technologies from simple tools to more sophisticated motorized equipment. Agricultural mechanization must be sustainable in order not to compromise the comfort of present generation and future of yet unborn generation. Sustainable Agricultural Mechanization (SAM) is a mechanization that is economically feasible, environmentally sensitive and socially acceptable. Sustainable mechanization leads to sustainable agriculture like conservation agriculture (CA). CA is an approach of maintaining agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing resource base and its environment. CA helps to preserve Soil Organic Matter (SOM) which is the lifeblood of agricultural soil. Merits of sustainable agricultural mechanization include increase in land productivity, supporting opportunities that relieves burden of labour shortages and enable households to withstand shocks and decreasing the environmental footprint of agriculture when combined with adequate conservation practices. For any technology to be adopted by farmers, the technology's technical feasibility, economic feasibility, social acceptability, complexity, visibility/observability, and infrastructural compatibility needs to be assessed and evaluated for the benefits of the adoptees.

Keywords: Lifeblood, Sustainable, Soil Organic Matter, Mechanization, Conservation, Agriculture

1. Introduction

There is no doubt that food is one of the basic needs of every human being and this has made it compulsory to boost food production with the development, introduction and adoption of improved technologies. Agricultural mechanization covers all levels of farming and processing technologies.

The objectives of agricultural mechanization include precision agriculture, timeliness of operation, improvement on efficient use of resources, enhancement of market access and mitigation of climate related hazards, www.fao.org; FAO, (2018).

Though agricultural mechanization is an essential input for boosting food production, its sustainability remain an issue to prioritize for the benefit of present and future generation. Sustainable Agricultural Mechanization (SAM) can be described as mechanization that is economically feasible, environmentally sensitive and socially acceptable, Brians and Josef (2017). SAM addresses mechanization across/along the value chain (production, harvesting, post-harvest handling, processing and marketing), Brewer *et al.*,(2015). It also encourages Conservation Agriculture (CA). CA preserves the Soil Organic Matter (SOM) and soil's life.

In adopting agricultural technology by the farmers, some basic requirements like technical feasibility, economic feasibility, social acceptability, complexity, infrastructural compatibility and visibility/observability, Friedrich (2013).

The essence of this work is to brainstorm the importance of SAM and on how to promote it. SAM has the potentials of increasing food production without compromising the environment.

2. Mechanization across /along the value chain

Table 1: The potential for mechanization along the agricultural value chain

Production:	**Post-harvest/storage:**	**Processing:**	**Marketing:**
Crop establishment, weeding, fertilization, irrigation crop, protection, harvesting	**Drying, Grading, Winnowing, Cleaning, and storage**	**Chopping, Milling, Grinding, Pressing**	**Packaging Transport**

Source: After Brewer *et al.*, (2015)

3. Appropriate mechanization

Appropriate mechanization rests on: range of power sources and selection from a range of options.

4. Sustainable mechanization

Sustainable mechanization interests lies on the economic and social sustainability and environmental sustainability. It is important to note that mechanization is an investment for farmers and they have to generate income and profit from their investment by means of greater productivity or increased value.

5. Objectives of mechanization

It enhances timeliness of operation, precision agriculture, improves water supplies and water controls

6. Factors that can aids progress in agricultural mechanization

The factors are growing needs by farmers, establishment of agricultural mechanization training center, research, education and extension, Anazodo (1975).

7. Conservation agriculture

CA is an approach of maintaining agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and its environment, Friedrich (2013).

8. Elements of sustainable agricultural mechanization

The elements of SAM include: Boosting farm power through appropriate technologies and innovative business model; Promoting innovative financing mechanisms for agricultural mechanization; Building sustainable systems for manufacturing and distribution of agricultural mechanization inputs, sustainable mechanization across agri-food value chains, innovative systems for sustainable technology development and transfer.

9. Challenges of sustainable agricultural mechanization in the developing world

According to Asoegwu and Asoegwu (2007), the challenges of agriculture include management of land resources, management of capital, management of labour, management of water resources, agricultural power and machinery, storage facilities, livestock manure, IT Inputs and other inputs.

10. Benefits of sustainable agricultural mechanization (SAM)

Sustainable agricultural mechanization has the following potentials: Increase in land productivity by facilitating timeliness and quality of cultivation; supporting opportunities that relieve the burden of labour shortages and enable households to withstand shocks; decreasing the environmental footprint of agriculture when combined with adequate conservation practices.

11. Basic requirements in adopting agricultural technology

Some of the basic requirements include: technical feasibility, economic feasibility, complexity, infrastructural compatibility, visibility and social acceptability, Aremu *et al.,*(2015).

1. Conclusion

Mechanization should be viewed as a necessary component of a transformational development process that promotes the sustainable commercialization and modernization of small, medium and large scale farms in order to accelerate agricultural development and initiate sustained poverty-reducing economic growth in both rural and urban areas. Agricultural mechanization covers all level s of farming and processing technologies, form simple and basic hand tools to more sophisticated motorized equipment. Agricultural mechanization can be described to be sustainable when it is economically feasible, environmentally sensible and socially acceptable. Agricultural mechanization covers both on-farm and off-farm operations.

The principles of sustainability include economic, social and environmental viability. Factors that aid in mechanization include growing desire by farmers, education, research and extension.

Conservation helps to preserve soil organic matter (SOM). SOM is the lifeblood of the soil since it helps to maintain soil fertility.

Elements of sustainable agricultural mechanization include boosting farm power through appropriate technologies and innovation business models, sustainable agricultural mechanization across agri-food value chain. The challenges of sustainable agricultural mechanization include management of land resources, capital and labour.

Benefits of sustainable agricultural mechanization are decreasing the environmental foot print of agriculture when combined with adequate conservation practices, reducing poverty and achieving food security while improving people's livelihood.

Some of the basic requirements in adopting technology include economic viability, technical feasibility, social acceptability, complexity and infrastructural compatibility.

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The Roles of Legumes in Maintaining Food Security in Nigeria

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Abstract

The paper reviewed the roles of legumes in the maintenance of food security in Nigeria. The paper established that legumes could be a base for development of many functional foods to promote human health and maintain food security. Nigeria is endowed with favourable ecologies for the production of legumes hence moves to increase legume production should be intensified in the country. Building economically sustainable and effective legume seed systems in Nigeria are seen as a way of boosting legume production to meet the Nigerian seed road map target. The use of legumes to improve soil nitrogen content can also be a practicable way to improve soil fertility that guarantees food security. The need for aggressive education worldwide about the nutritional values of legumes, genetic modification to develop transgenic leguminous species that cook faster and have low level of anti-nutrients as well as soaking in water prior to cooking could help to increase peoples' interest in the consumption of legumes in Nigeria.

Keywords: Legumes, roles, food security, Nigeria.

Introduction

Food security is the availability of food and one's access to it (Borlaug, 2007). A household is considered food secure when its occupants do not live in hunger or fear of starvation. According to the UN committee on World Food Security, food security means that all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meet their food preferences and dietary needs for an active and healthy life. Food insecurity is still a major global concern as over 1 billion people are suffering from starvation. This paper among other things seeks to improve food security through legume production. Some food security organizations include FAO, Food Tank, Food First, Feeding America etc. Food security crises jeopardize the lives of millions of people in vulnerable area where malnutrition, poverty and death from hunger is widespread. Food, clothing, and shelter remain the basic necessities of life and food is central to human existence. Food has been shown to shape human history, driving migration, provoking war as well as undermine the growth of Nations (Agbogidi *et al*., 2019).

Legumes are plants (members of the pea family), especially ones grown as crops. They include groundnuts, peas, tamarinds, alfalfa, common beans, soy beans and chick bean. Legumes are valuable world wide as a sustainable and inexpensive meat alternative and considered the second most important food sources after cereals (FAO, 2016). Legumes are sustainable and inexpensive sources of proteins, unsaturated fats, dietary fibre, complex carbohydrates, micronutrients and important phytochemicals hence their consumption could contribute to a healthier life style (Messina, 2016). They are considered appropriate foods for health conscious consumers, celiac and diabetic patients as well as those concerned with weight loss. It is recommended that legumes should be incorporated in children and infants' diets at home and through school feeding programmes (Messina, 2016). Shiferaw *et al*. (2011) maintained that legumes are among the crops that feed the world. A combination of legumes with vitamin C rich foods helps to prevent anemia in women of reproductive age. Legumes are foods for all ages. They could be prepared in so many ways including baked, canned, cooked, boiled, bean beverage, chill, barbecue, ranch style, bacon bits, meatless, cranberry, akara and moin-moin. All animals depend on plants (Okigbo, 2008; Agbogidi *et al*., 2017; Agbogidi, 2019).

Other examples of legumes are clover, peas, lupines, carob, mesquite and peas fenugreek. Dried seeds known as pulses are also part of the legume family. Legumes also include Adzuki beans, Anasazi beans, black beans, black-eyed peas, fava beans and kidney beans.

Legumes are nutritional valuable food crops rich in protein and dietary fibres. They have been given economic, cultural, physiological and medicinal roles owing to their possession of bioactive compounds. Their consumption has been reported to be associated with various beneficial health attributes including hypochlolesterolemic and hypoglycemic properties (Ndidi *et al*., 2014; Massina, 2016). Legume are affordable and do not requires expensive irrigation system and fertilizers because they can do well in poor soil and adverse weather condition. As cover crops, they reduce erosion and have symbiotic relationship with nitrogen fixing Rhizopus resident in their root nodules thus making then excellent rotational crops. Beside the nutritional demand of legume, it is still rising globally due to the consumer awareness of their nutritional and health benefits. Developed countries have seen light in thus and highly exploited hence it is very important to increase the utilization of legumes and increase new legume-based produce in our meal to reduce poverty and alleviate malnutrition. Figure 1 shows the desirable attributes of legumes.

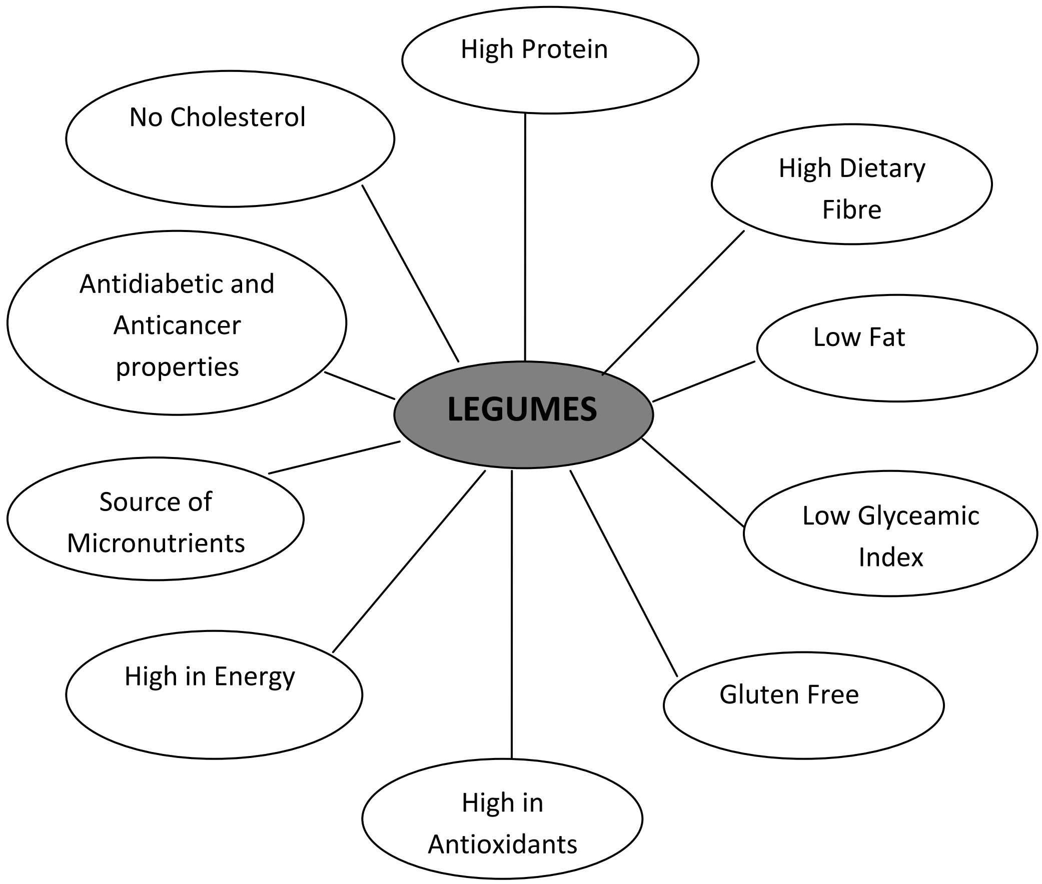

Figure 1: Desirable attributes of legumes.

Source: (Qayyum, *et al., 2012).*

Although prior efforts by government at enhancing food security through agricultural productions were in place but they did not yield successful results due to the absence of comprehensive policy framework, excessive political interference, ineffective targeting of beneficiaries as well as overlapping functions. As a result of all these and other factors, achieving food security continues to be an issue in developing countries like Nigeria as well as undeveloped world. According to Norman *et al.* (1995) and Kouris-Blazoas and Belski (2016), the following constitute the nutrients composition of legumes:

i. Protein (20 – 45%) generally rich in essential amino acids lysine

ii. They are sources of a complex, energy giving carbohydrates with up to 60% carbohydrate (dry weight)

iii. They are also available source of dietary fibre (5 – 37%) containing significant amount of both soluble and insoluble dietary fibre.

iv. Legumes have no cholesterol. They are generally low in fat with the exception of peanuts (45%, Chickpeas 15% and soybean 47%). They are rich in more and polyunsaturated fatty acids.

v. Legumes are good sources of micronutrients like B-group vitamins and poor in fat soluble vitamins. They are sources of abundant essential minerals including zinc, iron, calcium, selenium, phosphorus, copper, potassium, magnesium and chromium with great roles in enzyme activity, iron metabolism, haemoglobin synthesis, bone health and other general body metabolism.

Food legumes are grouped into two groups viz oil seeds, with high oil content including soybean, peanuts and pulses, dry seeds of cultivated legumes used as traditional foods. Common legumes used for human consumption are also referred to as grain legumes or food legumes. Comparative protein yield of legume crops is shown in Table 1 while the area, yield and production of crop legumes in the tropics are presented in Table 2. Table 1 indicated that the average protein yields of soy bean, groundnut, beans and chick pea are appreciably high hence when efficiently harnessed could contribute to food security. Similarly, on world production and yield, with an increase in area of production, food security could be achieved through legume production.

Table1: Comparative protein yield of legume crops

S/N	Crop	Average Tropical Yield (t ha-1)	Protein Content	Average Protein Yield (kg ha)
1	Soybean	1.34	38.0	509
2	Groundnut	0.89	25.5	227
3	Beans	0.60	22.0	132
4	Chick pea	0.66	20.0	132

Source: Norman *et al*. (1995).

Table 2: Area, Yield and Production of Crop Legumes in the Tropics

Crop legumes	Tropical Africa	Tropical America	Tropical Asia	Total Tropics	World	Tropics as % of world
Area (m ha)						
Soybean	0.47	10.32	4.81	15.60	55.37	28
Groundnut	5.80	0.32	10.00	16.12	20.36	79
Pulse	12.00	9.36	29.34	50.70	70.38	72
Total	18.27	20.00	44.15	82.42	146.11	56
Yield (t ha^{-1})						
Soybean	0.94	1.53	0.97	1.34	1.86	72
Groundnut	0.84	1.36	0.90	0.89	1.15	77
Pulse	0.55	0.59	0.60	0.59	0.85	69
Total	0.65	1.09	0.72	0.80	1.27	63
Production (m t)						
Soybean	0.44	15.78	4.66	20.88	103.07	20
Groundnut	4.89	0.44	9.02	14.35	23.37	61
Pulse	6.54	5.50	17.75	29.79	59.90	50
Total	11.87	21.72	31.43	66.02	186.33	35

Source: Norman *et al*. (1995).

Challenges of legumes in human nutrition

Legumes contain non-nutrient bioactive compounds or anti-nutrient like linins, protease inhibitors, though non-toxic but could generate adverse physiological effects and interfere with protein digestibility of some minerals. They are however rich in alkaloids, saponins and other phytochemicals that prevent cancers, heart diseases and other chronic degenerative diseases (Kouris-Blazoas and Belski, 2016).

Inadequacy of the knowledge of their nutrition and functional benefits has limited the attention given to their other factors associated with their limited use include flatulence, difficulty in cooking, myths about their consumption. Low yields, poor seed availability, lack of market, labour intensive and lack of awareness of indigenous legumes.

Way forward

Development of new legumes products hence increasing the production for commercial purposes by local farmers could help to improve food security.

Rinsing legumes and changing the boiling water several times could significantly reduce the oligosaccharides responsible for the bloating and flatulence in legumes.

The need for aggressive education worldwide about the nutritional values of legumes, genetic modification to develop transgenic leguminous species that cook fasters and have low level of anti-nutrients (Messina, 2016).

Soaking prior to cooking also softens the seeds thereby reducing cooking time.

Nigeria is endowed with favourable ecologies for the production of legumes hence moves to increase legume production should be intensified in the country.

Building economically sustainable and effective legume seed systems in Nigeria are seen as a way of boosting legume production to meet the Nigerian seed road map target. The use of legumes to improve soil nitrogen content can also be a practicable way to improve soil fertility that guarantees food security.

Conclusion

Humanity is facing a lot of global challenges and the chief among these is achieving food security for a rapidly growing population estimated by United Nations (2019) as 7.7 billion. Adopting legume-based cropping practices could improve the food security of Nigeria. This has to do with recognizing the numerous benefits of grain legume production as well as other strategic legume species. The potential for introducing improved production practices in food legumes will enhance security of food and nutrition of farmer. There is power in nature's pulses to enhance food security and mitigate the degrading environments. Agbogidi *et al*., (2019) posited that global food security requires a major refocusing of plant sciences, crop improvement and production agronomy. Throughout the world, legumes of different classes are used for household food security.

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Commercial Banks' Credit to Agricultural Sector and Economic Growth in Nigeria, 1981 to 2016

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Abstract

The study assessed the relationship between agro-credit from commercial banks and economic growth in Nigeria from 1981 to 2016. Data for the study were obtained from the Central Bank of Nigeria's statistical bulletin and analysed on EStata14 with descriptive statistics and Pearson Correlation. The Pearson correlation coefficient was high, positive and statistically significant ($p < 0.01$) for the relationship between TCNB and ACNB (0.9938) and between ACNB and GDP (0.8140). Also, the Pearson correlation coefficient between RACTC and GDP was moderate, negative (-0.6580) and statistically significant ($p < 0.01$). It was concluded that agro-credit from commercial banks was associated with increase in economic growth. The study recommended that commercial banks should increase credit allocation to agricultural sector, while, in conjunction with the Central Bank of Nigeria, review proportional credit allocation to key sectors.

Keywords*: Agro-credit, total credit, commercial banks, gross domestic product.*

Introduction

Economic growth refers to an increase in the capacity of an economy to produce goods and services within a period of time. It can also be seen as the increase in the inflation-adjusted market value of goods and services produced by an economy over a given period of time. Economic growth, often measured by the gross domestic product (GDP), refers to annual increase in productivity over a given period of time (Ayeomoni and Aladejana 2016). Economic growth can be intensive or extensive. It is intensive when it is caused by more efficient use of inputs typified as increased productivity of labour, capital, energy or material resources. On the other hand, economic growth is extensive when it is caused by increase in the amount of inputs available for utilization by various agents of transformation, especially in the sector where the country in question has abundance of natural endowment or comparative advantage. Agriculture contributed 90 % of the Nation's GDP and foreign exchange before oil boom was discovered in Nigeria in early 1970s. Commercial agriculture requires substantial capital injection. The capital often emanates from domestic savings, foreign investment or credit sources.

Agriculture credit is essentially a development strategy in a variety of ways. It promotes agricultural investment and adoption of technology necessary to spur economic growth. Although, agriculture finance is only one of the growth factors, it is one of the more important factors in attaining the objectives for overall development of an economy. Several credit schemes have been put in place in Nigeria. Awotide *et al*. (2015) and Ayeomoni and Aladejana (2016) stated that successive governments in Nigeria have formulated and implemented several financial programmes all aimed at ensuring availability of funds to agricultural sector in order to boost real sectors thereby lead to economic growth and development. These financial measures were aimed at spurring overall economic development.

The schemes are administered by the Central Bank of Nigeria (CBN) through commercial banks. In their collaboration with the CBN, the commercial banks focus attention on four key sectors. These sectors are production (agriculture, forestry and fishery; manufacturing; mining and quarrying; and real estate and construction), general commerce (bills discounted, domestic trade, exports and imports), services (public utilities, transport and communications, and credit to financial institutions), and others (government, personal and professional, and miscellaneous).

Commercial banks are custodians of depositor's funds and operate by receiving cash deposits from the general public and loaning them out to the needy at statutorily allowed interest rates (Ngure, 2014). In Nigeria the financial sector is dominated by commercial banks, therefore any failure in the sector has a grave consequence on the economic growth and development of the country (Ndubuaku *et al*., 2017). In addition, commercial Banks as financial intermediaries perform financial intermediation function of mobilization and allocation of funds from the economic surplus (lenders) to the economic deficit unit (borrowers). This function is directly linked with banks profitability which encourages economic growth.

On the impact of agricultural development on economic development, Lewis (1954) theorised that agriculture was the basis for industrial growth and development. Thus, the engine of growth and development of any society must start with agricultural production. Irgco (2004) stressed that with mechanization, labour could be freed for industrial development. Enoma (2010) found that agricultural variables (interest rate, exchange rate and credit to agricultural sector) had impact on economic growth. Ayeomoni and Aladejana (2016) found that short and long run relationships existed between agricultural credit and economic growth in both short and long runs.

Problem Statement

Despite the existence of several financial packages, credit requirements of farmers are hardly met. Also, delay in disbursement of public loans constitutes an impediment to growth. This can result in loan diversion. Furthermore, commercial banks hardly approve loans to agriculture and or do so at higher interest rates with other stringent conditions. Also, commercial banks are discouraged from devoting their attention to agricultural sector because of the economic nature of land holdings and lack of acceptable securities (Bassey *et al*., 2014 in Ayeomoni and Aladejana, 2016). Similarly, Rahji and Fakayode (2009) in Awotide *et al*. (2015) indicated that banks' perception of agricultural credit as a highly risky venture limit credit allocation to the sector.

While, Child (2008) observed that the impact of agricultural sector on economic growth and development has been minimal, Adetiloye (2012) noted that supporting agriculture by way of finance and subsidies have been held to distort the financial markets, leading to higher financing costs, and can slow down the rate of growth of the domestic economy. Hence, the impact of agro-credit on economic development has mixed results. The study, therefore, seeks to examine the summary statistics of commercial banks' credit to agriculture, total credit from the commercial banks to the economy, the ratio of agro-credit to total credit from the commercial banks, and GDP from 1981 to 2016. It was hypothesised that there is no significant relationship between total credit and agro-credit from commercial banks; there is no significant relationship between agro-credit and GDP; and there is no significant relationship between the ratio of agro-credit to total credit and GDP.

Methodology

The study focused on Nigeria's economy from 1981 to 2016. Time series data for the study were obtained from CBN and analysed with descriptive statistics (mean, standard deviation and coefficient of variation) and Pearson correlation. The models for the hypotheses include:

$$r = \frac{\mathrm{n}\Sigma xy - \Sigma x \Sigma y}{\sqrt{[[\mathrm{n}\Sigma x^2 - (\Sigma x)^2]][[\mathrm{n}\Sigma y^2 - (\Sigma y)^2]]}}$$

where,

r = correlation coefficient; X = Total credit from commercial banks in N billion (TCNB)

Y = Agro-credit from commercial banks in N billion (ACNB)

$$r = \frac{\mathrm{n}\Sigma xy - \Sigma x \Sigma y}{\sqrt{[[\mathrm{n}\Sigma x^2 - (\Sigma x)^2]][[\mathrm{n}\Sigma y^2 - (\Sigma y)^2]]}}$$

where,

X = Total credit from commercial banks in N billion (TCNB); Y = GDP (N billion)

$$r = \frac{n\Sigma xy - \Sigma x\Sigma y}{\sqrt{[[n\Sigma x^2 - (\Sigma x)^2]][[n\Sigma y^2 - (\Sigma y)^2]]}}$$

where,

X=Ratio of agro-credit to total credit from commercial banks in % (RACTC); Y=GDP (N billion)

Results and Discussion

Summary Statistics of Commercial Banks' Credit

The summary statistics of commercial banks' credit between 1981 and 2016 presented in Table 1 shows that, in N billion, the average agro-credit, total credit, and GDP were 207.85, 6,332.81 and 22,393.38, respectively, while the RACTC was 8.66 %. The result of RACTC implies that only 8.66 % of total credit from commercial banks was allocated to the agricultural sector. This is considered low since agriculture is the mainstay of Nigeria's economy. The result further showed that agro-credit had the highest coefficient of variation (2.42) while RACTC had the least (0.66).

Table 1: Summary Statistics of Commercial Banks' Credits (N = 36)

Statistics	**Agro-credit (AC) (NB)**	**Total credit (TC) (NB)**	**GDP (NB)**	**Ratio of Agro-credit to Total credit (RACTC) (%)**
Mean	207.85	6,332.81	22,393.38	8.66
Standard deviation	502.16	15,051.03	31,287.38	5.73
Coefficient of variation	2.42	2.38	1.40	0.66
Skewness	2.91	2.91	1.33	0.45
Kurtosis	9.88	10.15	3.39	1.85

Source: Computed from Statistical Bulletin of the Central Bank of Nigeria, 2016.

Relationship between Total Credit and Agro-credit

The analysis of the relationship between total credit (TCNB) and agro-credit (ACNB) is presented in Table 2. The result shows that the Pearson correlation coefficient (0.9938) was high, positively signed and statistically significant ($p < 0.01$). The implication is that there was significant relationship between total credit and agro-credit. The result further implied that a one percent change in TCNB is likely to grow ACNB by 0.9938 percent.

Table 2: Relationship between TCNB and TCNB (N = 36)

	TCNB	**ACNB**
TCNB	1.0000	
ACNB	0.9938*	1.0000
Sig. (2-tailed)	0.0000	

* statistical significance at 0.01 level

Relationship between ACNB and GDP

The analysis of the relationship between ACNB and GDP is presented in Table 3. The result shows that the Pearson correlation coefficient (0.8140) was high, positively signed and statistically significant ($p < 0.01$). The implication is that there was significant relationship between ACNB and GDP. A one percent increase in ACNB would be associated with 0.814 percent increase in Nigeria's GDP. Hence, agro-credit from commercial banks was associated with GDP in Nigeria within the period under review.

Table 3: Relationship between ACNB and GDP (N = 36)

	ACNB	**GDPNB**
ACNB	1.0000	
GDPNB	0.8140*	1.0000
Sig. (2-tailed)	0.0000	

* statistical significance at 0.01 level

Relationship between RACTC and GDP

The analysis of the relationship between RACTC and GDP is presented in Table 4. The result shows that the Pearson correlation coefficient (-0.6580) was moderate, negatively signed and statistically significant ($p < 0.01$). The RACTC was introduced as a measure of proportional credit to agriculture as it affects GDP. This result implies that a one percent increase in RACTC was associated with 0.6580 percent decrease in GDP. This shows that, with respect to GDP growth, proportional credit allocation to agriculture was faulty.

Table 4: Relationship between RACTC and GDP (N = 36)

	RACTC	**GDPNB**
RACTC	1.0000	
GDPNB	(0.6580)*	1.0000
Sig. (2-tailed)	0.0000	

* statistical significance at 0.01 level

Conclusion and Recommendations

The study concluded that agro-credit from the commercial banks was associated with increase in GDP in Nigeria. It was recommended that commercial banks should increase credit allocation to the agricultural sector to sustain growth in GDP. In addition, proportional credit allocation by commercial banks should be reviewed by the Central Bank of Nigeria and other stakeholders to reverse the negative trend in the relationship between RACTC and GDP.

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Effects of Agricultural Commercialization on Poverty Status of Maize Farm Households In Niger State, Nigeria

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Abstract

The study analysed the effects of agricultural commercialization on poverty status of maize farming households in Niger State, Nigeria. A total of 252 respondents were selected through a multi-stage sampling procedure from the three agricultural zones in the state. Data were collected through structured questionnaire administered to the sampled respondents and interview schedule. Analysis of the data collected was done using descriptive statistics, HCI and FGT formulae, Logit and OLS regression models. Results showed that an average respondent was 43 years old, 93.60% of them were males and 92.86% were married. The farming households had an average household size of 7 persons. Also, 54.76% of the respondents lack formal education and 68.20% were full time farmers. The farmers were moderately commercialized with mean HCI of 54.56% recorded. 83.33% of the farmers were classified poor based on World Bank $1.90 per day poverty line threshold while only 45.24% of them were poor based on FGT poverty measures. Agricultural commercialization had a significant relationship with the poverty status of the maize farming households at $p \leq 0.01$ *probability level. The OLS regression estimates revealed that household size* ($p \leq 0.01$)*, age of the farmer* ($p \leq 0.10$)*, farm size* ($p \leq 0.05$)*, crop output* ($p \leq 0.10$) *and the level of household commercialization* ($p \leq 0.01$) *were the significant determinants of household subsistence orientation in Niger State. Lack of insurance and lack of extension service delivery among others were constraints faced by the farmers. The study concluded that agricultural commercialization has a significant potential of alleviating poverty among the maize farming households in Niger State. It was recommended that government through relevant agencies should develop appropriate policies and strategies to promote the commercialization of smallholder agriculture in Niger State and farmers should effectively make worthwhile the efforts of government and other stakeholders to form and maintain effective farmer groups to take advantage of credit facilities other financial services offered by microfinance and other financial institutions available in the area.*

Keywords: Agriculture, Smallholder, Farming households, Commercialization, Poverty

Introduction

Agriculture is critical to achieving global poverty reduction targets and it is still the single most important productive sector in most low income countries, often in terms of its share of Gross Domestic Products (GDP) and almost always in terms of the number of people it employs International Development Association, 2009 (IDA). In countries where the share of agriculture in overall employment is large, broad-based growth in agricultural incomes is essential to stimulate growth in the overall economy, including the non-farm sectors selling to rural people. Hence, the ability of agriculture to generate overall GDP growth and its comparative advantage in reducing poverty will vary from country to country Food and Agriculture Organization (FAO, 2012). The majority of the poor and food insecure in Africa live in rural areas, and most of them depend on agriculture for their livelihoods. To support broad-based poverty reduction and food security in Africa, investment in small scale agriculture must centrally focus (Garvelink *et al.*, 2012).

Poverty alleviation is a process which improves the standard of living of the poor, thus, reducing the proportion of individuals or households who are living below an acceptable minimum standard of living. According to Kraai (2015), poverty alleviation aims at reducing the negative impact of poverty on the lives of poor people in a sustainable way. Poverty in Nigeria is pervasive despite the country being rich in human and material resources that should translate into better living standards. The high poverty rates in Nigeria go beyond low incomes, savings and growth because these are compounded by the high level of inequality resulting from unequal access to income opportunities and basic infrastructure (Sadiq and Kolo, 2014). In Nigeria, poverty is on the increase despite the country's sixth position as the world largest oil exporter (Ahmadu and Alufohai, 2011). The incidence and depth of poverty over the past few decades in the country continue to worsen (Ahmadu and Alufohai, 2011), being worse than the rates in most countries of the world (Kanayo, 2014).

Agricultural commercialization is the process by which farmers produce surpluses which can be sold in the market and thus increase their market participation (Jayne *et al.,* 2011). Salami *et al.* (2010) further added that improved market participation is a strategic precondition for transformation of the agricultural sector from subsistence to commercial production. In line with policy thrusts, the Federal Government of Nigeria in recent times has consistently promoted the increasing commercialization of agricultural production through its different schemes, policies and programmers. For example the focus of the Agricultural Transformation Agenda (ATA) is to formulate policy and regulatory framework that will enhance quality compliance with local, regional and international standards; facilitate measures that will foster private sector investment into the sector and provide means for strong public private partnership (Ajani and Igbokwe, 2014).

The aim of the study is to examine the effects of agricultural commercialization on poverty status of maize farm households in Niger state. The specific objectives of the study are to: (i). describe the socio-economic characteristics of farm households on commercialization in the study area, (ii) determine the level of commercialization and poverty status of maize farm household, (iii) determine the effect of commercialization on poverty status of maize farm households, (iv)analyze the determinants of subsistence orientation among maize farm households, (v) identify the constraints, face by commercialize maize farm households in Niger state.

Methodology

Study Area

The study will be undertaken in selected Local Government Areas (LGAs) of Niger State, Nigeria. Niger State is located between Latitudes $8^0 22^/$N and $11^0 30^/$N and Longitudes $3^0 30^/$E and $7^0 20^/$E. The State is bordered by Zamfara and Kebbi States in the North and North-west respectively, Currently, the State covers a total land area of 74.244 sq.km, which is about 8% of Nigeria's total land area. This makes the State the largest in the Country (www.nigerstate.gov.ng). The population of the State was 3,950,249, comprising 2,082,725 males and 1,867,524 females (National Population Commission (NPC), 2006). The projected population of the State as at 2016 was 5,556,200 (United Nations Population Fund (UNFPA), 2016). The State is divided into three agricultural Zones (that's Zone I, Zone II and Zone III respectively). Zone II is made up of Suleja, Tafa, Paikoro, Chanchaga, Bosso, Gurara, Shiroro, Rafi and Minna.

Method of Data Collection

Primary data was used for the study. The data was collected using a well-structured questionnaire administered to the respondents by the researcher and a team of trained Extension Agents. Information on the socio-economic characteristics of the farmers such as age, gender, marital status, farm size, level of education, years of farming experience, access to extension services, crop enterprises undertaken access to credit, agricultural input usage costs, output levels, expenditures, poverty status, prices as well as constraints faced in commercialization by farmers in the study area were the data required for the study.

Analytical Techniques

Combinations of analytical techniques were used to collect data in the study area. These include descriptive statistics, Household Commercialization Index (HCI), Foster Greer and Thorbecke (FGT) index, Logit regression and multiple regressions was employed to analyze the data elicited from the field. Specifically, Objectives (i) and (v) was achieved using descriptive statistics such as frequency distributions and means. HCI and FGT index was used to achieve objective (ii), Logit regression was also used to achieve objective (iii) and multiple regression analysis was used to achieve objective (iv).

Specification of Models

Household Commercialization Index (HCI)

The Household Commercialization Index (HCI), will be use in assessing the current level of commercialization among maize farm households in the study area. The HCI formula was used by Edward *et al.* (2012) and is adopted which is expressed as: $= \left\{\frac{\text{Gross value of crop sales}_{\text{hhiyearj}}}{\text{Gross value of all crop produced}_{\text{hhiyearj}}}\right\} * 100$ (1) Where,

HCI_i refers to the extent of i^{th} household's commercialization. That is, it measures the degree to which a household sold its output to the market. The index measures the ratio of the gross value of crop sales by household *i* in year *j* to the gross value of all crops produced by the same household *i* in the same year *j* expressed as a percentage. The index measures the extent to which household crop production is oriented toward the market. A value of zero would signify a totally subsistence oriented household and the closer the index is to 100, the higher the degree of commercialization. The advantage of this approach is that commercialization is treated as a continuum thereby avoiding crude distinction between "commercialized" and "non-commercialized" households. The effectively bring subsistence food production to the centre of discussions about commercialization.

Results and Discussions

Socioeconomic characteristic of farmers in the study area

The socioeconomic characteristics of the respondents under consideration include age, marital status, sex of household head, household size, years of farming experience, level of education among others.

As showed in Table 1, 50.0% of the respondents were between the age of 41-50 years while 33.7% were within the age of 31-40 years. The mean age of respondents was 43.2 years, implying that respondents in the study area were still in their active and productive age, young, agile with lots of innovative ideas in commercialization of agricultural produce. However, this could go a long way in reducing poverty among the households. This finding agreed with Adepoju (2018), who reported that majority of farmers in Oyo State, Nigeria were young and in their productive age.

Majority (92.9%) of respondents were married while 3.6%, 3.2% and 0.4% were widow/widower, single and divorced respectively. This finding implies majority of respondents were married. However, married respondents are expected to benefit from unpaid family labour that will enhance production and marketing of farm produce. On the other hand married could be disadvantageous when it comes with lots of responsibilities among households in the study area. This finding agreed with Adepoju (2018), who reported that married household were more into commercialization that single households in Oyo State, Nigeria. It's revealed that 93.6% of the household were headed by men while 6.4% were headed by female. This implies that majority of the household were headed by males. This might be attributed to belief in the rural area that always recognizes men as the household head and major decision making in Nigeria. It also indicated that 50% of the respondents had household size of between 6 – 10persons while 34.1% had household size of between 1-5 persons. The mean household size of the respondents in the study area was 7.0 persons. This implies that respondents were of moderate household size. However, moderate household size is expected to make provision for unpaid family labour that will enhance agricultural commercialization and also reduce poverty in the study area. This study agreed with Mohammed *et al*. (2018), who reported that the majority of household in Niger State, Nigeria had moderate household size. Majority (54.8%) of respondents had non-formal education while 25.8% had tertiary education. Also, 12.3%, 4.8%, 1.6% and 0.8% had secondary, Qur'anic, junior and primary education respectively. This finding showed that most of respondents did not have formal education. However, this is strong indication of low literacy level among farming households and this could negatively affect agricultural commercialization and poverty status of farmers especially those with few years of experience in farming. This finding is in line with Barnabas *et al.* (2019), who reported low literacy level among farming households in Kogi State, Nigeria. It also showed that (51.9%) of the respondents had farming experience of between 11-20 years while 21% had farming experience of 21-30 years. The mean farming experience of the respondents was 21.1 years. This implies respondents in the study area had been in farming business for long period of time. However, large experience could serve as practical expertise gathered over a long period of time which could serve as catalyst to improve commercialization and poverty reduction. This finding did not contradict Adepoju (2018), who indicated that commercialization in agriculture increase with increase in farming experience. It revealed that 68.2% were full time farmers while 31.8% were part-time farmers. This implies that most of the respondents were into full time farming. This finding was similar with that of Olaoye *et al.* (2016) who reported that majority of fisher forks in Nigeria were full time farmers.

Distribution of respondents according to socio-economic characteristics

Variables	**Frequency** (n = 252)	**Percentage**	**Mean**
Age			43.20
21-30	15	5.95	
31-40	85	33.73	
41-50	126	50.00	
51-60	22	8.73	
>60	4	1.59	

Marital status			
Married	234	92.86	
Single	8	3.17	
Widow/widower	9	3.57	
Divorced	1	0.40	
Household head			
Male	236	93.60	
Female	16	6.40	
Household size			7.00
1-5	86	34.13	
6-10	126	50.00	
11-15	35	13.89	
>15	5	1.98	

Level of commercialization among the maize farming households

The result of the analysis of the level of commercialization among the farming households are presented in Tables 2 and 3 The levels of commercialization were categorized into low, moderate and high following Alhassan (2017) based on the computed household commercialization index (HCI). Farmers with HCI range of 0.00 to 33.33 were categorized to have low level of commercialization; those with HCI of 33.34 to 66.67 were categorized as moderately commercialized while those with HCI of 66.68 and above were regarded as highly commercialized. The result revealed that most of the farmers representing 58.73% were moderately commercialized while 21.83% and 19.44% had low and high commercialization levels respectively. This implies that the farmers have multiple farming objectives such as achieving household food security and profit maximization in the area. The result of the summary statistics presented in Table 4.4 further revealed that the mean household commercialization index of the farmers recorded in the area was 54.56%. This implies that on the average, the maize farmers in the area sold a total of 54.56%of their farm produce. Thus, the farmers could be considered to be moderately commercialized in the area. This is finding similar o the findings of Alhassan (2017) who reported a mean HCI of 67.25% for rice farmers in Niger State. This is also consistent with Ele *et al.* (2013) and Osmani and Hossain (2015) who reported that the degree of commercialization in Nigeria is moderately high (about 60.40%).The result further showed that the household commercialization index ranges from 14.49% to 89.92% in the study area. This indicates that the most commercialized farmers sold about 89.92% of their total produce and the least commercialized household sold only about 14.49% of their total produce.

Level of household commercialization

Household commercialization level	Frequency	Percentage
Low (0.00 – 33.33)	55	21.83
Moderate (33.34 – 66.67)	148	58.73
High (66.68 – 100.00)	49	19.44
Total	252	100.00

Poverty status of maize farming household

The poverty status of the maize farming households was analyzed using both the World Bank $1.90 per day poverty line threshold and the FGT poverty measure. The results of the analyses were presented in Tables 4 and 4.1.The result of the analysis using the World Bank poverty measure approach revealed that only 16.67% of the farmers were non-poor while an overwhelming 83.33% of them fall under the poor category. Among the poor farmers, 33.33% were mildly poor, 48.02% were moderately poor while only 1.98% were extremely poor. More so, based on the FGT poverty measures, farm households were categorized into poor and non-poor. The result showed that only 45.24% of the farmers were poor while 54.76% of them were non-poor. It is noteworthy that both the World Bank and FGT poverty measures revealed that poverty is still a major issue of concern in the area.

Poverty status of maize farming households

Poverty status	International poverty measure		FGT measure	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Non-poor	42	16.67	138	54.76
Mildly poor	84	33.33	114	45.24
Moderately poor	121	48.02	-	-

Extremely poor	5	1.98	-	-
Total	252	100	252	100

Conclusion and Recommendations

From the findings of this study, it was concluded that agricultural commercialization has a significant potential of alleviating poverty among the maize farming households in Niger State. The maize farming households were moderately commercialized with an average HCI of 54.56 and poverty remains a major issue of concern among the farmers in Niger State. More so, other significant factors that influence the poverty status of farming households in Niger State were marital status, household size, education, off-farm income, credit amount obtained, access to extension services and sex of the household head. Household size, age of the farmer, farm size, crop output and level of household commercialization were the significant determinants of household subsistence orientation in Niger State.

Based on the empirical evidence emanating from the findings of this study, the following recommendations were made;

1. Government must develop appropriate policies and strategies to promote the commercialization of smallholder agriculture. Particular attention should be focused on campaigns, sensitization and training of farmers to view farming as a business as well as equipping farmers with marketing and negotiation skills.
2. Policy thrust should aim at strengthening of extension services delivery system, reducing the wide gap of extension agent to farmer ratio, introducing market linkage related packages and periodic training and upgrading of the skills of extension agents on most effective way of technology package and delivery. Extension agents must also be well motivated by the government through the relevant agencies to regularly visit and monitor the progress of smallholder farm households.

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Local rice production trends and consumption factors in Benue State, Nigeria (1980-2016)

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Abstract

The research examined local rice production trends and factors inhibiting the consumption of local rice from 1980 to 2016 in Benue State. Primary data and secondary data were used. Multi – stage random sampling method was employed in selecting respondents. Primary data were collected from one hundred and fifty-six (156) respondents. Descriptive statistics, Z – test, Growth model and kendall`s coefficient of concordance were used for the analysis. The results revealed that from 1980 to 2016total of 9.5 million MT of local rice was produced in Benue State. The result also shows that the respondents were all married (99%) having household size of 1 - 10 persons (95%) with mean household size of 8 persons. The result further indicated that majority of respondents' attained tertiary school level. The result also shows that the respondents were having low income (40.3%). The mean quantity of local rice production in Benue State was 257,333.06M T per year. The instantaneous growth trends of local rice production and price were 0.00122 and 0.01103. Compound growth rate were 3.72 MT and 3.76MT. The result also indicate d that majority of respondents were above the age of 41 years (49%) with the mean age of 47 and all respondents were male. The presence of stones, poor aroma, impure rice and broken grain were some of the factors inhibiting consumption of local rice in Benue State

Key words Consumption, Factors, Growth, Local rice, Production, Trends.

Introduction

Rice is an important food crop and major normal food for up to half of the world's population (Dauda*et al.* 2019). It is also the staple food in most African countries, providing dietary energy to the rapid increasing population (Dauda*et al*. 2019). In Africa, rice provides 715 kcal, 27% of nutritional supply of energy, 20% of nutritional protein and 3% of nutritional fat (Dauda*et al*. 2019). Rice occupied fifth major source of energy in diet for mankind, providing 9% of caloric usage (FAO, 2012).

Rice is a source of raw material for industries and offers job opportunity for the growing Nigerian population of different forms, from the onset of rice cultivation, processing, wholesales and sales to final consumers (Marlia*et al*. 2011). Local rice is all rice, regardless of improved or non- improved varieties that are produced within Nigeria. They are non- refined and non-polished rice that are produced by removing the husk of rice. The rice retains the nutrient in bran during soaking and parboiling (Tonifelix, 2017). The objective of the study was to examine the growth trends and inhibiting factors of local rice and rank them as shown in the Table 5 below.

Materials and Methods

The study area is Benue State, created in 1976 and is located in the middle belt. The State is within latitudes6^0 $25'^N$and 8^0 $8'^N$of the equator and longitudes7^0 $47'^E$and 10^0 $0'^E$of the Greenwich meridian (NPC, 2006). Benue State stretches across the transition belt between the forest and savannah vegetation. Much of the areas consist of undulating hills or grassy open space on the North and dry savannah on the South.

A multi-stage sampling method was used in the selection of respondents. The first stage was selection of two local government Areas purposively due to higher concentration of production of local rice, from each agricultural zone. This makes a total of six (6) local Government areas in all from the three (3) Agricultural zones in Benue State.Enumeration areas were also randomly selected from local Government areas. Sampling frame of households were generated using 2006census Enumeration list The final stage was simple random proportion sampling of 156 household heads from sample frame of 246,172 respondents from 6 local governments in the state using Taro Yamane's formula at 8% precision as detailed in the Table1.

Taro Yamane's formula stated as $n = N/1+N(e)^{2}$. Example

Sampling frame of each EAs was obtained from enumeration list of 2006 National population census through random sampling given a total of 246,172.

Table 1 Sampling distribution of respondents by zones in Benue State

Zones	**LGAs**	**EAs**	**Sampling Frame**	**Sample size**
1	Logo	Ayyin	14,920	9
		Ugba	16,510	10
	Kwande	Adikpo	16,507	10

		Ada	14,491	9
		Ushah	15,009	9
2	Gboko	Gboko	20,254	13
		Vende	21,210	13
		Masajeipav	11,950	8
	Makurdi	Gyado	26,107	17
		Nbalah	27,230	17
3	Agatu	Igba	11,501	7
		Obagaji	10,850	9
	Oturkpo	Adikwe	20,420	13
		Okpomoju	19,143	12
Total			246,172	156

Source; 2006 National population census figure

Data were analysed using both descriptive statistics and non-parametric methods. Growth Modelwas used to analyse the exponential trend or log –linear trend of local rice. It was used to model trend in rice production. The exponential or log – linear trend equation for the output of local rice production and price in Benue State was presented as

$Lnpro = \beta_o + \beta_1^t + e_i$ -- (1)

$Lnprice = \beta_o + \beta_1^t + e_i^t$ -- (2)

Where

Lnpro= Quantity of local riceoutput (measured in metric tons) at period t

Lnprice= value of quantity oflocal rice output (measured in million of naira) at period t

β_o=the constant in the regression line

β_1=the trend coefficient

t = trend measured in years

e_t= error term

The point in time growth rate (instantaneous growth rate) model is given as

Growth rate $=\beta_1{}^t$x 100--- (3)

Where

β_1=relative change in quantity of output

t = trend measured in years

Multiplying the relative change in local rice output by 100 gives the percentage change or growth rate in local rice output for change in time.

After the estimation of equation 3 at certain point in time growth rate of local rice, the compound rate of growth was computed in line with (Onu et al, 2015) as

$r = (e^B - 1)$x 100-- (4)

Where

e= Euler's exponential constant (2.71828)

β_1= estimated co efficient in equations (1) (2) and (3) respectively

(Years) of money (price) measured in naira per metric tons at period t considered

Kendall's Coefficient of Concordance.

Result and Discussion

Socio economic Characteristics of the Local rice Consumers in the Study Area.The result in Table2 shows that most of the respondents fall within the age range of 41 - 50 years (49%). This is an indication that majority of the respondents have large family sizes that led to larger consumption of food especially local Rice.This is because family increases with age as matured ones got married and bear children. This corroborates the work of Iweke and Ederewhenbe (2018) who asserted that as the age of youths increases they get marry and family size increase and this increase consumption of rice. The mean ages of the respondents were 47. Income of the household head has great impact on local rice consumption pattern, as opined by Ehiakpor *et al. (*2017) as their income determine the quantity of local rice that will be purchased. Household size determines the quantity of local Rice to be bought and consumed. The household size was relatively high among the respondents. Majority of the respondents have household size of 1-10 persons. The mean household size was 8 persons. Majority of the respondents were educated in one way or the other. It is assumed that a well-educated respondent can easily get access to information concerning nutritional value of all kinds of local rice available in the market. This agrees with the works of Qisthy*et al.* (2018) who argued that literate consumers used labels on packaged bags to identify the products of their choiceeasily. Income is a vital factor that influences household food consumption. As income of household increases the rice consumption also increases (Salihu*et al.* 2017.The result presented in table 2 shows that 64% of the respondents were low income earners. The implication is that there will be low demand and consumption of local rice. This agrees with the studies of Salihu*et al.* (2017), who argued that income may affect the consumption oflocal rice..

Table 2: Socio – economic characteristics of the respondents

Variables	**Frequency**	**Percentage**
Age		
20 -30	2	1
31 – 40	32	21
41 – 50	78	49
51 – 60	8	5
Total(mean)	156(47)	100
Gender		
Male	156	100
Total	156	100
Household size		
1 – 10	118	75
11 – 20	38	25 .
Total(mean)	156(8)	100
Edu.level		
Primary	29	19

Secondary	53	34
tertiary	73	47
Non formal	-	
Total (mean)	156 (39)	100
Annual income		
201,000 -300,000	12	7.5
301,000 – 400,000	3	1.9
401,000 – 500,000	63	40.3
501,000 – 600.000	11	7.4
601,000 – 700,000	7	4.4
701,000 – 800,000	17	10.8
801,000 - 900,000	22	14.2
901,000 – 1,000,000	21	13.4
Total (mean)	156 (489	100

Source: Field survey2017

The mean scores were ranked as detailed in Table 5 below. The pattern in rice production and price in Benue State covering the period of 1980 – 2016 were observed. It is clearly shown that the total of 9.5 million metric tons of local rice was cultivated in Benue State from 1980 – 2016. The quantity of local rice cultivated in Benue State differs from minimum of 69,528.2 in 1980 to maximum of341, 735metric tons in 1996. The cultivation of rice increased from 69,528.2 metric tons in 1980 to 251,718.4 metric tons in 1982 and declined to 184,277.6 metric tons in 1983. The production picked up in 1984 to 241,737.6MT continuous in 1985 and declined back to 20,1960 metric tons in 1997. The production in 1998 witnessed increase of 253713.6 thousand metric tons and got to the peak of 276,808 in 2002 production period. In 2003 production was less by 808 thousand metric tons but started increasing in 2004 from 272080 metric tons and got the peak of 341286 metric tons in 2011 production period

Table 3 shows the quantity of local rice growth and price in Benue State. There was significant growth of local rice and price from 1980 – 2016. The result depicted that the coefficient of time variable was also positive and significant at 1% in respect of quantity produced and the price of rice within these production seasons.. The Table 3 also shows that the coefficient of determination were (R^2 = 0.4962) for the local rice production and (R^2 = 0.7054) for the price and were all significant at 1% (p< 0.000) during the period.

Rate of Growth of Production and Price in Benue State (1980 – 2016).

Table 3.Estimated exponential trend equation for quantity produced and price in Benue State (1980 - 2016)

Dependent Variable	B_0	B_1	R^2	Adj. R^2	F-ratio
Qty of production	1991.94	0.0000122	0.4962	0.4781	0.000***
Price per tonne	1986.806	0.0001103	0.7054	0.6970	0.000***

*** represent 1% significant level

The computed growth rate of local rice produced and price in Benue State within these periods were presented in Table 4 below. These slope coefficients were multiply by hundred to obtained growth rate. The growth rate of 0.00122% and 0.01103% for local rice production and price revealed that over the period of 1980 – 2016 the production and price of local rice in Benue State increased at apoint in time. The compound growth rate (r) were also estimated from point in time growth rates. In a related development the compound growth rate for 1980 – 2016 were 3.72% and 3.76% respectively.

Table 4 Point in time growth rate and Compound growth rate for quantity of local rice production and price in Benue State (1980 – 2016)

Variable	Parameter B_1	Point growth rate	Compound growth rate
Qty of local rice produced	0.0000122	0.00122	3.72
Price of local rice produced	0.00011	0.01103	3.76

Source: Computed by Researcher 2017

The Table 6 below indicates that 62% of the respondents agreed that local Rice inhibiting factors were presence of stone, poor aroma, poor taste, broken rice grain, Rice with debris, low swelling ability and presence of foreign materials. The result in Table 5 revealed that presence of stone in local Rice has mean score of I.38 and was ranked 1st.. Ranked next is poor aroma and impure with mean scores of 3.30 and 3.73 respectively. This corroborates the work of Diako*et al*. (2010) confirmed that local rice without aroma have low demand. In Table 5 broken local rice grain and poor taste were ranked 4th and5$^{th.}$ This work disagreed with the findings of Diagne*et al*. (2017) who confirmed that about 77% of the respondents prefer broken Rice grain to whole – grain. The presence of foreign materials and low swelling ability were ranked 6th and 7$^{th.}$ This corroborate the findings of Abubakar*et al*. (2015), who confirmed that rice with low swelling ability always have low patronage. The study also reveals that rice with debris have the mean rank score of 6.37. This has positive and significant impacts on buying local rice. Better taste and good clean appearance were the two main features of high quality local Rice.

The Kendall's coefficient of concordance gave 62% of the sampled consumers were in total agreement with each other those there were different inhibiting characteristics of local Riceand these characteristics have significant effect on consumption.

Table :5 Inhibiting factors of local Rice in Benue State with mean and rank Scores

Inhibiting factor	Mean scores	Rank scores
Presence of stone	1.38	1st
Poor aroma	3.30	2nd
Impure local Rice	3.73	3th
Broken grain	4.00	4th
Poor taste	5.13	5th
Foreign materials	5.84	6rd
Low swelling ability	6.23	7th
Local Rice with debris	6.37	8th

Source: Field survey, 2017

Table 6: Factors Inhibiting Consumption of Local Rice Hypothesis Testing

Test Statistics	Estimated value
N	281
Kendall's W	0.62
Z- calculated	41.3

Z critical	0.000

Source: Field survey, 2017

Conclusions and Recommendations

The study which cover the period of 37 years has shown that local rice consumes was middle aged (40 – 51). The household heads were all male with high household size and mean of 8 persons. Majority of the respondents were educated (81%) and low income earners. The growth rate of production and price were low. The study also concluded that poor qualities associated with local rice were inhibiting factor that limited the consumption. The study recommended that quality of local rice should be enhanced to motivate consumption. The breeders and scientist should breeds local rice with aroma and grain tolerant to breakage during milling consumers.

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Costs and Benefits Analysis of Maize Production in Giwa Local Government Area of Kaduna-State, Nigeria

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Abstract

The study analyzed the costs and benefits as well as the socio-economic characteristics of maize farmers in Giwa Local Government Area of Kaduna State. A sample of 84 farmers were purposively selected from Giwa, Shika, and Yakawada districts that were randomly selected. Primary data were collected using structured questionnaire and analyzed using descriptive statistics and gross margin analysis. Results of the analysis depicted that majority (39.3%) are between 31-40 years, 94% were males and about 92% were married. Majority (47.6%) of maize farmers had farm sizes of less than 1.5 hectares and majority (82%) reported to not having contact with extension agents at all. The result further showed that the farmers on average spent about N142,300.40 per hectare and realized an average output of about 31 bags (of 100kg bag) per hectare. The farmers made a gross profit of about N234,870.40 per hectare. Thus it can be concluded that maize farming in the study area is profitable and recommended that government should provide a means of selling inputs to grass root farmers and also ensure more extension agents are posted to rural areas.

Introduction

Maize is one of the staple crops in Nigeria and featured among the major food grains produced in Nigeria. It is the second most cultivated crop in Nigeria in terms of area harvested (5.8million Ha, FAOSTAT, 2014). Nigeria is the second largest maize producer in Africa, after South Africa, with an estimated 10.79 million MT produced in 2014 (FAOSTAT, 2014). According to NAERLS 2019 National report, Nigeria produces about 12.59 million tons in the year 2019 which when compared to the year 2018, decreases by about 1.26 % (NAERLS, FDAE, and P&PCD, 2019). Its production in the country is ranked first among the cereal's crops (NAERLS, FDAE, and P&PCD, 2019). In Nigeria, the largest volumes of maize are produced in the Northern region, particularly in Kaduna, Borno, Niger, and Taraba and in the South -Western states (Sahel Reports, 2017). The country has comparative advantage in the production and export of maize in Africa over its counterparts for it has large cultivable land area for production and conducive climatic condition.

However, one of the most pronounced problems constraining the production of maize in Nigeria by its farming community (majority of whom are small-scale producers) is stagnant production technology and high cost of inputs as well as poor price at harvest. This paper attempted to find out the costs and returns of maize production. It also analyzes the socio-economic characteristics of maize producers in the study area. Specifically, it aimed at; describing the socio-economic characteristics of maize farmers in Giwa LGA Kaduna State and Determining the costs and returns in maize production in the study area.

This was motivated by the importance of maize production in the Nigeria economy. Maize production not serves only as an important staple food to majority of the Nigerians but also a source of revenue to both farm households and nation at large.

Methodology

Study Area

The study was conducted in Giwa Local Government Area of Kaduna State, Nigeria. Giwa Local Government Area of Kaduna State is located in the plain of the northern part of Kaduna State. It lies between latitude 12.20^{o}N to 12.52^{o}N and longitude 7.0^{o}E to 7.5^{o}E. The LGA had an estimated population of 286,427 people in 2006 (NPC, 2006). The mean annual rainfall varies from 635 mm to 1,524 mm. The lowest mean temperature is usually recorded during the harmmattan period. This occurs between November and February with the range from 18^{o}C - 23^{o}C.The major source of livelihood in this area is agriculture and the bulk of agricultural production is undertaken by small farmers. Major crops grown in the area includes; maize, cowpea, tomatoes, pepper, onions, sugarcane.

Sampling procedure, data collection and analysis

A multi stage sampling technique was employed. The first stage involved the random selection of three districts out of the eleven districts in the area. The selected districts are Giwa, Shika, and Yakawada districts. In the second stage, a total of 84 maize farmers were purposively selected from Giwa, Yakawada and Shika this is due to the unavailability of reliable sampling frame of maize farmers in the study area.

Data Collection

Primary data were collected based on 2019 cropping season using detailed structured questionnaires. Data on socio-economic characteristics of respondents, farm production information as well as prices of input and output were collected. Descriptive statistics and Farm budgeting analysis were employed in analyzing the data.

Results and Discussion

Socio-Economic Characteristics of the Maize producers.

Age distribution of respondents

Age is expected to have influence on the respondent's participation on production system, that is, younger farmers are more active in the maize production. Figure 1 shows the age distribution of the farmers. It shows that, majority (39.3%) are between 31-40 years. This implies that, the farmers are strong and active and can participate adequately in production.

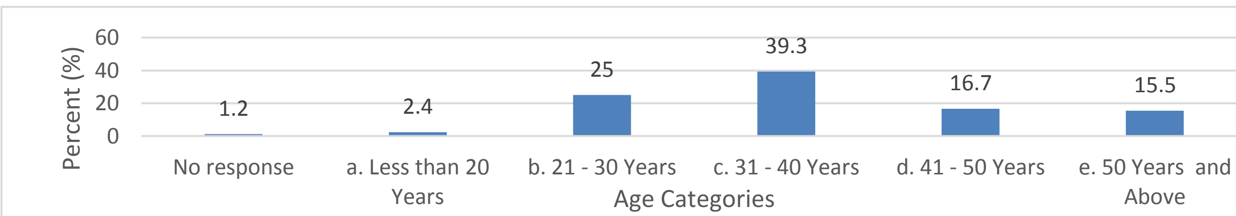

Figure 1: Age distribution of respondents

Sex of respondents

The gender distribution of maize farmers is shown in figure 2. It showed that 94% of the respondents were male while only 6% were female. This means that, females are not much involved in maize production. The dominance by males could be due to the fact that women are mostly involved in proceesing activities only.

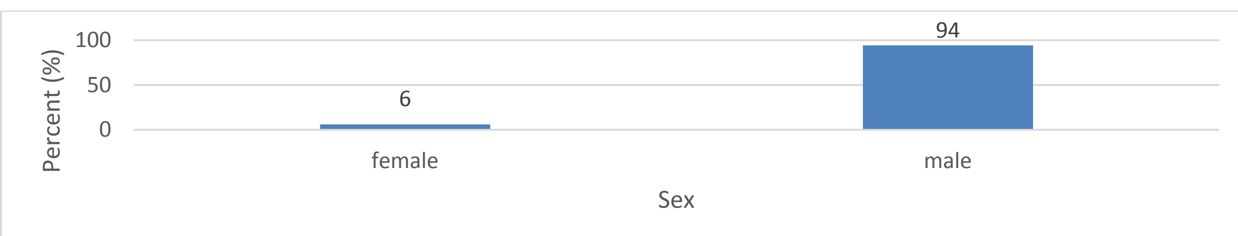

Figure 2: Sex Distribution of Respondents

Marital Status of the respondents

Figure 3 below indicated that 91.7% of the respondents were married and 8.3% were single. This implies that, there is the possibility that there could be easy and cheap source of labour for farming activities.

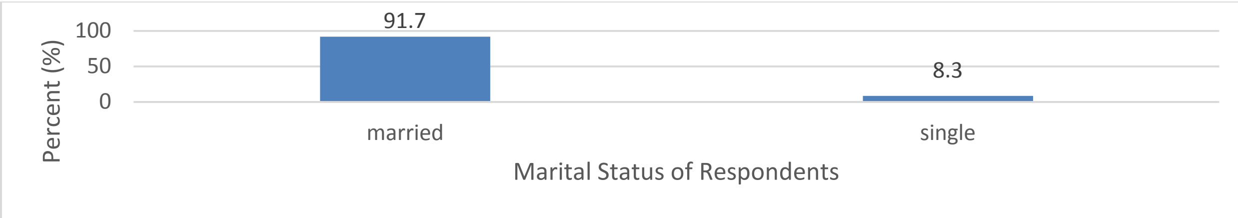

Figure 3: Distribution of respondents by Marital status

Household size distribution of respondents

The percentage distribution of the household size of the respondents is shown in figure 4 below, 46.4% were between 1-8, 35.7% were between 9-16, 13.1% were between 17-27, and 3.6% were between 28-36, 1.2% were above36. It shows that majority of the farmers have their household size within 1-8, which also determines their production status.

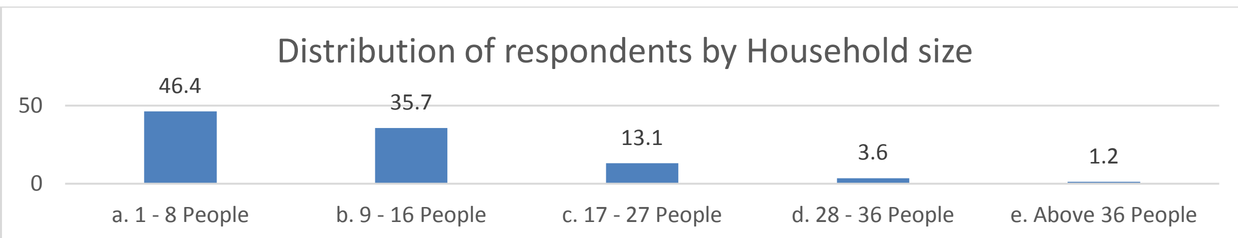

Figure 4: Distribution of respondents by Household size.

Farm size distribution of respondents

The distribution of the respondents' farm size is shown in figure 5 below. The results showed that majority (47.6%) of maize farmers had farm sizes of less than 1.5 hectares with the least (1.2%) having a farm size of 6.0 or more hectares. This implies that maize farmers in the study area were made up of small, medium, large scale farmers.

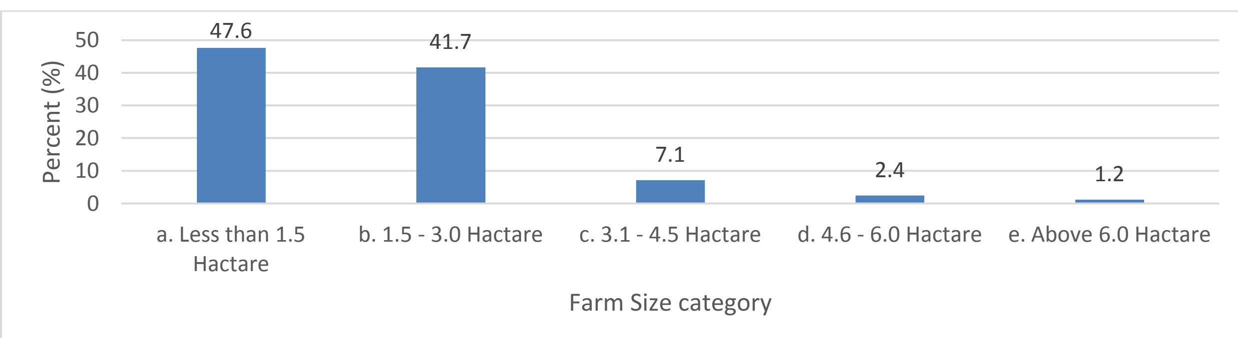

Figure 4: Distribution of respondents by Farm size

Access to credit by the respondents

Figure 5 below showed that majority (74.4%) of the respondent have little or no access to credit. This means that majority used either informal means of lending to finance their production or uses their personal savings otherwise their production may suffer from insufficient capital.

Results in Table 1 below showed distribution of the amount of credit accessed by the respondents. The results showed that even among those that received formal credit, majority (84.52 %) received a loan of less than N200,000; 14.29 % received between N200,000 to N400,000. However, only 1.19% received above N400, 000 as formal credit. This implies that farmers may likely not expand their production due to limited capital.

Table 1: Amount of credit accessed by respondents

Loan Category	Frequency	Percent
Less than N200,000	71	84.52
N200,000 - 400,000	12	14.29
Above N400,000	1	1.19
Total	84	100.0

Source: Field work, 2019

Frequency of Extension Visit

Results in Table 2 showed the frequency of extension visit to farmers in the study area. The majority (82.1%) of the respondents had no contact with extension agents at all. Only 8.3 percent of the respondents reported having contact with extension agents once in 3 months and another 8.3% said had contact with extension agent once a month. One could say that the extension services is not enough in the study area and this could translate to poor yield.

Table 2: Frequency of Extension Contact

Extension Contact	Frequency	Percent
No contact	69	82.1
Once in 3 month	7	8.3
Once in a month	7	8.3
once per 2weeks	1	1.2
Total	84	100.0

Source: Field work, 2019

Cost and Return Analysis of maize Production in Giwa LGA

Cost and return analysis of maize production in Giwa LGA is presented in the table 3 below. The result showed that the farmers on average spent about N142, 300.40 per hectare on all variable inputs used. The average output gotten by the farmers was found to be 3069.5kg equivalent to about 31 bags (of 100kg bag) per hectare. The farmers equally sales on average a kg of maize at N74.4 per kg thus making them to realize about N377, 170.80 per hectare. Therefore, deducting the expenses from the revenue farmer are expected to make a gross profit of about N234, 870.40 per hectare. The return per naira turns out to be about 1.65 thus implying that on every naira spend in the production of maize, farmers realized 1.65 in return for the naira expended. This means that maize production in the study area is profitable. As such, farmers should keep to maize production in the area.

Table3: Cost and Return for maize production in Giwa LGA

Labor for Different Maize Operation	Qty	Price/Unit	Amount
Average farmers farm size	1.9		
Land clearing Labor	7.1	924.7	6594.0
Labor for Planting	7.2	1009.2	7281.0
Labor for Weeding	6.3	2148.7	13557.0
Fertilizer application labor	6.4	631.3	4065.8
Harvesting Labor	7.6	1438.9	10929.1
Labor for Transportation	4.4	1432.8	6362.5
Threshing Labor	6.1	1353.1	8231.3
Bagging Labor	4.6	1943.0	8858.8
Sub-Total / Average	49.7	1,360.21	65,879.5
Output	3069.53	74.4	377,170.80
Material Input			
Seed kg	38.4	353.3	13,576.4
Fertilizer	421.4	143.5	60,470.9
Agro-Chemical (Liter)	2.1	1151.8	

2,373.6			
Maize Man days	49.8	1360.2	65,879.5
Total Input expenses			142,300.4
Gross Revenue			377,170.80
Gross Profit			234,870.4
Return of rate			1.65

Source: Field work, 2019

Summary, Conclusion and Recommendations

This paper attempted to find out the costs and returns of maize production and also analyzes the socio-economic characteristics of maize producers in the study area. Multistage sampling technique was employed in the selection of respondents for this study. Primary data were collected from 84 respondents using structured questionnaire. Data were analyzed using descriptive statistics and gross margin analysis. Results of the analysis depicted that majority (39.3%) are between 31-40 years, 94% were males and about 92% were married. Majority (47.6%) of maize farmers had farm sizes of less than 1.5 hectares and majority (82%) reported not having contact with extension agents at all. The result further showed that the farmers on average spent about N142, 300.40 per hectare and realized an average output of about 31 bags (of 100kg bag) per hectare. The farmers made a gross profit of about N234, 870.40 per hectare. Thus, it can be concluded that maize farming in the study area is profitable and recommended that government should provide a means of controlling the inputs prices and also ensure more extension agents are posted to rural areas.

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Economic Profitability of Rice Production Systems in Kebbi State, Nigeria

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Abstract

The study was carried out in Kebbi State, Nigeria. Using the Ex-ante Carbon-balance Tool, the carbon footprint of the rice production systems was estimated and used in estimating the economic budget of the rice production systems. The result of the study revealed that economic profits for upland and lowland production systems were positive indicating that the systems are economically efficient. The irrigation system was found to be economically inefficient. That is, the sector is exploiting resources which could have been utilized more efficiently in some other sectors of the economy. The study recommends the use of improved technology such as improved rice seeds and production practices for the system to be economically efficient. It is also recommended that farmers, especially those producing under the irrigation systems should be targeted in the campaigns for climate smart agriculture and the use of improved practices that would reduce the effect of conventional agriculture practices on the environment

Introduction

Climate change has the potential of being a major impediment to economic development, environmental sustainability, and overall human well-being due to its lasting impact on economic activity of a country and the ecosystem (Stern, 2007). This is the reason why in 2015 one hundred and ninety-five countries, including Nigeria, came together and agreed to make strides to limit the effects of global warming by reducing carbon emissions to 26-28 percent below 2005 levels by 2025. Agriculture and land use change sector has been identified as one of the main contributors to anthropogenic GHG emissions. Rice production systems in particular have been shown to contribute to global climate change by emitting carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) gases to the atmosphere and in turn, are also affected by the changed climatic variables (Ali et. al., 2019). Kebbi State is one of fifteen targeted by the Rice Transformation Agenda of the Federal Government in which rainfed and irrigated lowland rice production systems were the main priority.

The Government desires to encourage rice intensification and increase supply response through the expansion of irrigation systems. Considering the implication of such investments to carbon balance, there is need to carefully design such systems so that the negative environmental externalities are minimized.

The basic framework underlying the estimation of a project's development impact rests on three principles one of which is that a project is expected to contribute to development if expected benefits justify the expected cost (World Bank, 2013). These include both tangible and intangible benefits that can be realistically stated in monetary terms or otherwise. Therefore, for a rice production system to be considered efficient, it must be able to give optimum yield with low environmental impacts, such as low greenhouse gas (GHG) emissions and its associated Global Warming Potential (GWP) (Boateng et. al., 2017). This study, therefore, sets to specifically determine the economic profitability of rice production systems considering their environmental impact.

Methodology

Study area

The study was carried out in Kebbi State, Nigeria. Kebbi State's topography which consists of high plains in the south and south east, plain landscape in the north and the riverine lowland of the Niger and lower Rima valleys provides suitable ecologies for the dominant rice production systems found in the country. These are the Lowland and Upland rainfed systems and the Irrigation system. A multistage sampling technique was adopted in the selection of respondents for the study. Primary data was obtained for the 2018 cropping season using a combination of structured questionnaire and interview schedule.

Profitability Analysis

Gross margin (GM) and Net Farm Income (NFI)

Gross Margin (GM) is used as a planning tool where fixed capital forms a negligible portion of the farming enterprise as is the case in subsistence agriculture. Net farm income (NFI) on the other hand is the difference between gross income and total costs of production. It measures returns to naira invested in an enterprise. The GM and the NFI are expressed as:

$$GM = TR - TVC = \sum_{j=1}^{m} P_j Q_j - \sum_{k=1}^{m} P_k Q_k$$

$$NFI = \sum_{j=1}^{m} P_j Q_j - \sum_{k=1}^{m} P_k Q_k - \sum_{1=1}^{1} FL$$

Where: TR = total revenue (gross value of output), TVC = total variable cost, P_j = price of a unit of jth output; Qj = quantity of jth output; P_k = price of a unit of kth input; Q_k = quantity of kth input; FL = cost of fixed inputs.

Economic profitability of rice production systems

Carbon balance of rice production systems

The carbon balance for each of the rice production systems was estimated using the Ex-Ante Carbon-balance Tool (EX-ACT). The result as shown in table 2 indicates that the least net emission of 0.04 tCO_2eq is observed by the lowland rice system. This is followed by the upland rainfed rice system with a net GHG emission of 0.05 tCO_2eq. The irrigation system has the highest net emission of 2.42 tCO_2eq.

Table 1: Carbon Balance of rice production systems expressed in tCO_2eq

Production Systems	Total Emission	Total emission/ha	Total emission per ha per year
Upland Rainfed	37,465.96	0.97	0.05
Lowland Rainfed	29,738.30	0.89	0.04
Irrigation	1,980,927.24	48.47	2.42

Source: Ex-Ante Carbon-balance Tool

The positive values of the net GHG emission indicate that all production systems add more CO_2 equivalent into the atmosphere than it is sequestered. Consequently, all production systems come at a cost to the society. The high value of net GHG emission from the irrigation system may be due to farmers employing higher amounts of farm inputs such as fertilizer than the other rice production systems. As recommended by FAO (2017), the low and high values of the shadow price of carbon was used to get varying estimates of the profitability of the production systems. This is consistent with the presence of uncertainty in agricultural production. Table 2 is the estimates for the shadow price of carbon balance for rice production systems expressed in Naira.

Table 2: Shadow price of Carbon balance for rice production systems

	tCO2eq emitted per ha per year	Low Estimate (₦)	High Estimate (₦)
Upland rain fed	0.05	549.61	1,114.07
Lowland rain fed	0.04	504.58	1,022.80

Irrigation	2.42	27,349.96	55,439.11

Note: The low and high shadow price of carbon recommended for the year 2017 is 37 and 75US$/ t CO2e.

Table 3 is the economic budget of rice production systems in the study area. Two values of net farm income were estimated for each of the production system. One indicated the low value of the shadow price of carbon, while the other was estimated using the high values of shadow price of carbon as recommended by FAO (2019).

Results and Discussion

The result of the economic profitability of the production systems shows that upland and lowland rain fed systems recorded positive values for the net farm income while the irrigation and system had negative values. The net benefit for the upland rainfed system were ₦30,325 (using low carbon estimate) and ₦29,761 (using high carbon estimate). For the lowland rainfed, the net benefit was ₦32,721 (using low carbon estimate) and ₦32,203 (using high carbon estimate). In case of the irrigation system, a net benefit ₦-58,388 was recorded using low carbon estimate while ₦-86,477 was recorded using high carbon estimate. The result of both analyses indicates that the economic efficiency of the irrigation system is the most affected by the economic value of GHG emitted into the atmosphere. This could be attributed to the use of water pumps, and higher levels of fertilizer.

Conclusion and Recommendation

Economic profits for upland and lowland production systems were positive indicating that the systems are economically efficient. That is the country uses scarce resources efficiently. The irrigation system was found to be economically inefficient. In other words, the sector is exploiting resources which could have been utilized more efficiently in some other sectors of the economy. This implies under the irrigation system would need government support through distorting policies to survive. Yield and production costs have a direct effect on the profitability of a production system. It is imperative that yield must increase significantly to offset any increase in production costs as is the case with irrigation systems. Therefore, attention should be paid to improved technology such as improved rice seeds and production practices for the system to be economically efficient.

Table 4.12a: Economic budget of rice production systems

Item	Unit price	Upland rain fed		Lowland rain fed		Irrigation	
		Number	Economic value	Number	Economic value	Number	Economic value
TOTAL OUTPUT (₦/75kg bag)	**6,191**	**61**	**377,677**	**55**	**340,529**	67	414,826
FIXED INPUTS USED/ HECTARE							
Rental Value of Land			15,361		15,318		10,166
Borehole	3,525					3	8,813
Submersible Water pump	4,849					1	4,849
Handheld hoes	183	2	367	2	367	2	367
Sickle	67	2	133	2	133	2	133
Cutlass	250	2	500	2	500	2	500
Axe	367	1	367	1	367	1	367
Knap sack sprayer	999	1	999	1	999	1	999
Total Fixed Cost			17,727		17,684		26,193
VARIABLE INPUTS							
Agro-chemicals							
Insecticides/litre	1,715	2	3,945	2	3,877	4	7,479
Herbicides/litre	1,319	5	6,263	4	5,762	8	9,889
total		7	10,208	7	9,639	12	17,368
Inorganic fertilizer							
NPK (50kg)	6,019	8	46,045	7	39,424	11	66,208

Urea(50kg)	4,338	5	21,863	4	17,829	6	26,027
total		13	67,907	11	57,252	17	92,235
seed (Kg)							
Local seed	150	36	5,409	49	7,422	46	6,957
Improved seed	660	27	17,978	11	7,372	32	20,896
total seed		63	23,387	61	14,794	78	27,853
Bagging	113	61	6,863	55	6,188	67	7,538
Transportation cost	176		10,736		9,680		11,792
Fuel/liter	773					52	40,213
Labour cost							
family labour		31	63,196	39	76,435	49	90,925
Hired labour		72	146,778	59	115,632	71	131,748
Total Labour		103	209,974	98	192,067	120	222,673
Shadow price of carbon							
Low estimate (tCO_2eq			550		505		27,350
High estimate			1,114		1,023		55,439
Total Variable Cost (low)			329,625		290,124		447,021
Total Variable Cost (high)			330,190		290,642		475,110
Net benefit (low CO_2 estimate)			30,325		32,721		-58,388
Net benefit (high CO_2 estimate)			29,761		32,203		-86,477
Average net benefit			30,043		32,462		-72,433

Source: Field survey, 2018

Farmers, especially those producing under the irrigation systems should be targeted in the campaigns for climate smart agriculture and the use of improved practices that would reduce the effect of conventional agriculture practices on the environment such as adhering to the recommended doses of agro-chemicals, site-specific soil-crop fertilizer use and solar powered irrigation technologies.

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SUB-THEME B

AGROFORESTRY AND WILDLIFE

The Impact of Human Activities on biodiversity Conservation in a Tropical Ecosystems in Nigeria.

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Abstract

Nigeria is widely regarded as an African power source due to it being the most populous and arguably the largest economy on the continent. There have been many studies to document these biological resources in terms of quantity and location across the country. Biodiversity is the wealth of life forms found on earth-animals, plants, and microorganisms in their millions and their differences; the gene they contain and the intricate systems they form. However, Biodiversity is under serious threat today. It is being destroyed at an alarming rate. The principal causes of this threats are the degradation and destruction of habitats by human activities. The biodiversity of Nigerian tropical ecosystems is increasingly being destroyed or depleted. **T**his paper highlights the causes of destruction such as illegal and bad mining practices, bush burning, unsustainable agricultural practices, over grazing, illegal logging, deforestation as well as high population growth rate, Poverty, poor planning land use and control and management of human activities to minimize damage on biodiversity conservation.

Key Words: Biodiversity; Tropical Ecosystem; Anthropogeny Degradation.

Introduction

Biodiversity loss is among the most serious environmental problems facing the world today. Natural habitats in the moist tropical regions, which harbour the majority of the world's flora and fauna, are being lost at an alarming rate. It is estimated that in tropical rain forests alone the rate of loss of entire species (not merely genetic varieties or subspecies) is in the icrease. (Izah et al, 2015). This rate of decline is believed to be at least 1,000 times the 'ordinary' rate of extinction (Wilson, 1992). There are many who believe that we are facing a biodiversity crisis and others have gone as far as to suggest that we are slipping into a rate of extinction that may well rival that which resulted in the demise of the dinosaurs some 65 million years ago. Biodiversity is the wealth of life forms found on earth-animals, plants, and microorganisms in their millions and their differences, the gene they contain and the intricate systems they form. There are fundamentally two reasons for conserving biodiversity. The first is the moral justification and the second is the value to human existence. Biodiversity is essential to human development because of the goods and services it provides. An estimated 40 percent of the global economy is based on biological products and processes (Christ *et al*., 2003). However, on a global scale, biodiversity is being lost at a rate many times higher than that of natural extinction. This is caused by a number of factors, including uncontrolled land conversion, climate change, pollution, unsustainable harvesting of natural resources and introduction of invasive species (Christ *et al*., 2003). Nigeria is blessed with rich and unique array of ecosystems and a great variation in natural resources. These have evolved a diversity of fauna and flora supporting more than 1,340 species of animals, among which are 274 mammals, 860 birds and about 4,600 species of plant (FORMECU, 1996). This ranks Nigeria as one of the richest countries of Africa in terms of biodiversity (FMoE, 2001).

Status of Biodiversity in Nigeria

Nigeria is rich in biodiversity and among the regions of the world, houses comparable levels of endemism and species richness due to a complex topography and wide variety of habitats. These include but are not limited to coastal creeks of the Niger Delta, the rainforests of the Cross River basin and the mountains along the Cameroun border with Nigeria (WCS, 2015). Along with the Atlantic Ocean which forms the southern border part of Nigeria, and with its highly diverse marine and freshwater ecosystems, there exists an inland layout of an array of other forest and woodland ecosystems which end up in Sudan Savannah and Sahel/semi-desert belt in the northern part of Nigeria. With very extensive and broad based river systems that emerge out of the two largest Rivers – Niger and Benue, Nigeria has a huge watershed resource which supports agriculture, navigation and commerce. The key environmental issues facing Nigeria includes land degradation, deforestation. Nigeria is strongly predisposed to severe negative impacts of climate change due to the nature of its economy, weak resilience and low adaptive capacity. Nigerian forests are threatened as the forest cover declines from approximately 24 million hecters to 15 million. (Bisong 2002). This was caused by poor land use planning and has made habitat loss one of the most significant threats to biodiversity.

Major causes of Biodiversity loss in Nigeria.

According to Westing, Warwick and Renner (2001) reported that studies have shown that today's human activities are an empirical evidence of humans ruining what nature has bestowed to our care for sustainability. More than 70% of Nigerians live in rural areas where they depend on agriculture and other natural resources for survival (FEPA 1992).

Deforestation

Deforestation has been seen to constitute the single greatest cause of species extinction in the coming decade, hence tropical forests are the major storehouse of biodiversity. If the present trends in the loss of tropical plant habitats continue, as many as 60,000 plants nearly 1 in 4 of the planets total could be extinct by the middle of the century (WWF and IUCN, undated).

The implication of these loses is that many plants including many potentially valuable species may become extinct before they have even been discovered let alone analyzed for their possible benefits to man.

<u>Table Showing Biodiversity in Nigeria: Species Statistics</u>

Mammals	274
Birds	941
Amphibians	109
Reptiles	135
Fish	338
Inland Fisheries	(314 species for Niger Delta alone)
Orchids	145
Flowering plants	5209

Nigerian Conservation Foundation (2012).

Unsustainable Agricultural practices

Rainforests and savannah woodlands are under the greatest threat from agricultural conversion. Communities in and around protected areas continue to encroach on these protected areas in total disregard to their protection status. (Weatings et al 2001). Until more sustainable agricultural practices are put in place, the process of slash-and burn agriculture continues, since tropical soils under cultivation can only support crops for a few years before becoming depleted, thereby requiring the clearing of new lands for continued harvests. Mangroves are also heavily harvested for fuel-wood and for construction materials USAID(2008) also reported that degradation of habitats and loss of species is not always as visible as out-and-out conversion, but it occurs in other more insidious ways with equally damaging results. In areas where particular species, such as hardwood trees, rattans, medicinal and food plants, and other non-timber forest products, are harvested unsustainably, not only are these species lost but also a myriad of associated plants, such as insects and fungi, that require these specific hosts to meet their own ecological requirements for survival.

Illegal Mining Practices

The history of mining activities in Nigeria dates back to the tin mines on the Jos Plateau, for tin and bauxite and the coal mines of Enugu. (*J*. sustainable management). The tin deposits on the Jos plateau had been extracted through open cast mining, until when surface deposits were depleted. Sumaila (1989) reported that tin mining activities which have caused considerable erosion damages to lands arising from active gully equal to 7, 240km in length. The influx of mining operators without adequate monitoring of production and documentation does not augur well for conservation of the vegetation cover, minerals and land use systems. The erosion problem created in the mining sites is on a steady increase, leading to development valleys. Solid mineral mining in Nigeria has left behind, abandoned and un-reclaimed mine sites, to the detriment of the surrounding communities, the environment and biodiversity.

Indiscriminate Bush burning

Bush burning produces emissions such as carbon monoxide, hydrocarbons, hydrogen sulphide, oxides of nitrogen, sulphur, ozone and particulate matters. (Hamid et al, 2010; Jamal et al, 2012). Bush burning occurs widely and extensively and has become common occurrence in the Nigerian environment. Accidental bushfires are also known to have started by improperly discarded cigarettes by smokers (Ambe et al, 2015). Fire also creates negative impacts on the composition and density of vegetation and delays the attainment of sustainable development targets and also accelerates desertification and general environmental degradation.

Overgrazing

Overgrazing occurs when plant material is grazed faster than it can naturally regenerate, often leading to the permanent loss of plant cover EPI (2011). It is a common effect of too many animals grazing on limited range land and also occurs when plants are exposed to livestock grazing for extended periods of time without sufficient recovery periods. It reduces the usefulness of the land and is one of the causes of soil erosion and desertification. Overgrazing can occur under continuous or rotational grazing. Plants become weakened and have reduced root length. The area devoted to grazing in Nigeria rose from 166, 326 km2 in 1978, to 187, 236km2 in 1995. Because most of the cattle are concentrated in the semi-arid zones that support 90% of cattle. EPI (2011).

The main threats to biodiversity in nigeria

World Rainforest Movement (1999) records show that 70-80% of Nigeria's original forest has disappeared and presently the area occupied by forests is reduced to 12%. In the period between 2000 and 2005, Nigeria lost about 2, 048ha of forest (FAO 2005).Although Nigerian government established several forest reserves for conservation of forest resources, these forest reserves have been seriously neglected and received little or no improvement in terms of investment and management (Pelemo *et al*., 2011). The implication of these loses is that many plants and animals, including many potentially valuable species are on the fast track to extinction. The USAID Report on Biodiversity and Tropical Forestry Assessment (2002) recorded that there are many – too many environmental threats in Nigeria affecting biodiversity. A National Assessment (NCF2012) confirmed the reality of high rise and fast tracked increase in biodiversity loss in Nigeria. An analysis of the major underlying factors responsible for the continuous degradation of biodiversity in Nigeria, were categorized as follows:

High Population Growth rate

Biodiversity loss is a problem in many other countries in the world and most particularly developing countries where poverty is still pervasive. The population of Nigeria is estimated at 183, 523, 434 people as at July 2015, which is equivalent to 2.51% of the total world population and makes Nigeria number 7 in the list of the total world population (Source: Worldometers). More than 70 percent of Nigerians live in rural areas where they depend on agriculture and other natural resources for their survival (FEPA, 1992). However, Nigeria's large population is characterized by high percentages of illiteracy, unemployment and poverty, which act as powerful drivers of increasingly severe demands on the remaining biodiversity in Nigeria. Evidence based field studies have confirmed that natural processes of regeneration are not able to cope with the over-exploitation in high magnitude (Happold, 1997). New roads and tracks enable farming, hunting and wood cutting to occur in previously undisturbed habitats. In addition, several socio-economic factors can be reported to be mediating the relationship between population and natural resource degradation in Nigeria..

Poverty

According to the Human Development Index Report (UNDP 2008-2009), the number of poor people in Nigeria remains high and the level of poverty rose from 27.2 per cent in 1980 to 65.6 per cent in 1996, an annual average increase of 8.83 per cent over a 16-year period. However, between 1996 and 2004, the level of poverty declined by an annual average of 2.1% to 54.4%. To a large extent, Poverty contributes a major threat to biodiversity and in other ways continues to further deepen the level of poverty in most rural areas. Biodiversity is always at the receiving end being the readily available option for food, fibre and minimal commercial gain by the rural poor. The need for protection of biodiversity is therefore seen as elitist by the rural poor whose deprivation in terms of food and domestic needs have been pushed to the wall.

Poor land use planning

USAID (2002) observed that no land use policy exists in Nigeria, despite the existence of a land use Act. Instead, states are encouraged to derive their legislation from the Federal legislative framework. While some states have taken steps to develop legislation to improve (from an environmental perspective resources management through laws against bush burning and agricultural expansion into forest lands, major impediments to sustainable environmental management still exist.

Two key land tenure and land use issues that require future consideration include how to mediate/resolve problems that arise between tenure systems; and how, within the various tenure systems, to support policy/institutional frameworks that are capable of promoting the sustainable use of natural resources.

Land use and land cover change have emerged as a global phenomenon and perhaps the most significant regional anthropogenic disturbance to the environment. As is the case in Nigeria, rapid urbanization/industrialization, large scale agriculture and major changes in human activities have been identified as the major causes of the dramatic changes in land cover and land use patterns globally.

Control and management of human activities to minimize damage on biodiversity

Measures to curb the damage on biodiversity by human activities, which impact tropical ecosystems in Nigeria, are the most intricate and expensive and have attracted insignificant attention from both the public and government. Biodiversity of tropical ecosystems in Nigeria is threatened by various human activities, which culminate in diverse forms of pollution. There is the urgent need for proper control and management of the various negative effects resulting from diverse cultural and social-economically important human activities in order to attain sustainable development. There is an obvious need for an integrated approach to the control and management of human activities that impact biodiversity. This integrated approach should be an activity that will provide the framework for decision-making on how biodiversity can be conserved. The success of management depends on the level of awareness and co-operation of the public, decision-makers in government and managers. Control and management can further be enhanced by having national and regional coordination mechanisms. (Ngoile *et al*., 1993).

Conclusion

The over exploitation activities of biological resources by human activities has caused problem to the entire ecosystem which brought destruction to the nations biodiversity such as unplanned and intensive land use, over grazing, bush burning, over population, uncoordinated expansion of settlement, clearance for farming, over exploitation and wasteful practices in use of forest and wildlife, poverty and illegal and bad mining are all implicated. it is evident that the status of these biological resources is at various stages of depletion. While other nations of the world are working towards exploiting their biological resources for stabilization of ecosystems, in the Nigeria's focus should be first to salvage the resources while utilizing them at the same time for sustainability.

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The Potential of Agro-forestry practices in sustainable environmental management system

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Abstract

Agro-forestry, generally refers to land use system or farming system in which trees or shrubs are grown in association with agricultural crops, pastures or livestock and in which there is ecological and economic interaction between the trees and other components. However these practices have a distinctive arrangement of components in space and time. This paper highlights Agro-forestry practices and concepts in sustainable environmental management. The benefits derivable from the interface between forest trees and agricultural crops are enormous such as trees, food, fruit, fuel wood, tannin, resins, leaves and forage aesthetic value, climate amelioration, improve soil structure . Also, the economical and ecological effects of agro-forestry which are germane to sustainable environmental management system and livelihood.

Key words: Agro forestry, practices, Environmental , sustainable; Farming system

Introduction

Agro forestry practices offer practical ways of applying various specialized knowledge and skills to the development of sustainable rural production systems. Agro-forestry is recognized as a land use option in which trees provide both products and environmental services. In agro forestry systems, the trees grown on different farmlands in the same locality when aggregated can bring about improved wooded situation thereby enhancing environmental protection (Otegbeye, 2002). In most agro forestry systems, the trees grown do not have the usual silivicultural recommendations in terms of spacing (Owonubi, 2002). Given the reality of awareness among the farmers of multiple land use management, the need to improve on the existing agro forestry practices becomes necessary in the face of increasing population and limited nature of land. Rural people have been discovered to have a wealth of indigenous knowledge and have incorporated trees in production systems in areas where they lived for a very long period of time (Evans and Alexander, 2004).

Agro forestry has both protective and social-economic benefit. Kang (1993) reported that besides direct agricultural benefit, trees exhibit social - economic values. The benefit of the tree components derived by farmers from agro forestry was evaluated from a social-economic and ecological perspective (Anderson and Sinclair, 1993). The social economic benefits of agro forestry can be evaluated in terms of productivity, stability and sustainability.

Concept of Agro forestry Management

Agro forestry is a land management system that combines perennials (including trees, shrubs and palms) with annual agricultural crops and/or livestock to increase total production while providing economic, social and environmental benefits. The goal is to reduce risk and increase total productivity in an agricultural system while simultaneously providing regular income and increased cash flow. By integrating trees, perennials and/or livestock into a conventional agricultural system, agro forestry promotes the efficient use of sunlight, moisture, plant nutrients and other ecological services. Globally, it is estimated that about half of agricultural lands contain at least 10 percent tree cover (Buttoud, 2013). Although agro forestry is a relatively newly defined system, the integration of trees and agriculture has been practiced throughout history.

Indian scriptures from as early as 1000 B.C. mention multipurpose tree species being used as fodder, and Roman era writers offered detailed accounts of mixed livestock and tree systems. During the Middle Ages, Europeans and Asians began pioneering the method of shifting cultivation, in which certain trees are retained during forest clearing because of their use as canopy for exposed soil (Conklin, 1957). During this same time period individuals in Central America were attempting to recreate the layered structure of mixed tropical forests by growing dozens of crops on plots smaller than one-tenth of a hectare (Wilken, 1997). During the mid-19th century, foresters and other land use planners began researching methods to create a forest system that would be capable of surviving competition from other agricultural species while also ecologically benefitting from them. Increasing concerns about soil erosion during this time spurred countries including France to plant trees on overgrazed slopes to protect against erosion (King, 1987). . The USsDA's Agro forestry Strategic Framework depicts the United States' ongoing dedication to incorporating agro forestry into federal programs, policies and activities in order to further highlight its use as an effective sustainable land management system that seeks to balance agricultural production and natural resource conservation.

Agroforestry Sub-systems

Agroforestry can be separated into three sub-system classifications - Agrisilviculture, Silvopastoral and Agrosilvopastoral (Weiwei, 2014).

• *Agrisilviculture* combines annual and perennial crops with woody perennials (trees, shrubs, vines),

• *Silvopastoral* combines trees with pastures and animals, and

• *Agrosilvopastoral* combines crops, pastures, animal and trees Silvopasture

Silvopasture is a system in which forests are managed for timber production along with domesticated animals being raised on the same plot of land (King, 1979). This system utilizes several agronomic principles such as fertilization, native pasture grasses, and rotational grazing systems with short grazing periods that maximize plant growth and harvest while avoiding damage to the tree crop. Silvopasture is a highly intensive agroforestry method that requires grazing and timber management that can involve tree pruning, grazing, haying, fertilization and enhance tree growth (due to the ability of grazing animals to control competition for moisture, nutrients and sunlight), provide a cooler environment for livestock and allow for control of weeds and brush without herbicide applications. been scientifically evaluated to a great extent (Sharrow, 2007).

Alley Cropping

Alley cropping is an agro forestry practice where trees are planted in row or shrubs at a spacing that provides an "alley" where perennial and annual agricultural crops are then grown. Agricultural crops within an alley cropping system are often referred to as intercrops. In this system, special care must be taken to ensure that crops and trees are compatible with one another as well as local climatic and geologic conditions. Alley cropping requires careful maintenance and pruning to limit the lateral spread of tree branches and to ensure that trees will provide the desired level of shade. The typical intercrops for this agro forestry system are row crops (corn, wheat, barley), forage crops (bluegrass, clover, alfalfa), specialty crops (dogwood, Christmas trees) and biomass crops (willows, birches) (Hodge, 1999). Alley cropping improves crop health through the creation of tree canopies that protect against wind damage and pests and also aid in pollination activities. It also improves soil health in areas prone to erosion, adds carbon to improve soil health, and enhances nutrient recycling (Wotjkowski, 2006)

Farming Systems and Multipurpose Trees

The impetus for much of the research and development work on multipurpose tree species (MPTs) can be traced back to two crises of the 1970s-deforestation and the 'energy crisis' i.e. fuel wood. Eckholm (1975) viewed with alarm the huge and growing demand for fuel-wood endangering the world's forests, while Earl (1975) proposed using forests as a source of renewable energy. The World Bank focused on tropical deforestation, and in 1978, substantially discussed the fuel wood issue in its Sector Policy Paper (World Bank 1978). Later in the same year, the US Agency for International Development echoed the World Bank document in a strategic position paper on Tropical Deforestation (USAID 1978). The Eight World Forestry Congress in Jakarata then voiced the need to augment forest resources with MPTS to provide continuing supplies of tree products. The primary focus was to be on household use and income generation in rural areas, based on active participation by rural people.

The concept of MPTS originated from the publication of Smith (1950) and Bene *et al*.(1977) on the role of trees in trees in agriculture. Singh (1982) reported on tree folders and US National Academy of Sciences (NAS 1980) on fire wood crops. The literature on MPTS is now huge and there have been many efforts to synthesize it into species compendia.

Role of Agroforestry in Environmental Management

Agroforestry, the science of integrating trees into farming systems, was institutionalized in 1977 with the establishment of the International Council (now Centre for Research on Agroforestry (ICRAF). Since then, a huge amount of research and development work has transformed the potential of MPTs into reality, and long lists of recognized environmental management systems have been published. At the simplest level, however, trees play two basic roles in Service and production.

Services of Agroforestry

Trees in environmental management systems affect the farming site itself, filling a service role that is either beneficial or detrimental to crop growth and farm stability, depending on the situation. For example, when properly managed in contour strips, trees and other perennial vegetation can reduce soil erosion. Trees affect soil nutrient status through litter fall and when used as green manure. Nitrogen-fixing trees (NFTs) can contribute substantial amounts of nitrogen to agricultural systems, depending on the site, species, and management. Over storey trees in traditional systems such as the *faidherbia albida*/ grain parklands of Africa and home gardens give considerable shelter to under storey vegetation and livestock. Trees also make effective field and boundary fences, and are used widely for this purpose. These service roles of trees in environmental management systems have always interested forester. However, a growing body of experience suggests that many foresters are far more attracted by the potential products of trees and their potential effects on the site. (Otegbeye and Famuyide, 2005).

Products from Agroforestry

Tree products are many and various- food, fruit and spices; fibre, lumber, tannin, and other industrial raw materials; livestock fodder; wood for fuel, implement and housing. From the perspective of farming systems, there are several important aspects of MPTs production to consider: in many cases, the opportunity to grow trees for sale is a stronger incentive than growing trees for home consumption. An example is fire wood where early projects, emphasizing small fire wood plantations for home consumption, did not meet expectations. Growing fuel wood for sale, however, has proved successful in northern part of Nigeria (Otegbeye and Famuyide, 2005)

Economical effect of Agro forestry

- It reduces poverty and improved economy among farmers
- Agro-forestry provide employment to the people especially in rural area
- Farmers income´s are more secure
- The market has an influence on agro-forestry farmer´s income
- Expenses in time and effort for caring of tree seedlings, trimming, plowing and planning.
- Earnings in time and effort are less foraging of fuel wood, fodder and timber
- Most farmers are self sufficient with food, timber, fuel wood and fodder Increased income so the family affords school fees and school material
- Agro-forestry is suitable for a lot of people because it is a low cost and low technology system. (Aune et,al, 2008).

Ecological effect of Agro forestry in environmental management

- Reduces soil erosion through tree planting and contours.
- Water catchment, effective water use.
- Increased fertility in soils
- Less overgrazing since zero grazing
- A more resilient land use
- Commercial fertilizer is not extensively used, many farmers use manure
- Industrial chemicals such as pesticides is extensively used
- The natural forest is conserved
- Wild animals are not a big problem except for farms nearby national parks
- Trees give shade that favor other crops
- Conservation of biodiversity and indigenous tree species.
- Lakes and inland waters can benefit from soil conservation measures (Oke, et, al 2007).

Conclusion

The potential of Agroforestry practices in sustainable environmental management system cannot be over emphasized. Agroforestry practices offer practical ways of applying various specialized knowledge and skills to the development of rural production systems and is a part of solution which has contributed to sustainable environmental management, providing a means to produce food, improve income, improved micro-climate, conservation of the resources ,improved on soil structure, improved on soil fertility and promote economical stability. Sustainable environmental management system based on agroforestry is multi-functional and diversified, which promotes nutrient management, soil and water conservation, tillage and residue management, land restoration and rehabilitation, integrated livestock management, integrated pest management, and sustainable energy.

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Agricultural And Forestry Research Funding In Nigeria:A Review

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ABSTRACT:

The aim of this study is to ascertain the factors militating against financing the agricultural and forestry research which includes corruption, policy inconsistencies, high transaction cost, funding instability etc. The study also reviewed the problems of agricultural and forestry research which includes inadequate funding of research and extension systems, weak linkage between research, extension and farmers/industries, absence of appropriate communication strategies . Finance for agricultural and forestry development has an increasing role in contemporary times owing to the fact that agricultural sector is an important engine of national economic growth. The federal government has embarked upon series of programs and policies to transform the productive capacity of the sector but the sectors performance remains skimpy.

Keywords: Finance, Research, strategies, policies.

Introduction:

Agricultural finance is all about the acquisition and utilization of capital (finance), the factors of production that facilitates the acquisition, procurement and management of the other factors of production namely; land, labour, capital in agriculture, which is not only the lubricant but also the lifeblood of the economy (Mohammed et al,2015).. Ayodele *et al*(2014), citing Chandavaker said'' one of the basic problems facing the less developed countries is the scarcity of domestic capital relative to the size of investment required to achieve a higher and self sustaining rates of growth of national and per capital income. Although the accumulation of capital itself is not highly regarded by economists as a uniquely important source of growth. Agriculture financing brings about the growth and solves the problems militating against the agricultural sector productivity, economic sustainability, poverty reduction, business opportunities, institutional changes, innovation incentives as well as growth (Obansa et al ,2013).This paper compiles literature from previous publications about problems of agricultural funding and different steps to ameliorate the problems.

Problems of agricultural and forestry funding in Nigeria .

Corruption according to Ariyo (2006) is the greatest problem and bane of economic recovery in Nigeria which cuts across every facet of the society and unless something is done seriously, the country may as well be going around in circles. He opined that the level of corruption in the country had gone beyond mere corruption but leaning more on the side of insanity on the part of eminently corrupt Nigerians and has become the major precipitator of the avoidable three development gaps experienced by the nation, especially through the endemic budget deficit. This position was supported by (Herz,1996).

Policy Inconsistencies has contributed to the failure of agricultural sector. Every new government wants to pursue its own political agenda without consideration to build on the policies of the predecessor (Obansa *et al*,2013)

Lack of certainty in securing banks and financial loans has reduced the pace at which agricultural funding should have moved (CBN, 2014). The banks do not disburse any loan without surety and security. Most farmers find it difficult to arrange satisfactory security as well as surety to the bank (Ariyo, 2006) shared the opinion that Credit inadequacy is a serious problem for farmers to increase their hectarage. The banks have not been making a fair assessment of the credit needs of the farmers. It results in the shortage of finance and there arises inadequacy of credit. .

The farmers have to incur many other costs in addition to the interest they pay on the loan. These may include the loss of wage earning days, revenue stamps, letter of guarantee, cost of photographs, agreement and other unidentified charges (CBN, 2014). These high costs hamper the spirit of the farmers from getting loans (ASTI, 2011).

The financial system has the crucial role of availing funds to the real sector, any interference in its central role, causes asymmetrical flow of information leading to financial instability. Funding instability can be defined as an antithesis of financial stability or absence of financial stability (CBN, 2014). Failure to provide stable funding for agricultural and forestry activities by government have actually set the country backward rather than progressing (Herz 1996).

The research and extension systems in Nigeria are faced with various funding related challenges which are inadequate funding. Although the normal funding of research has improved over the years, this still remains inadequate because most of the increases are in the area of personnel and not the actual research subheads. Agbamu (2015), reported research and extension budgets of 3% and 2.1% respectively, expressed a percentage of the national agricultural budget. Data from ASTI (2011) showed that Nigeria has one of the lowest agricultural research spending intensity. Research funding is also erratic and untimely most of the time with no evidence of adequate consideration of the time-bound nature of research activities in most policy decisions. This funding constraint makes it difficult for research to be responsive to the needs of the clientele and compounds the challenges of long gestation of research.

Linkages explain the kind of connection between two or more organizations pursuing commonly shared objectives in other to have regular contact and improved productivity Adesoji and Abegunde, 2012.). The linkages are established mainly through communication, feedback mechanism and working relationship among organizations. To develop agricultural technologies that work and meet the need of end users, researchers, extension workers, farmers and other industry actors must partner in identifying research problems, adapting the recommendations to local conditions and providing feedback to research about the developed innovations (Pardey and Beddow 2016). However, the weak linkage between these key actors in the agricultural industry has created a level of disconnect in information flow and limited the benefits derivable from the research technology. This weakness stems from lack of close working relationship between the various actors within the agricultural sector. Also, the level of farmers' education is an important factor affecting information flow between them and extension agents and research (Adesoji and Abegunde, 2012).

The importance of knowledge sharing and communication in Agricultural and Forestry research cannot be over-emphasized. Communication in an organization can be internal or external. To effectively achieve development, communication actions should be research based and planned (Ramirez and Quarry 2004). Effective communication is essential to achieving organizational research objectives and promoting performance. It's paramount to have communication strategies that address the communication needs of the organization, projects and clientele from time to time (Ramirez and Quarry 2004). This is because the information needs of the clientele varies and therefore requires different approaches for effective communication Unfortunately, several research and extension institutions do not have communication strategy clearly articulated, and therefore have no particular mechanism for monitoring and appraising their communication performance and progress. Some of the guiding principles of the communication strategy of CGIAR program on aquatic agricultural system include quality partnership, knowledge sharing and learning, open access and focus (CGIAR – AAS, 2012)

The research system has the responsibility of developing sustainable innovation solutions to the challenges facing the agricultural and forestry sector. So the absence of research staff stability will reduce the success of agricultural investments and also the quality of research output will be reduced. Based on different challenges and problems confronting agricultural research ,creation of Agricultural research Department in the Ministry of Agricultural is essential (Ariyo,2006) as confirmed to the assertion (Mohammed et al,2015) postulated that training and retraining of agricultural extension officers be given high priority.Efficient Supervision of agricultural projects by government at all levels and priority for agricultural loans by banks and other finance house should be intensified.

Conclusion:

Agricultural funding in Nigeria is inadequate .This explains why school leavers and retirees should be encouraged to invest in Agriculture and achieve food security in order to alleviate the poverty in the country. Finance no doubt, is strategically important in the growth of agricultural and forestry research in Nigeria. Unless the problems are tackled with honesty of purpose, agricultural and forestry research revival will continuously be a mirage. In Nigeria, we have had enough of agricultural revival and poverty alleviation policies, initiatives and programmes without serious efforts in implementation. All that is required is the seriousness and loyalty of committed economic and political leaders with good intention, sincerity of purpose, integrity, transparency and accountability.

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Assessment of Waste Associated with Timber Flitching in Bodija Plank Market, Ibadan, Nigeria

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Abstract

This study was carried out at the Bodija plank market in Ibadan to assess waste associated with timber flitching. Data were randomly collected on commonly flitched timber species via the use of questionnaires and dimensional measurement i.e. length, breadth and thickness were taken and recorded. The result shows that thirteen (13) different species namely; *Cordia milleni*, *Albizia zygia*, *Sterculia rhinopetala*, *Anningerra robusta*, *Mansonia altissima*, *Terminalia superb*, *Ceiba pentandra*, respectively were randomly selected as the most available flitched logs in the market. The mean volume of 58788.76cm^3, 62168.83cm^3, 50609.61cm^3 and 62377.77cm^3, respectively were discovered to have variations from the conventional volume of 56633.69cm^3. Also, nine (9) different lumber species were considered under the conventional dimension of 28316.85cm^3 (i.e. 5.08cm x 15.24cm x 365.76cm). The study also revealed that *Sterculia rhinopetala*, *Terminalia superba*, *Terminalia ivorensis* and *Celtis intergrifolia* flitched dimensions were greater than the conventional dimension. The lumber conversion efficiency was noticed in *Anningerra robusta* and *Anogeissus leiocarpus* with volume recovery of 28330.83cm^3 and 28316.84cm^3, respectively. *Albizia zygia* had the lowest volume recovery of 11,466.28cm^3**.** Therefore, the act of timber flitching, which is mostly rampant among the timber exploiters, cannot be discarded since they supplement the sawn log.

Keywords: Flitches, plank, wood waste, timber species, log, kerf

Introduction

Flitching is a logging activity usually carried out in the forest by artisanal sawyer's also known as mobile chain operators. It involves the identification of trees with appropriate bole lengths, which are then marked to be cut by mobile chain saw operators (FAO, 1992, Awe, 2000). This activity is not only illegal but also unauthorized and yet it is thriving. In most cases, the activity takes place in difficult terrains where accessibility to the forest is difficult (Gerwing, *et al.*, 1996). Nonetheless, these chain operators gain access to the forest somehow, cut down tree into logs and quickly reduce them into planks of different dimensions, which is then carried by head to the road, where they are conveyed by trucks to the market. Sometime, they seek permission from the forestry authorities to carry out this operation, which is granted on the grounds that they could help bring out these logs from the forest where authorized trucks find it difficult or almost impossible to gain access. These chain saw operators often abuse this permission by even going to flitch outside the difficult terrains into areas where the terrain is quite accessible (Badejo, *et al.*, 2001; Zhu, *et al.*, 1998; Olaleye, 1999; Ayakwa and Addae-Mensah, 1999). The flitch method is generally recognized as the most prevalent method of log sawing in the forest and could be assumed as the general pattern of sawing especially when the log size is not too small (Smith and Joe, 2006). Therefore, the study was aimed at assessing the amount of waste associated with timber flitching in Bodija plank market.

Materials and Methods

Study Area

The study was carried out in Ibadan North Local Government Area (LGA) of Oyo State. Ibadan is the capital of Oyo State and one of the most populous cities in Africa. The projected population of Ibadan North Local Government Area (LGA) as at 1996 was 348,896. The LGA was created in 1991.

Data Collection Procedure

The primary source of information was basically through personal interview of the plank sellers. Questionnaires were randomly administered within the planks market and questions such as sources of sawn log, dimensions of flitched species and their prices, amount of waste generated and species mostly flitched were asked from the plank sellers. Bodija plank market comprises of one hundred (100) plank sellers in Ibadan North Local Government Area. Fifty (50) structured questionnaires were randomly distributed in Bodija plank market. The fifty (50) questionnaires were retrieved from the plank sellers. Thirteen (13) different sawn log species prominently flitched were selected and their individual dimensional measurements (i.e. length, breadth and thickness) were taken and recorded. The volumes of flitched species were computed.

Data analysis

The responses in the questionnaires from the individual respondents were processed and analyzed. Descriptive and inferential statistics like the use of table and bar chart were used to analyze the data acquired.

Results and Discussion

The sawn log species that are commonly flitched at Bodija plank market were comprehensively obtained from the respondents and various dimensions of available sawn logs were equally collated. The flitched log species are as follows; *Cordia millenii*, *Albizia zygia, Mansonia altissima, Terminalia superba, Ceiba pentandra*, *Nesogordonia papaverifera, Triplochiton scleroxylon, Terminalia ivorensis*, respectively as presented in Table 1. The first 3 dimensions (2” x 6” x12’, 2” x 12” x 12’, 3” x 4” x 12’) were generally the most available flitched sizes, while the last dimension (2” x 8” x 12’) was usually on special requests by plank sellers as presented in Table 2. There was no much difference in length across species, expect the proportionate increase noticed in *Ceiba pentandra* beyond the conventional size of 373.39cm, which could result into waste. However, *Cordia milleni* has a mean length of 356.09cm and this is less than the conventional size. This is usually considered to be substandard lumber, which attract low market value. There was a variation in mean breadth across species showing that waste generated from such lumber during processing could be very high because of deviation from the conventional size. For instance, *Anogeissus leiocarpus* and *Milicia excelsa* have been greatly reduced compare to the normal metric values of 16cm in breadth. *Anningerra robusta* (16cm), *Celtis intergrifolia* (16.21cm) and *Terminalia superba* (16.61cm) were discovered to be closed with the conventional sizes. Therefore waste generated could be very minimal as presented in Table 1.

Table 1: Mean dimensions of volumes and the difference

Flitched Species	Length (cm)	Breadth (cm)	Thickness (mm)	Volume (cm^3)	Conventional volume (cm^3)	Difference
Cordia milleni	356.09	30.09	5.51	56633.7	56633.7	2404.57
Albizia zygia	362.65	15.04	5.46	28316.9	28316.9	1463.39
Sterculia rhinopetala	372.1	15.49	5.28	38316.9	38316.9	-7883.83
Anningerra robusta	371.19	16.00	4.73	28316.9	28316.9	-225.19
Mansonia altissima	371.49	15.34	4.78	28316.9	28316.9	-1077.27
Terminalia superba	368.65	16.61	5.51	28316.9	28316.9	5422.40
Ceiba pentandra	373.39	29.99	5.41	56633.7	56633.7	3947.31

Nesogordonia papaverifera	361.73	28.65	4.85	56633.7	56633.7	-6370.40
Milicia excelsa	365.69	9.92	7.41	28316.9	28316.9	-1436.00
Triplochiton scleroxylon	374.45	30.74	5.44	56633.7	56633.7	5983.94
Terminalia ivorensis	369.99	15.78	5.25	28316.9	28316.9	2334.97
Celtis intergrifolia	368.72	16.21	5.48	28316.9	28316.9	4436.84
Anogeissus leiocarpus	367.33	9.85	7.22	28316.9	28316.9	-2193.44

Table 1 revealed that four (4) species namely; *Cordia milleni*, *Ceiba pentandra*, *Nesogordonia papaverifera* and *Triplochiton scleroxylon* had volume values of 58788.76cm^3; 62168.83cm^3; 50609.61cm^3 and 62377.77cm^3, respectively. Thus, it can also be concluded that much waste were generated from *Cordia milleni*, *Ceiba pentandra* and *Triplochiton scleroxylon* because their dimensions were higher than the normal value thereby leading to a lot of wood removal from the forest estate which reduce the ability of forest to produce wood at current level and other components of the environment suffer from the use of wood. *Nesogordonia papaverifera* shows reduction in size compare to conventional size, which consequently affect the market value of the plank and thus attract lesser price. Also, *Anogeissus leiocarpus* was considered under the conventional dimension of 28316.85cm^3 (i.e. 5.08cm x 15.24cm x 365.76cm).

Table 2: Common dimensions and price of flitched/conventional sawn log

Species	Sizes	Flitched (₦)	Conventional (₦)
Annigeria robusta	2” x 6” x12’	1,100	1,200
Mansonia altissima	2” x 12” x 12’	1,800	3,500
Antiaria Africana	3” x 4” x 12’	380	450
Terminalia ivorensis	2” x 12” x 7’	950	1,100
Khaya ivorensis	2” x 6” x 7’	1,200	1,400
Hallea ciliate	2” x 8” x 12’	1,100	1,200
Alstonia boonei	2” x 12” x 12’	380	450
Sterculia rhinopetala	2” x 12” x 12’	680	750
Nauclea diderrichii	2” x 12” x 12’	1,300	1,500

Albizia zygia	2" x 12" x 12'	750	1,200

Comparison of prices of flitched and conventional sawn log

There are variations in the sizes or dimensions of flitched and conventional sawn wood, which therefore lead to difference in price. *Mansonia altissima* was the most expensive sawn wood species and it's flitched size goes for 1,800 naira while the conventional size of *Mansonia altissima* cost 3,500 naira, followed by the flitched sizes of *Nauclea diderrichii, Khaya ivorensis*, and *Annigeria robusta* at 1,300 naira, 1,200 naira, 1,100 naira, respectively while their conventional sizes cost 1500 naira, 1400 naira, 1,200 naira, respectively in the open market. *Antiaria africana* was the cheapest sampled wood species and its flitched size cost 380 naira while the conventional size cost 450 naira in the open market as revealed in Table 2. Moreover, the logs are usually well graded thus resulting in the production of good quality and smooth operation, which of course tilts the peoples demand towards this type of wood. Unlike, the chain saw operators who engage in what can be described as a low technology activity which does not requires expensive machinery, skilled labourers etc. this of course results in flitched wood that appears rather rough in appearance, with rough edges and not too smooth surfaces with the resultant effect that prices are dragged down to encourage consumers to buy from them.

Conclusion

Since the demand for sawn wood and other wood products in Nigeria and the world over have continued to be on the increase and there is need to meet the local consumption. Then, the act of timber flitching, which is mostly rampant among the timber exploiters, cannot be discarded since they supplement the conventional sawn wood. But the basic problems before hand are those of reducing the volume of unavoidable wastes, avoiding the avoidable and finding uses for both. In conclusion, it is also believed that this will not only give the sawyer an opportunity to produce flitches of high grade, but also increase its market value and subsequently reducing the pressure on resource base.

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A Review of Agroforestry Technologies Practiced by Nigerian Farmers and their Adoption Constraints

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Abstract

Agroforestry is a type of farming system that combines trees/shrubs with tree crops with the objective of enjoying a mutual benefit that enhances productivity, profitability and biodiversity. Agroforestry seems to have replaced the traditional shifting cultivation in most part of the world. In the process, the extensive demand for land associated with shifting cultivation, which usually make man to clear more forest land for agriculture has been eliminated. Different agroforestry technologies exist which can be used to achieve the mutual benefit that agroforestry promises, some of which include taungya system, home garden, alley cropping, woodlots, live fences, fodder banks, orchards or tree gardens, windbreaks, shelterbelts, trees on pasture and apiculture with trees. This paper hence reviews some of these technologies as it relates to Nigerian farmers, as well as the constraints limiting their adoption.

Keywords: Agroforestry, farming-system, agroforestry-technologies, mutual-benefit, adoption-constraints.

Introduction

Agroforestry is an agronomic practice aimed at combining trees and shrubs with crops with emphasis on their mutual benefits to enhance diversity, productivity and sustainability of the land use system and hence the farmers (Adeola 2015). Agroforestry has long been recognized in sustainable development models throughout the world due to the benefits they bring not only to the economy and society but also to the ecosystem (Rocheleau *et al*, 1989; Thanh *et al*, 2005). A number of factors have contributed to a rising increase in agroforestry since the 1970s and these are deteriorating economic situation in many developing countries, increased deforestation and scarcity of land because of population pressures, interest in farming systems, intercropping and the environment (Nair 1993).

There are several agroforestry technologies that can help improve land and social conditions of people (Adeola, 2015), some of these include improved fallow, taungya (systems consisting of growing annual agricultural crops along with the forestry species during the early years of establishment of the forestry plantation), home gardens, alley cropping, growing multipurpose trees and shrubs on farmland, boundary planting, farm woodlots, orchards or tree gardens, plantation/crop combinations, shelterbelts, windbreaks, conservation hedges, fodder banks, live fences, trees on pastures and apiculture with trees (Nair 1993; Siclair 1999). Usuallyeach of the technologies is associated with specific objectives for the tree component for example, serving as barriers for wind, production of fruits, fuel woods and poles, production of fodder among others.

Some of the planting models in agroforestry include:

Homegarden

This is the planting of trees along with vegetables and food crops in free spaces around the homes. They could be arranged to include many multipurpose trees in multistory association with animal, crops and small livestock. Home gardens are very well developed in the southern part of Nigeria especially in the East. Fernandes (1987) indicated that farmers in this part of the country value this technology and it generates a lot of income for them. The food crops are integrated with trees behind homesteads. The smaller the trees occur near the house while the bigger trees are at the border of the home farm. A lot of fruits, nuts, and grains have been known to be produced from this technology, generating a lot of income for the farmer. In the Northern part of Nigeria where participation by farmers is low for this technology, their major reason for planting home gardens is for food and fruits production (Adeola *et al*, 2000a). According to Adeola (2015), of the few farmers practicing homestead in the semi-arid zone, the emphasis is on fodder for animals and shade around homestead. The major tree species used are fruit trees like *Mangifera indica*, *Psidium guajava*, *Anacardium occidentale*, *Moringa oleifera* and *Termarindus indica* (Adeola *et al*, 1995).

Taungya System

According to Adeola (2015), taungya system involves the cultivation of food crops in forest reserves. Lands under forests are known to be fertile and in communities with limited land where there are Government forest reserves; forest lands are distributed to land hungry farmers to grow their food crops after forest exploitation. Such farmers will however plant seedlings of government preferred tree crops on such land along with their food crops. The growth of food crops is temporary as the trees soon close canopy in one or two years and take over the entire land. Meanwhile, the farmer would have harvested his crops (usually maize, cassava, pepper, okra etc) at the end of the first year. He could now be allocated another portion of forest land for clearing, packing, burning and planting for the next planting season. In this way, the farmer has fertile land to use, while the Governement obtains farmer’s free labour to plant trees. Most plantations of Teak and Gmelina along roadsides in the former Western region of Nigeria were grown through this method.

Woodlots and Orchards

These are plots on farmer's lands where fuelwood or fruit trees are planted by the farmers. These plots are usually about 0.5ha or less in area (Adeola, 2015). This is mostly practiced in the Northern/semi-arid zone of Nigeria.

Fodder tree banks

Also referred to as protein bank, they are blocks of forage plants that are planted by farmers to serve as browse for their animals during off-season when there is fodder shortage e.g. during rainless months. Usually, the forage plants used are legumes like *Leucaena leucociphalla*. Most farmers have been taught to mix *Leucaena leucociphalla* with *Gliricidia sepium* in order to minimize the intake of mimiocine from Leucaena. The trees may be grown with grasses or with herbaceous legumes to make the bank richer. The pruning from the fodder trees could be fed to restricted animals in a cut and carry method (Adeola, 2015).

Live fences

These are lines of trees/shrubs planted as boundary crops to delineate farm lands or pasture lands. It is made up of very dense hedges or thicket of trees (usually thorny) planted around a garden or farm to protect it from free ranging livestock. In most circumstances, they are planted around gardens within family compounds and buildings. (Adeola, 2015). The trees are of limited height and are usually heavily pruned to form a continuous shield that is difficult for animals to break through thorns or prinkles. Live fences keep off animals from destroying farmer's crops or confine them to a location.Species that are mainly used in the semi-arid region include *Acacia nilotica*, *Acacia senegal*, *Prosopis juliflora* and *Zyziphus spp* (Ekwebealm, 1988). If the live fences are used to keep animals within, the trees may be left to grow so that they can serve as shade, protection and privacy for the animals (Adedire, 2014).

Borderline planting

In this practice, trees, shrubs and grasses are established to delineate individual farmlands. They are property markers even though they provide wood and other forest products for various purposes. Species used for this technology include *Moringa oleifera* and *Termarindus indica*. These species are useful as vegetables and in water treatment in the Northern parts of Nigeria (Verinumbe *et al*, 1994). In this technology is also used in the south to demarcate farmlands. *Newbouldialeavis*has been frequently used for this role in many farms of the southern Nigeria. In the North, the leaves of Moringa are highly valued as vegetables more recently for its medicinal and other uses. A lot of Moringa are found as borderline crops on farmlands (Adeola, 2015).

Scattered trees on cropland

This is also referred to as parkland agroforestry. In this practice, trees are retained or planted on farmer's cropland in a much dispersed sequence while the crops are grown in the understorey unhindered (Adeola, 2015). They could also be scattered at random based on farmer's desire. Typical examples of this form of arrangement can be found in many parts of the semi-arid areas of Nigeriawhere trees, dispersed naturally on farm lands form an integral part of the cropping system. Different species are found in such dispersed, park-like stands, depending on the site conditions. Examples are *Vitelleria paradoxa*, *Parkia biglobosa*, *Adansonia digitata* (Ekwebealm, 1988), *Parkia biglobosa*, *Adansonia digitata*, *Vitellaria paradoxa*, *Tamarindus indica* (Adedire, 2014), *Irvingia gabonenesis*, *Crysophyllum albidum* and *Meletia excels*a (Adeola, 2015). Traditionally, the trees are homogenously distributed across farms in random patterns due to their ability to regenerate naturally. They do not take up as much space, thus a large part of the productive land is left for the crop production. They provide wood, fodder and other forest products to the farmers. Some of the trees like Parkia provide a lot of income for the farmer through fruits. It is the main component of the shifting cultivation system in which farmers allow some preferred trees to stay on the farmland with their food crops during the farming season. Such trees however have specified roles. They may be for soil fertility, fruits, nuts food, timber, fuel or a host of other reasons.

Windbreaks

These are strips of trees/shrubs planted to protect fields, homes, canals or other areas from wind and blowing soil or sand. It is planted to reduce soil erosion, improve microclimate for growing crops as well as shelter people and livestock. It can also improve and sustain crop yield (Rocheleau *et al* 1988). Usually, one or two rows of trees are established across the path of the prevailing wind (Onyewuotu, 1985). The length is usually across a farmers plot or property. Windbreaks are used both in sahel and sudan savanna. Major species used are *Azadiracta indica, Eucalyptus camadulensis* and *Prosopis juliflora* (Adeola *et al*, 1995). Some of these species are also used for erosion control (Adeola, 2015).

Roadside planting

This is amenity planting one to three rows of trees along roadsides and in public spaces. Apart from beautification, the trees have an effect on the microclimate of the area. They provide shade and protect the houses in the cities from storms which could otherwise be destructive (Verinumbe *et al*, 1994).

Constraints to the adoption of Agro Forestry Technologies

Some of the constraints that have been identified as to affect adoption of agroforestry among different societies are highlighted below:

National and Local Policies: some local customary practices and institutions prevailing in the sub-region (especially incidence of bush fires and browsing by livestock during the dry season, and absence of perennial private right over land) limit the widespread uptake of some agroforestry technologies (Phiri *et al,* 2004). The animals destroy the trees after planting either by browsing the leaves and removing the biomass or by physically trampling over the plants. Community's institutional regulations for fruit collection, land and tree tenure all affect individual farmer's decision to invest in establishing an indigenous fruit tree orchard.

Land ownership is also likely to influence adoption if the investments are tied to the land and the benefits of these investments are long term (Fernandez-Cornejo *et al*, 1994). Tenants are less likely to adopt technologies that require high investments on the land and whose benefits are long term because the benefits of adoption do not necessarily accrue to them. However, agroforestry institutions have been working in collaboration with traditional rulers, government officials, community-based organizations, NGOs, and national partners to resolve these institutional bottlenecks (Ajayi and Kwesiga, 2003).

Training: Agroforestry technologies are generally incipient technologies and relatively new phenomenon compared with conventional agricultural practices that farmers have known, been used to and have received training for a much longer period. Unlike annual crop production technologies and conventional soil fertility management options, fertilizer trees systems require skills in terms of management of the trees. Capacity for doing this need to be built at the national level (Ajayi *et al*, 2003), the costs of providing information greatly decrease over time, but they are critical when helping farmers get started with the practice (Parwada *et al*, 2012).

Seed and germplasm: One of the greatest constraints of some agro forestry technologies is lack of access to quality seeds (Thangata and Alavalapati, 2003). Unlike the seeds of annual crops in which established institutions exist to promote them and private sector organizations have been engaged in their multiplication and distribution, there is little or no institutional structure to make the seeds of agro forestry available "off the shelf". There are also no improvements on the tree varieties used in agroforestry (Parwada *et al*, 2012).

Awareness: Over several years, there have been structural shifts towards "quick fixes" and technologies that render immediate benefits (Ajayi and Kwesiga, 2003). The opportunity of agro forestry technologies to provide some medium and long-term benefits to individuals and the public simultaneously is not yet well communicated to many stakeholders (Parwada *et al*, 2012).

Human resource capacity: The human capacity, infrastructures and institutional supports for agroforestry are not as well developed as for annual crop technologies (Gladwin e*t al*., 2002). Such missing support include well developed input and output market to enhance access of small-holder farmers to ensure that they get the price premium for their crop produce. Households will likely adopt labour intensive innovations with high access to farm and off-farm labour. Fernandez-Cornejo *et al* (1994) identified another type of farm labour that influences technology adoption, that is, the labour provided by the farm operator him/herself. This kind of labour is often called operator labour and is thought to have a positive impact on level of adoption of agroforestry technologies because the technologies have a high requirement of operator's time. In general, the factors, which influenced farmers' adoption decision concerning agroforestry technologies, fall within four broad categories. These are those, which exert (1) positive influence on farmers' adoption decisions, (2) negative impacts (3) ambiguous or no direct effect (4) systemic influence on all types of households in a given community and spatial locations (Place and DeWees, 1999).

Conclusion

Agroforestry has been identified as one of the sustainable ways to combat food insecurity while mitigating the effects of climate change. However, for it to be widely accepted among farmers there is need to eliminate the numerous constraints preventing its adoption.

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Ecological Distribution and Nutritional Values of *Garcinia Kola* in West Africa

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Abstract

Garcinia kola Heckel (Clusiaceae), known as bitter kola, is a multipurpose tree species in West Africa. The species is sometimes referred to as a "wonder plant" because each of its parts has been found to be of medicinal importance. There is vast evidence that bioactive components of the seeds can serve as alternative medicine to treat and prevent severe illnesses such as malaria, hepatitis and immune destructive diseases. Despite the species'pharmaceutical potential and its high preference, *G. kola* is still at the beginning of its domestication process. The sample has high level of Carbohydrate, little amount of Crude Fibre and Protein. This composition shows that the sample could be a good source of Carbohydrate, dietary fiber and Protein. The Mineral content shows a high level of calcium, Potassium and Sodium. It could be a good source of minerals despite the negligible amount of Anti-Nutrients found in it that could prevent the absorption of these minerals. Even though, there are numerous scientific articles published on the species' biological activities, it is a difficult task to find basic information on its diversity, distribution, genetics and silvicultural management in West Africa. This paper compiles different scientific information published by different authors previously in various scientific journals, conference proceedings and workshops.

Keywords: *Garcinia kola*, phytochemicals, indigenous fruit tree; bio-active, medicinal plants.

Introduction

Bitter cola (*Garcinia kola*) belonging to the family Clusiaceae is naturally found in humid tropical forests of West and Central Africa, where the local population usually harvests the fruits. However, in some regions in Nigeria, farmers plant and manage the trees in their home gardens or agro forests outside natural forests; it is popular in Southern Nigeria where the plant is extensively used in herbal medicine and as food (Ullah *et al*., 2012). It prevails as a multipurpose tree crop in the home gardens of Southern Nigeria and the seeds are chewed as an aphrodisiac or used to cure cough, dysentery, or chest colds in addition to serving as raw material for pharmaceutical industries (Usunomena, 2012). The raw stem bark of *Garcinia Kola* is a purgative, the powdered bark is applied to treat malignant tumors; its sap is used for curing parasitic skin diseases and the latex or gum is used internally against gonorrhea, and applied externally on fresh wounds (Omokpo *et al.,* 2012).The seeds prevent or relieve colic disorders or cure head or chest colds, suppressed cough and is often used in the treatment of Cirrhosis and hepatitis (inflammation of the liver) (Kalu *et al.*, 2016). Consumption and use of bitter kola in West Africa is low due to inadequate information on the physico-chemical and nutritive properties, it plays an important role in African ethno medicine and traditional ceremonies (Iwu *et al*., 1990). Traditional knowledge of these valuable tree species has been disappearing due to the pressures of modern lifestyle and effects of rampant deforestation. Its seeds are amongst the most-traded NTFPs in Central and West Africa including Nigeria (Onyekwelu *et al.*, 2015). The most valued product of this plant is the seeds which are smooth elliptically shaped, with yellow pulp and brown seed coat (Zhang, 2004). *G. kola* is listed as one of the priority species for conservation in the Sub-Saharan Forest Genetic Resources Programme (SAFORGEN) and was selected as one of six preferred tree species by the World Agro forestry Centre (ICRAF) for domestication in West and Central Africa (Franzel and Kindt, 2012). Mainly due to habitat loss, slow-growing seedlings, continuous felling, and overexploitation of the tree in West Africa, the species are still classified as "vulnerable" in IUCN's Red List of Threatened Species (Cheek, 2004). Despite the importance, potential and popularity of *G. kola* in West Africa, a great deal of information and basic knowledge is still missing about the species (Franzel and Kindt, 2012).

Distribution and Ecology of the Plant

Garcinia kola is a monocotyledonous plant found in moist rain forests and swamps and grows as a medium sized tree up to a height of about 12m high, it is cultivated through the seedlings or by cutting; it grows more easily using the cuttings, the plant is found in countries across west and central Africa and it is distributed by man around the towns and villages of such countries like; Nigeria, Ghana, Cameroon, Sierra Leone, Togo, Congo Democratic Republic, Angola, Liberia and Gambia. Across the places where it is grown, it is known by various names such as bitter kola, male kola (English name), Orogbo (Yoruba), Aku ilu (Igbo) and Namijin Goro (Hausa) (Eisner, 1990). *G. kola* is known as false kola mainly due to the absence of stimulants which characterizes the kola nut seeds, it is also known as male kola due to the reported aphrodisiac properties of *Garcinia kola* (Eisner, 1990). The mean rainfall ranges between 1000 and 3000 mm per year, this is complemented by a relatively high air humidity of about 75% (Babalola and Agbeja, 2010). The species are cultivated in various types of soils with a slight preference for sandy loams, whereas its fine roots were found to harbor an arbuscular type of mycorrhiza (Bechem *et al.*, 2014).

Nutritional Values

Bitter cola fruit, which is believed to contain a high source of vitamins and minerals such as Vitamins A, C, E, B1, B2, B3, fiber, calcium, potassium, and iron, also carry other antioxidants and the usage is not limited to traditional activities alone (Eisner, 1990). Even though *G. kola* is considered a medicinal plant and the seed production is profitable activity providing a substantial contribution to the livelihood of households, particularly those living in rural areas (Adebisi, 2004). most of the current research targets the characterization of its bioactivity, the seeds are usually eaten raw, in their crude form, therefore, it is also important to focus on their nutritional value: scientific literature provides quite confusing data on the species dietary properties, the seed contains moisture, ash, crude protein, crude fat, NFE and crude fiber, overall studies agree on relatively high amounts of moisture in the seeds, around 70%, which is a crucial aspect for kernel preservation. Carbohydrates, also described as nitrogen-free extracts (NFE), form the largest part of seed proximate composition varying around 65% (Eleyinmi *et al.*, 2006). Compared to the proximate content of kola nut (*Cola* spp.), is also a popular masticatory stimulant in West and Central Africa Arogba (2000) revealed that bitter kola kernels contain twice the amount of protein but are twice as low in fat, whereas amounts of ash and NFE are mostly similar. The seeds are low in anti-nutrients such as phytate or oxalate, however, relatively high amounts of vitamin C were recorded in them (Onyekwelu *et al.*, 2015). Potassium and phosphorus are the most abundant minerals in the seeds which are often peeled before consumption and hulls are discarded as waste: Eleyinmi *et al*.(2006) discovered the feeding potential of seed coats for domestic animals due to their high protein content, livestock and small ruminants are generally lacking high-protein fodder in developing countries and bitter kola hulls might, according to in vitro and in vivo studies, provide a reasonable solution for this problem on a regional level.

Conclusion

This review shows that *Garcinia kola* can be used as a good source of Carbohydrate and Protein. Also a good source of Minerals necessary for metabolic activities in the body despite the trace amount of Anti-nutrients. The presence of nutritionally valuable components in the seed and hull of *Garcinia kola* suggests that it may be fond further useful in food and feed formulation. The Phytochemical composition also shows that *Garcinia kola* can be useful in the Pharmaceutical and Medical science to make vaccine and supplements that can prevent diseases. It can be useful also in various manufacturing industries as raw material.

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Investigation of rubber-based agroforestry system and its impact on smallholder livelihood in Edo State, Nigeria

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ABSTRACT

This paper investigates the performance of smallholder Rubber Agroforestry System (RAS) livelihood based on a case study in 4 communities (Iguoriakhi, Iyoha, Imasobor and Obagie Nevbosa) in Edo State, Nigeria where rubber production is practiced on a large scale. The objectives of the study were to: to investigate the farm characteristics of the rubber farmers who practiced RAS; to categorize the main RAS system; to determine the sources where the smallholder farmers obtain their planting materials in RAS and to examine the variety of crops which the rubber farmers are interested in intercropping with Rubber. The analysis of the emerging system in the study area reveals that the rubber agroforestry system is viable, it minimizes crop failures and environmental shocks as this system creates opportunities for income enhancement through integration of arable crops on the inter-rows during the immature phase of Rubber. Findings further indicate that promoting the development of alternative livelihood options through the integration of Rubber, domesticated high-value agroforestry tree crops and annual crops enhances resilience and contributes to the overall wellbeing of the farmers' families. Thus, this innovate system provides the smallholders with ample capability for resilience during market uncertainties and ensure a sustained flow of income. This study demonstrates the need to promote and scale up rubber agroforestry system in the smallholder dominated rubber producing States in Nigeria.

Keywords: Rubber agroforestry, smallholder, livelihood options, Edo State.

Introduction

Demand for Natural Rubber, mostly for tyres, has driven sustained expansion of *Hevea brasiliensis* plantations (Warren-Thomas, *et al*., 2015), which generates income as well as fundamental influence on their way of life (Romyen *et al*., 2018) for many rural people in Nigeria, particularly in the South-South of the country. In Nigeria, Natural Rubber provides raw materials for the agro-based industries; foreign exchange earnings and offers employment to a sizeable segment of the Nigerian farming population (Abolagba, *et al*., 2003). Since the mid-1970s, Natural Rubber (*Hevea brasiliensis*) production in Nigeria has suffered decline, from 248,900 ha to 154,000 ha (96,000 ha belonging to small-holder Rubber farmers and about 38,000 ha under Rubber estate) of land area, due to low Rubber prices in the international market and over-dependence on revenue from petroleum (Micheal, 2006). This continuous price hikes creates the need to diversify the land utilization to improve smallholder farmers livelihoods and conservation of its natural resources (Smith and Martino, 2007). Hence, to modify the production of Rubber, there is need for agroforestry systems that reduces susceptibility to market crashes, provide ecological services which could be the best option to the expansion of Rubber cultivation in Nigeria.

Rubber Agroforestry System (RAS) has evolved as an innovate approach to improve the lives of smallholders by developing and promoting model farms with quality planting materials of high yielding Rubber clones to meet farmers' requirements (Esekhade *et al*., 2014). This system is the deliberate integration of high value trees, arable crops and or animals into Rubber plantations. Thus, this system is helping the smallholder community to be self-sufficient and economically independent (Asaah *et al*., 2014; Esekhade *et al*., 2014). Somboonsuke, Wetayaprasit, Chernchom, and Pacheerat (2011) reported that a rubber agroforestry system is an alternative form of agriculture to complement biological integrity, crop diversity, and financial stability. RAS can be divided into three main systems: (1) intercropping rubber-food crop system, (2) rubber-tree crop system, and (3) rubber mini-livestock system.

In order to reduce the risks associated with market uncertainties and to improve efficiency at the farm level, operating a rubber-based agroforestry system seems to offer a revised method of practicing agriculture which could diversify crop production and enable farmers to earn extra income (Rodrigo, 2001) during the immature phase of Rubber. Therefore, the objectives of this paper were: (1) to investigate the farm characteristics of the rubber farmers who practiced RAS; (2) to categorize the main RAS system; (3) to determine the sources where the smallholder farmers obtain their planting materials in RAS; (4) to examine the variety of crops which the rubber farmers are interested in intercropping with Rubber.

Materials and Methods

The study area purposively selected were Iguoriakhi, Iyoha, Imasobor and Obagie Nevbosa communities in Edo State, Nigeria where smallholder RAS is being practiced on a large scale. To investigate the rubber-based agroforestry system and its impact on local livelihood in Edo state, Nigeria, the key informants were personally interviewed using structured questionnaires in which questions investigated the farming characteristics of the smallholder's farms and practical approaches to their respective Rubber agroforestry farms. A total of 60 questionnaire was administered interpersonally to 15 respondents in each of the communities selected. A descriptive statistics tool such as frequency and percentages presented as tables was used to interpret the variables of interest.

Results and Discussion

Farming practices of the respondents

The result of the farm characteristics of the smallholder rubber-based agroforestry farmers is represented in table (1). Result on plot size revealed that 46.67 % of the respondents had a plot size of 1 – 2 hectares, with 46.67 % of the respondents having between 8 to 10 years in farming experience. This finding is expected as the species in focus is a cash crop with an economic life span of 35 years (Idoko *et al*., 2013). Proximity to the smallholders farm lands from their community showed that majority 76.67 % had an average distance of 1 – 2 km to their respective Rubber farms. This is expected due to the planting density of Rubber stands which is approximately 500 ha^{-1}. Thus, the least hectarage to be used for Rubber farming is 2 ha for those farmers who venture into Rubber as a business venture. According to El Tahir *et al*., (2015), land is the primary source of livelihood for the farmers mainly. In rural development, land distribution is an important issue, the size of the land also dictates its utilization and where land is insufficient to support the basic needs of a family, there is a tendency for communities to encroach into protected areas such as forest reserves. Hence, the need to adopt and promote agroforestry practices that will intensify and diversify the system to create a more integrated, productive, profitable, healthy and sustainable land-use system (Asaah *et al*., 2014). This integration and interaction will promote agroecosystem functions (Tchoundjeu *et al*., 2006). Also, it was observed that majority 73.33 % of the smallholders belong to Rubber co-operatives while collective sales of their products accounted for 90.91 %. Interaction and trainings with extension officers on a yearly basis accounted for 65 % and 70 % respectively. Majority of the respondents were members of a co-operative society. For famers to be at abreast with new information and technical know-how of Rubber farming and related agricultural activities, it is imperative that the farmers interact with extension officers with similar mandate.

Table 1:Farming practices of the respondents

Categories	Variables	Freq.	%
Plot size of Rubber (hectare)	1 – 2	28	46.67
	3 – 4	26	43.33
	5 – 7	6	10
Proximity to farm (km)	1 – 2	46	76.67
	3 – 4	14	23.33
	Above 5	0	0

Farming experience (years)	4 – 7	19	31.67
	8 – 12	28	46.66
	13 – 18	13	21.67
Rubber co-operative	Yes	44	73.33
	No	16	26.67
Collective sales	Yes	40	90.91
	No	4	9.09
Interaction with extension officers	Monthly	18	30
	Quarterly	3	5
	Yearly	39	65
Trainings	Yes	42	70
	No	18	30

Source: Field Survey (2018)

Categorizes of the Rubber Agroforestry System

Table 2 depicts information on the categories of the Rubber Agroforestry System. Findings from the study showed that majority 50 % of the smallholders practiced Rubber-intercrop. Amongst these categories, the three most practiced system by the Rubber farmers according to the frequency of mention were Rubber and cassava intercrop, Rubber and maize intercrop and Rubber and honey bee with 43. 3 %, 25 % and 10 % respectively. According to Asaah *et al*., (2014), RAS promotes the development of alternative livelihood options through the production of domesticated planting materials and mini-livestock in a Rubber plantation. Information on Rubber related activities revealed that 26.7 % obtain their information from relevant agencies like R.R.I.N while majority of their planting materials where sourced from R.R.I.N and R.E.N.L with 40 % and 20 % respectively. The source of information on Rubber related activities is key to the successful implementation and output from farm produce, respondents reported that most of their information on Rubber related activities were through relevant agencies and knowledgeable farmer; planting materials was purchased mostly from R.R.I.N. or Rubber Estate Nigeria Limited (R.E.N.L.).

Table 2: Categorizes of the Rubber Agroforestry System

Categories	Variables	Freq.	%
RAS main systems	Rubber intercrop	30	50.0
	Rubber-shade tolerant trees	21	35.0
	Rubber mini-livestock	9	15.0
Prioritize Rubber Intercrop	Rubber cassava	26	43.33
	Rubber Honey	6	10.0
	Rubber Plantain	4	6.67
	Rubber Pineapple	3	5.0
	Rubber Maize	15	25.0
	Rubber Ogbono	2	3.33
	Rubber Rabbit	1	1.67
	Rubber Vegetable	3	5.0
Sources of related information RAS	Radio	6	10
	Knowledgeable farmer	10	16.67
	Newspaper	10	16.67
	Bulletin	9	15
	Periodicals	9	15
	Relevant agencies	16	26.66
Source of planting materials	Locally sourced	13	21.67
	R.R.I.N.	24	40.0

	R.E.N.L.	12	20.0
	Farmers nursery	11	18.33

Keys:

R.R.I.N. = Rubber Research Institute of Nigeria

R.E.N.L. = Rubber Estate Nigeria Limited

Contribution of Rubber-based agroforestry on smallholder livelihood

Table 3 revealed that 45 % of the respondents generates income between ₦50,000 - ₦100,000 from their intercrop within their Rubber farms monthly. Very few respondents 16.6 % earned above ₦250,000 monthly from their intercrop. This shows that the Smallholder rubber farmers generates sufficient income from intercropping the rubber-based system with fruit trees, medicinal plants, crops and mini-livestock. In the last decade, the adoption of RAS has provided additional economic and environmental advantages (Okwu-Abolo *et al.*, 2020). Consistent with this report, Chambon (2001) found that rubber agroforests performed considerably better than an appropriate rubber farming approach. Thus, RAS practice in the study area has positive impact on poverty alleviation through its contribution to farmer's income.

Table 3: Average annual income of derived from Rubber Agroforestry System

Categories	**Variables**	**Freq.**	**%**
Income (₦)	Below 50000	19	31.67
	50001 – 100,000	27	45
	100,001 – 150,000	4	6.67
	Above 150,001 – 200000	10	16.66

Conclusion

Despite the recent decline in Natural Rubber price, global rubber area continues to increase (FAO, 2018) and this will likely drive the intensification and expansion of plantations. Hence, this generates the need for investigating a Rubber-based system and its derivable impact on the smallholder's livelihood in Edo State, Nigeria.

Our findings revealed that this system contributes greatly to the socio-economic wellbeing of the smallholder rubber farmers in terms of income generation derived from the intercrop during the immature phase of Rubber, promotes the development of alternative livelihood options and also minimizes crop failures and environmental shocks. Thus, diversification of food crops in the system contributes to higher income and better livelihood security. Following the results obtained from this study, smallholder Rubber farmers are aware of the immense benefits derived from the RAS, it is therefore recommended that Government should further encourage these farmers by giving them incentives in form of subsidizing the high value planting materials, this act will promote and scale up Rubber Agroforestry System in Rubber producing States in Nigeria.

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Prospects of Forest Conservation in Environmental Sustainability Practise in Nigeria

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Abstract

This paper examines the predominant role of forest as an integral factor that can influence sustainable environment. It identifies forest as a natural resource that must be sustainably managed to maximize its contribution to the environment in Nigeria as well as the people. If forest is to contribute meaningfully to the economy its conservation must be taken seriously. To this end, the paper highlights certain factors that must be addressed to enhance the contributions of forest conservation to the realization of a sustainable environment. These include taking into account the status of the forest, importance of forest conservation and the factors responsible for forest degradation. The paper therefore recommends appropriate steps to forest conservation

Key words: environmental sustainability, forest conservation, challenges

Introduction

Forest conservation is the practice of planting and maintaining forested areas for the benefit and sustainability of future generations. It involves the upkeep of the natural resources within a forest that are beneficial to both humans and the environment. However, the history of the exploitation of forests is as old as man himself, but during earlier times it was balanced through a natural growth process because at that time forest cutting was done for personal or community use only. But with the expansion of agriculture, forest lands have been cleared. More destruction has been done after industrial revolution and urbanisation. During the colonial period commercial exploitation began and this was the main cause of the depletion of forests.

Forests contain nearly 75 percent of the earth's biomass (Cloughesy, 2006). They can be either sources or sinks of carbon, depending on the specific management regime and activities (IPCC, 2000). Due to forest variation, mainly in terms of their structure and type, the rate of sequestration varies. FAO (2010) stated that sustainable management, planting and rehabilitation of forest can conserve and increase the amount of carbon sequester which in turns gives rise to a healthy environment.

Forest Status

Nigeria is well endowed with forest resources, accounting for about 2.5 percent of the Gross Domestic Products. The resources abound in the high forests, woodlands, bush lands, plantations and trees on farmlands. The forests occupy about 10 million hectares representing almost 10 percent of the total land area of 92 377 hectares, while FAO (2009) puts Nigeria's forest area as 11,089 million hectares, representing only 12.2% of the total land area. The area of forest per 1000 people is given as 77 ha while the annual change was -2.7% and -3.3% for 1990 to 2000 and 2000 to 2005 respectively. The forest growing stock is given as 125 m3/ha while the total growing stock is given as 1386 million m3. The total biomass is 2803 million tonnes (253 tonnes/ha). The carbon in biomass is given as 1402 million tonnes or 126 tonnes/ha. These statistics show continuous annual negative changes as a result of degradation and deforestation. Nigeria has lost over 90% of its original forest cover due to logging, clearing for slash and burn agriculture and collection of NTFPs, especially firewood. Nigeria is Africa's most populous nation with a rapidly expanding population (140 million), resulting in an overwhelming demand for farmland and forest products. The forest estates from which wood and other products are obtained have been subjected to severe encroachments, vegetation degradation and de-reservation for agriculture, industrial development and urbanisation among others (Ighodaro et al, 2016).

Forest Degradation

Human activities have contributed significantly in shifting the composition of the earth atmosphere from its natural equilibrium (Bonsu 2007). Since 1991, estimate indicate that the global atmospheric concentration of CO_2 has been increasing at a rate of about 1.8 part per million (ppm) or 0,0018% per year (Rosenzweig and Hillel,1998). Agriculture and deforestation are two major factors responsible for greenhouse gases in the developing world. Deforestation means a complete change from forest to agriculture, urban areas or desert. Others include any area that has been logged, even if the cut was selected. Cunningham and Cunningham,2002). Forests sequester and store more carbon than any other terrestrial ecosystem and are an important natural 'brake' on climate change. The greenhouse effect is one of our most severe current environmental problems (Backéus *et al.*, 2005). Carbon (C) is accumulating in the atmosphere and the largest proportion is resulting from the burning of fossil fuels, deforestation and the conversion of tropical forests to agricultural production (Paustian *et al.*, 2000). Nikolic *et al*. (2008) also stated that land-use change through deforestation and degradation of natural forests diminishes overall carbon storage capacities in vegetation and in soils. When forests are cleared or degraded, their stored carbon is released into the atmosphere as carbon IV oxide. Emissions from land use, and land use changes mostly due to deforestation in the tropics, are estimated at 17% of total annual global CO_2 emissions (IPCC 2007).

FAO (2005) stated that in Africa, deforestation accounts for nearly 70% of total emissions. In the study of Houghton and Hackler (1999), two types of land-use change are distinguished: conversion of natural forest to cultivated crop land and the reverse, i.e. reforestation, and secondly, activities that don't change the forest area (ha) but the carbon density (Mg/ha), i.e. shifting cultivation, logging, fires, grazing of woodland and (fuel)-wood harvest can lead to a loss or accumulation of carbon. However, Houghton and Hackler (1999) state that the major contributor of carbon to atmosphere is the conversion of natural forest into cultivated crop land, as 20-50 times more C is stored in forest than in agricultural land, resulting in a release of 100-200MgC/ha, without counting the loss from C stored in the soil, which can be in a few years' time as much as 25% of the initially stored carbon in the top 100cm of soil .This can only be achieved through cultivation of new lands, such as opening new forest lands through intensification of production on a non-sustainable basis. Non-sustainable agricultural practices involving deforestation lead to partial oxidation of soil organic carbon and the release of CO_2 into the atmosphere. Trees soils and forest take in carbon at a rate that is determined by a number of factors including the type of forest, its location and it age. Forest store large amounts of carbon in trees and soil Also, consequence of deforestation and degradation are the release of the carbon originally held in the forest to the atmosphere, either immediately through the burning of the vegetation or more slowly as unburned organic matter decays. Cultivation further oxidizes 25-30% of the organic matter in the upper part of the soil and these are released into the atmosphere (Houghton, 2005). Deforestation and forest degradation are said to contribute to between 20 and 25% of the global greenhouse gas emissions. The burning of forests for the purpose of land clearing and the oxidation of carbon compound in the vegetation are additional sources of emissions of CO_2 through land use into the atmosphere (Parker, 2009). Plant production and decomposition determine C inputs into the soil profile. The type of vegetation cover may influence the abundance of organic C in the soil, which in turn affects plant production (Jobbagy and Jackson, 2000). Further, deforestation consequently leads to soil erosion which exposes organic carbon in the soil to rapid oxidation resulting in CO_2 release into the atmosphere. The office of the United Frame Work Convention on Climate Change(UNFCCC) now talks of rising concentration of greenhouse gases (GHGS) in the earth's atmosphere, resulting from economic and demographic growth over the past two centuries since the industrial revolution (Spore,2003). The effect of GHGS especially carbon dioxide (CO_2) the most abundant from human resource is to act like a blanket over the earth surface, keeping it warmer than it would otherwise be. The intergovernmental panel on climate change (IPCC) project that global mean temperatures on average by 1.4 5,8 degrees Celsius by 2010. may increase on an average. According to sathaye et al (2006) this unprecedented increase is expected to have severe impacts on the global hydrological system, ecosystem, sea level, crop production and related processes. The impact would particularly severe in the tropical areas, which mainly consist of developing countries including Nigeria. According to Bolin and Sukumar (2000) the oceans contains 39,000 gigatons of carbon fossil fuel deposits about 16,000Gtc, soil and vegetation about 2500Gtc, and the atmosphere 760Gtc. High temperatures in the tropics, promote rapid decomposition of soil organic carbon and the release of carbon dioxide into the atmosphere, thereby compounding the problem of global warning. However, negative changes in the global climate (rising temperatures, higher frequency of droughts and floods) are often the most consequential processes associated with an increased concentration of CO_2 in the atmosphere (USDA NRCS, 2000). A vital role of forests is recycling of air in the lower atmosphere and its ability to store and release carbon dioxide through natural processes. As a tree grows it takes in CO_2 from the atmosphere and releases oxygen in the process of photosynthesis. The carbon that is taken from the air is incorporated into sugars (such as glucose), that become the building blocks for production of wood. About one-half the weight of dry wood is carbon and that carbon is stored or sequestered as long as the wood is in existence. When trees die, decay or burn they release carbon stored in the soils and biomass (organic matter such as stems, stumps and slash) as CO_2 into the atmosphere. Carbon is also released as CO_2 when trees are harvested, although considerable carbon is stored in wood put into long-term use such as in houses, furniture, and books. As the amount of tree biomass increases (within a forest or in forest products) the increase in atmospheric CO_2 is mitigated.

Nigeria's Policy Formulation with Regards to Protection and Conservation of Forest

The forestry act which was promulgated in 1958 provides for the preservation of forests and the setting up of forest reserves. It is an offence, punishable with up to six months imprisonment, to cut down trees over 2ft in girth or to set fire to the forest except under special circumstances. The Federal Ministry of Environment, (2006) reported that one of the factors that militate against sustainable forest management is the absence of a National Forestry Act. Apart from using the provision of the Act to regulate forestry practices in Nigeria and to give also a legal backing for the National Forest Policy, it would further enable us to meet the obligations on the treaties and conventions relevant to forestry development to which Nigeria is a signatory. The Federal Ministry of Environment, (2006) also reported that the first ever National Forestry Act has been evolved to back the policy and have since been presented to the Council for ratification and to be passed into law.

There is a law that borders on conservation and protection of forests. This law should therefore be properly implemented and enforced to the law with proper policing and monitoring and stringent punishment. Aforestation and Reforestation programmes with incentives should be organized to recuperate the dwindling forests. Moderate Resolution Imaging Spectrometer (MODIS) should be launched onboard Nigeria's satellite so as to enable the monitoring of deforestation and necessitate quick action in case of unlawful deforestation. More studies using advanced models should be carried out to investigate the actual impact deforestation has on global warming/temperature increase and climate change in Nigeria.

Ways to Conserve the Forest

- **Controlled Deforestation**

While deforestation cannot be avoided completely, there are various steps to control it. Young and immature trees should not be felled as far as possible. We must look to avoid large-scale commercial deforestation as well. Adapting practices such as clear-cutting or selective cutting will be beneficial in the long run.

- **Protect against Forest Fires**

Forest fires are the most common and deadly cause of loss of forests. They can start due to natural causes or can be accidents caused by man or even intentional in some cases. Once a fire spreads in a forest it is very difficult to control. Precautions must be taken for such incidents. Making fire lanes, spreading chemicals to control fire, clearing out dry leaves and trees etc.

- **Reforestation and Afforestation**

The sustained yield concept dictates that whenever timber is removed, either by block cutting or by selective cutting, the denuded area must be reforested. This may be done by natural or artificial methods. Similarly, any forested land which has been destroyed by fire or mining activities should be reforested.

- **Better Farming Practices**

Slash and burn farming, overgrazing by cattle, shifting agriculture are all farming practices that are harmful to the environment and particularly to forests. these practices should be put under control.

Conclusion

The forest resources are valuable as an integral part of the ecosystem, from the commercial point of view, and as providers of shelter to wildlife the importance of forests cannot be underestimated as we depend on forests for our survival, from the air we breathe to the wood we use. Besides providing habitats for animals and livelihoods for humans, forests also offer watershed protection, prevent soil erosion and mitigate climate change.

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SUB-THEME C

CLIMATE CHANGE AND AGROMETEOROLOGY

Rice Farmers' Vulnerability to Climate Variability in the North Central Nigeria: A Vulnerability Composite Index Approach

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Abstract

Vulnerability assessments to climate change have a long history on multidisciplinary research. Identification and assessing the degree of vulnerability as a result of climate change is an essential pre-requisite for reducing climate change impacts. The broad objective is to develop composite index based on indicators/variables from exposure, sensitivity and adaptive capacity. Data were collected through structured questionnaire survey. A total of 15 environmental and socio-economic indicators were identified and analyzed to measure vulnerability status in the agricultural zones. Selected indicators were first normalized and then multiplied by appropriate weights to compute the exposure, sensitivity adaptive capacity and vulnerability indices. Scores of Exposure-Sensitivity Index (ESI) suggest that Kabba/Bunu (1.239), Lokoja (1.107), Kogi (1.203) were most prone and susceptible zones to climate change whereas Ibaji (0.718) is the least Exposed and sensitive zone. Katcha,(0.692), Ijumu (0.610), Kabba/Bunu (0.579) and Shiroro (0.575) are categorized under very high to high degree of vulnerability while Bassa (0.065), Ibaji (0.237) and Idah (0.332) were rated low vulnerable to climate change. These prioritized areas, based on rank and degree of vulnerability, should be given immediate consideration, and measures should be taken by internalizing region specific needs and by carrying out necessary changes in allocation of funds and resources to address the growing challenge of climate change.

Keyword: Climate change, Adaptive capacity, Exposure, Sensitivity, Composite index Vulnerability

Introduction

Climate change has become one of the most intervening global issues facing human kind and earth's natural system. Intergovernmental Panel on Climate Change (IPCC) (2007) refers climate change to a change in the state of the climate that can be identified by changes in the mean or the variability of its properties which persists for an extended period, typically decades or longer. According to Amajath-Babu, *et al*. (2016), climate change is a global challenge facing humans and their socio-economic activities, health, livelihood and food security with a more serious threat than global terrorism (King, 2004).

Nmadu *et al.* (2017) posited that about 90% of the total population in Nigeria depends on rain-fed agriculture for food production. Therefore, any changes in climate will have an impact on productivity and their social-economic activities in the country. The effects can be measured in term of its effects on crop growth, soil erosion, incidence of pests and diseases and availability of soil water. In Nigeria, the adverse impacts of climate change are already having their toll on the livelihood of people as farmland are being destroyed by floods, due to heavy rain falls. All the changes will aggravate the situation leading to increased vulnerability of the communities to the impacts of climate change and affecting sectors of the economy, especially agriculture, water, energy and health (Mugula, 2013). Vulnerability is a function of the character, magnitude and the rate of climate variation to which a system is exposed; its sensitivity and adaptive capacity (McCarthy *et al*. 2001), where, exposure can be interpreted as the direct danger and the nature and extent of changes to a region's climate variables (temperature, precipitation, rainfall, extreme weather events) while sensitivity describes the human-environmental conditions that can worsen the hazard or trigger an impact. However, adaptive capacity represents the potential to implement adaptation measures that help avert potential impacts

Brooks (2003) identified exposure, sensitivity and adaptive capacity as the three main components of vulnerability. Exposure is the degree to which a system is exposed to climatic variability like rainfall, temperature, precipitation and drought. Sensitivity on the other hand can be defined as the degree to which a system is affected either negatively or favorably by the climate variability while adaptive capacity is the ability of the system to cope up the negative effect of climatic variability.

Several approaches have been used by several authors in ranking zones. Swain and Mohanty (2010), Mohanty and Ram (2001) have developed different ranking techniques including multivariate ones to rank the districts / states of the country. In the present study, Composite Climate Change Vulnerability Index (CCCV) approach has been adopted to classify the agricultural zones according to different levels of vulnerability on the basis of some selected indicators mentioned below in the methodology.

Materials and Methods

Study Area

The study was carried out in Niger and Kogi States in North Central Nigeria. Niger State is located between latitudes 3^0, 20^1 and 7^0, 20^1E and between longitudes 8^0, 35^1 and 11^0 30^1 and with a total population of 4,412,037 (National Population Commission (NPC), 2006). Niger State experiences distinct dry and we seasons with annual rainfall varying from 1,100mm in the northern part to 1,600mm in the southern parts. Its maximum temperature is usually not more than 31^{0}C which can be recorded between December and January Kogi State is also located in the north central Nigeria.It comprise 21 local government areas and with a total land area of and with a population of 3,595,789 (NPC, 2006). The state is situated between latitude 6^{0}21^{1}N and 8^{0}45^{1}N and longitude 6^{0}E and 8^{0}E.). Kogi State has two seasons, the wet and dry. The wet season begins in March and ends in October, while the dry season spans between Novembers to early March. The annual rainfall is between 1016mm and 1524mm while mean temperature ranges between 24^{o}C and 27^{o}C (National Bureau of Statistics, 2016).

Sampling Techniques and Data Collection

In order to select a representative sample of the respondents for this study, multistage and stratified sampling techniques were adopted. The North Central Nigeria comprises six states but Niger and Kogi States were purposively selected in the first stage considering their greater production of local rice and stratified into agricultural zones. The second stage involves random selection of two local government area each from all the agricultural zones. Thirdly, two (2) villages were randomly selected based on the enumeration areas making a total of twenty eight (28) villages in all. Sampling frame of households was generated using the 2006 population census enumeration area list. However, Taro Yamane's (1967) formula was used to generate the sampled size at 8% and 9% precision respectively for Niger and Kogi States from each of the agricultural zones. Lastly, a total of two hundred and seventy nine (279) household rice farmers' were interviewed in the study areas. However, one hundred and fifty six (156) from Niger State while one hundred and twenty three (123) from Kogi State were selected to make up the two hundred and seventy nine rice farmers'. The Yamane, (1967) formula is $n = \frac{N}{1+N(e)^2}$

In this study fifteen (15) important indicators have been selected to measure the level of rice farmers' vulnerability in the zones as showed in Table 1

Table 1 showing the distribution of Exposure, Sensitivity and Adaptive Capacity

S/N	Exposure indicators	Sensitivity indicators	Adaptation capacity
1	Percentage change in rainfall from the base year value (E1)	Population density (S1)	Member of association (AC1
2	Change in maximum temperature (E2)	Rice output (S2)	Percentage with access to credit (AC2)

3	Change in minimum temperature (E3)	Percentage of smallholder farmers (S3)	Percentage with access to health clinic (AC3)
4		Percentage of malaria fever (S4)	Distance to the market to sell produce (AC4)
5		Percentage of male households head (S5)	Average farm size (AC5)
6		Percentage Area not cultivated (S6)	Literacy rate (AC6)

The model is given implicitly as

Vulnerability = [Adaptive capacity – [Exposure + Sensitivity]

It can thus be written mathematically as

V = f(I – AC) ………………………………………………………………..(1)

Where

V = Vulnerability, I = Impact (exposure + sensitivity), AC = Adaptive capacity

Vulnerability indicators were normalized in order to obtain indicator which are free from units and scales. Suppose we have collected information on change in maximum temperature or change in annual rainfall, it is clear that the higher the values of these indicators, the more will be the vulnerability of the region to climate change. In this case we say that the variables have upward functional relationship with vulnerability and the normalization is done using the formula in equation (2) and all the scores will lie between 0 and 1. The indicators/variables have different units and have different functional relationship with vulnerability. The Mini-Max Method normalization equations for an upward and downward functional relationship are;

The upward functional relationship is

$$X_{ij} = \frac{X_{ij - \underset{i}{Min}\langle Xij \rangle}}{\underset{ii}{Max\{X_{ij}\} - Min\langle X_{ij} \rangle}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (2)$$

While the downward normalization functions stated that

$$y_{ij} = \frac{Max\{X_{ij}\} - X_{ij}}{\underset{ii}{Max\{X_{ij}\} - Min\langle X_{ij} \rangle}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (3)$$

Where Xi represents the value of the I-th variable and is either positive or otherwise with the vulnerability of the zone. The choice of weights in this matter would ensure that larger variation in any one of the indicators would not unduly dominate the contribution of the rest of the indicators and distort inter regional comparisons. However, we opted for a simple average of the scores to construct the vulnerability index and for a meaningful categorization of the different stages of vulnerability, quartiles was calculated and used to classify the zones.

Results and Discussions

Exposure Index: Zones-wise scores of exposure and sensitivity index and classification of zone under different degrees of exposure have been given in Table 2

Table 2 showing the score of Exposure and sensitivity index with degrees of Exposure and Sensitivity

Zone	Exposure Index	Rank	Degree of Exposure	Sensitivity	Rank	Degree of Sensitivity
Katcha	0.54	7	High	0.493	7	High
Mokwa	0.515	9	Medium	0.284	13	Low
Wushishi	0.401	14	Low	0.393	8	Medium
Mariga	0.568	4	Very high	0.365	9	Medium
Shiroro	0.690	1	Very high	0.288	12	Low
Paikoro	0.680	2	Very high	0.296	11	Medium
Bassa	0.400	13	Low	0.331	10	Medium
Ibaji	0.441	12	Low	0.277	14	Low
Ijumu	0.496	10	Medium	0.582	3	Very high
Kabba/Bunu	0.510	8	Medium	0.729	1	Very high
Kogi	0.562	5	High	0.545	5	High
Lokoja	0.599	3	Very high	0.604	2	Very high
Idah	0.454	11	Medium	0.543	6	High
Omalla	0.520	6	High	0.548	4	Very high

Table 2 showed that Paikoro (0.680), Shiroro (0.69), Kogi (0.560) and Lokoja (0.599) zone emerged most highly exposed climate change/variability because they have exposure score that is more than 0.560 as per quartile analysis under the high degree of exposure while Wushishi, Bassa and Ibaji emerged as least exposed zone. This agrees with Kumar et al., (2016) in the study of assessment of vulnerability to climate change in Karnataka.

Sensitivity Index: The result showed that Kabba/Bunu (0.729) was rated as highly sensitive while Ibaji (0.277) was rated as least sensitive zone. Rural population densities, area under small and marginal farmer, household dependent on family farm for food and crop diversity index were the major factors for high sensitivity in the zone.

Adaptive Capacity Index: Table 1 showed estimated set of proxy socio-economic indicators for adaptive capacity to cope with the impact of the climate variability in the zone. Lokoja, Bassa, Idah and Kogi (0.762, 0.705, 0.667 and 0.644) respectively ranked high in terms of adaptive capacity while Wushishi, Mokwa, Shiroro and Katcha ranked least in adaptive capacity as showed in Table 3. High adaptive capacity in the area could be as a result of increase in net irrigated area, access to information on climate variability and increase in literacy rate of the farmers.

Table 3 showing score of Adaptive Capacity, Exposure and Sensitivity and Vulnerability index

Zone	AC	Rank	Degree of AC	ESI	Rank	Degree of ESI	VI	Rank	Degree if Vulnerability
Katcha	0.340	14	Low	1.032	6	High	0.692	1	Very High
Mokwa	0.434	12	Low	0.797	12	Low	0.363	10	Medium
Wushishi	0.449	11	Medium	0.794	11	Medium	0.345	11	Medium
Mariga	0.538	7	High	0.955	10	Medium	0.417	9	Medium
Shiroro	0.403	13	Low	0.978	8	Medium	0.575	4	Very High
Paikoro	0.527	8	Medium	0.976	9	Medium	0.449	7	High
Bassa	0.577	2	Very high	0.732	13	Low	0.065	14	Low
Ibaji	0.481	9	Medium	0.718	14	Low	0.237	13	Low
Ijumu	0.468	10	Medium	1.078	4	Very High	0.61	2	Very High
Kabba/Bunu	0.544	6	High	1.239	1	Very High	0.579	3	Very High
Kogi	0.644	4	Very high	1.107	3	Very High	0.463	6	High

Lokoja	0.762	1	Very high	1.203	2	Very High	0.441	8	Medium
Idah	0.667	3	Very high	0.997	7	High	0.332	12	Low
Omalla	0.574	5	High	1.068	5	High	0.494	5	High

Vulnerability Index: The results showed that Katcha (0.692) was the most vulnerable zone on the account of being poor in adaptive capacity and are prone in terms of exposure-sensitivity, followed by Ijumu (0.610), Kabba/Bunu (0.579) and Shiroro (0.575) respectively. The finding is in conformity with vulnerability status reported by Kumar *et al* (2016) using a composite index.

Conclusions

This study focused on the micro-level to assess the variability of vulnerability across different zones. The climate change vulnerability index obtained from this study will assist policy makers, donor organizations, farmers and government in making decision to climate variability developments and support to reduce vulnerability rural farmers in the North Central Nigeria.The composite vulnerability index explains that rice farmers in Katcha, Ijumu, Shiroro and Kabba/Bunu zones were more vulnerable to adverse effects of climate variability.

In other to moderate the damaging effects of exposure and reduced sensitivity, there is need to take the adaptive measures such as provision of infrastructure, conserving *in-situ* soil moisture and augmenting groundwater and rain harvesting for supplemental irrigation that will enhance farmers' wealth and assets. There is need also to put in place holistic approach moderating exposure level, sensitivity and enhancing adaptation strategies/resources for sustaining the rice farmers' in the wake of frequent climate aberrations manifested in the form of erratic rainfall pattern and moderate droughts.

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Mitigating Strategies to Climate Change by Potato Farmers in Bokkos Local Government Area, Plateau State, Nigeria

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Abstract:

This study assessed mitigating strategies to climate change by potato farmers in Bokkos Local Government Area, Plateau State, Nigeria. Questionnaire was used to collect data from a sample of 304 respondents in four (4) districts of the LGA. Data were sampled through simple random sampling techniques. The study revealed major effects of climate change in the study to include low rainfall ($\bar{x}$ =3.47), early cessation of rain ($\bar{x}$ =3.04), incidence of pests and diseases ($\bar{x}$ =2.99), low yield ($\bar{x}$ =2.97) among others. Mitigating strategies adopted by potato farmers against climate change on their source of livelihood include planting early maturing cultivars ($\bar{x}$ =2.84), planting at the onset of rain ($\bar{x}$ =2.81), use of agro chemicals ($\bar{x}$ =2.77) and observing spraying regime ($\bar{x}$ =2.50) among others. The study therefore recommends that there is need for the development and dissemination of agricultural technologies such as early-maturing varieties, disease/pest resistant varieties, drought resistant varieties by research institutions and that Governmental organizations should support small-holder farmers by providing the improved varieties of potato seeds at a subsidized rate.

Keywords: Mitigating Strategies, Climate, Potato, Farmers

Introduction

Potato (*Solanum tuberrosu L*) is one of the tuber crops grown cultivated in Jos, Plateau State, Nigeria. It ranked fourth in the world as food crop after maize, rice and wheat (FAO, 2010). It is one of mankind's most valuable food crops in the world. Potato is important to the national food security because it takes short time to mature and has high yield (3.9 tons/ha) compared to other root and tuber crops that have the yield of one ton/ha (Wuyep, *et al* 2015).

Potato is an important source of nutrient, revenue and employment. Findings shows that Jos Plateau has a sole comparative advantages in potato production in Nigeria because of its temperate climatic condition which meets the condition for the production in both rainy and dry seasons Maddison, D. (2006). Over the years the temperate climatic condition of Plateau State has supported the successful production of potato; however with climate change threat a decline in annual yield of potato production generally has been recorded.

Climate change is a shift in the average weather condition of a given area experienced over a period of time (Krishna, 2011). It is an insistent alteration in climate parameters (temperature, rainfall, humidity and soil moisture) and atmospheric gases due to variation in the statistical distribution of weather condition over time which range from decades to millions of years. Alteration in the atmospheric composition is attributed to the emission of greenhouse gases such as methane (NH_4), Carbon IV Oxide (CO_2), Nitrogen II Oxide (N_2O) and other gases (Alade and Ademola 2013). Climate change according to Adejowon (2004); Odewumi, *et al* (2003) is the most serious environmental threat to agricultural production. Direct impact of climate change on agricultural system include changes in temperature and rainfall which could impacts on agro climatic conditions, altering planting and growing seasons, harvesting calendars, water availability, pest prevalence, weed and disease populations (Nelson, *et al* 2009).

Agricultural production in Nigeria which is the major source of survival for the rural people is apparently affected by climate-related shock; this is usually manifested by the occurrence of pest and insect infestations as well as land degradation problems (Obioha, 2009); and in climate change impacts alternation in evapo-transpiration, photosynthesis, biomass production and land sustainability for agricultural production (Obiohia, 2009; Ozor and Madukwe, 2012). Deressa (2006) stated that climate change has negatively affected farmers of both crops and livestock and has increased the frequency of extreme events such as drought and flooding which has reduced soil fertility and yield from crop production and livestock keeping. There has also been loss of some major crops due to the threats of climate change; accordingly, farmers are trying to keep up by cultivating crops that are able to survive short or no rainfall.

In the word of Stem (2007) climate change is threatening to undo decades of development efforts due to its negative impacts on agriculture, health, environment, roads, and buildings especially in developing countries. It affects both food and water resources that are critical for livelihood in Africa, where most population especially the poor, rely on local supply system that are sensitive to climate change to survive. However, adaptation to climate change requires that farmers must first perceive that climate has changed, identify useful adaptations and implement necessary mitigating responses (Maddison, 2006). Obioha (2019) noted that the sustainability of the environments to provide all life support system and the materials for fulfilling all developmental severity to man depend on suitability of the climate which is undergoing constant changes. The effect of these changes is posing threat to food security in Nigeria and world at large.

This paper therefore assessed mitigating strategies to climate change by potato farmers in Bokkos Local Government Area, Plateau State, Nigeria. Specific objectives are:

i. To identify effects of climate change on potato production; and

ii. To determine mitigating strategies to climate change in the study area.

Methodology

This study was conducted in Bokkos Local Government Area (LGA), Plateau State, Nigeria. Bokkos LGA is one of the 17 LGAs in Plateau State. It is located between latitudes 9^0 8'00 North and longitude 9^0 00'00 East and covers a land area of about 1,682 km^2. The estimated population of the LGA was about 193,392,500 persons (National Population Commission (NPC, 2006). It has a temperate climatic condition which favor's the growth of different crops such as maize potato, sorghum, cowpea, fruits and vegetables and also livestock production. The primary occupation of the populace is farming.

The population of this study comprised all potato farmers in the LGA. Out of seven (7) districts in the LGA, four (4) districts were purposively selected because of their involvement in potato production and were used for the study. In each of the four (4) districts selected, eighty (80) respondents were selected using simple randomly sampling method which gave a population size of three hundred and twenty (320) respondents. Questionnaire was used to collect data. Out of the three hundred and twenty (320) copies of questionnaire distributed, three hundred and four (304) copied were retrieved and used for analysis.

A four point Likert-type scale of "strongly agree (4)", "agree (3)", "disagree (2) and strongly disagree (1) was used for objective two and three. The values were added to obtain 10 which were further divided by 4 to obtain a mean of 2.5. Any mean value that is equal or greater than 2.5 was regarded a major effect and major mitigating strategy, while a mean score of less than 2.5 was regarded as a minor effect and minor mitigating strategy.

Results and Discussion

Perceived Effects of Climate Change in the Study Area

The study revealed that low rainfall ($\bar{x}$ =3.47), early cessation of rain ($\bar{x}$ = 3.04), incidence of pests and diseases ($\bar{x}$ =2.99) and low yield ($\bar{x}$ =2.97) among others were the major effects of climate change in the study area. Low soil fertility was found to be a minor effect of climate change in the study area as it is below the cut-off mean of (2.50) (Table 2). This implies that climate change has negatively affected potato production in the study area. This is affirmed by Deressa (2006) who recapitulate that agriculture is the most important sector but has been negatively impacted by climate change.

Table 1: Effects of Climate Change on Potato Production

Effects	Mean Score	Standard Deviation	Ranking
Low rainfall	3.47	0.832	1
Late on-set of rain	2.58	0.728	7
Early cessation of rain	3.05	0.843	2
Incidence of pest and disease	2.99	0.903	3
Low yield	2.97	0.959	4
Loss of soil fertility	2.33	1.013	8
Erratic rainfall	2.82	0.849	5
High temperature	2.80	1.002	6

Source: Field Survey, (2019); Cut-off Mean ($\bar{x}$ =2.50)

Table 3 revealed mitigating strategies adopted by the farmers to manage the adverse effects of climate change on potato farming in the study area. Planting early maturing variety of potato ($\bar{x}$ =2.84), planting potato at onset of rain ($\bar{x}$ =2.81), use of agro-chemicals (pesticides and herbicides) ($\bar{x}$ =2.77), use of inorganic fertilizer ($\bar{x}$ =2.72) among other strategies were the major mitigating strategies over climate change adopted by potato farmers in the study area. This result is in concurrence with Wuyep, Ari and Samuel (2019) who recapped that majority of farmers use improves crop varieties, maturing cultivars, pest and disease resistant varieties, inorganic pesticides and fertilizer as mitigating strategies against climate change on small scale agriculture.

Table 2: Mitigating Strategies to Climate Change in the study area

Mitigating Strategies	Mean score	Standard Deviation
Planting early maturing variety of potato	2.84	0.941
Planting potato at onset of rain	2.81	0.966
Changing the planting date for potato	2.56	0.899

Plant disease resistance variety	2.57	0.891
Plant pest resistance variety	2.43	1.004
Planting in off season (ending July and August)	2.53	1.090
Observing spraying regime	2.51	0.963
Crop diversification	2.46	0.975
Provision of irrigation	2.23	0.995
Mix cropping	2.22	0.949
Use information on weather and climate	2.63	1.082
Use of inorganic fertilizer	2.72	0.924
Use of agro-chemicals (pesticides and herbicides)	2.77	0.873
Use of proper land management practices(drainage, ridge construction among others)	2.51	0.812

Source: Field Survey, 2019; Cut-off Mean ($\bar{x}$ =2.50)

Conclusion

Majority of the respondents were males, married with relatively large household size, had formal education and relatively fair experience in potato farming. The study revealed major effects of climate change in the study area to include low rainfall, early cessation of rain, incidence of pests and diseases, low yield among others. Mitigating strategies adopted by potato farmers against climate change on their source of livelihood include planting early maturing cultivars, planting at the onset of rain, use of agro chemicals and observing spraying regime among others.

Recommendations

The study recommends that

i. There is need for the development and dissemination of agricultural technologies such as early-maturing varieties, disease/pest resistant varieties, and drought resistant varieties by research institutions.

ii. Governmental organizations should support small-holder farmers by providing improved varieties (early maturing and disease/pest resistant varieties) of potato seeds at a subsidized rate.

iii. Farmers should be provided with accurate weather forecasts to enable them fully exploit seasonal rainfall distribution to improve and stabilize crop yields.

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Climate variability and its impact on the yield of cassava and yam: A case of Benue state, Nigeria

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Abstract

Benue state has continuously experienced floods, which is a manifestation of climate change. How this climate change manifestation affects the production and productivity of cassava and yam that are the major livelihood sources of majority of the farmers in the state remains largely underestimated. This paper examines the impact of climate change on the productivity of cassava and yam with specific interest in assessing changes in climate variables; estimating growth rate in production and productivity of the crops and evaluating the impact of selected climate variables on the productivity of the crops. Data on climate variables were obtained from NIMET and the worldweatheronline.com from 1999 to 2018, while crop yield data for the same period were sourced from Benue State Agricultural and Rural Development Authority Agency (BNARDA), Makurdi. This study employed quantitative approach using linear regression model and descriptive statistic to determine the impact of temperature and rainfall on cassava and yam production and productivity. The findings reveal that the area under cassava cultivation has been growing while output of cassava has been on the decrease. Temperature was found to have a positive effect on the yield of yam within the years under review. The cropping area for both cassava and yam was also found to positively influence yield of both crops. This study thus recommends among other things, educating extension workers and farmers generally on issues concerning climate change and specifically on the causes, indicators and effects of climate change on agriculture.

Keywords: Climate change, Cassava, Yam, Productivity, Benue state

Introduction

In Nigeria, agriculture is the largest sector of the economy and employs two-thirds of the entire labour force (FAO, 2020). It is predominantly a rain fed system and hence vulnerable to climate change (NFNC, 2003). Dominant crops cultivated in the country include yam, cassava, maize, sorghum, millet, rice and among others. Cassava and yam are important staple foods and cash crops in several tropical countries especially Nigeria where they play principal role in food security. Nigeria is the highest producer of both cassava and yam in the world with an output of57 million tons and 44 Million tons respectively in 2016 (FAOSTAT, 2016).

Despite the fact that these plants grow and produce well in the Nigerian environment, it has shown different growth behaviour and yield in different years as a result of differences in the annual weather condition. This is because climate variability has possibility of degrading soil and water resources and subsequently subsistence agricultural production, which is largely practised by root and tuber crops farmers (Pidwirny and Sidney, 2007). Temperature and precipitation are dominant climatic factors that affect crop yield and they vary widely throughout the year and over time (Alexandrov & Hoogenboom, 2000). In a study conducted by Nwalem et al. (2019) in Benue State, Nigeria, climate change have caused a shift in the timing of rainfall, drought, extreme temperatures, floods, excess rain, nutrient leaching, soil erosion, pest and disease infestation. According to Kuta (2011) local farmers are seriously concerned about weather variations because of the impact on food security, availability, stability, accessibility and utilization. The change in weather affects livestock, forestry, fisheries and decreases plant species including cassava and yam that are important food security crops (Gumm, 2010). The above scenario has made it imperative to assess the effect of climatic variables on cassava and yam in the state.

Methodology

Study area

This study was conducted in Benue state, Nigeria. Makurdi is the capital of Benue state and it has a land mass of 6.595 million hectares (BNARDA 1998). Agriculture is the backbone of Benue state's economy, and the state is the primary source of food in Nigeria acclaiming the slogan 'the food basket of the nation.' Benue state is endowed with fertile arable land and abundant raw materials and human resources with about 80% of the population directly involved in agriculture (Akaakohol and Aye 2014). Based on its unique location, climatic condition, fertile land, and resources, the state is believed to have the highest opportunity for agricultural investment than any other state in Nigeria. Benue state manifests two major seasons, the rainy season from around April to October and the dry season from November to March. Annual average rainfall varies from 1750 mm in the Southern part of the State to 1250 mm in the North (Nwalem et al. 2016).

Method of Data Collection

Secondary data for climate variables were obtained fromliterature, Nigerian Meteorological Agency Headquarters, Tactical Air Command Makurdi Airport and worldweatheronline.com while cassava and yam yield data were collected from Benue State Agricultural and Rural Development Authority Agency (BNARDA), Makurdi. The secondary data collected include climatic data, yield and cultivated area. The period of study spans 1999-2018.

Model specification

The study employs linear regression model (Gujarati, 2013), to determine the impact of rainfall, temperature and area cultivated on the yield of cassava and yam in Benue State from 1999 to 2018.

The model is specified as:

$Yt = \beta o + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots \mu$

Where, Y = Cassava output or Yam output at time i *i*

X1 =Temperature

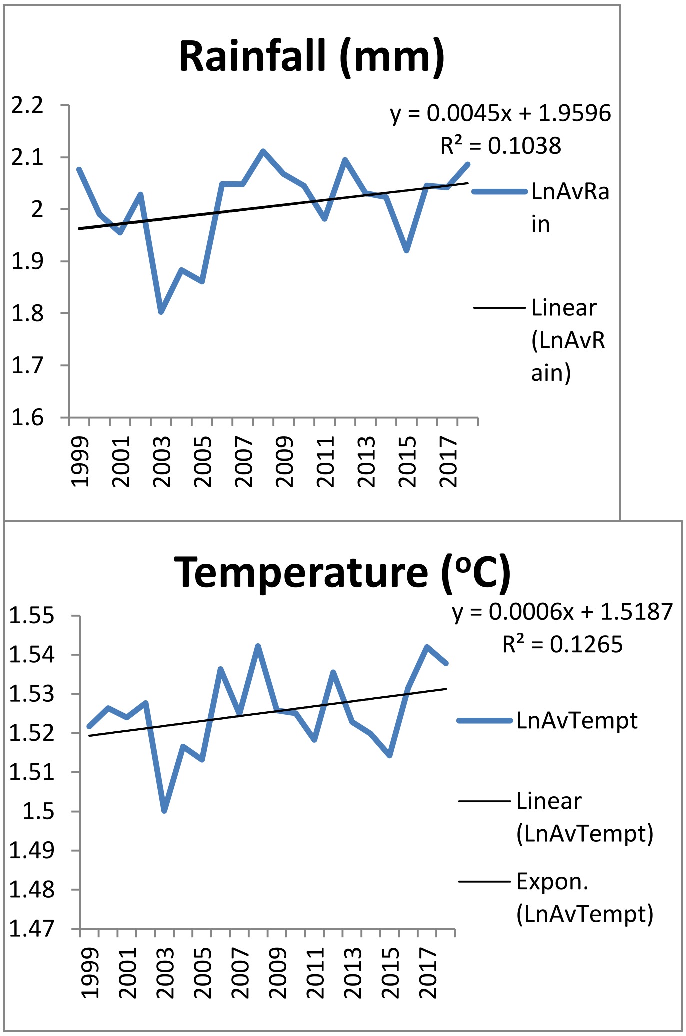
X2 =Rainfalls

μ = Stochastic term

β_0, β_1 *and* β_2= constants

Results and Discussion

Fig. 1: Trend Analysis Plot for rainfall and temperature in Benue state (1999 – 2018)



In figure 1, it could be seen that the trend in the annual rainfall of Benue state has been unstable, with precipitation level at the highest in 2008 and at the lowest in 2003. The estimated anomalies of the climate variables indicated that the amount of rainfall varied appreciably from year to year (Oluwasegun et al, 2010). The trend forecast indicated that the level of precipitation in Benue state will also increase in the next five years which could lead to flooding. The trend in the annual temperature of Benue state has also been unstable, with the temperature hitting the highest point in the year 2000. It is expected that the annual temperature will continue to increase from the five years' trend forecast.

The Rate of Growth in Production and Productivity of Cassava and Yam

Linear regression was used to examine the growth rate in production and productivity of cassava and yam and also establish whether the crops experienced stagnation, acceleration or deceleration within the study period.

Table 1: Estimated Growth Rate in Production and Productivity of Cassava and Yam

Variable	Coefficient	Std. Error	t-statistic	Probability
Production of cassava	75.31263	22.49611	3.35	0.004
Productivity of cassava	-32.85482	16.02777	-2.05	0.056
Constant	1940.555	39.07554	49.66	0.000
R^2	0.4090			
Adjusted-R^2	0.3395			
F-stat	5.88			
Production of yam	-18.83924	29.07537	-0.65	0.526
Productivity of yam	5.488701	29.53671	0.19	0.855
Constant	2033.579	55.51754	36.63	0.000
R^2	0.0524			
Adjusted-R^2	-0.0591			
F-stat	0.47			

The result presented in Table 1 showed that cassava production recorded positive and significant growth during the period. This implies that cassava per area cultivated experienced acceleration within the period. The apparent enabling environment, that fostered the country's comparative advantage coupled with the multiplicity of expansion programmes such as the presidential initiatives and Cassava Transformation Agenda have played contributory roles. However, productivity of cassava recorded negative and significant growth during the period. This implies that the output/yield of cassava experienced a deceleration within the period. This does not conform to a priori expectation. This could be because of degrading soil caused by climate variability.

On the other hand, the coefficient for production of yam recorded a negative and not significant growth during the period while productivity experienced a positive and not significant growth within the period. This implies that the production and productivity of yam in the state experienced stagnation within the period under review. This could be because of the fact that contrary to the numerous interventions in cassava, yam is yet to have its own significant share of interventions.

Table 2 shows determination of effect of rainfall, temperature and area under cultivation on cassava and yam productivity in Benue State, Nigeria (1999 – 2018)

Table 2: Determinants of Cassava and Yam yields in Benue state, Nigeria (1999 to 2018)

	Yield of cassava	**Yield of yam**
Temperature	11.7748 (0.05)	221.1676 (2.00*)
Rainfall (mm)	4.303447 (0.39)	-5.782171 (-1.17)
Area cultivated	13.99258 (8.42***)	9.521286 (9.99***)
Constant	-1181.47 (-0.16)	-6140.995 (-1.86*)
R^2	0.8415	0.8786
R^2- Adjusted	0.8118	0.8559
F	28.32***	38.61***

The effect of rainfall, temperature and area under cultivation were regressed with yield of cassava and yam as dependent variables (Y) using Ordinary Least Squares regression.

For cassava, the $R^2$was highly significant at 1% level of probability. The R^2 value of 0.8415 indicates that 84.15% variability of cassava yield was explained by the independent variables. The F-values was also highly significant at 1% indicating a regression of best fit. Temperature and rainfall had positive coefficients but were not statistically significant. This implies that temperature and rainfall had no significant effect on the productivity of cassava in the state within the period under review. However, area cultivated had a positive coefficient and was statistically significant at 1% level of probability. This implies that a 1% increase in area cultivated with cassava will led to a 14% increase in cassava yield from 1999 – 2018.

In the case of yam, the R^2 was also highly significant at 1% level of probability. The R^2 value of 0.8786 indicates that 87.86% variability of yam output was explained by the independent variables. The F-values was also highly significant at 1% indicating a regression of best fit. Temperature had a positive coefficient and was statistically significant. at 10% level of probability. This indicates that increase in the temperature over a period could lead to an increase in yam productivity. This could be because yam requires temperatures between 25 and 30°C to develop normally (IITA, 2020). Rainfall had a negative coefficient but was not statistically significant. This implies that rainfall had no significant effect on the productivity of yam in the state within the period under review. On the other hand, area cultivated had a positive coefficient and was statistically significant at 1% level of probability. This implies that a 1% increase in area cultivated with yam led to a 10% increase in the productivity of yam between 1999 and 2018.

Summary of major findings

- Despite an increase in area cultivated with cassava in the state, productivity has been on the decline.
- Production and productivity of yam in the state within the period under review was stagnated
- Variation in the yield of yam in Benue State could be attributed to climate variability (variation in temperature).

Conclusion and recommendations

The study examined the effects of temperature and rainfall variability on cassava and yam productivity in Benue State from 2000 to 2018. The result obtained from the regression statistics reveals that climate has an effect on yam productivity within the years under consideration. This study thus recommends:

- Provision of inputs like fertilizer to farmers to enable them increase their productivity
- Government should fund research and sponsor interventions in yam in order to increase its production and productivity
- Education of extension workers and farmers generally on issues concerning climate change and specifically on the causes and adaptation/coping strategies.

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Climate smart agricultural techniques and the need for proper post-harvest management in the face of changing weather condition

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Abstract

Agriculture which is the bedrock occupation of most rural households in Nigeria had witnessed a lot of challenges in recent times due to total neglect, preference for crude oil and other notable factors most importantly climate change variations. Empirical studies have shown that climate change will distort the economic growth direction and increase the poverty status of Nigerian farming households, hence the introduction cum innovations of climatic smart agricultural techniques and the need for proper post-harvest management. The study outlined the goals of climatic smart agriculture to be mitigation, adaptation and increased productivity which is a three-win strategy for sustained food availability and security. Climate smart technologies include solar energy techniques, green house technology and climate resilient storage structures. It is therefore recommended that farmers in Nigeria should adopt (CSA) as an alternative measure for increased food productivity in the face of climatic changes. Government and other relevant stake holders in agriculture should also integrate efforts to sustain CSA at all levels to achieve food sufficiency in Nigeria. Furthermore, there is need for adequate post-harvest management and climate smart techniques to curb the effect of climate change. Pre and post-harvest techniques that are climate smart should be encouraged among farming households and communities and the need for use of modern storage technologies.

Keywords: Agriculture, Climate Smart Techniques, Household Farmers, Post-Harvest Management

Introduction

Agriculture is the cultivation of crops and practice of animal husbandry to provide food, wool and other products. Agriculture remains central to most African countries economies and its growth has major implications for the region's food security and poverty reduction (Onyeneke *et al.,* 2019). Its contributions to gross domestic product (GDP) in Nigeria have dropped drastically owing to total neglect, preference for crude oil and other notable factors most importantly climate change variations (Osuji *et al.,* 2020). Empirical studies have shown that climate change will distort the economic growth direction and increase the poverty status of Nigerian farming households if not checkmated (Osuji *et al.,* 2019). This has initiated the innovations of climatic smart agricultural techniques and the need for proper post-harvest management to cushion the climatic adverse effects on agricultural production and stored produce.

Climate smart agriculture (CSA) involves farming practices that improve farm productivity and profitability, help farmers adapt to the negative effects of climate change and mitigate climate change effects, e.g. by soil carbon sequestration or reductions in greenhouse gas emissions. Climate smart agriculture is evidently an integrated approach to managing landscapes, cropland, livestock, forests and fisheries that address the interlinked challenges of food security and climate change (Chandra *et al.,* 2018). Heavy precipitation as a result of moist weather conditions may cause grains to absorb more moisture content above the recommended optimum moisture content for storage (Kumar *et al.,* 2020). Increase in moisture content will encourage the growth of fungi species and mould thereby causing huge loses in stored grains. Moisture content of stored produce increases in the presence of high ambient humidity encouraging the contamination of grains with mycotoxins that are toxic to human health. Drying of grains in moist weather conditions will require a longer drying time and sometimes it is impossible to achieve. High temperature results in fast drying of crop residue in fields and deterioration of bioactive compounds in crops. Increased vulnerability of high temperature and elevated levels of carbon dioxide and ozone causes change in the physicochemical quality of fruits and vegetables causing decrease in organic acid content, flavonoids and antioxidants and unacceptable firmness. High temperature facilities risk of fire hazards of mature crops and encourages shorter life cycle, new area of breeding and faster reproduction of insects and pest thereby helping in the quick deterioration of stored grains. Infected grains are thrown away (wasted) contributing to greenhouse gas emission or retreated (sorting, winnowing, drying and fumigation) and restored.

Goals of Climate Smart Agriculture

Climate change is expected to negatively impact at least 22% of the cultivated land area for the most important crops by 2050 (Karlsson *et al.,* 2018). As a result this has necessitated the core objectives and/or goals of climate smart agriculture which are;

Mitigation: CSA help to minimize and/or eradicate greenhouse gas (GHG) emissions wherever possible. This means that it has the capacity to minimize emissions for every calorie or kilo of fruit, fiber and fuel we generate. In essence, agricultural deforestation should be reduced and soils and trees should be treated in ways that optimize their potential to acts as carbon sinks and absorb CO2 from the atmosphere (Henri-Ukoha *et al.,* 2019).

Adaptation: CSA aims to minimize farmers' exposure to short-term risks, while at the same time improving their resilience by developing their adaptive potential. Particular attention is paid to the conservation of ecosystem resources. These practices are important for sustaining efficiency and farmers' ability to adapt to climate change variations.

Productivity: The goal of the CSA is to increase agricultural productivity and income from crops; livestock's and fishes in a sustainable manner without adversely affecting the climate. In exchange, this will improve food and nutritional protection. Sustainable intensification CSA is a key principle linked to rising productivity of household farmers.

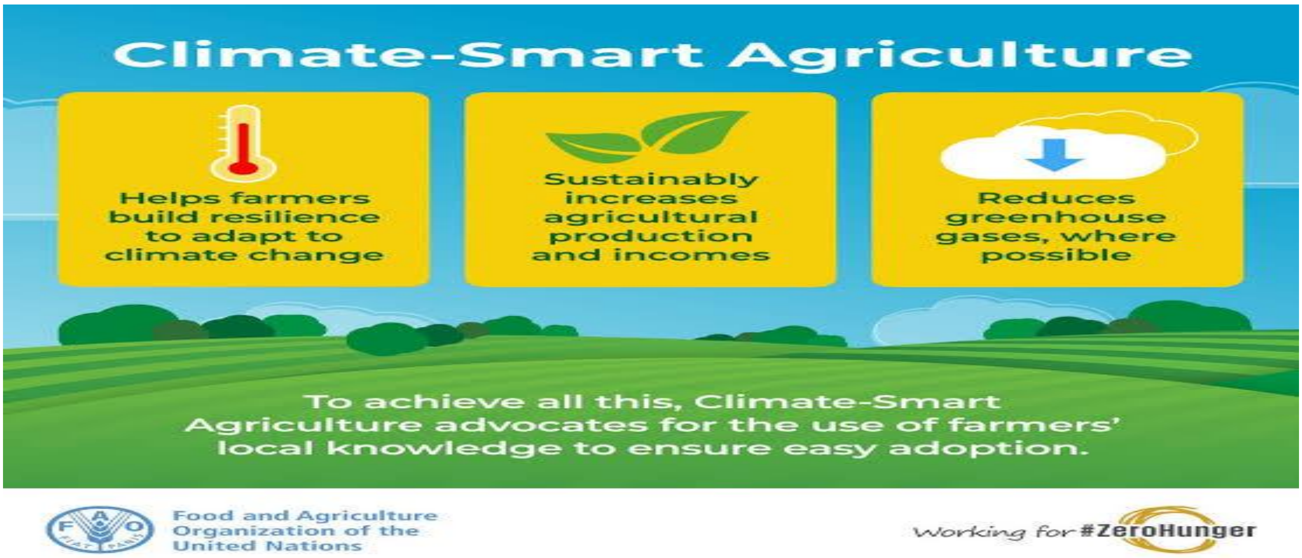

Fig.1 Goals of Climate Smart Agriculture

Source: FAO (2018).

Proper Post-Harvest Management

Improper post-harvest management can aggravates food losses in the face of changing weather conditions (FAO, 2011). The food value chain system should take into consideration the need for proper post-harvest management. Some of the adaptive post-harvest management that will mitigate the effect of climate change includes measures to check carrying over pest from field to grain storage. This can be achieved by early harvesting and storing techniques with controlled on farm drying practices. Drying under shade also can protect farm produce from unpredicted rainfall. Improved storage management practices such as sanitation and fumigation of food storage warehouses and monitoring should be incorporated in addition to storage of grains in airtight containers to enhance their storage periods and increase shelf life (FAO, 2018). Design of climate smart food storage warehouses that can withstand climate change related extreme weather conditions are also welcomed. In addition storage of varieties of crops that are less susceptible to post harvest pest attack and evaluating pre harvest and post-harvest crop characteristics should be encouraged.

Intricate Features of Climate Smart Agriculture

• CSA tackles climate change: CSA actively incorporates climate change into the planning and creation of sustainable agricultural systems, unlike traditional agricultural developments.

• CSA combines several priorities and handles trade-offs: CSA achieves triple-win performance, such as improved efficiency, increased resilience and reduced emissions. But it is also not possible to accomplish all three at once. Sometimes, trade-offs have to be made when it's time to enforce the CSA. This means that synergies be identified and the costs and benefits of various options evaluated on the basis of stakeholder priorities identified through participatory approaches (Totin *et al.*, 2018)

• CSA maintains services for habitats: Habitats provide vital services to farmers, including clean air, water, food and materials. It is imperative that CSA steps do not lead to their deterioration. CSA therefore adopts a landscape approach that draws on the concepts of sustainable agriculture but goes beyond the limited sectorial approaches to integrated planning and management that result in coordinated land uses.

Table 1: Climate Change Threats and Required Climate Smart Agricultural Practices

Climate change index	Impact of Agriculture	CSA practices required
Extreme weather events	Loss of crops & food grains	Improved techniques to increase resilience of crops to extreme weather events. Improved extreme weather events & early harvesting of matured crops in field. Prediction and early warning systems
Increased incidence of pests, diseases, fungi, mould, and aflatoxin contamination	Reduced crop yield and quality	New crop varieties with improved pest and disease resistance. Improved pests and disease management techniques
Increased flooding or water logging	Reduced crop yields or loss of crops. Causes difficulty in drying of grains in field & increases ability to absorb moisture beyond the optimum condition for storage	New crop varieties with higher moisture tolerance. Improved drainage or flood control techniques. Using climate smart solar drying techniques to conserve and renew energy.
Salt water intrusion	Reduced irrigation	Barrier to salt water intrusion.

	Water	New crop varieties with greater salinity tolerance. Improved water collection, storage and distribution techniques.
Reduced availability of irrigation water	Reduced crop yields in irrigated agriculture	Improved irrigation efficiency. New crop varieties with lower water requirements.
Less precipitation	Reduced crop yields in rain-fed agriculture	New crop varieties with lower water requirements. Improved irrigation techniques. Improved water collection, storage and distribution techniques.
Higher temperatures	Reduced crop yields	New crop varieties with greater heat tolerance.
	Increase risks of fire hazards in matured crops & causes new breeding ground for pests & diseases	Early harvesting of matured crops. Sanitation & fumigation of stored food warehouses

Source: Ramachandran (2015).

Climate Smart Technologies

Since there of projections of the divesting effect of climate change in the future. Stored agricultural produce should be properly protected to ensure food security that will adequately feed the terming growing population. Climate smart techniques in post-harvest storage of food will help mitigate the adverse effect of climate change and provide quick response and environmental friendly approach. Some of these innovative climate smart techniques include

Solar energy techniques

Solar energy is a vital source of renewable energy for the generation of electricity and heat. Solar energy techniques find its application in post-harvest handling of food such as drying of food products. It is non-polluting, environmental friendly and conserves energy by storing energy at peak time and using it at time of inadequacy. It is effective in management of energy.

Green house technology

Green house technology is used to grow plant in an enclosed transparent structure with solar radiation that creates modified agro-climatic conditions inside it. The advantages of greenhouse technology is to make room for off season cultivation and also to protect the plants from unfavorable environmental and agro climatic conditions such as extreme temperature, precipitation, disease and pest while other climatic factors like temperature, humidity, carbon dioxide, light, pH of soil and dissolved oxygen are controlled.

Perceived Climate Smart Agricultural Problems in Nigeria

The CSA faces a variety of problems relating to conceptual awareness, implementation, the political climate and the funding of the strategy. Below are unique issues that are considered to require critical attention and intervention(s):

• Lack of practical knowledge of the strategy. Most smallholder farmers in Nigeria have limited awareness and understanding of the CSA approach, thus making it difficult for its applications (Osuji *et al.*, 2020).

• Lack of data and knowledge and adequate local and national analytical resources. There is no long-term climate and landscape level data in many African countries, including Nigeria. (Giulio *et al.*, 2020)

Conclusion and Recommendations

For Nigeria to provide adequate food needs for her increasing population requires the use of sustainable agricultural practices which involves the introduction of Climate-Smart Agriculture (CSA) and proper post-harvest management. CSA has been viewed as a catalyst for improving domestic agricultural production, food sustainability and extension of shelf-life of agricultural produce using vast approach that combines different methods under a climate change umbrella. It assesses the risks and needs of a specific farm or farming community through a climate impact lens, and then addresses them using practices chosen for that particular situation. It is therefore recommended that farmers in Nigeria should adopt (CSA) as an alternative measure for increased food productivity in the face of climatic changes. Government and other relevant stake holders in agriculture should also integrate efforts to sustain CSA at all levels to achieve food sufficiency in Nigeria. Furthermore, there is need for adequate post-harvest management and climate smart techniques to curb the effect of climate change. Pre and post-harvest techniques that are climate smart resilient should be encouraged among farming households and communities and the need for use of modern storage technologies.

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Utilization of Indigenous Knowledge Practices for Climate Change Management by Farmers in Cross River State Nigeria

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Abstract

This study assessed the utilization of indigenous knowledge practices in climate change management by farmers in Cross River State Nigeria.Cross River State is one of the thirty-six states in Nigeria. The study utilized both quantitative and qualitative research methods. Primary data were collected using questionnaire and one hundred and twenty (120) respondents were selected using multi-stage sampling procedure while data were analyze with descriptive statistics. The result shows indigenous knowledge practices to include atmospheric phenomenon and bush fallowing 15% each, fruit production and tree phenology, seasonal forecast information, animal behaviour and spiritual manifestations 12% respectively; factors eroding indigenous knowledge practices include lack of indigenous knowledge in formal schools and lack of oral record keeping 30% respectively while fruiting of trees, birds and insects songs were used to predict onset of rains. Local people possess indigenous knowledge that assist in climate change management.

Keywords:, Climate change, farmers, indigenous knowledge, management, utilization

Introduction

Ban-Ki Moon, the former United Nations Secretary-General said; "Indigenous People have centuries of old wisdom to live harmoniously with nature. We have to learn those wisdoms from them. I urge you to ensure that Indigenous Peoples, their rights and contributions will remain central as we address climate challenges". Therefore, ideas and practices of indigenous peoples around the world is traditional knowledge. Osterhoudt (2018) investigated the role played by oral histories within a community in Madagascar that cyclone in 2011devastated. It was found that the histories can facilitate climate adaptation through sharing of stories and memories of such events which are anticipated to become more common due to climate change. It therefore implies that keeping of oral histories is important in climate change adaptation strategies. Reyes et al (2018) argue that working with indigenous people can bring about improve relationship with tribes and improve opportunities in production especially during climate change challenges. Most farmers use seasonal forecasts and indicators of the environment to see to the future relying on local knowledge of the situation like fruit flowering and production of some trees, temperature, and attitude of certain insects and birds. Bezner Kerr et al. (2018) examined the way and manner smallholder farmers in Malawi perceive, learn, share and even use their knowledge on changing climate and it was discovered that participation was the key in agro-ecological system supported for smallholder farmers to develop adaptive capacities. It is survival of the Indigenous knowledge systems that Jiri, (2016) asserts that "valuable local knowledge of relevance to climate change assessment and adaptation is held by rural societies. These knowledge systems are transmitted and renewed by each succeeding generation, ensuring the wellbeing of people by providing food security, environmental conservation, and early warning systems for disaster risk management".

In the same manner, Braman *et al*. (2013) show how local people in West Africa forecast flooding through rainfall patterns to guide against loss of lives and properties. In other words, features mostly employed by farmers include tree phenology and fruit production, the phenomena of wind and atmosphere; behaviour of some animal and spirituality such as divinations, dreams and visions while differences in the fruiting and flowering of plants equally influence the expectations of farmers. For example, so much fruits on a particular side of a tree signify the direction of first rain while trees growing very close to houses are used to announce the onset of rain (Mafongoya & Ajayi, 2017). In other words, farmers use their local or indigenous knowledge of the moon and stars changes or appearances for cropping calendars. More so, farmers also use animals' behaviour such as songs and movements to forecast rainy season. Even the rainfall amount can be predicted based on whether the bird was singing with happiness or not (Mafongoya & Ajayi, 2017). According to Luseno *et al*., (2003), "when the bird sings with a clear, sharp voice it means the bird is happy and indicates to farmers that a lot of rain that will fall, and vice versa". The chief and other traditional stakeholders also play a significant role in indigenous forecasting for smallholder farmers as farmers believed that they commune with their ancestors and spiritual beings to give them bumper harvest (Kolawole *et al*., 2014; Roudier *et al*., 2014). Thus, there is a belief in God and spirit among indigenous people. One of the social capitals for the poor is Indigenous knowledge systems (IKS) which the people must preserve at all cost in order to prevent its extinction. Lane et al., (2018) suggest that "skepticism towards anthropogenic climate change among farmers, structural influences such as financial and economic pressures, and broader risk perceptions associated with non-climate concerns limit adaptive and mitigative actions among farmers in New York and Pennsylvania". However, locally acquired knowledge is capable of bringing about practical remedies that enhance adaptation and mitigation against global warming and as such indigenous knowledge is the focus of locally acceptable strategies for combating climate change effects (Mapfumo *et al*., 2015). In Botswana, the resilience of smallholder farmers start from their knowledge of seasonality while in Zimbabwe, *Zunde Ramambo* which is a social capital programme assist in storing foods for distribution to community members in the time of scarcity (Wuebbles et al., 2018). Similarly in Nigeria, *Obatu yenyi* a water reservoir programme in Okpoma Yala, where there is a reservoir to collect water during rainy season and the reservoir open to entire community members during the dry season as main source of drinking water.

Several factors sometimes beyond the control of indigenous communities are contributing to the gradual loss of indigenous knowledge. In other words, indigenous knowledge systems in Sub-Saharan Africa are rapidly eroding and being lost due to its unavailability in curriculum of formal schools, globalization, migration; lack of oral record keeping in terms of songs, dance and other folklores; and easy access to western culture (Mafongoya & Ajayi, 2017). Despite this, formal education in several countries is contributing to the extinction of indigenous knowledge by reducing the social capital of younger generations. It is on this note that this study assesses the utilization of Indigenous Knowledge practices for climate change management by farmers in Cross River State Nigeria.

Materials and Methods

This study was conducted in Cross River State, one of the thirty-six states in Nigeria. The State is bounded with Cameroun Republic and has a land area measuring 98,000 square kilometres with a population size of nearly 3 million persons. The major crops grown in the state are cassava, yams, rice, melon, pineapples, cowpeas and vegetables. Several wildlife inhabit the state such as monkeys, gorillas; chimpanzees; reptiles and buffalos. The study utilizes both quantitative and qualitative research methods. Primary data were collected using questionnaire and one hundred and twenty respondents (120) respondents were selected using multi-stage sampling procedure. In the first stage, two agricultural blocks each were selected to reflect a high population of indigenous people across the three agricultural zones in the state. The second stage involved a random selection of two agricultural cells each from the selected blocks (12 cells). The last stage was a random selection of ten respondents from each cell to make 120 as sample. Descriptive statistics such as frequency and percentages were used to analyze the data collected.

Results and Discussion

Table 1. Distribution of Respondents by Different IK Practices (n=120)

S/No.	Indigenous Knowledge Practices	Frequency	Percentage
1	Fruit production and tree phenology	12	10
2	Seasonal forecast information	12	10
3	Atmospheric phenomenon	18	15
4	Animal behaviour	12	10
5	Spiritual manifestations	12	10
6	Role of Chief and other traditional rulers	6	5
7	Indigenous social capital (collective wealth	18	15
8	Trade by barter	3	2.5
9	Bush fallowing	18	15
10	Mulching	6	5
11	Use of under-utilized and neglected species	3	2.5

Source: Field survey, 2019

The result of Table 1 shows indigenous knowledge practices to include atmospheric phenomenon and bush fallowing 15% each, fruit production and tree phenology, seasonal forecast information, animal behaviour and spiritual manifestations 12%; role of chief and other traditional stakeholders and mulching 6% while trade by barter and use of under-utilized and neglected species 3%. This result is in agreement with earlier studies by ((Kolawole *et al*., 2014; Roudier *et al*., 2014; Mapfumo *et al*., 2015; Mafongoya & Ajayi, 2017; Wuebbles *et al.*, 2018). Thus, locally acquire knowledge is capable of bringing about practical remedies that enhance adaptation and mitigation against global warming.

Table 2. Distribution of Respondents by factors eroding IK Practices (n=120)

S/No.	Indigenous Knowledge Practices	Frequency	Percentage
1	Lack of indigenous knowledge in formal schools	36	30
2	Globalization	6	5
3	Internal and external migration	24	20
4	Access to imported Western foods/popular culture	6	5
5	Lack of oral record keeping	36	30
6	Uptake of English Language/youth dissent towards ecological practices	12	10

Source: Field survey, 2019

Table 2 shows the distribution of respondents by factors eroding indigenous knowledge practices with lack of indigenous knowledge in formal schools and lack of oral record keeping 30% respectively, internal and external migration 20%; uptake of English language and youth dissent towards ecological practices 10% while globalization and access to imported western foods/popular culture 5% respectively supporting the works of Mafongoya & Ajayi, (2017). Although some of the factors are beyond the control of local farmers, there is absolute need to preserve them.

Table 3. Utilization of Indigenous Knowledge Practices (n=120)

S/No.	Indigenous Knowledge Indicators	Utilization (Type of explanations)
1	Fruit production and tree phenology	So much fruits on a particular side of a tree signify the direction of first rain while trees growing very close to houses are used to announce the onset of rain not (Mafongoya & Ajayi, 2017)
2	Seasonal forecast information	Forecast flooding through rainfall patterns to guide against loss of lives and properties; Use of moon and stars changes or appearances for cropping calendars (Braman *et al*. (2013)
3	Atmospheric phenomenon	A better rainy season comes with increasing temperatures while a bad one comes with violent winds during dry season not (Mafongoya & Ajayi, 2017)
4	Animal behaviour	Use of animals' behaviour such as birds and insect songs and movements to forecast rainy season. Even the rainfall amount can be predicted based on whether the bird was singing with happiness or not "When the bird sings with a clear, sharp voice it means the bird is happy and indicates to farmers that a lot of rain will fall, and vice versa" not (Luseno et al,. 2003; Mafongoya & Ajayi, 2017)
5	Spiritual manifestations	Worship of special deities as gods of harvest
6	Role of Chief and other traditional rulers	Farmers believed that chief and other traditional stakeholders commune with their ancestors and spiritual beings to give them bumper harvest (Kolawole *et al*., 2014; Roudier *et al*., 2014).

7	Indigenous social capital (collective wealth	*Zunde Ramambo* which is a social capital programme assist in storing foods for distribution to community members in the time of scarcity. *Obatu yenyi* a water reservoir programme in Okpoma Yala, where the Lutheran Church provides a reservoir to collect water during rainy season and open it for use by the entire community to community during the dry season as a main source of drinking water (Wuebbles et al., 2018).
8	Trade by barter	Practice of exchanging what they have with what they do not have. This is still practice in Akpabuyo Nigeria
9	Bush fallowing	The practice of shifting cultivation by allowing the land to fallow before returning to it again.
10	Mulching	Use of cover crops
11	Use of under-utilized and neglected species	Mixed cropping. For instance, use of early maturing crops and crops with short season for harvest.

Source: Field survey, 2019

Conclusion

Local people no doubt possess local or indigenous knowledge that have been employed in the management of climate crisis in Nigeria. There is therefore a need to blend such knowledge with modern science in order to develop hybrid skills.

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Climate-smart agriculture and effects on production efficiency of maize farmers in Kano and Nasarawa States, Nigeria

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Abstract

This study assesses the effects of climate-smart agriculture (CSA) adoption on production efficiency of maize farmers in Kano and Nasarawa States. The data were collected by personal interviews of maize farmers drawn in a multi-stage random technique, covering 491 farmers' household heads in both States. Data were analysed using descriptive statistics, likert scale, marginal factor productivity (MFP) and econometric method within the framework of logistic regression. The MFP result shows that the CSA-adopters in both States were technically efficient, as Kano recorded 1.00 and Nasarawa recorded 1.01. The non-CSA adopters recorded allocative, technical and economic inefficiencies in the maize production in both states. The logit result, however, shows that access to credit, extension, educational level and income significantly and positively influenced CSA adoption at P≤0.5 and P≤0.1 in Kano and Nasarawa, states respectively. High cost of inputs was the most severe constraint to CSA-adoption. This study recommends that maize farmers should join cooperative societies to enjoy cheaper production cost and increase production efficiency.

Key words: *Climate-smart agriculture, production efficiency, Kano, Nasarawa*

Introduction

In Nigeria, food insufficiency is a problem as the agricultural practice is subsistence and climate based with low production output, despite the abundant resources. The sector is challenged by the climate-change and farmers continuously seek for adaptable farm practices to maintain productivity. Nigerian policy makers are aware of the vulnerability of the sector to this change, despite paucity of research data, as it struggles to provide food for the growing populations, raw materials for processing industries and export crops to generate foreign exchange. The first evidence of climate change in Nigeria was experienced during the

1972/1973 drought, which led to the decline in cash crops productions. Although, various studies have indicated increase in food crop productions over the years, the country is yet to be self-sufficient. Climate Smart Agriculture (CSA) comprises a wide range of technologies and practices such as risk, integrated crop-livestock and improved water management techniques; conservation tillage and agroforestry management, among others (Lipper *et al*., 2014 and McCarthy *et al.* (2014), aimed at sustaining increased productivity. According to McCarthy *et al.* (2012), "SMART", is an acronym derived from the word: specific; measureable; achievable; reliable and timely. Thus, CSA has proven to be a feasible solution to combat the effects of climate change. CSA approach aims to address simultaneously and holistically the multiple challenges of agriculture and food systems, as it helps to avoid unproductive policies. It is premised on three core principles, such as sustainably increase in agricultural productivity and income, adaptation/resilience to climate change and greenhouse gas (GHG) emissions mitigation (FAO, 2013). Although, Nigeria is known to be the tenth world's producer of maize at about 10.4 million tonnes annually, most of it is produced in Northern-Nigeria, yet, previous studies did not indicate how the adoption of CSA by the maize farmers affects the production efficiency in Kano and Nasarawa States. This study aimed to provide lasting solution to food scarcity by providing empirical data on the level of awareness and CSA-adoption among maize farmers in Kano and Nasarawa States; estimating the costs and returns of CSA-adopters and non-adopters; identifying farmers' socio-economic factors that influence CSP-adoption and the constraints faced during the adoption. Policy makers are expected to be guided by this information to ensure the achievement of optimum efficiency through CSA-adoption; investors are guided by such policies in investment decisions, while the rural small scale farmers will adjust the production resources to improve maize output, income and themselves. The study indicates need for further studies.

Materials and Methods

The study was carried out in Kano and Nasarawa States in northern Nigeria. Kano State represents the Sahel Savannah region and is made up of about 20,760 square Km2, with 86,000 hectares of dry-season irrigation farmland (Kano ADP, 2011). The State has 400-1,200mm average rainfall per annum and temperature range of 14.02^{0}C-32.03^{0}C. Nasarawa State represents the Guinea Savannah region, which lies in the central part of Nigeria. It covers about 27,137.8Km^2 rich fertile soil from the cretaceous sand, silt, iron stones and shale. It has an average annual rainfall of 1100-2000mm from April to October, but the traditional farming expose farmlands to erosion, drought and desert encroachment. Primary data for this study were the maize farmers' socio-economic characteristics and production data. Both structured questionnaires and household interview schedule were used to collect the data between June and September, 2018 from the literate and illiterate farmers, respectively. The production data included maize annual outputs (kg), inputs, such as farm size (hectares), maize seed and fertilizer (kg), labour (man-days) and capital (Naira and Kobo). Multi-stage sampling technique enabled the selection of maize farmers' household heads or immediate subordinate with the desired characteristics and 10% of registered sample frame, which is 491 (275 CSA and 216 non-CSA) was used as the sample size for the study. Descriptive and inferential statistics, logit and Marginal factor productivity analysis were used in analyzing the data. The expected value of the dependent variable Y is interpreted as the probability that a farmer with certain characteristics X will adopt CSA or not adopt CSA, and the scored is 1 or 0. Marginal factor productivity analysis determined the influence of CSA-adoption on maize production efficiency (allocative, technical and economic). The intensity of the constraints was measured with the use of Likert scale (1 = very serious; 2 = serious; 3 = not serious; 4 = not a problem and 5 = no response). The results of the analysis were compared between the two States and presented in Tables.

Results and Discussions

Awareness of climate change, adoption of the CSA in maize production in Kano and Nasarawa States in Nigeria

Kano State has the highest populations (76% and 92%) of farmers who are aware and adopted CSA, and those who are neither aware nor adopted CSA in maize production (50% and 60%), respectively, as shown in Table 1. In Nasarawa State, only 51% and 56% are CSA-adopters and 50% and 56% are the non-adopters.

Table 1. Farmers level of awareness and adoption of climate-smart agriculture (CSA) in Kano and Nasarawa States

State	LGA	Village	Number/Percentage of Respondents			
Studied	Selected	Selected	Registered CSA-Adopters	10 % Registered CSA-Adopters	Registered Non-CSA Adopters	10 % of Registered Non-CSA Adopters
Kano	Dawakintofa Tofa	Dawaki/Marke Ditofa/Tsakuma	760 920	76 92	500 600	50 60
a	***Sub-total***		***1,680***	***168***	***1,100***	***110***
Nasarawa	Karu Keffi	Gitata/Uke Gwata/Sabon	510 560	51 56	500 560	50 56
b	***Sub-total***		***1,070***	***107***	***1,060***	***106***
Total (a+b)	**4 LGAs**	**8Villages**	**2,750**	**275**	**2,160**	**216**

Note:% = percentage; CSA = climate smart agriculture; LGA = Local Government Area: Source: Field survey (2018)

Farmers' socio-economic characteristics influencing climate smart agriculture (CSA) adoption in maize production

The socio-economic characteristics of the farmers studied from the two States are as shown in Table 2. Majority of the CSA-adopters and non-adopters were males, which indicates imbalance of gender distribution in the agricultural sector as male farmers are known to own production assets in Nigeria. The highest percentage of maize farmers from Kano belonged to the age group of 41-50 years old, which indicates their youthfulness and production abilities. In Nasarawa State, majority (38%) of the farmers are non-CSA adopters aged 51years old and above. Average farmer was married, which is one of the characteristic of farmers in Nigeria. Average CSA-adopters from both Kano (49%) and Nasarawa (46%) States indicate to have primary school level of education and could understand basic farming principles, while most non-adopters (83% Kano and 52% Nasarawa) had no formal education, could not. Majority of them has more than 5 household members, which implied availability of family labour if they were of productive ages, which could lead to increased maize production. Most non-adopters (46% and 51%) in both States owned 1.1-2.0 hectares of farm lands and were small scale farmers. The CSA-adopters from both States have access to extension services and adopted CSA for high yield. Average CSA-adopters had more than 10 years of farming experience and 72% of Kano farmers indicated not to have sufficient rainfall, while majority of Nasarawa farmers indicated to have sufficient rainfall for the maize production.

Socio-economic Determinants of Farmers' Adoption of CSA in the Study Area

Logistic regression result showing the estimated coefficients of the farmer's socio-economic determinants of CSA-adoption and non-adoption in both States are presented in Table 3. Estimated Pseudo R^2 for Kano and Nasarawa were 50.5% and 50.4% respectively, while the significant Log likelihood ratio were 52.0% and 50.9% respectively. These imply that the exogenous variables in the model jointly explained the decisions of the farmers to adopt CSA in maize production. Educational level, access to credit, extension and income of CSA-adopters were significant and positively related to the farmer's decisions to CSA-adoption at $P<0.01$, $P<0.05$, $P<0.1$ and $P<0.1$ for Kano and Nasarawa States respectively. Thus, CSA-adopters recorded efficiencies, while non-adopters recorded inefficiency throughout the production process. The CSA-adopters in both States were technically efficient, which is in agreement with the findings of Onyeneke *et al.* (2017), where farmers in Nigeria were found to use creative measures to deal with climate change in crop production. The Z-calculated are 2.61 and 2.83 at 1% level of significance for Kano and Nasarawa respectively, which are greater than Z-tabulated (1.96). Thus, the hypothesis of no difference between the mean incomes of both farmers is rejected.

Table 2. Socio-economic characteristics of the farmers in the study area

	Kano State				Nasarawa State			
	CSA Maize Adopters		Non-CSA Maize Adopters		CSA Maize Adopters		Non-CSA Maize Adopters	
Variable	Freq	%	Freq	%	Freq	%	Freq	%
Gender: Male	142	85	92	84	89	83	76	72
Female	26	15	18	16	18	17	30	28
Farmer's age (yrs): < 30	11	6.5	21	19.1	14	13.1	13	11.4
31 – 40	51	30.4	28	25.5	33	30.8	15	14.3
41 – 50	62	37.0	36	32.7	42	39.3	38	36.2
> 51	44	26.1	25	22.7	18	16.8	40	38.1
Marital Status: Married	144	85.7	108	98.2	103	96.3	95	90.4
Single	3	1.8	0	0	1	0.9	2	1.9
Divorced	10	6.0	1	0.9	1	0.9	4	2.9
Widowed	11	6.5	1	0.9	2	1.9	5	4.8
Educational Level: Non-formal	22	13.1	91	82.7	13	12.2	55	52.4
Primary Education	83	49.4	17	15.5	49	45.8	41	39.0
Secondary Education	31	18.5	2	1.8	38	35.5	10	8.6
Tertiary Education	32	19.0	0	0	7	6.5	0	0
Household Size(No.): 5	64	38.1	72	65.5	41	38.3	19	18.1
6-10	56	33,3	29	26.4	57	53.3	39	37.1
> 11	48	28.6	9	8.1	9	8.4	48	44.8
Farm Size (ha): < 1.0	21	12.5	51	46.4	6	5.6	53	50.5
1.1 – 2.0	40	23.8	23	20.9	55	51.4	35	33.3
2.1 – 3.0	35	20.8	22	20.0	38	35.5	12	10.5
> 3.1	72	42.9	14	12.7	8	7.5	6	5.7
Cooperatives Status: Full member	168	100	80	72.7	1007	100	65	61.9
Non-member	0	0	30	27.3	0	0	41	38.1
Source of Credit: Personal Savings	32	19.1	91	82.7	32	29.9	72	68.6
Loan from Cooperatives	78	46.4	18	16.4	44	41.1	21	20.0
Loan from Banks	58	34.5	1	0.9	31	29.0	13	11.4
Extension Services: Has access	168	100	10	9.1	107	100	41	38.1
Does not have access	0	0	100	90.9	0	0	65	61.9
Reasons for Adoption: High yield	124	73.8	2	1.8	58	54.2	27	25.7
Early maturity	16	9.5	30	27.3	41	38.3	32	29.5
Pest resistant	28	16.7	78	70.9	8	7.5	47	44.8
Cropping System: Sole	142	84.5	61	55.5	76	71.0	42	40.0

Mixed	26	15.5	49	445	31	29.0	64	60.0
Farming Experience: Less than 10yrs	42	25.0	25	22.8	22	20.6	12	11.4
11-15 years	99	58.9	37	33.6	53	49.5	31	28.6
More than 15 years	27	16.1	48	43.6	32	29.9	63	60.0
Rainfall (mm): Not sufficient	121	72.0	88	80.0	23	21.5	14	13.2
Sufficient	47	28.0	22	20.0	84	78.5	92	86.8
Total	*168*	*100*	*110*	*100*	*107*	*100*	*106*	*100*

CSA = Climate Smart Agriculture; Freq = Frequency; % = Percentage; Yrs = years; < = less than; > = more than

Source: Field survey, 2018

Table 3. Logit Regression Result of the Socio-economic Factors Influencing CSA-adoption and non-adoption

Variables	Kano State		Nasarawa State	
	CSA Adopters	Non-CSA Adopters	CSP Adopters	Non-CSA Adopters
Age of farmer (years)	0.0685 (-0.84)***	0.0844 (-1.14)***	0.0511 (-0.71)***	-0.1392 (-0.53)***
Educational Level	0.5195 (2.06)***	0.4214 (-1.31)***	0,4738 (1.28)***	-0.7213 (-1.05)***
Household Size(No.)	-0.4123 (-0.81)**	-0.3543 (-0.29)	-0.3317 (-0.76)**	0;3726 (-0.38)
Access to Credit:	2.0071 (1.09)**	1.9712 (1.07)**	2.0082 1.08)**	1.8922 (1.06)**
Access to Extension	1.9253 (0.6)***	1.6234 (-1.17)	1.5177 (0.8)***	-2.5601 (-1.09)
Farming Experience	0.0257 (0.41)***	-0.0265 (-0.44)	0.0273 (0.39)***	0.0522 (-0.35)
Income in Naira	1.08E-07 (1.72)*	0.07E-04 (0.59)	1.06E-09 (1.65)*	1.02E-05 (0.33)
Number observed	168	110	107	105
Log likelihood	-49.238574		-38.538961	
LR Chi-square	51.98 **		50.87 **	
Peo > Chi-square	0.0005		0.0004	
Pseudo R^2	0.5045		0.5038	

CSA = Climate Smart Agriculture; Number in parentheses are Z-values; *** = Significant at 1% level of probability; ** = Significant at 5% level of probability; * = Significant at 10% level of probability

Source: Field data analysis, 2018

Influence of CSA Adoption on Production Efficiency (allocative, technical and economic) of Maize Production in the Study Area

The influence of CSA adoption on production efficiency of maize production in the study area is as shown in Table 4. Marginal Value Productivity (MVP), as the yardstick for measuring the efficiency of resource use at a given level of production process involves the comparison of the cost of the inputs and the value of the outputs. In both Kano and Nasarawa States, the CSA-adopters in maize production recorded allocative, technical and economic efficiencies, while all the non-CSA adopters recorded inefficiency throughout the production process. Technical efficiency was observed to be the most efficient for the CSA-adopters in both States, as Kano recorded 1.00 and Nasarawa recorded 1.01. This implied that the CSA-adopters were most efficient in the technology used in the maize production, which is in agreement with the findings of Babatunde & Boluwade (2004), where it was found that increasing the level of the resources used in crop production can lead to output.

Table 4. Influence of CSAs' adoption on production efficiency (technical, allocative and economic) of maize in the study area

Production Efficiencies	Kano State					
	CSA Maize Adopters			Non-CSA Maize Adopters		
	MVP	MFC	$r = \frac{MVP}{MFC}$	MVP	MFC	$r = \frac{MVP}{MFC}$
Allocative	42,870	41,980	1.02	65,450	73,620	0.89
Technical	95,650	94,870	1.00	87,970	99,730	0.82
Economic	139,520	136,850	1.02	153,420	173,350	0.89
	Nasarawa State					
Allocative	58,960	57,890	1.02	62,310	64,920	0.96
Technical	78,910	77,940	1.01	74,580	76,310	0.97
Economic	137,870	135,830	1.02	136,890	141,230	0.97

CSA = Climate Smart Agriculture; MVP=Marginal Value Product; MFC=Marginal factor Cost; r = Efficiency
Source: Data analysis 2018

Both Kano and Nasarawa non-CSA adopters over-utilized the scale, technology and overall resources management and thus, recorded allocative, technical and economic inefficiencies, respectively in the maize production. Therefore, for optimal level of efficiency to be attained, the non-CSA adopters must reduce the amount of resources such as the maize seed, fertilizer, and agrochemicals by increasing their scale of operation. The labour and farm tools ought to be reduced, while the overall management has to be adjusted to obtain efficiency. This result is in agreement with the findings of Ogunniyi *et al*., (2012) where over-utilization or under-utilisation of agricultural production resources were found to be attributed to the cultivation of small farm size and the use of crude farming implement. To increase the maize output, more land should be cultivated, which can be achieved if farmers are provided with modern farm tools and other production resources at affordable prices.

Constraints that limit the adoption of CSA among the maize farmers in the study area

The constraints that limit the adoption of the CSA in maize production in Northern Nigeria is as presented in Table 5. Majority of the maize farmers indicated high cost of production inputs to be the most severe constraints that affect the adoption of the CSA in the maize production in Northern Nigeria. This scored the highest weighted mean (2.64) and was thus, ranked as the first constraint, while poor transportation problem was recorded as the least severe constraint, and was thus, ranked as the eleventh.

Table 5. Constraints that limit the adoption of CSA among maize farmers in Northern-Nigeria

Constraints	CSA	Non-CSA						Weighted	
			1	2	3	4	5	Mean	Rank
	Freq	Freq	%	%	%	%	%		
High cost of inputs	275	216	72(33.3)	56(25.9)	43(19.9)	36(16.7)	9(4.2)	2.64	1
Low rainfall	275	216	66(30.6)	52(24.1)	40(18.5)	35(16.2)	23(10.6)	2.32	2
Pest and diseases	275	216	51(23.6)	68(31.5)	33(15.3)	27(12.5)	37(17.1)	2.30	3
Lack of sufficient credit	275	216	54(25.0)	44(20.4)	58(26.8)	22(10.2)	38(17.6)	2.26	4
lack of improved production technology	275	216	60 (27.8)	51 (23.6)	54 (25.0)	38 (17.6)	13 (6.0)	2.21	5
High cost of labour	275	216	59(27.3)	42(19.4)	55(25.5)	21(9.7)	39(18.1)	2.18	6
Low Pricing for output	275	216	55(25.5)	48(22.2)	37(17.1)	45(20.8)	31(14.4)	2.17	7
Lack of processing facilities	275	216	49 (22.7)	39 (18.0)	29 (13.4)	66 (30.6)	33 (15.3)	2.13	8
Few Extension contact	275	216	53(24.5)	45(20.8)	46(21.3)	48(22.2)	24(11.2)	2.04	9
Lack of production subsidy	275	216	46 (21.3)	59 (27.3)	49 (15.5)	38 (17.6)	59 (27.3)	1.86	10
Lack of storage facilities	275	216	47(21.8)	53(24.5)	49(22.6)	39(18.1)	28(13.0)	0.63	11

Note: CSA = Climate Smart Agriculture; Freq = frequency; % = percentage; 1=Serious problem; 2= Problem: 3=Not a serious problem; 4= Not a problem; 5=Indifferent; Figures in parenthesis are percentages
Source: Field survey, 2018

Conclusion

The study of climate-smart agriculture and the effects on production efficiency of maize farmers in Kano and Nasarawa States in Nigeria revealed that the CSA-maize adopters earned more net income and were more efficient in the crop production than the non-adopters. High cost of production inputs, was the most severe constraint to the CSA-adoption. The farmers were advised to adopt CSA and join cooperatives to benefit from cheaper inputs and increase efficiency.

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Carbon farming: Growing food, absorbing carbon, combating climate change

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Abstract

Carbon dioxide accounts for almost 70% of human-induced greenhouse gas, thereby making it the main greenhouse gas driving climate change. It is a known fact that the amount of carbon prevalent in the atmosphere has reached dangerously high levels. Agriculture, horticulture and forestry have all been implicated for a third of greenhouse gas emission yet, these same sectors also hold an enormous potential to reduce emission. Carbon farming is all effort employed to increase the rate at which carbon is stored in vegetation (stem/trunk, leaves and root) and in the soil, otherwise known as carbon sequestration. These efforts often include agricultural practices and land use. Through management and conservation, farmers can increase the rate at which carbon dioxide is removed from the atmosphere and converted to organic matter or vegetation. By managing land for soil carbon sequestration, carbon can be stored in soils for centuries. This article hence explores and highlights the links between growing crops and climate change and the measures or farming practices that farmers can employ to actively reduce carbon footprint. We recommend that food production efforts should be channeled not only in reducing carbon emissions but to also capture and store carbon.

Keywords: Carbondioxide, carbon-farming, carbon-footprint, greenhouse-gas, climate-change.

Introduction

Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. It is a method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global warming. According to Toensmeier (2014), perennial species will generally increase the carbon sequestration capability of a system over annual species. Coppice and biomass systems can sequester 1 – 6 tons/hectare/year, tree crops and bamboo 2 – 28 and 6 – 33 tons/hectare/year respectively, while multistrata agroforestry systems sequester 4 – 40 tons/hectare/year (Toensmeier, 2014).

Carbon farming is an active response to global climate change. It works to mitigate climate change by increasing the rate at which carbon is stored in soil organic matter to the point that it surpasses the rate at which it is being emitted into the atmosphere. This reduction in atmospheric carbon dioxide has the potential to slow and possibly reverse the current trends of global warming. Many carbon farming plans include the application of compost to the soil. When compost or organic matter is added, carbon is being added directly to the soil, some of which can be stored in stable state (Ryals*et al*., 2014). Utilizing compost or other organic matter can also help to avoid methane (CH_4) emissions from the diversion of organic wastes from landfills or slurry ponds (DeLonge *et al*., 2013). Increasing soil's carbon content can aid plant growth, increase soil organic matter, improve agricultural yield, improve soil water retention capacity and reduce fertilizer use.

Some Carbon Farming Techniques

Conservation Farming

Conservation farming is a sustainable agriculture production system comprising of a set of farming practices adapted to the requirements of crops and local conditions of each region, whose farming techniques protect the soil from erosion and degradation, thus preserving the soil quality and biodiversity. It includes a set of practices which conserve the soil, water, and soil moisture, enhance fertilizer and seed use, and ultimately assures their highest economic and social benefits. Conservation farming also entails no-tillage (zero tillage) and minimum tillage. No-tillage is a method of planting crops without any significant cultivation of the soil, and often by leaving the previous crop residues on the soil surface as protective mulch. It basically involves no seedbed preparation other than opening small slits in the soil so that seed can be placed at the intended depth. There is generally no cultivation during crop production but chemicals are often used for weed control (Huxley and Van Houten, 1997). According to Farooq and Siddique (2015), conservation agriculture (CA) or farming is characterized by minimal soil disturbance, diversified crop rotations, and surface crop residue retention to reduce soil and environmental degradation. The implication of conservation farming is more tilted towards conserving carbon within the edaphic ecosystem, as opposed to conventional agriculture where a lot of tilling is involved thereby releasing inherent soil carbon into the atmosphere.

Composting

Compost can be simply put as a mixture of organic residues and soil that have been made to undergo biological decomposition (Huxley and Van Houten, 1997). It involves the biological decomposition of organic waste such as food or plant material by bacteria, fungi, worms and other organisms under controlled aerobic (occurring in the presence of oxygen) conditions

(Tuomela *et al*., 2000). The end result of composting is an accumulation of partially decayed organic matter called humus. Composting with worms, also known as vermiculture, results in nutrient-loaded worm castings. Composting is another effective way to sequester carbon, storing it in the soil instead of releasing it to the air. This practice has the potential to help offset carbon footprint associated with agriculture.

Cover Crops/Living Mulch/Green Manure

Living mulch or green manure are cover crops planted either before or with a primary crop and maintained as a living ground cover during the growing season. Asides controlling soil erosion, suppressing weed and improving soil structure, cover crops are also essential in adding to the soil organic carbon pool. Cover crops manage soil erosion, soil fertility, soil quality, water, weeds, pests, diseases, biodiversity and wildlife in an agroecosystem. Cover crops are an important soil carbon sequestration strategy (Adeyemi and Idowu, 2017). The roots and shoots of cover crops feed bacteria, fungi, earthworms and other soil organisms, which increases soil carbon levels over time.

Organic Mulch

Mulch is a layer of material applied to the surface of soil. Reasons for applying mulch include conservation of soil, improving fertility and health of the soil, reducing weed growth and enhancing the visual appeal of the area. Mulch is usually, but not exclusively, organic in nature. It may be permanent (e.g. plastic sheeting) or temporary (e.g. bark chips). It may be applied to bare soil or around existing plants. Mulches of manure or compost will be incorporated naturally into the soil by the activity of worms and other organisms. The process is used both in commercial crop production and in gardening. Organic mulches decay over time and are temporary. This source of mulch is even less manual labor since it does not need to be removed at the end of the season and can actually be tilled into the soil. This way, carbon is being incorporated back into the soil (Nunez, 2019).

Biochar

Biochar is a stable carbon compound created when biomass (feedstock) is heated to temperatures between 300 and 1000^{0}C under low (preferably zero) oxygen concentrations (Verheijen*et al*, 2009). Biochar can be a simple yet powerful tool to combat climate change (Adeyemi and Idowu, 2017). Biochar's ability to impact important properties to soil, such as raising of soil pH and water holding capacity, attraction of beneficial fungi and microbes, improvement of cation exchange capacity (CEC), high carbon sequestration ability and nutrient retention capacity as well as its large surface area makes it a potential remedy to global warming and climate change (Adeyemi and Idowu, 2017).According to the

International Biochar Initiative (IBI), biochar can sequester up to 2.2 billion tonnes of carbon every year by 2050 and this carbon will remain in soil for thousands of years. As organic materials decay, greenhouse gases, such as carbon dioxide and methane (which is 21 times more potent as a greenhouse gas than CO_2), are released into the atmosphere. By charring the organic material, much of the carbon becomes "fixed" into a more stable form, and when the resulting biochar is applied to soils, the carbon is effectively sequestered (Liang *et al*, 2008). According to Woofl *et al*, (2010), it is estimated that the use of this method to "tie up" carbon has the potential to reduce current global carbon emissions by as much as 10 percent.

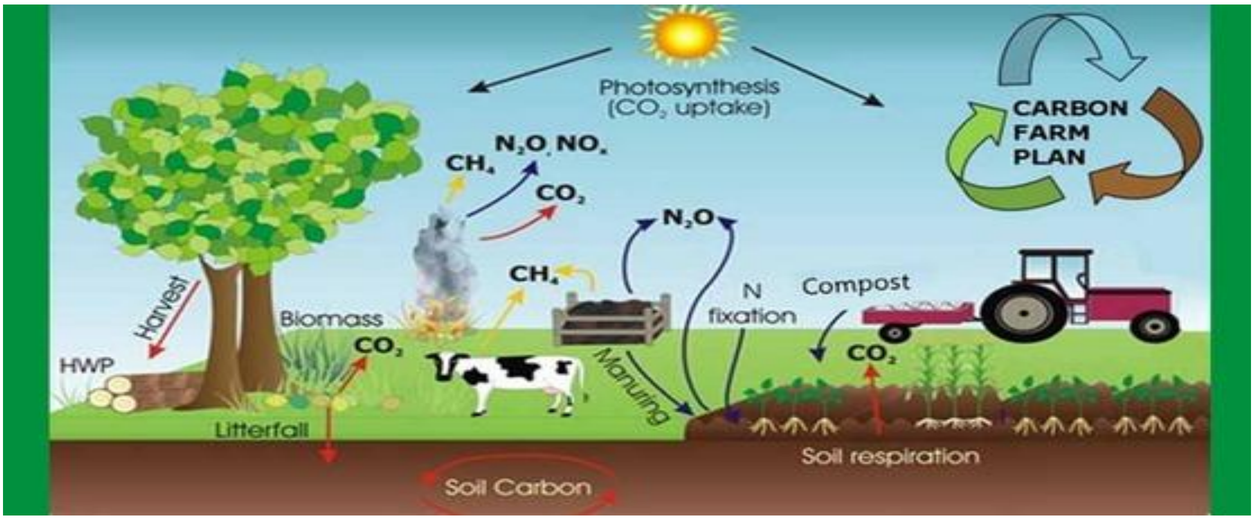
Agroforestry

Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, bamboos) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence (Huxley and Van Houten, 1997). Agroforestry can also be defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (FAO, 2015). This is a multidimensional way of sequestering carbon.

There are three main types of agroforestry systems:

- **Agrisilvicultural** systems are a combination of crops and trees, such as alley cropping or homegardens.
- **Silvopastoral systems** combine forestry and grazing of domesticated animals on pastures, rangelands or on-farm.
- **Agrosylvopastoral** systems involves the integration of all the three elements, namely trees, animals and crops and are illustrated by homegardens involving animals as well as scattered trees on croplands used for grazing after harvests.

Fig. 1: Carbon Cycle



Source: Intergovernmental Panel on Climate Change (IPCC), 2007

Sequestration Potentials of Various Farm Assets

Trees

Trees, like other green plants use photosynthesis to convert carbon dioxide into sugar, cellulose and other carbon-containing carbohydrates used for food and growth. Trees are unique in their ability to lock up vast amounts of carbon in their woods and continue to do so as they grow. At this point, the carbon is decomposed by micro-organisms (subsequently becoming humus), stored in wood (later used as furniture) or released as CO_2 when burnt down. Trees also store carbon in the soil that their roots inhabit and this stays locked away until the soil is cultivated or eroded. Broadleaf and coniferous woodlands for instance absorb about 10t CO_2/ha/year in both soil and biomass (www.farmcarbontoolkit.org.uk). Although forests do release some CO_2 from natural process such as respiration, decay and deforestation, however a healthy forest typically stores carbon at a greater rate than it releases carbon.

Bamboo

Bamboos are treelike grasses of the family Poaceae, comprising more than 115 genera and 1,400 species. Bamboos are distributed in tropical and subtropical to mild temperate regions, with the heaviest concentration and largest number of species in East and Southeast Asia and on islands of the Indian and Pacific oceans. Bamboos are typically fast-growing perennials, with some species growing as much as 30 cm (1 foot) per day. The woody ringed stems, known as culms, are typically hollow between the rings (nodes) and grow in branching clusters from a thick rhizome (underground stem). Bamboo culms can attain heights ranging from 10 to 15 cm (about 4 to 6 inches) in the smallest species to more than 40 meters (about 130 feet) in the largest. Bamboo's fast growth is one of its many attributes which makes it a useful resource for mankind. It is commonly seen as an indication of a high ability to capture and sequester atmospheric carbon and consequently mitigate climate change in a similar way that trees do (www.inbar.int). Bamboo can sequester can sequester 6 – 33 tons/ha/year (Toensmeier, 2014).

Grassland

Grasslands are areas where the vegetation is dominated by grasses (Poaceae). Grasslands are characterized as lands dominated by grasses rather than large shrubs or trees. According to Nunez (2019) In the U.S. Midwest, they're often called prairies. In South America, they're known as pampas. Central Eurasian grasslands are referred to as steppes, while African grasslands are called savannas. What they all have in common are grasses, their naturally dominant vegetation. Grasslands are found where there is not enough regular rainfall to support the growth of a forest, but not so little that a desert forms. In fact, grasslands often lie between forests and deserts. Depending on how they are defined, grasslands account for between 20 - 40 percent of the world's land area. They are generally open and fairly flat, and they exist on every continent except Antarctica, which makes them vulnerable to pressure from human populations. Permanent grassland can mitigate climate change by sequestering vast amounts of carbon, most of it held in the soil. A 100m length of a 2m permanent grass margin could sequester over (0.075t) CO_2/year.

Soil

The soil is perhaps one of the most remarkable and overlooked carbon sinks that the planet has. Carbon dioxide is removed from the atmosphere and stored in the soil carbon pool. This process is primarily mediated by plants through photosynthesis, with carbon stored in the form of soil organic carbon. Organic matter is over 50% pure carbon, and that carbon has two fates – either it can become stabilized in the soil as humus, or it can be oxidized into CO_2 when cultivated or eroded. Building organic matter levels in the soil require a two pronged approach. Firstly, by adding organic matter in the rotation in the form of composts, manures and green manures. Truly sustainable land management will continue to build humus at varying rates for many years. Rate of sequestration in soil is staggering. 1ha of soil that raises its organic matter level by 0.1% per year can sequester 900kg (0.9t) CO2/year (Nunez, 2019).

Conclusion

Carbon footprint is applicable to every item of food as all agricultural and horticultural operations emit greenhouse gases (GHG); from diesel in tractors, to ruminants belching methane and the CO_2 created in plastic manufacture used for all sorts of application on farm. Reducing the levels of these gases from food production is critical in reducing the effects of climate change. Farmers and growers are in a unique position in not just being able to minimize carbon emissions but to sequester (absorb) carbon in the soils and biomass of farmlands. By carefully managing biomass and soils, farmers and growers can make informed decisions towards sustainable farming that absorbs more carbon than it emits.

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Level of Awareness and Climate-Smart Agricultural Technologies used by Rice Farmers in South-east, Nigeria

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Abstract

In Nigeria, climate change is seriously threatening agricultural productive activities in rural communities which are mainly rain-fed. The evidence of the unpleasant impact of climate change abounds in southeast, Nigeria. These include: increased cases of flooding and numerous gully erosion sites which have resulted to loss of arable farmlands, farm stead, economic tree, biodiversity and others. In south-east zone of Nigeria, there have been observed changes in rainfall regime and decreased yield of some traditional crops as a result of climate change. Thus, agriculture production systems require adaptation to these changes in order to ensure the food and livelihood security of farming communities. Adaptation options that sustainably increase productivity, enhance resilience to climatic stresses, and reduce greenhouse gas emissions are known as climate-smart agricultural (CSA) technologies, practices and services. Despite the various benefits of CSA technologies, the current rate of adoption by Rice farmers is fairly low due to factors such as socio-economic characteristics of farmers, bio-physical environment of a particular location, and the attributes of new technologies. Furthermore, the fact that climate risk on agricultural production are location specific, the identification, prioritization, promotion and demand for available CSA technologies by Rice farmers are major challenges for scaling out CSA in diverse agro-ecological zones such as that of South-eastern, Nigeria. This paper sought to investigate the level of awareness and climate-smart agricultural (CSA) technologies used by Rice farmers in South-east Nigeria. There is paucity of information with regards to rice production. Hence, the need for the study. The study determined Rice farmers' level of awareness and CSA technologies used by the Rice farmers in Southeast, Nigeria. Three states out of five states in the region were purposively selected due to dominance of rice farmers in the states. Descriptive statistics was used to achieve the objectives. The result revealed that CSA technologies used by rice farmers were energy-smart, water-smart and nutrient-smart technologies. Farmers were more aware specifically of the following technologies: furrow-irrigated raised bed planting (2.87); drainage management (2.66); directed seeded rice (2.76); zero tillage / minimum tillage (2.75); intercropping rice with legumes (2.74); and application of organic manure (2.55) revealing poor awareness to climate smart agriculture in the study area. The study recommended the importance to offer awareness campaigns in order to improve environmental knowledge and encourage environmental enthusiasm amongst society. Awareness and knowledge play a major role in the sustainable CSA technology adoption and use. The findings of this research would be helpful in integrating farmers' level of use of CSA technologies with government programs in the study area.

Key words: Climate-smart agriculture, technologies, awareness.

Introduction

Climate change will affect agricultural production through higher mean temperatures and more frequent weather extremes (Daryanto et al., 2016; Lesk et al., 2016). Higher variability in crop yields and food prices may increase poverty and food insecurity, especially in developing countries (Wheeler & Von-Braun 2013; Brown & Kshirsagar, 2015) Smallholder farmers, who make up a large share of the world's poor and undernourished people, could suffer the most (World Bank 2010). Often located in the tropics and subtropics, smallholders are particularly vulnerable to climate shocks, and they are usually also ill-equipped to cope with risks (Vermeulen et al. 2012). Agriculture in developing countries must undergo significant transformation if it is to meet the growing and interconnected challenges of food insecurity and climate change (FAO, 2010). Deforestation and unplanned land-use change triggered by increasing extraction of the natural resource base have increased people's vulnerability to the impacts of climate change and variability (Antle, 2009; Gwambene, 2012; CCAFS, 2014). The demand for food, fiber and fuel results in biodiversity loss and decline in the productive capacity of ecosystems, which have negative implications on food security and income, especially to the rural poor (Nyanga et al., 2011; IDB, 2014).

In Nigeria, particular threats are posed to agricultural production arising from changes in rainfall patterns which has resulted to increased desertification in the Sahel region and flooding in the southern part of the country (Spurgeon, Wasilewski, Ikpi & Foster, 2009). In South-eastern, Nigeria, Ozor and Nnaji (2011) identified that the most significant impacts of climate change experienced by rice farmers are; soil erosion, lack of portable water for human consumption and livestock use, loss of vegetation/pastures, intense weed growth, incidence of pests and diseases distortion and destruction of wildlife ecosystems, decrease in soil fertility and health related issues of climate change which can affect production, drudgery and stress from heat. According to (Enete, Madu, Mojekwu, Onyekuru, et al., 2011), the biggest effect of climate change in the geopolitical zone include reduced farm yield and income, drying up of streams/rivers, reduction in storage quality of rice crops, loss of pastureland/vegetation and destruction of wildlife ecosystem. They noted that these effects are likely attributable to the fact that zone in view has a drier weather; being closer to the North, and hence has inherent insufficient rain water for maximum crop yield.

The challenge of rapidly boosting productivity is compounded by the current and expected impacts of climate change. Changes to precipitation and temperature, especially in marginal areas, are expected to reduce productivity and make production more erratic (Cline, 2008; Lobell et al. 2008; Boko, et al. 2007). Sub-Saharan African countries in particular are most at risk: resources for adaptation are scarce, temperatures are already close to or beyond thresholds at which further warming reduces yields, and agriculture forms a larger share of national economies than elsewhere in the world (Cline, 2008). Agriculture, which accounts for nearly 14 percent of greenhouse gas emissions, also contributes to climate change (IPCC 2007). The good news is that agriculture can be integrated into the solution to reduce the pace of climate change by sequestering carbon in the soil instead of emitting it into the atmosphere. It is possible to achieve what the World Bank (2010) terms "climate-smart agriculture" or "triple wins": attaining higher yields, placing more carbon in the soil, and achieving greater resilience to heat and drought.

A proposed means to achieve this is increased adoption of a 'climate-smart agriculture' (CSA) approach (FAO, 2010). Developing appropriate and feasible climate-smart and climate-resilient agricultural practices is perceived to reduce hunger and improve food security and income (CCAFS, 2014). Transforming existing agriculture systems into climate-smart systems to negate the impacts of climate change, is necessary in order to address these emerging and unavoidable challenges (CCAFS, 2014). The important option is to build sustainable food systems, improve productivity and income of smallholder farmers especially rice farmers. Agricultural intensification through improved technologies needs to consider farmers' level of awareness and use to new (Haule et al., 2010, Coulibaly et al., 2015) which motivated the study. Various studies (Palanisami, Kumar, Malik, Raman et al., 2015; Campbell, Cheong, McCormick, Pulwarty et al., 2012; Below, Mutabazi, Kirchke, Frank et al., 2012; Deressa, Hassan & Ringler, 2011) focused on the benefits of CSA technologies and Willingness to pay for CSA use, little or no study assessed awareness level and use of comprehensively agglomerated CSA technologies specifically in South-east, Nigeria.

Considering the adverse effects of climate change in South-east, Nigeria, the application of CSA technologies by rice farmers in their production activities may be the solution envisaged for food production deficits arising from climate change. Although, some traditional practices carried out by rice farmers could be termed 'climate smart', but then, there are some other innovative technologies/practices that rice farmers may not be aware of that which promotes the three pillars of CSA. Based on this premise and considering the fact that CSA may be a new concept to rice farmers in South-east zone of Nigeria, this study will address the following research questions: are rice farmers aware of CSA technologies and which CSA technologies do they use in their Rice farming activities?

Materials & Method

The survey was conducted in southeast agro-ecological zone of Nigeria. Southeast is located between latitudes 04°17' N and 07°06' N and longitudes 05°23' E and 09°28' E (Macmillan, 2009). The area comprises the geographical location of five states namely Abia, Anambra, Ebonyi, Enugu, and Imo. The climate of southeast Nigeria is generally tropical with two clear identifiable seasons: the wet and dry seasons with average highest annual rainfall at 1952 mm and temperature pattern-mean daily and annual temperature at 28 and 27°C, respectively (Igbokwe et al., 2008). It is primarily an agricultural zone with sandy, mostly loose and porous soil, hence its vulnerability to climate change. Three States namely Anambra, Ebonyi and Enugu states out of five states were purposively selected because of the dominance of rice farmers in the states. Having provided the list of rice farmers by the Agricultural development Programme (ADPs) in the purposively selected states, Yamane's formula of population size determination, 349 rice farmers constituted the population for the study.

Interview schedule was used to collect data from the respondents which addressed issues such as farmers' level of awareness of CSA technologies and the CSA technologies used. The instrument was validated by two experts, one from the Department of Agricultural Economics, University of Nigeria, Nsukka and one from Department of Agricultural Economics and Extension, Nnamdi Azikiwe University, Awka. Descriptive statistics was used to achieve the objective.

Result and Discussion

Table 1: Rice farmers' level of awareness and CSA technologies used by the farmers in Southeast, Nigeria.

Awareness parameters	Standard deviation	Mean	Remark
Water-smart technologies			
Rainwater harvesting	0.767	0.49	Reject
Drip irrigation	0.566	2.13	Reject
Cover crops method	0.891	2.24	Reject
Furrow-irrigated raised bed planting	0.369	2.87	Accept
Drainage management	0.211	2.66	Accept
Directed seeded rice	0.479	2.76	Accept
Systems of rice intensification	0.643	0.43	Reject
Sprinkler irrigation	0.800	1.42	Reject
Energy-smart technologies			
Use of solar pumps	0.398	1.09	Reject

Zero tillage or minimum tillage	0.435	2.75	Accept
Nutrient-smart technologies			
Mulching	0.719	1.59	Reject
Application of green manure	0.972	2.21	Reject
Integrated nutrient management	0.000	0.00	Reject
Leaf color chart	0.536	0.42	Reject
Intercropping rice with legumes	0.653	2.74	Accept
Application of organic manure	0.780	2.55	Accept
Weather-smart technologies			
Crop insurance	0.913	1.41	Reject
Weather based crop agro-advisories	0.715	0.03	Reject
Climate information (seasonal and in season)	0.929	1.51	Reject
Knowledge-smart technologies			
Improved rice variety that is flood tolerant	0.840	2.10	Reject
Mixed farming	1.188	1.91	Reject
Adjusting planting dates	1.134	1.70	Reject
Crop diversification	1.069	2.19	Reject
Contingent crop planting	0.679	0.46	Reject
Carbon-smart technologies			
Agro-forestry	0.818	1.44	Reject
Integrated pest management	0.780	0.96	Reject
Bio-gas	0.144	0.02	Reject

Source: Field data survey, 2020.

Twenty seven CSA technologies/categorical options as sub units were given in the same order throughout the survey in a consistent manner and options provided were just three, namely: “very much aware/moderately aware and slightly aware”. Rice farmers were informed to choose only one level of the options provided. This group of options tested the rice farmer's awareness with reference to improved CSA technologies. From the result, the response of 77.7% of the Rice farmers were rejected because they were less than the mean cut-off point of 2.5 while the response of the rest of the Rice farmers (22.2%) were accepted as their mean score met the cut-off point aforementioned. Rice farmers were more aware with the following CSA technologies (mean score in parenthesis): furrow-irrigated raised bed planting (2.87); drainage management (2.66); directed seeded rice (2.76); zero tillage / minimum tillage (2.75); intercropping rice with legumes (2.74); and application of organic manure (2.55). The result conforms to findings of Olorunfemi, Olorunfemi and Oladele (2020) who reported that extension agents in South West Nigeria were more involved in disseminating nutrient smart and tillage smart initiatives which are use of organic manuring, use of herbicides and Zero tillage or minimum tillage. The result is in contrast with the findings of Arun et al. (2017) who reported that maize farmers in India were aware and preferred crop insurance, rainwater harvesting, weather based crop agro-advisories and contingent crop farming. The study revealed poor awareness to climate smart agriculture by rice farmers in Southeast, Nigeria. Reasons for poor awareness may possibly be linked to the sectors saddled with such responsibilities. Dissemination of new technologies in developing countries is done jointly by the public and private sector (Wolf et al. 2001). Farmers receive information or are aware of new technologies from agricultural media, commercial vendors, cooperative extension, and commodity associations. Frequently media processes information obtained from cooperative extension. Different sources of information have varying degrees of reliability while also highlighting different aspects of some technology (Just et al. 2002). In many developing countries especially vulnerable to climate change, the knowledge dissemination system may be lacking. For example, the private sector may not invest in distribution networks, extension services may be understaffed and underfunded, and access to information from media may be limited. Frequently, the introduction of new technologies will require the development of a dissemination system. Dissemination cum awareness will improve with investment in extension services and a communication network. The implication of Rice farmers' awareness to rice production is that there would be improvement in terms of sales and ease in climate friendly rice production as well as increased output.

Conclusion and Recommendations

This study provides insight into the level of awareness and climate smart agricultural technologies used by rice farmers in Southeast Nigeria. Farmers' level of use may differ based on prevalent climate conditions and ability to use the technology. The study found that rice farmers in Southeast Nigeria used CSA technologies such as energy-smart, water-smart and nutrient-smart technologies. The level of use may be affected by technologies readily available to them. The findings showed poor awareness to climate smart agriculture in the study area. This result suggests that farmers need to be educated on the many CSA technologies available to them and their anticipated benefits. To make further buttress, the United Nations Food and Agricultural Organization (FAO) estimating that by 2050, agriculture will need to produce 60 per cent more food globally, and 100 per cent more in developing countries, if it is to meet demand at current levels of consumption. Food demand needs to be met primarily from productivity increase on existing agricultural land since opening up new land for agriculture carries major environmental costs. Hence, supporting the transformation to more sustainable production practices is a prerequisite for sustainable development. Agriculture and food systems at every scale, from the farm to the global, have to improve and become more efficient in resource use (use less land, water and inputs to produce food more sustainably together with reducing food loss and waste) to meet the future challenges. To achieve this they also need to adapt to climate change and natural resource pressure, and contribute to mitigating climate change in which awareness of CSA technologies poses a strong foundational prerequisite. The study therefore recommended that extension agents need to be involved to expose the rice farmers to the need to use weather-smart, knowledge-smart and carbon-smart technologies in order to contribute to mitigating climate change. Government policies aimed at promoting CSA technologies should focus on site-specific technologies that are appropriate to the rice farmers. The findings of this research would be helpful in integrating farmers' level of use of CSA technologies with government programs in the study area.

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Role of Agroforestry in Food Security and Climate Change Mitigation

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Abstract

Climate change and its attendant consequences have come to stay with us. This has evolved through the process of global warming occasioned by the release of greenhouse gases into the atmosphere. Carbon dioxide is the most abundant greenhouse gas in the atmosphere. Humanity need to not only reduce carbon emissions but to also capture and store carbon. Climate change is also projected to negatively impact the four pillars of food security – availability, access, utilization and stability – and their interactions. Trees are special gifts of nature that act as important carbon sinks thereby sequestering atmospheric carbon (CO_2). Planting trees as a component of crop farming is a smart way to achieve multiple purposes with a single enterprise.Tree planting in a world affected by climate change can decelerate the negative impact of anthropogenic cause of climate change while providing food for humanity. This paper hence reviews the roles of agroforestry in the global fight against climate change whilst also ensuring food security.

Keywords: Agroforestry, climate-change, food-security, carbon-dioxide, tree-planting.

Introduction

The world is currently experiencing a period of warming and it is widely accepted that the cause of this warming is a direct result of the increased levels of carbon dioxide (CO_2) in the atmosphere caused by man's actions (these being from industrial developments, deforestation, agricultural improvements, and the increase use of cars/planes) (Patterson, 2003).One way to arrest carbon dioxide build-up in the atmosphere is to preserve and plant more trees. Trees, especially young and fast growing ones, soak up a great deal of carbon dioxide from the atmosphere and store carbon in the wood (biomass). The successful planting of trees, asides sequestering carbon, will provide alternative source of food, wood, energy and some other resources which otherwise are being harvested or gotten from the forest.

According to FAO (2001a), food security is a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Global agricultural production will need to increase by 70% to meet the estimated world population of approximately 9 billion in 2050 (FAO, 2014). Rapidly rising resource scarcity of water and increasingly of land will add further constraints on food production growth (Rosegrant *et al.* 2014). The cumulative effect of changes in climate is undermining all dimensions of food security – food availability, access, utilization and stability (FAO *et al*, 2018). In the longer term, adverse impacts from climate change are expected to raise food prices further and dampen developing-country food demand translating into direct increases in malnutrition levels, with often irreversible consequences for young children (Nelson *et al.* 2010). For instance, climate change could decrease maize yields by 9-18% depending on climate change scenario, cropping system (rainfed or irrigated), and whether the carbon fertilization effect is included; rice yields could drop by 7-27%; and wheat yields would be particularly affected, sharply declining by 18-36% by 2050, compared to a scenario with no climate change (Nelson *et al*. 2009).

A lot of issues affect food production thereby impacting in food security not just of Nigeria but the world over. The impact of climate change on food security may be very adverse for Nigeria as a nation. To this end, less food may be produced and further compound the already stressful situation (Adeola, 2015). According to OlogunOrisa (2011), several African countries including Nigeria are currently affected by drought and this has very serious implications for food security in the region.

In the wake of geometric increase in population growth in Africa, the traditional farming system is unlikely to produce enough food for the people if appropriate steps are not taken. Two ways out of this scenario include; bringing more land under cultivation; and making existing lands more productive using sound management practices (Adeola, 2000).Agroforestry is a land management strategy and could be utilized as a farming system to curtail the shifting cultivation farming system common in Nigeria. In the process, the extensive demand for land associated with shifting cultivation, which usually make man to clear more forest land for agriculture will be eliminated. Thus, the forest and the resources therein will be conserved (Dera*et al.*, 2008). Agroforestry is an effort at combining trees, and shrubs with crops with emphasis on their mutual benefits to enhance diversity, productivity, profitability and sustainability of the land use system and hence the farmer. The Taungya system of agroforestry involves the cultivation of food crops in forest reserves. It is an agroforestry system which has wood or forest products as its ultimate objective even though the immediate motivation for practicing it is food production by landless farmers (Adeola, 2015). Also, agroforestry has the potential of addressing poverty issues and providing alternatives and diversified means of livelihoods for both small and large investors. Agroforestry practice will reduce human pressure on the natural forest and the resources therein. This is true because agroforestry stimulates the natural forest outlook and can provide resources close to what may be obtained from the forest.

According to Amonum *et al.* (2012), agroforestry programme as a practice is very useful in sequestering carbon and could be used on sustainable landscape management principle to address the needs of the stakeholders for food, fibre, fodder and energy as well as other services while still serving as carbon sink. Perennials (trees) are known to sequester more carbon than annual crops. For instance, coppice and biomass systems can sequester 1 – 6 tons/hectare/year, tree crops and bamboo 2 -28 and 6 – 33 tons/hectare/year, and multistrata agroforestry systems sequester 4 – 40 tons/hectare/year (Toensmeier, 2014) while a well-managed annual system will only sequester 1 – 2 tons/hectare/year (Adeola, 2015). From this, it can be inferred that agroforestry system will give the best land management system to sequester carbon and ultimately mitigate climate change.

Table 1: Carbon absorption capacity of different agroforestry models in India

Agroforestry model	**Carbon storage capacity**	**Region**	**Author**
Agrisilviculture system (aged 11 years)	26.0 tC/ha	Semiarid region	NRCAF (2005)
Block plantation (aged 6 years)	24.1–31.1 tC/ha	Central India	Swamy S.L. *et al*; (2003)
Silvopasture	31.71 tC/ha	Himachal Pradesh	Verma *et al* (2008)
Agrisilviculture	13.37 tC/ha		
Agri-horticulture	12.28 tC/ha		
Silvopastoralism (aged 5 years)	6.55 Mg ha–1 y–1	Kerala, India	Kumar *et al* (1998a)
Indonesian homegardens (aged 13.4 years)	8.00 Mg ha–1 y–1	Sumatra	Roshetko *et al* (2002)

In agroforestry, the three mains components - animals, crops and trees - can be combined in numerous spatial and temporal arrangements and for different functions, creating thus many different kinds of systems. The definitions for the systems are described below:

AgrisilviculturalSystem (Trees combined with crops)

Improved fallows: woody species planted and left to grow during fallow.

Taungya: combined stand of woody and agricultural species during early stages of establishment of plantations.

Alley cropping (hedgerow intercropping):	woody species in hedges; agricultural species in alleys in between hedges; microzonal or strip arrangement.
Multilayer tree gardens:	multispecies, multilayer dense plant associations with no organized planting arrangements.
Multipurpose trees on crop lands:	trees scattered haphazardly or according to some systematic patterns on bunds, terraces or plot/field boundaries.
Plantation crop combinations:	such as integrated multistorey mixtures of plantation crops; of plantation crops in alternate; shade trees for plantation crops; shade trees scattered; intercropping.
Home gardens:	multistorey combination of various trees and crops around homesteads.
Trees in soil conservation and reclamation:	trees on bunds, terraces, raisers, etc. with or without grass strips; trees for soil reclamation.
Shelterbelts and windbreaks, live hedges:	trees around farmland/plots.
Fuelwood production:	interplanting firewood species on or around agricultural lands.

SilvopastoralSystems (Trees and pastures or animals)

Trees on rangeland or pastures:	trees scattered irregularly or arranged according to some systematic pattern.
Protein banks:	production of protein-rich tree fodder on farm/rangelands for cut-and-carry fodder production.
Plantation crops with pastures and animals:	for example, cattle under coconuts in south-east Asia and the south Pacific.

AgrosilvopastoralSystems (Animals, trees and crops)

Homegardens involving animals:	intimate, multistorey combination of various trees and crops, and animals, around homesteads.

Multipurpose woody hedgerows:	woody hedges for browse, mulch, green manure, soil conservation, etc.
Apiculture with trees:	trees for honey production.
Aquaforestry:	trees lining fish ponds, tree leaves being used as 'forage' for fish.

Adapted from: Nair (1993)

Conclusion

Trees and forests influence both their immediate surroundings and the stability of the large environment and as a result have several important links to food security. Both at the micro and the macro-level, they help provide the stable environmental conditions on which sustainable food production depends. This is done by maintaining and improving soil fertility which help sustain crop yields. The shade cast from trees is also important in the production of some crops and in animal husbandry. The vegetative cover protects soils against wind erosion and intense seasonal rainfall. A well-managed multipurpose tree species on farm has the potential to make efficient use of natural resources, improve soil fertility, enhance biomass productivity, conserve soil and recycle nutrient, sequester carbon and improve the micro-climate. Nowadays, farmers, researchers, policy makers are interested in agroforestry for its ability to contribute in meeting deficit of agricultural and tree products with socio-economic and environmental benefits.

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The Climate Change Adaptation Strategies in Crop Production in Enugu State, Nigeria: Examining the Profitability Climate Adaptation Strategies

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Abstract

The aim of this study was to assess the relationship between climate change adaptation strategies and crop productivity. The study is motivated by the recent climate change that has continued to be a source of concern to farmers in Nigeria. To achieve the broad objective of this study, three major specific objectives (perception of climate change by farmers; strategies used by farmers to mitigate climate change influences; and, to estimate the cost and returns associated with the choice of strategies adopted by crop farmers in coping with climate change) were stated. Multi stage sampling technique was used to select 160 crop farmers. The data for this study were collected using a structured questionnaire. Descriptive statistics and partial budgeting were major analytical tools for the data. The results showed that the most widely used adaptation method by the farmers were adjustment of planting period (90%), use of resistant varieties (89%), planting early maturing crops (88%) and soil and water conservation. Some of the coping strategies adopted by the farmers with relatively high profitability indices include: adjustment of planting period (PI = 5.67), planting of early maturing crops, multiple intercropping (PI = 3.66), use of resistant variety (PI= 3.03), use of improved varieties (PI = 2.36) and mono cropping (PI =2.00). Therefore, farmers should invest more on these profitable climate adaptation strategies, as they tend to boost up crop production.

Keywords: Climate change, partial budget, economic development, crop productivity

Introduction

Climate change has remained a central issue among researchers in the recent time. According to Oladipo (2010) crop yields are directly affected by changes in climatic factors such as temperature and precipitation and the frequency and severity of extreme events like droughts, floods and windstorms. Based on past and historical climate development, there is now a general consensus on climate change (Reid and Huq, 2007). As well, there is increasing evidence that climate change will strongly affect the African continent and will be one of the most challenging issues for future development, particularly in drier regions (Adger et al., 2007; Haile, 2005; Kurukulasuriya et al., 2006). Accordingly, studies indicate that agriculture as a major source of livelihoods in Africa is negatively affected by climate change (McCarthy et al., 2001; Pearce et al., 1996), and future climate conditions will likely worsen the situation.

From a global perspective, it is established that climate change will have adverse effects on yields. In Nigeria, for instance, the Ministry of Agriculture and Rural Development predicted that yields of maize, cassava, beans, groundnuts, rice, yam, cotton and Sorghum will have decrease between 13% to 18% of the current level by 2025 due to climate change (FMARD, 2019; Paeth et al., 2008). Economic valuation of rice and maize farming profitability, 271 predicted for decreases in their output ranging from 5–20%, implying severe problems of food security challenges.

According to Ikeme (2009), Nigeria is currently experiencing increasing incidence of disease, declining agricultural productivity, increasing number of heat waves, erratic weather patterns, flooding, declining rainfall in desert prone areas in the north causing increase in desertification and decrease in crop production in the central regions due to climate change. Nigerian climate had shown considerable temporal and spatial shifts in its variability and change making extreme climate and weather event (drought, flood, heat waves, ocean surges, etc) a more regular event exemplified by destructive flood of 2012 which occurred in many parts of Nigeria (IPCC, 2014). Thus, climate change adaptation becomes a compelling necessity. Climate change adaptation is the ability to respond and adjust to actual or potential impacts of changing climate conditions in ways that moderate harm or take advantage of any positive opportunities that the climate may afford.

Generally, climate plays a dominant role in agriculture having a direct impact on productivity of physical production factors, for example, the soil's moisture and fertility adverse climate effects can influence farming outputs at any stage from cultivation to the final harvest (Smith and Skinner, 2012). Other potential impacts linked cropping systems include erosion that could be exacerbated by expected increase intensity of rainfall and crop growths period that is expected to be reduced in some areas (Agoummi, 2018). Climatic change adaptation can be classified as two major kinds of modification in the production system: (a) increased diversification and (b) protecting sensitive growth stages by managing the crops to ensure that these critical stages do not coincide with very harsh climatic condition, such as mid season droughts (Hassan and Nhemachena, 2017). They noted that under these two modification techniques, the adaptation strategies farmers perceive as appropriate include crop diversification using different crop varieties, varying the planting dates, harvesting dates, planting resistance varieties, increasing the use of irrigation and increasing the use of water and soil conservation techniques. Others include shading and shelter as well as shortening the length of the growing season (Hassan et al., 2008).

Farmers have been exposed to different coping approaches to climate change. For instance, Deressa et al., (2009), in their study, analyzed the factors affecting the choice of suggested adaptation methods but failed to indicate the monetary or yield impact of climate change adaptation methods. The knowledge of the adaptation measures taken by farmers and the cost of such adaptation measures will contribute to deriving policies aimed at solving the problems that climate change has put up against farmers. Farmers adapt to reduce the negative impacts of climate change. The success of adaptation depends critically on financial (cost) effects of the adaptation strategy. The assumption here is that farmers adopt a new technology only when the perceived utility or profit from using this new technology is significantly greater than the traditional or the old method. Farmers consider the cheapest options that will cost them less and yield more return to them.

Ukwuaba (2014) presented a proposal on the adaptation strategies to climate change among small holder farmers in Enugu State with no regards on the costs and returns of these adaptation strategies used by small holder farmers in the area. Onoja (2014) in his study estimated the costs involved in adapting to climate change in Nigeria but the Enugu state was not included. Iorliam (2014), Ojemba (2014) also estimated the costs and returns of adaptation strategies but none of them was carried out in Enugu state. Iorliam (2014) carried out his study in the Northern part of the Country, Oniah (2012) was carried out in Cross River State, Obi (2013) studied the effect of flood coping strategies in Anambra State and Ojemba (2014) carried out his study in Southeast of Nigeria (Imo, Ondo and Delta State). Enete, Ihemezie and Otitoju (2014) in their study on adaptation strategies among food crop farmers in Southwest Nigeria did not consider the costs and returns associated with these strategies. Of a particular importance to this paper is that little or nothing is known about the cost of adaptation of climate change strategies in the study area. This study therefore, was designed to fill in this gap in knowledge.

Material and Methods

The study was carried out in Enugu State. Enugu State is divided into six agricultural zones namely: Awgu; Agbani; Udi; Nsukka; Enugu Ezike and Enugu. Multi-stage random sampling technique was used in selecting crop farmers (the respondents) in the study area. In the first stage, Nsukka and Enugu zones were random selected out of the six agricultural zones. In the second stage, two LGAs were randomly selected from each of the two agricultural zones giving a total of four LGAs. These LGAs are UzoUwani and Igbo Etiti in Nsukka zone, while Isi-Uzo and Enugu East in Enugu zone, In the third stage, one community was randomly selected from each of the four local governments. Lastly, proportional random sampling was used to select 180 crop farmers from the selected communities as follows; Uzo-Uwani (60), Igbo Etiti (40), Isiuzo (50) and Enugu East (30). However, the response rate was 89% due to non-compliance of some respondents and badly filled questionnaire. Therefore, the analysis was based on 160 respondents.

The data for the study were collected from primary source with a set of well-structured questionnaire, which was pretested and subsequent correction made. The questionnaire were administered through the help of research assistants who were conversant with the selected localities. The survey lasted for eight months of 2019 in two phases of March to June and November to February to accommodate all the farming seasons. Information gathered include crop farmer's socio-economic characteristics, farmers' level of awareness on climate change variables, adaptation strategies used by farmers, factors affecting the choice of each adaptation strategy, cost and returns associated with the choice of strategies adopted by farmers in coping with climate change and constraints encountered by farmers in adopting climate change adaptation strategies. Two experienced agricultural economist experts examined content validity independently. The experts gave their critical opinion on the adequacy and relevance of the instrument to objectives of the study. To ascertain the reliability of the questionnaire, copies were tested on crop farmers in Enugu Ezike Agricultural Zone (Igbo-Eze North LGA) of Enugu state and reliability coefficient of 0.78 was obtained using Cronbach alpha technique.

The major tools for data analysis were descriptive statistics and partial budgeting. For the partial budget used, each adaptation practices, the total positive impacts, comprising of added returns and reduced costs were summed. In addition, the total negative impacts, comprising of added costs and returns were totaled. The latter was subtracted from the former to get the net returns from each of the practices. The constraints encountered by the farmers in the course of adopting climate change adaptation strategies were measured through proxy in form of perception of the seriousness of the constraints to the farmers. Each constraint had its perception scale (with likert rating scale) to reflect seriousness of the constraint. To determine if the constraint was serious, the weighted mean of 2.50 was used as cut-off.

Results and Discussion

To get information on their perceptions to climate change, farmers were asked two sets of questions. The first was on knowledge of any change on the climate variables. The second question was the direction of climatic variables in terms of increase or decrease. The perception of climate change by respondents shows that most of the farmers are aware of the fact that climate has changed. Temperature (82.5%), heat wave (60.0%), wind (51.3%), sunshine (90.0%) and drought (62.5%) are increasing and rainfall (54.4%), flood (50.6%), thunderstorm (60.0%) and humidity (74.4%) are declining (see Table 1). This affirms that perception of some climate variables are relatively high among crop farmers in Enugu States.

Table 1: Distribution of Respondents according to their Perception of Climate Change Variables

Climate variables/Stressors	Increase in climate variable (%)	Decrease in climate variable (%)
Climate Variables		
Temperature	82.5	17.5
Humidity	25.6	74.4

Sunshine	90	10
Rainfall	45.6	54.4
Wind	51.3	48.8
Stressors		
Flood	49.4	50.6
Drought	62.5	37.5
Thunderstorm	39.4	60.6
Heat wave	60.0	40.0

Source: Field Data, 2019

Flood, thunderstorm, heat wave and drought

Adaptation measures embarked upon by the respondents to minimize the effect of climate change in the area is presented in Table 2. The distribution shows that about 90% of the respondents adjust their planting date, while about 89% use resistance varieties. In addition, about 88% of the respondents planted early maturing seed and about 82% use soil and water conservation technique (mulching), while 42% plant their crops deeper than usual. This study has revealed that farmers adapt different adaptive measures to minimize the effect of climate change in the area. Further, the table identified that adjustment of planting period dominated all other strategies (90%). This is closely followed by use of resistant varieties (89%), while planting early maturing crops (88%) is the third most popular climate adaptation strategies used by farmers.

Table 2: Distribution of Respondents based on Adaptation Strategies Practiced

Adaptation strategies	Yes (%)
Soil and water conservation	
Planting of cover crops	78.8
Mulching	82.5
Planting of canopy trees for shade	66.2
Irrigation	77.5
Varying planting date	78.8

Multiple intercropping	43.8
Planting deeper than usual	42.5
Adjustment of planting period	90.0
Crop diversification	50.0
Planting early maturing crops	88.8
Use of resistant varieties	89.4

In calculating the profitability index, the researcher adopted a dominant adaptation practice by each respondent. In this situation, the profitability index was calculated for the dominant climate adaptation strategy as practiced by the crop farmer as presented in Table 3. However, most farmers combined use of resistant crop varieties with some other adaptation strategies in the study area. The table shows that the adaptation measures with the highest profitability index (PI) are the adjustment of planting period (PI = 4.67). It is assumed that these measures make it easy for the crops to escape the vagaries of climate change by completing their growth cycle before storm and drought set in, thereby checking the impact of climate change. Molua (2002) reported that changing planting dates protected farmers' crops from climate constraints such as stormy and torrential rains. Planting of early maturing crops (PI = 2.75), mixed cropping with PI of 2.66, use of resistant variety (PI= 2.03) and combination crop diversification/resistant variety/varying planting date/mulching (PI = 2.14) are the second most cost effective strategies. The result of this study was in line with that of Enete et al. (2011) who observed that multiple/intercropping had the highest Profitability Index (PI) i.e return per unit investment among the adaptation strategies considered. Growing of two or more crops at the same time in the same field helps reduce the risk of crop failure, if the production of one crop is affected, farmers can rely on the other crops. Moreover, intercropping allows farmers to use their land optimally by taking different crops at a time (Kurukulasuriya and Rosenthal, 2003). John (2009) also reported that mixed cropping had the highest gross margin among the drought coping strategies practiced by crop farmers in Borno State, Nigeria. Though farmers that combined adaptation strategies recoded profit in their farming business, those that combined crop diversification, resistant variety, varying planting date and mulching recorded relatively higher profitable index of 2.14.

Table 3: costs and returns of associated with the adaptation strategies practiced by farmers

Adaptation strategies	PI	Cost (N)	Return(N)	Gross Margin(N)
Adjust the planting period	17,000	96,400	79,400	4.67
Planting early maturing crops	82,200	308,040	225,840	2.75
Mixed cropping	56,000	205,000	149,000	2.66
Use of resistant varieties	102,360	310,400	208,040	2.03
Planting of cover crops	74, 020	131,790	57,770	0.78
Irrigation	53,360	85,240	31,880	0.60
Mulching	39,000	66,200	27,200	0.93
Crop diversification	36,000	52,000	16,000	0.44
Combinations				
Crop diversification/using resistant variety/adjusting				
Planting date	122,040	278,900	156,860	1.29
Crop diversification/resistant variety				
Varying planting date/mulching	114,076	389,470	275,394	2.14
Irrigation/resistant variety	104,787	209,084	104,297	1.00
Mixed cropping/resistant variety	98,675	186,040	87,365	0.89

PI = Profitability Index (return per naira invested)

Source: Field data, 2019.

Four scale Likert rating point was used to determine the factors that affect the choice of adaptation strategies by the farmers. The average point is 2.50. Four scale Liker rating point was used to determine the factors that affect the choice of adaptation strategies by the farmers. The average point is 2.50. From the result on table 4.4, the total average cut off is above 2.50 showing that farmers are facing constraints. These include: lack of information on climate change, lack of improved agricultural technologies, lack of access to weather forecast technologies, lack of access to credit, Poor agricultural extension service delivery, and lack of access to supporting institutional facilities (see Table 4). Most of these constraints (lack of improved agricultural technologies, lack of access to weather forecast technologies and lack of access to supporting institutional facilities, high cost of improved varieties are associated with poverty. According to Enete and Onyekuru (2011), lack of information on climate change could pose serious challenges to farmers` copping strategies as they may not be aware of recent developments regarding climate change adaptations and the necessary readjustments needed. Lack of money hinders farmers from getting the necessary resources and technologies, which assist to adapt to climate change.

Table 4: The Constraints Encountered by the Crop Farmers in Adopting Climate Change Adaptation Strategies.

Constraints	Average rating/point
Poor access to information about climate change	3.55
Lack of improved agricultural technologies	3.53
Lack of access to weather forecast technologies	3.50
Lack of access to credit	3.46
Poor agricultural extension service delivery	3.40
Lack of access to supporting institutional facilities	3.25
Land ownership	2.93
High cost of irrigation facilities	2.93
High cost of improved varieties	2.56
Costs associated with the adaptation strategy	2.27
Involvement of the crop farmer in some off farm jobs	2.23
Traditional belief/practices	1.98

Source: Field data, 2019.

Conclusion and Policy Recommendation

From this study, it is evidenced that crop farmers are experiencing change in climate (increased temperature and decreased rainfall). Farmers' knowledge of climate change variables enable them to devise a means of survival by using one or combination of different climate adaptation strategies. The study concluded that beside all the constraints those farmers are facing in the course of adapting to climate change adaptation strategies, almost all the adaptation strategies that the farmers are practicing are worthwhile because they are profitable.

Based on the findings of the study, we suggest that farmers should be encouraged to be adjusting their planting date/period to coincide with less severe heat period, planting early maturing crops and multiple intercropping, use of resistant variety and use of improved varieties yield high profit per hectare. Farmers identified that a number of constraints to climate change adaptation are lack of technology, access to information related to weather forecast and poor extension delivery services. Therefore, there should be a close linkage between farmers, extension agents and policy makers, in order to build up the current coping strategies into sustainable adaptation strategies which will be streamlined into national agricultural, economic and climate change adaptation policies. The government, NGOs, and private sectors should make efforts to ensure that credit support facilities are made available to farmers so as to increase their ability and flexibility to change production strategies in response to climate change. In addition, non-formal educational programs should be encouraged, through extension services manned by competent and qualified extension agents to enlighten and sensitize farmers about the impact of climate change on agriculture and information on adaptation strategies.

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Use of sustainable production practices for climate change adaptation by rice farmers in Ebonyi State, Nigeria

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Abstract

The study assessed the use of sustainable production practices for climate change adaptation by rice farmers in Ebonyi State, Nigeria. Multistage sampling technique was used to select 108 respondents from two agricultural zones in the study area. Data was collected using interview schedule. Descriptive statistics such as frequency, percentage, mean deviation were used in data analysis. Results show that the major individual sustainable production practices for climate change adaptation adopted by the respondents include use of furrow to drain excess water from rice field, use of recommended quantity of inorganic manure/fertilizer and diversification of crops. Community-based sustainable production practices adopted by rice farmers in the area include controlled bush burning, adjustment of planting season, replanting/maintaining of vegetation and trees along streams/rivers, regulation of surface water use. The most effective sustainable production practices for climate change adaptation in the area include use of recommended quantity of inorganic manure to replenish soil nutrient (M=3.80), use of furrow to drain excess water from rice field (M=3.74), controlled bash burning (M=3.69). It was recommended that rice farmers should be trained and encouraged on the need to use a good number of both individual and community-based sustainable production practices for climate change adaptation which will help increase productivity and also enhance the environment.

Introduction

Climate change over the years has been a great challenge to the agricultural sector. Climate change affects the agricultural sector mainly through rising temperature, decreasing rainfall, changes in carbon dioxide concentrations, atmospheric humidity, and solar radiation. Rice which is a major food security crop in Nigeria is vulnerable to climate change in many ways. Significant changes in climate parameters have implications on rice yield and productivity including reduction in the areas for rice cultivation, reduction in yield and grain quality resulting in significant losses of crop and income among rice farmers (Tedoo and Feola, 2016). A viable adaptation option which constitutes little or no harm to the environment has been promoted by relevant stakeholders. Sustainable agricultural production which considers both natural and human resources can be optimally utilized to mitigate the negative impacts of climate change. Sustainability in agricultural production is a process of ensuring agriculture that produces enough to feed the growing population while protecting land and other natural resources for future generation (Nwobodo and Agwu, 2015).

Sustainable rice farming is the process by which farmers manage soil and water, relying mainly on farm resources, to enhance productivity and maintain it to meet farm and family needs, without adversely affecting the production environment (Najim, Lee, Haque et al., 2007). Sustainability has three core principles which include the environmental, social and economic aspects. Economic sustainability refers to practices that reduce input consumption (e.g. water, pesticides, and fertilizers) and improve crop productivity (Wezel, Casagrande, Celette and Jean-Ojuum, 2014). Environmental sustainability advances the biological diversity and ecological integrity of a natural system. This focuses on the health quality of the natural environment, thus making it differ from the economic model whose unit of focus is creating capital (Agyei, 2016). Social sustainability implies a system of social organization that alleviates poverty. In a more fundamental sense, however, 'social sustainability' establishes the nexus between social conditions such as poverty and environmental decay (Wanamaker, 2018). Farmers utilize several social sustainability practices in managing climate risks (Onyeneke, 2020). These practices can take the form of individual or community-based approaches. Individual farmers can adopt certain practices capable of off-setting the impacts of climate change on their rice fields such as irrigation and use of drought tolerant varieties during periods of drought (Takama et. al. 2014). Also, a group of rice farmers can come together and pull resources to embark on adaptation projects which will benefit every member of the community or group. For instance, a community-based irrigation system was found to enhance sustainability in rice production in Indonesia (Komaladara et. al., 2015). These practices not only enhances the adaptation of rice production system to climate change but also ensure judicious use of natural resources in a way that enhances sustainability of the environment. Ebonyi State is very outstanding in rice production in Nigeria with a long history of commercial rice farming. Rice production has continued to be a major economic activity in the State resulting in extensive use of natural resources. Therefore, stewardship calls for greater use of sustainable production practices among rice farmers in the State in order to ensure that they are able to maintain optimum productivity while sustaining natural resources for future generation. Some questions one needs to ask are; what are the individual sustainable production practices adopted by rice farmers in Ebonyi State? What are the community-based sustainable production practices adopted by rice farmers in Ebonyi state? How effective are these production practices that rice farmers adopt in cushioning the effects of climate change in the area?

Purpose of the study

The overall purpose of the study was to assess the use of sustainable production practices for climate change adaptation by rice farmers in Ebonyi State, Nigeria. Specifically, the study sought to:

1. Identify the individual sustainable production practices used for climate change adaptation in rice production among farmers in Ebonyi state;

2. Identify the community-based sustainable production practices used for climate change adaptation among farmers in Ebonyi state;

3. Determine the effectiveness of sustainable practices used for climate change adaptation among farmers in Ebonyi;

Methodology

This study was carried out in Ebonyi State, Nigeria. Multistage sampling technique was used to select one hundred and eight (108) respondents from two out of the three agricultural zones in the State. Structured interview schedule was used in data collection. Individual sustainable production practices for climate change adaptation were collected by asking respondents to tick 'yes' or 'no' to indicate the individual sustainable production practices they adopt. The community-based sustainable production practices for climate change adaptation were collected by asking respondents to tick ‘yes' or ‘no’ to indicate the community-based sustainable production practices they adopt. The effectiveness of sustainable production practices for climate change adaptation were collected by providing a list of sustainable practices for climate change adaptation to respondents by asking respondents to tick on a four-point Likert-type scale to indicate their responses. The mean/cut-off point was 2.5. Data was analyzed using “descriptive statistics.

Results and discussion

Individual Sustainable production practices for climate change adaptation

Result in Table 1 shows the individual sustainable production practices for climate change adaptation. From the Table, majority (98.1%) of the respondents indicated use of furrow to drain excess water from rice field, 94.4% each of the respondents indicated use of recommended quantity of inorganic manure/fertilizer and diversification of crops respectively, 26.9% indicated use of cover crops and use of mulching materials from previous harvest respectively, 13.0% indicated the use of reservoirs or ponds to regulate flash floods, 7.4% indicated use of organic manure only, 4.6% indicated use of furrow water to irrigate rice fields.

Also, Table 1 show respondents use of unsustainable production practices for climate change adaptation. From the Table, majority (91.7%) of the respondents indicated conventional tillage, 6.5% of the respondents indicated use of unrecommended dose of herbicide, 2.8% indicated use of excess water for irrigation, 1.9% indicated incessant application of inorganic fertilizer, 0.9% of the respondents indicated use of clayey materials to retain water in the rice field. This implies that farmers adopt certain strategies to adapt to the effects of climate change. This finding agrees with that of Agyei (2016) who stated that sustainable practice could be grouped into indigenous and introduced strategies. Indigenous strategies include practices as use of mulching, loosening the soil, creating of bunds and regular weeding while introduced practices include use of early maturity varieties, use of compost and reduction of farm size (diversification).

Table 1: individual sustainability production practices

Individual sustainability production practices	Frequency	Percentage
Use of organic manure only	8	7.4
Use of recommended qty of inorganic manure/fertilizer	102	94.4
Use of cover crops	29	26.9
Use of mulching materials from previous harvest	29	26.9
Use of cultural method in weed control (for example use of trees to smother weeds)	2	1.9
Use of reservoirs or ponds to regulate flash floods	14	13.0
Use of furrow water to irrigate rice fields	5	4.6
Use of furrow to drain excess water from rice	106	98.1
Diversification of crops	102	94.4
Use of furrow to retain water in the field	1	0.9
Use of ash to reduce soil acidity	2	1.9
Incorporation of organic and inorganic manure	1	0.9
Unsustainable adaptation strategies		
Conventional tillage	99	91.7
Incessant application of inorganic fertilizer	2	1.9
Use of unrecommended dose of herbicide	7	6.5
Use of excess water for irrigation	3	2.8
Use of clayey materials to retain water in the rice field	1	0.9

Community-based sustainability production practices for climatic adaption

Table 2 shows community sustainable production practices for climate change adaption. From the Table, majority (98.1%) of the respondents indicated controlled bush burning, 84.3% of the respondents indicated adjustment of planting season, 81.5% of the respondents indicated replanting/maintaining of vegetation and trees among streams/rivers, 75.9% of the respondents indicated regulation of surface water use, 25.9% of the respondents indicated construction of drainage systems around the community, 7.4% of the respondents indicated construction of community shallow wells, 5.6% indicated regulation of groundwater use. This implies that there are some sustainable practices which are community-based. The result of this findings agrees with that of Ayers and Forsyth (2009) stated that the most obvious forms of community-based adaptation includes simple but accessible technologies such as storing freshwater during flooding or raising houses near the sea.

Table 2: Community-based sustainable production practices for climate change adaptation

Community-based sustainability production practices	Frequency	Percentage
Building of damn/reservoirs	1	0.9
Construction of drainage systems around the community	28	25.9
Construction of community shallow wells	8	7.4
Building of community seed banks	1	0.9
Adjustment of farm season	91	84.3
Replanting/maintaining of vegetation and trees along streams/rivers	88	81.5
Forbidding the use of agrochemicals	1	0.9
Regulation of surface water use	82	75.9
Regulation of groundwater use	6	5.6
Controlled bush burning	106	98.1
Collective pest control measures	5	4.6

Effectiveness of sustainable productions practices for climate change adaption

Table 3 shows the effectiveness of sustainable productions practices for climate change adaptation adopted by rice farmers. From the Table, the effective sustainable production practices for climate change adaptation include: use of recommended quantity of inorganic manure to replenish soil nutrient (M=3.80), use of furrow to drain excess water from rice field (M=3.74). Controlled bush burning (M=3.69), diversification of crops (M=3.39), use of organic manure to replenish soil nutrient (M=3.15), establishment of rice seedlings in nursery to reduce pest attack (M=3.00). It also includes; regulation of surface water use (M=2.99), adjustment of planting season (M=2.78), replanting/maintaining of vegetation and trees along streams/rivers (M=2.60), establishment of rice seedlings in nursery to reduce weed infestation (M=2-54). This implies that these sustainable production practices had helped these farmers to avert the effects of climate change on their rice farms. This agrees with the of Enete, Madu, Mojekwu, Onyekuru et al. (2011) who stated that at the farm level, the practice of organic agriculture, varying the planting date and diversification is one of the most measures to adaptation to climate change by farmers.

Table 3: Effectiveness of sustainable productions practices for climate change Adaptation

Sustainable production practices	Mean	Standard deviation
Individual based sustainable production practices		
Use of organic manure to replenish soil nutrients	3.15*	1.040
Use of recommended dose of inorganic manure to replenish soil Nutrient.	3.80*	0.427
Use of cover crops to replenish soil nutrients and water	1.85	1.066
Use of mulching materials from previous harvest	1.60	0.735
Planting of trees around rice field to reduce pest attack	1.21	0.454
Establishment of rice seedlings in nursery to reduce pest attack	3.00*	0.862
Establishment of rice seedlings in nursery to reduce weed infestation	2.54*	0.779
Use of cultural method in weed control(for example use of trees to smother weeds)	1.23	0.445
Use of reservoirs or ponds to regulate flash floods	1.25	0.582
Use of furrow water to irrigate rice fields	1.14	0.420
Use of furrow to drawn excess water from rice field	3.74*	0.461
Diversification of crops	3.39*	0.708
Community-based adaptation strategies		
Building of damn. reservoirs	1.03	0.165
Construction of drainage systems around the community	1.43	0.845
Construction of Irrigation facilities by government/non-government organization.	1.00	0.000
Construction of modern storage facilities	1.01	0.096
Construction of community shallow wells	1.14	0.483
Building of community seed banks	1.05	0.252
Adjustment of planting season	2.78*	0.989
Replanting/ maintaining of vegetation and trees along street/rivers	2.60*	1.041
Collective diseases control measures	1.03	0.214
Forbidden the use of agrochemical	1.02	0.193
Regulation of surface water use	2.99*	1.219
Regulation of ground water use	1.22	0.535
Controlled bush burning	3.69*	0.486
Collective pest control measures	1.16	0.45

Conclusion

Based on the findings of the study, it can be concluded that rice farmers in Ebonyi State adopt individual sustainable production practices to adapt to the effects of climate change on rice production. Also, the respondents use few unsustainable production practices to adapt to climate change. Rice farmers in the area also use community-based sustainable production practices for climate change adaptation and that most of the sustainable production practices are effective.

Recommendations

It is recommended that rice farmers should be trained and encouraged on the need to use a good number of both individual and community-based sustainable production practices for adaptation which will help increase productivity and also enhance the environment. Government/Non-Governmental Organization should provide modern facilities such as irrigation facilities to help farmers produce all year round, storage facilities to reduce waste and spoilage, construct community seed banks to enable farmers access resistant varieties of rice.

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Trends of Sector Specific Vulnerability to Climate Change in Nigeria

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Abstract

The study aimed to analyze the trends in climate vulnerability for Nigeria, focusing on sector-specific vulnerabilities estimates. It employed a quality country level dataset from Notre Dame-Global Adaption Index measures of vulnerability for food, water, ecosystem, habitat, health and infrastructure specific-sectors for Nigeria. Using descriptive statistics, ANOVA and Trend graphs; the results of the analysis showed that the food sector is the most vulnerable whereas the infrastructure sector is least vulnerable to climate changes. However almost all the sectors were highly vulnerable to climate variability, with gradual decrease in the trends of vulnerability across the years for four sectors. The study recommended a painstaking attitude towards the implementation of the Climate action document for Nigeria across all levels government using an inclusive approach to stimulate the private sector, CSO and local communities.

Key words: Vulnerability, sector, Notre Dame-Global Adaptation Index, trend, Nigeria

Introduction

Climate change is a persistent global phenomenon which all living organisms most especially man, tackles on a daily basis. Climate change and its unsettling effects such as global warming, regular climate-related disasters, etc. is a long established worldwide happenstance which has been of major concern to the scientific community for several years now. The negative effects of climate variability is far from rescinding, rather it tends to gather momentum in time and space with new records set from time to time. The adverse incidence climate change spans different climes world over, with the impact on units of the ecosystem differing across regions owing to the degree of climate variability, the sensitivity of the systems and the adaptive ability. The nature of these climate occurrences raised the question of vulnerability levels across places, populations, races, sectors and systems of the economy. Vulnerability could be defined as human society's tendency or predisposition to be adversely affected by climate hazards (Chen et al., 2015). In like manner, the Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC, 2007). This body also affirmed that, developing countries, especially African farmers, are highly vulnerable to climate change impacts due to their low adaptation and mitigation capacity (IPCC, 2014; Nwafor, 2007); otherwise supporting the claims that vulnerability is context specific to sectors and systems, and that it is based on multiple factors and processes (Brooks, Adger and Kelly, 2005; O'Brien *et al.*, 2007). Climate change has harmful effects on man's physical environment, with influences on the global, national, social, economic and political structure. The underlying fundamental question is: who is most vulnerable? Which locations or parts of the world? Which regions? Which countries? Which sectors? Vulnerability measures, assessments and trends otherwise became very relevant. Its complexity accounted for delays in developing appropriate measures (Fankhauser *et al*., 1999)

The efforts of researchers through scientific procedures, observational and experimental data modeling have provided considerable vulnerability assessment methodologies considering the multi-dimensionality of climate change outcomes – physical, environmental, social, cultural, economic perspectives, with the accompanying temporal reference (Cardona *et al.,* 2012). There are top-bottom and bottom-top approaches which by methodology are properly integrated to capture the bio-physical and socio-economic stressor patterns, impacts and adaptive strategies of climate change using carefully articulated indicators amidst challenges (Dessai and Hulme, 2004; OECD 2008). The indicators are such that it measures vulnerability using a combination of features which accounts for the three components of climate change – exposure, sensitivity and adaptive capacity. Social vulnerability (Leichenko *et al.*, 2004); biophysical vulnerability (O'Brein *et al.*, 2004); technological vulnerability (Leichenko *et al.*, 2004); institutional vulnerability (Agrawal *et al.*, 2008) are broad dimensions by which the effects of climate has been proposed in assessing systems and economies. However, there is a large consensus to assess vulnerability at sector-specific levels to ensure more detailed information, as Ludena and Yoon (2015) even suggested local sector-specific vulnerability assessments – agriculture, coastal areas, water resources, forestry, health, etc.

Nigeria is a country in the sub-Sahara Africa region, and Nigeria boasts of a large agrarian society, with much dependence on the agriculture/rural sector. The disastrous events and the after effects of the infamous nationwide flood which wrecked havoc across the country remain ever livid in the minds of the people (Nigeria Emission Reduction Policy, 2016). That peculiar event clearly and vividly gave a peek into the vulnerability and readiness levels of the Nigeria society. A combination of adverse climatic conditions with attendant large population demography in a developing economy presents an antecedent for survival problems. The conceptualization of the relationships involving climate vulnerability amongst other factors shows high propensity to climate risk as the end point for any sector (Preston and Stafford-Smith, 2009). Scholarly contributions to literature abound on the different aspects of vulnerability to climate change in Nigeria; some on gender-based vulnerability assessments (Nnadi, Lyimo and Liwenga, 2019; Chukwuemeka, Offia and Ume, 2018); others on farming household vulnerability (Adeoti, Coster and Akanmi, 2016; Foloronso, Adewuyi, Okojie and Bada, 2014); and some others focused on general household vulnerability assessment at national level (Awoyemi and Olajide, 2018). On a larger scale, Ogbonna, Albrecht, Ugochukwu, Nwajiuba and Onyeneke (2019) focused on the vulnerability of the coastal regions (Niger Delta) of Nigeria to climate change. However, there is paucity of studies assessing vulnerability indices at the macroeconomic levels and sectors. This paper aims to address the knowledge gap by using country-level time series data to identify the sector most vulnerable to climate variability and examine the trends in sector-specific vulnerability levels for Nigeria.

An understanding of the vulnerability levels and trends strengthens and informs the ability to install appropriate climate adaptation policy changes, capital projects and community engagements. Vulnerability and resilience are closely linked to - and by - adaptive capacity (Engle 2011), indicating the vital importance of vulnerability estimates for effective resilience building for the Nigeria economy and environment.

Methodology

The study used secondary data from the Notre Dame-Global Adaptation Index (ND-GAIN)[3] dataset which shows countries' current vulnerability to climate disruptions. ND-GAIN is a high-quality dataset which uses over 74 variables (computed from National and World Bank datasets) to create 45 key indicators to measure vulnerability, and readiness, of 192 countries in the United Nations (UN), from 1995 to 2018. The study used the time series of the following variables; food vulnerability index, water vulnerability index, ecosystem vulnerability index, habitat vulnerability index, health vulnerability index and infrastructure vulnerability index, computed at country-level for Nigeria.

To compare the sector-specific vulnerability indices and analyse the trends across the years; the Analysis of Variance (ANOVA), descriptive statistics and Trend graphs techniques are employed. The vulnerability indices are standardized index scores points which ranges from 0 to 1 based on the ND-GAIN reference points; where 0 is the least vulnerable (ideal state) and 1 signifies the most vulnerable (Chen *et al.*, 2015).

Results and Discussion

The mean value of the sector-specific vulnerability indices show that the food vulnerability score (0.6450) is highest, followed by the habitat and health vulnerability scores (0.6136) and (0.5764) respectively; whereas infrastructure vulnerability index score is the lowest (0.2767). This translates that food, habitat and health of Nigerians are most vulnerable (most threatened) by climate change vagaries, whereas the infrastructural sector is the least threatened.

[3] The ND-GAIN is a country-level dataset managed by the Climate Change Adaptation Program of the University of Notre Dame's Environmental Change Initiative (ND-ECI).

Table 1: Mean values of the vulnerability scores of different sectors to climate change over time

Sector	Mean
Ecosystem	0.4656
Habitat	0.6136
Food	0.6450
Water	0.4975
Health	0.5764
Infrastructure	0.2767

Figure 1 reveals that the level of vulnerability of the food sector to climate change is decreasing with the highest index and lowest scores recorded in 1999 and 2015 respectively. However, the lowest score is still above 0.5. Food crop production in Nigeria is largely affected by climate change. The effects include flower abortions, wrong flowering and fruiting times, poor yields, due to the high variability in rainfall and distortions in seasonality which affects farmers' cultivation decisions (Dahiru and Tanko, 2018). Medugu, Majid and Filho (2014) also found that Nigeria crop farmers were more disadvantaged in food production. Figure 2 shows a trend of the vulnerability of the water sector to climate change. The graph shows that the vulnerability scores rose gradually and then declined. Changing rainfall patterns affect the seasonality and manageability of water, and the West Africa regions expected to be impacted by the declining runoff with a limited buffer system (Turral *et al*., 2011).

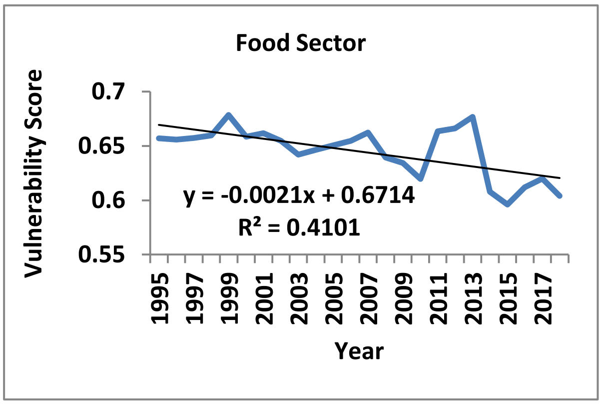


Fig. 1: Trend of food vulnerability

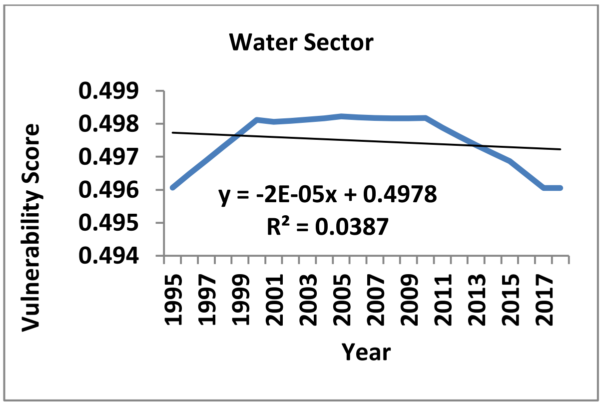
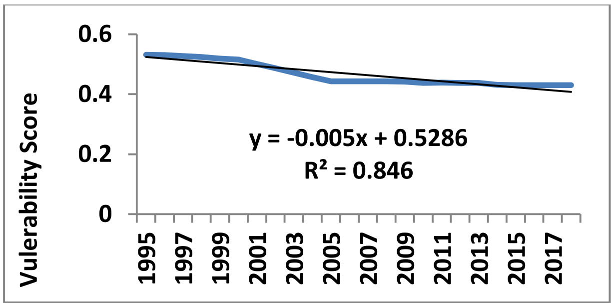


Fig 2: Trend of water vulnerability

Africa and Asia exhibit high vulnerability to groundwater systems (World Bank, 2009). More so recent innovations in groundwater accessibility like use of boreholes creates a more complex scenario with respect to the difficulties in modeling the predictability of surface water - groundwater dynamics in terms of climate change hydrology (Turral *et al.*, 2011). Figure 3 is a graph showing the trend of vulnerability of ecosystems to climate change which shows a gradual but downward sloping trend. The graph also reveals that since year 2002, the vulnerability score of ecosystems has remained below 0.50 index points but above 0.41. Based on the uncertainty of climate change, wide predictions point to higher vulnerability and damages to ecosystem services which also reduces resilience (UNEP, 2016). Figure 4 presents the trend of the climate change vulnerability scores of habitats. Overall, the graph is upward sloping indicating that the vulnerability is increasing with respect to time. This means that habitats in Nigeria are becoming more threatened by climate change vagaries, hence the rising vulnerability. This is not unconnected to the marked levels degradation attributable to the land and topographic structures found in regions of the country: deep gully erosion in the South-East (New Climate Institute, 2015), submersion of the habitats by water bodies in the South-South and coastal areas due to rising sea levels, high population density in the urban regions due to rural-urban drift, the high risk in land reclamation projects owning to urbanization and pressure on land (Ogbonna and Albrecht, 2015). Awoyemi and Olajide (2018) established on average high levels of vulnerability across the geo-political zones of Nigeria with the habitats in the North facing more challenges. Meanwhile in the Southern region the large coastal habitat (Niger Delta) is highly vulnerable to climate change due to rising sea-levels, eroding river banks, siltation, etc (Adelekan, 2010; Ogbonna *et al.*, 2017). Figure 5 shows the health vulnerability index curve which is downward sloping with all the scores above 0.5. The vulnerability scores of the health sector in Nigeria is considerably high given the realities of GHG emission activities and other pollutants in poorly managed environment with weak institutions and limited health infrastructural capacity exacerbating the ills of climate vagaries (WHO, 2004).



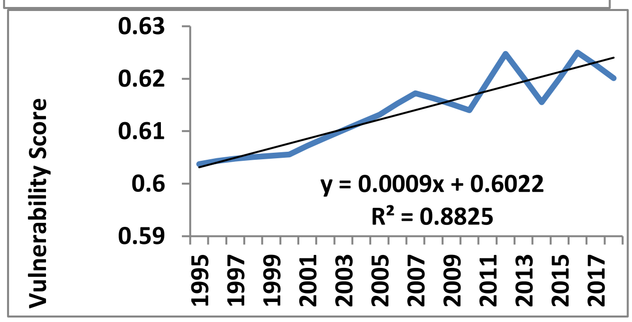
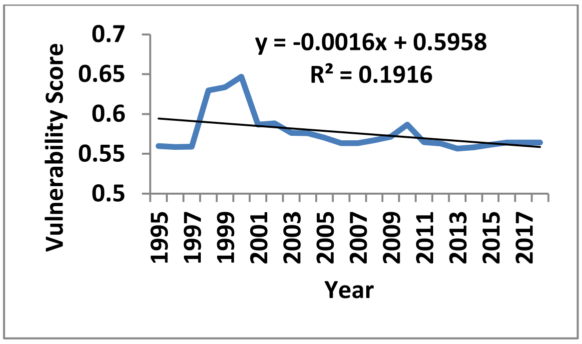


Fig. 3: Trend of ecosystem vulnerability **Fig. 4: Trend of habitat vulnerability**

Figure 6 is the graph of trend of the vulnerability of the infrastructure sector to climate change over time. The vulnerability scores are quite low (less than 0.30 points) across the years hence. The low level of vulnerability could be surprising considering the indications of institutional challenges, weak governance structure and poor infrastructure in Nigeria reported by Ogbonna *et al.* (2019).



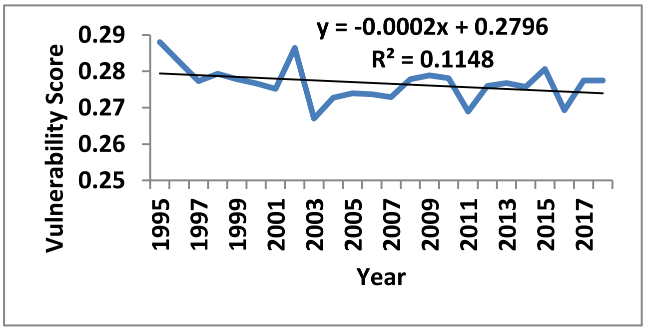


Fig. 5: Trend of health sector vulnerability **Fig. 6: Trend of infrastructure vulnerability**

Conclusion

Vulnerability assessments based on specific sectors prone to climate challenges involved the use of various vital composite variables in domain of Exposure, Sensitivity and Adaptive capacity to reflect a good picture of the trend for Nigeria. Overall the country is faced with significant threat of climate disruptions across the sectors. The challenges are linked to many issues with so much irregularity as reflected in the vulnerability graphs; a lot still needs to be done to improve capacity across sectors. The study recommends the intensification actions to build resilience, adaptation and mitigation capacity in Nigeria. This can be achieved by effectively implementing the dictates of the Climate document of Nigeria in all levels of government while involving the private sector, civil society organizations, the local communities, etc. Further research can be done on the dynamics of the constituents of the sector-specific vulnerability to proffer more technical strategies to build-up climate readiness in the society.

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Role of Extension Personnel in Mitigation and Adaptation Measures Against Climate Variability in South East Nigeria

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Abstract

The study investigated the role of agricultural extension on climate variability mitigation and adaptation measures. Primary data was collected from the Agricultural Development Programmes (ADPs) of the three selected states of South East Nigeria by use of structured questionnaire. Simple random sampling technique was used in selecting Agricultural zones and blocks. Data was analysed by use of mean score and standard deviation. The list of expected role of extension agent was measured by the use of four points likert-type scale.It was found that the role of extension workers includes production of publication on the cause of climate change ($\bar{x}$= 2.23) and village transect walk and study of the environment in relation to climate change ($\bar{x}$= 2.23) The advisory role of extension agents in climate variability mitigation and adptaion measures were inadequate therefore it was recommended that extension agents should be trained on their role on climate variability mitigation and adaptation measuressince

Keywords: Climate variability, Extension role, mitigation, Adaptation measures.

Introduction

Omotayo (2010) reported incidence of new crops disease and low crop yield due to change in climate. Change in climate may perhaps reduce yield to below economical threshold for the farmers. More so, the high frequency of the natural disaster like flood and drought connected with change in climate may perhaps lead to yield reduction. Production is subject to many uncertainties that could threaten returns or even the feasibility of farms, risk management becomes part of farmers' business strategy. The source of risk in agriculture are numerous and diverse, and some of them include disease infestations, pest, impacts of change in climate, natural and human caused disasters among others.

According to Ngoddy, (1991), the capability of the arable farmers to solve problems posed by their environment involving the systematic use of scientific methods will depend on their awareness and training. Frangton *et al* (2015) maintained that farmers in Africa have traditionally used indigenous knowledge to cope with climate hazards based upon observations and interpretation of natural phenomena. There will be need to realign and adopt new policies that contribute to greater resilience of the agricultural sector to change in climate (Frangton, *et el*2015).

Agricultural extension has a role to play in providing farmers with information, technology and education on how to cope with climate change and way to contribute to GHC mitigation. Thus, this study has been designed to highlight the role of agricultural extension in a changing climate.

In many parts of the world, climate represents one of the major uncertainties affecting the performance and management of agricultural Systems Devereux and Edwards (2004) opined that due to global climate change, climatic variability and occurrence of extreme weather conditions, there was likely to be increase in agricultural risks and destabilization of farm income. In southeast Nigeria, the impacts of climate are very evident as observed in the increased flooding, land slide and erosion which has led to loss of lives, houses, farm lands, properties and roads (Agwu and Oklumamhe, 2009).

A study conducted on information needs of rural farmers in Enugu state by Okoro (2010) revealed that farmers need for information on mitigation and adaptation measures against climate change was not high. Creating awareness on issues of climate change, its effects and adaptation options available to farmers have been a challenge to agricultural extension agents. Studies have shown that the level of awareness on climate change issues were inadequate (Nzeadibe, Egbule, Chukwuone and Agu, 2010; Nzeh and Eboh, 2010)Thus the study would investigate the role of agricultural extension on climate variability mitigation and adaptation measures among arable farmers in the study area.

Objectives of the study The broad objective of the study was to examine the effects of climate variability on yield of cassava, yam and maize in southeast Nigeria. The specific objective was to identify the role of agricultural extension agents on climate variability mitigation and adaptation.

Materials and Method

The study was carried out in southeast Nigeria. Nigeria is comprised of six geopolitical zones namely North East, North West, North Central, South East, South West, and south South zones. The South East comprises the following states: Abia, Anambra, Ebonyi Enugu and Imo. The zone is bounded to the North by Kogi and Benue States; to the east by Cross River; to the west by Delta and parts of Kogi state; and to the south by Rivers and Akwa-Ibom States (Aniedu, 2006). It covers an area of 29,908 square kilometres with a population of about 16,381,729 (National Population Commission, 2006) Theregion experiences flooding and innumerable number of gully erosion on farmland as a result of weather hazards (Agwu and Oklumamhe, 2009).

All agricultural extension workers in southeast Nigeria constituted the population of study. Simple random sampling technique was used in selecting states, agricultural zones, and blocks. All the extension professionals including the Zonal Managers (ZM), Zonal Extension Officers (ZEO), Subject Matter Specialist (SMS), Block Extension Supervisors (BES), Block Extension Agents (BEA) and the Extension Agents (EAs) in the selected zones constituted the extension workers. This was made up of 44, 97 and 48 extension workers from Anambra, Ebonyi and Enugu state respectively as seen in Table 2. This gave a total of one hundred and eight nine (189) extension workers.

Table 1 Distribution of Agricultural Zones and blocks in the three selected States of South East Nigeria

States	Agricultural Zones	Blocks
Anambra State	*Aguata*	Aguata, Nnewi North and South, Orumba North and South
	Awka	Awka North and South, Anoicha, Dunukofia and Njikoka
	Anambra	Oyi, Anyamelum, Anambra East and West
	Onitsha	Idemili North and South, Onitsha South and North, Ekwisigo and Ihiala
Ebonyi State	*Ebonyi North*	Abakaliki, Ebonyi, Izzi and Ohaukwu
	Ebonyi Central	Ikwo, Ezza South and North and Ishielu
	Ebonyi South	Afikpo North and South, Onitsha and Ivo.
Enugu State	*Agbani*	Enugu South, Nkanu West, Nkanu East
	Awgu	Oji River, Awgu and Aninri
	Enugu	Enugu North and East, Isi-Uzo
	Enugu-Ezike	Igboeze South and North and Udenu
	Nsukka	Nsukka, Igboetiti and Uzo-Uwani
	Udi	Udi and Ezeagu

Source: Anambra, Ebonyi and Enugu States ADPs

TABLE 2:Population of Extension workers in selected states and zone

SELECTED STATE (50%)	SELECTED ZONE (50%)	NUMBER OF EXTENSION WORKERS
Anambra		
	Anambra	19
	Awka	25
Ebonyi	Ebonyi North	43
	Ebonyi Central	54
Enugu	Udi	12
	Nsukka	25
	Enugu-Ezike	11
	TOTAL	**189**

Instrument for Data Collection

Primary data were collected by use of structured questionnaire. A set of questionnaire was used to elicit information from Extension workers on role of agricultural extension agents on climate variability mitigation and adaptation measures.

Measurement of variable

Role of agricultural extension agents on climate variability adaptation and mitigation measure

A list of expected roles of extension agents were presented to the extension agents. These were measured by the use of four point Likert -type scale. The scale was coded as follows; strongly agree = 4; agree = 3; disagree = 2; strongly disagree = 1, A cut off point of 2.50 was used to dichotomize the responses into agreed and disagreed. Any item with a score of 2.50 and above was regarded as agreed while below 2.50 was regarded as disagree.

Data Analysis

Data collected was realized using mean score and standard deviation.

Results and Discussion

Table 2.1 shows that out of the fifteen expected roles of extension workers in climate change adaptation and mitigation measure the ones agreed on by extension agents are: production of publication on the cause of climate change ($\bar{x}$=2.23) and village transect walk and study of the environment in relation to climate change ($\bar{x}$=2.06), the extension workers did not agree with the remaining thirteen roles expected by the extension workers.

From Table 3, linking farmers with the sources of drought resistant crops variety ($\bar{x}$=1.87) regular update on the situation and current trends on issues of climate change($\bar{x}$=1.79), production of publications on the effects of climate change and Training on climates change adaptation strategies($\bar{x}$ =1.74) were among the most poorly performed roles. Others are linking farmers with early maturing crop variety, training on the cause of climate change and training on the effects of climate change ($\bar{x}$=1.68), the introduction of improved climate friendly agronomic practices($\bar{x}$=1.62), introduction of organic manure ($\bar{x}$=1.59), training on mitigation approaches($\bar{x}$=1.56), introduction of improved crop variety($\bar{x}$=1.44), regular visit to farms($\bar{x}$=1.37) and introduction of drought resistant crop variety($\bar{x}$=1.32).

Table 3: Responses of Extension workers on the Role of Agricultural Extension Service on Climate change adaptation and mitigation

Roles of Extension workers on climate change adaption and mitigation	*Mean*	*SD*
Regular visit to educate farmers on climate mitigation adaptation measure	1.37	0.528
Introduction of improved crop variety	1.44	0.559
Introduction of drought resistant crop variety	1.32	0.510
Training on mitigation approaches	1.56	0.664
Training on climate change adaptation strategies	1.74	0.665
Training on the causes of climate change	1.68	0.701
Training on the effects of climate change	1.68	0.606
Production of publications on the effects of climate change	1.74	0.752
Production of publication on the cause of climate change	2.23*	0.987
The introduction of improved climate friendly agronomic practices	1.62	0.708
Introduction of organic manure	1.59	0.758
Linking farmers with the sources of early maturing crop variety	1.69	0.789
Linking farmers with the sources of drought resistant crops variety	1.87	0.854
Regular update on the situation and current trends on issues of climate change	1.79	0.740
Village transect walk in study of the environment in relation to climate change	2.06*	0.854

*Means indicating respondent perception of roles of agricultural extension

2.5 is the cut-off point

Conclusion

The advisory role of extension agents in climate variability mitigation and adptaion measures were inadequate therefore extension agents should be trained on their role on climate variability mitigation and adaptation measures. Climate smart Agricultural Dlivery services require climate data therefore the extension workers should be armed with the year to year variablity data before advising farmers on climate mitigation and adaptation measures Government should integrate issues of climate variability as well as adaptation strtaegies into the national developmental plan and project since the climate variability risks is always high.

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2019 Extended Rainfall and the Consequences on Harvested crops: The case of Samaru, Northern Nigeria

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Abstract

The supply of soil moisture may vary from the two extremes of wilting point when no water is available for crop use to water logged condition when soil moisture is excessive thus completely filling the soil pores with water impeding free movement of air within the soil and forming compounds toxic to the roots of crops. The mean rainfall of Samaru has been 1059.4 ± 376mm over the period of 1928 to 2019. This record has also indicated serious rainfall intensity due to increasing rainfall amount at the rate of 0.96mm per year and decreasing rainy days at -0.25 days per year. The year 2019 recorded very heavy amount of rainfall (1272.2mm) which was 211.7mm above normal (1059.4mm). The rainfall onset was on May, 8 which was about a week earlier than normal (May 19 ± 3). The cessation date was October, 27 which was far above the normal of October 10 ± 2 days leading to a longer than normal rainy season (170 days). The year 2019 recorded the heaviest and highest amount of October rainfall (217.4mm) in the 91 year record. This extension in rainfall made it a difficult season for farmers especially maize, soybeans and sorghum growers, with many producers across the country reporting losses and unexpectedly difficult harvesting windows. Farmers are recording losses whenever there is a sudden change in the weather and therefore the need for adaptation techniques to reduce these losses to the barest minimum.

Keywords: Adaptation, Growing season, Harvested crops, Soil moisture, Rainfall variability,

Introduction

Agriculture in developing countries is almost completely rain-fed especially in the semi-arid tropics where the state of soil moisture is totally controlled by rainfall. Crop growth and development depends entirely on moisture as a medium by which chemicals and nutrients are conveyed from the soil to various parts of crops. It is a reagent of photosynthesis and a constituent of plant tissue. The supply of soil moisture may vary from the two extremes of wilting point when no water is available for crop use to water logged condition when soil moisture is excessive thus completely filling the soil pores with water impeding free movement of air within the soil and forming compounds toxic to the roots of crops.

Shifts in rainfall patterns may lead to an overall drying trend in some ecological regions, and to increased rainfall in other regions, including Africa (Christensen et al. 2007). On an annual (seasonal) time scale, the number of rainfall events is likely to decrease, while rainfall intensity is likely to increase due to greater atmospheric moisture retention with increased air temperatures. Potential manifestations of increased seasonal variability include more extreme hot days during the growing season, a shift in rainfall toward heavier but less frequent rainfall events, and longer periods between rains—which, when coupled with increased rates of evapotranspiration under warmer temperatures, could negatively affect crop growth (Huntingford et al. 2005).

Historical Rainfall over Samaru

Samaru has ninety one (91) year record of daily rainfall data, from 1928 to date. The mean rainfall of Samaru has been 1059.4 ± 376mm over the period of 1928 to 2017. The long term record (1928 – 2019) has indicated serious rainfall intensity due to increasing rainfall amount at the rate of 0.96mm per year and decreasing rainy days at -0.25 days per year (Figure 1). The implication of this trend to agricultural production is the risk of soil fertility depletion due to leaching losses, soil erosion and farmland destruction.

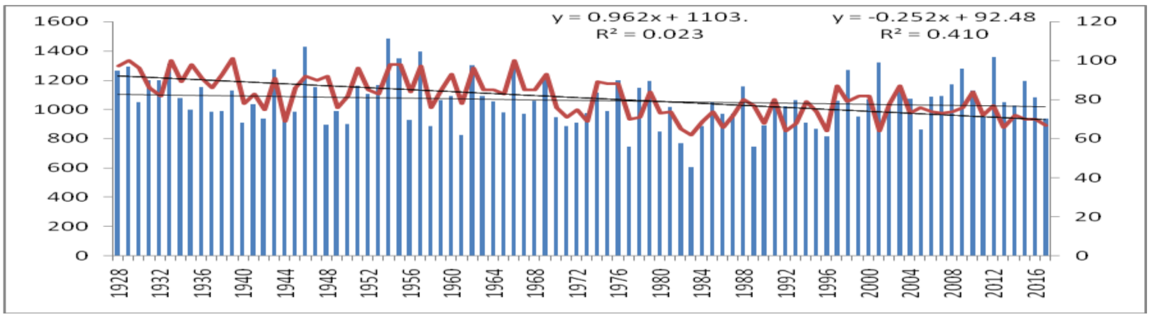


Figure 1: Trends of Rainfall amount and Rainy days over Samaru (1928 – 2019)

The coefficient of variation of annual rainfall is 15.4%, indicating that it is highly stable and dependable, though the monthly coefficient of variation varied from 5.6% in April to 95.4% in October (Table 1). It also show that the monthly rainfall is relatively stable from April (CV-5.6%) to May (47%) during the onset period and highly stable from the month of June (CV- 16.2%).

Table 1: Mean monthly normal rainfall (1928 – 2019) over Samaru

Month	Normal	Standard Deviation	CV (%)
Apr	36.84	2.07	05.6
May	120.94	56.93	47.0
Jun	151.92	24.62	16.2

Rainfall Anomaly

The figure on anomalies of rainfall showed increasing trend in the early years from 1928 to around 1938 thus experiencing near normal to very wet conditions with some few cases of isolated mild, moderate and severe droughts. Again from 1952 another decade of above normal rainfall was observed with highest positive anomaly (421.3mm) recorded in 1954. From 1966 to 1996, near normal to extremely dry years were witnessed with the severest drought (-452.3mm) recorded in 1983, followed by 1977 and 1982 with negative anomalies of (-315mm) and (-292mm) respectively. The years 2000 to date are witnessing the return of above normal rainfall with the highest anomaly recorded as 297.6mm in 2012.

Thus about 43% of the years between the late 60s to early 90s experienced varying degrees of drought ranging from moderate to extreme conditions while from the year 2000 to date, with the exception of some couple of years, the condition has been of no-drought to extreme wetness. This observed record is in agreement with the findings made by Ati et al., (2007) and Abaje et al., (2012), that the Sudano-Sahelian Ecological Zone of Nigeria has been experiencing decreasing number of drought occurrences and consequently increasing wetness in recent years.

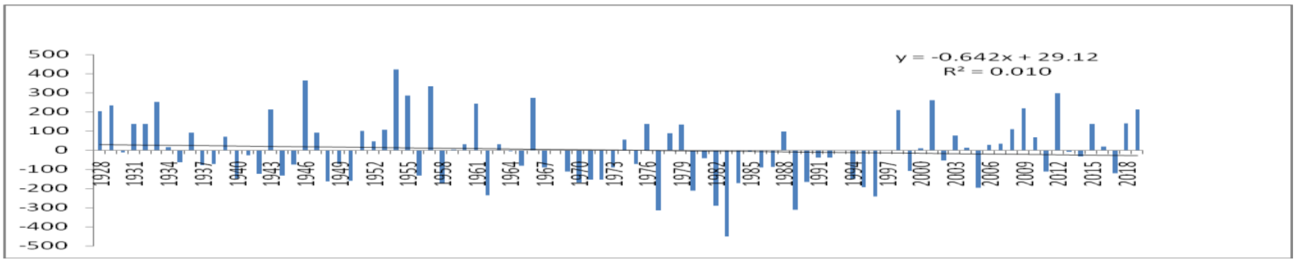


Figure 2: Rainfall Anomaly of Samaru (1928 – 2019)

Rainfall Onset and Cessation over Samaru

Rainfall Onset is not the first day the rain falls (Adebayo and Oruonye, 2013). For agricultural purpose, it refers to the time a place receives an accumulated amount of rainfall sufficient for the growing of crops. Omotosho et al (2000) define onset of rains in Nigeria as the beginning of the first two rains totaling 20 mm or more within 7 days, followed by 2 to 3 weeks each with at least 50% of the weekly crop water requirement. Rainfall cessation on the other hand, refers to the termination of the effective rainy season. It does not imply the last day rain fell, but when rainfall can no more be assured (Adebayo and Oruonye, 2013). Omotosho et al (2000) defined the rainfall cessation as any day from 1st September after which there are 21 or more consecutive days of rainfall less than 50% of crop–water requirement. The 50% crop water requirement being 5 mm for Samaru as given by Kowal and Knabe (1972).

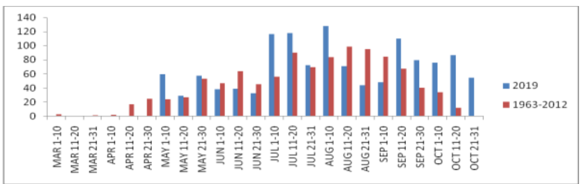
The figures below show that there are upward trends of onset dates which can conveniently be interpreted as increasing late onset of rain with corresponding downward trend of the cessation date (Fig. 3a and b). This indicates that the rain is starting late and hence the beginning of growing season is being delayed in the study area. This was reported in previous studies by Oluwasemire and Alabi (2004), Yamusa et al., (2013) and Oruonye

(2014 a,b). These clearly show a decreasing length of the growing season in the study area. The specific date of occurrence of either the onset or cessation of the rains is an important consideration in determining the beginning and end of the growing season in an area (Umar, 2011). Efficient crop production in the tropics is equated with the onset and cessation of rainy season and its variability. This is because, onset, cessation and length of the rainy season form important components of moisture resources status for determining the potential of various crops (Olanrewaju, 2006). The average onset of the rainy season in Samaru is May 19 ± 3 days while the average cessation is October 10 ± 2 days.

Fig. 3a and b: Rainfall Onset and Cessation of Samaru

2019 Rainfall Distribution

The year 2019 recorded very heavy amount of rainfall (1272.2mm) which was 211.7mm above normal (1059.4mm.). The rainfall onset was on May, 8 which was about a week earlier than normal (May 19 ± 3). The cessation date was October, 27 which was far above the normal of October 10 ± 2 days. This led to a longer than normal length of rainy season of about 170 days. Figure 4; show the comparison of the 2019 rainfall with normal (1963 – 2012) on decadal bases. The rainfall distribution from its onset in the 1st decade of May (May 8) to its cessation in the last decade of October (Oct. 27) was very adequate. Above normal decadal rainfall was recorded throughout the year with exception of the months of June and 2nd decade of August to 1st decade of September. Even these decades recorded above 20mm of rainfall which was quite adequate for sustainable crop growth and development.



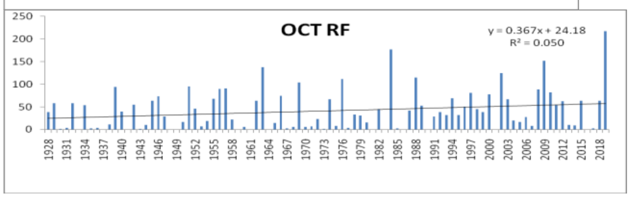


Fig. 4: Normal and 2019 Decadal Rainfall of Samaru. Fig. 5: October rainfall anomaly of Samaru

October Rainfall Anomaly

The year 2019 recorded the heaviest and highest amount of October rainfall in the 91 year record. Figure 4 show that the highest rainfall ever recorded within this period was in 2019

(217.4mm) followed by 1984 (177.5mm) and 2009 (151.7mm). For the first 30 years (1928 – 1958), the highest rainfall recorded was a little above 90mm. From 1963 to 1983, the highest rainfall recorded was a little above 100mm; this was followed by high rainfall of 177.5mm in 1984 which was the highest in the history before the 2019 October rainfall event.

2019 Extended rainfall and harvested crops

The extended rainfall of the year 2019 made it a difficult season for farmers especially maize, soybeans and sorghum growers, with many producers across the country reporting many losses and unexpectedly difficult harvesting windows.

While the weather is something growers cannot control, perfecting other areas of crop establishment and growth can help reduce risk of further losses.

Maize

Maize is a tropical grass that is well adapted to many climates and hence has wide-ranging maturities from 70 days to 210 days. The optimum temperature for maize growth and development is 18 to 32 °C, with optimum soil temperatures for germination and early seedling growth as 12 °C or greater. Maize can grow and yield with as little as 300 mm rainfall but prefers 500 to 1200 mm as the optimal range. – Depending on soil type and stored soil moisture. Maize is relatively well adapted to a wide range of soils with pH 5.0 to 8.0. It does not do well in acidic soils. Aluminium toxicity could become a problem on soils with pH less than 5.0 (Al > 40%). Maize is moderately sensitive to salinity, which reduces uptake of nutrients and decreases total dry matter production. Hence, low soil water storage is more of a problem for maize.

Curing of Maize

The maize plants when harvested are tied into small bundles called *'taari'*. All bundles from different fields are collected and stacked in upright positions. Upright stacking of maize bundles is called *'Bukka'* (Plate 1). After a period of about one month, the maize cobs are separated individually from the husk.

Plate 1: Maize curing by stacking (Bukka)

Stacking of maize in the *Bukka* for 30-45 days ensures drying and it also facilitates the easy separation of cobs from the husk. Curing results from heat and moisture equalization in the grains in the *Bukka*.

Effects of the extended rainfall on the harvested maize

Most of the farmers harvested their maize based on their normal timings without considering the rainfall anomaly of the year. The result was that the maize grains in the stacked bundles (Bukka) started sprouting from the cobs as a result of the prolong rainfall. This led to a lot of losses by farmers (Plate 2a - d).

Plate 2a – d: Maize grains sprouting from the cobs in the stacked bundles

Soybeans

The beans contains about 45% moisture when matured and about a week later, seeds, pods and stem turn yellow and then brown at 33% moisture. With good drying weather, the beans should be harvested at 13 – 14% moisture to avoid shattering losses which is very high at below 13% moisture. Late season wet conditions and flooding affect soybeans as growers wait for field conditions to improve and harvest to resume.

In 2019 season, the implications were observed various degrees of damage from fungal pathogens as a result of increasing wet condition due to the rainfall extension. Stems were weakened thus increasing the chance of lodging and harvest losses. There were also the occurrences of pod chatter as a result of several cycles of drying and re-wetting.

Sorghum

Sorghum can do with a little bit of water. It can grow in areas with 375 to 1000 mm of rainfall per year. The optimum rainfall is 500 to 600 mm. For a short time it can endure waterlogging, the best temperature for growth and high yields seems to be 27 - 28 °C. It tolerates very high temperatures better than any other cereal and is therefore very well adapted to conditions in semi-arid climates. Although sorghum tolerates harsh weather condition to some extent, the 2019 extended rainfall had impacted negatively on sorghum farms that are situated close to areas liable to flooding thus affecting the stalks and to some extent the grains (Plate 3).

Plate 3: Sorghum farms under extended rainy season

Adaptation strategies

Monitoring crop carefully throughout the growing season, taking into consideration the weather pattern is the most essential adaptation strategy. Weather factors, especially rainfall and temperature affect maturity and harvest dates and could mean an earlier or later harvest than usual, so it is important to be prepared for both eventualities. The following are adaptation strategies to be adopted:

1.Flexibility in planning

As proved last year, the weather can very quickly change things for farmers and adapting to it can make all the difference between a good or bad crop. So it is essential to be flexible with your approach and not get tied to dates.

2.Harvest delays

Delayed harvest in the case of soybean will influence your ability to conduct fall tillage operations and fertilizer applications so that as field conditions improve harvest can resume. This will help maximize crop quality and yield.

3.Use of Dryers

In the past, crops were usually dried by means of solar energy or sun which is a cheaper and economical method with limitations. Where weather conditions are not normal and rains are frequent, this method hardly works. In this case, the best approach is to use a mechanical device is used for removing the moisture contents from the crop, termed as crop drying machine that uses electric or chemical energy for their operations.

4.Use of Artificial Intelligence (AI)

Machine learning, which is a smart process of machines being able to function automatically, reason and learn by themselves. This is essential for climate resilience to help small-scale farmers tackle climate uncertainty. AI can analyse vast data sets to provide short-term weather forecasts and long-term climate predictions

5.Crop and Livestock insurance

This will require quality data (meteorological, agricultural) for insurers to know the likelihood of crop failure

6.Use of crop models in decision making

Models can be used to compare crop management strategies helping producers weigh both environmental and economic consideration as they make decision about crop varieties, cropping dates and management practices.

7.Application of remote sensing and precision agricultural technologies

Satellite and on-the-go field equipment scanners can be used to measure crop characteristics like growth rate and biomass. This will allow researchers to assess the effectiveness of modifications in cropping systems for precision agriculture

8.Identifying crop germplasm that can tolerate stresses related to climate variability

The integration of beneficial traits into existing crops through the use of germplasm collections, related datasets and breeding can help in achieving optimum yields while withstanding stresses, such as drought and water-logging

Conclusion

Increased rainfall variability and climate change are impacting negatively on crop production. Farmers are recording losses whenever there is a sudden change in the weather and therefore the need for adaptation techniques to reduce these losses to the barest minimum. In 2019, the rainfall extended beyond the normal harvest period thus causing a lot of damages to crops and losses to farmers.

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SUB-THEME D

CROP PRODUCTION, IMPROVEMENT, PROTECTION, DISEASES & GENETICS AND AGRONOMY

Soil Properties and Yield Response of Okra grown in animal waste amended soil

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Abstract

Agricultural soils have the capacity to produce abundant nutritious food to serve the present and future populations if such soils are prudently managed. This study investigated the effects of cow dung, pig manure and poultry manure application on soil properties, yield and growth performance of okra (*Abeemoschus esculentus* L.). The treatments: T1 Mixture of Cow dung and pig manure applied at 30 t/ha); T2 (Mixture of pig manure and rabbit manure applied at 30 t/ha), T3 (Mixture of poultry manure and pig manure applied at 30 t/ha) and T4 (Control, unamended treatment) were laid out in a Complete Randomized Design (CRD) with three replications. Soil chemical properties and plant parameters (plant height, number of leaves, number of branches, fruit length, fruit girth, and fruit yield) were measured. Data collected were subjected to Analysis of Variance (ANOVA) using Genstat software. Treatment means were separated using LSD at five percent level of significance. Results showed significant effects on soil chemical properties following animal manure application relative to the unamended control (treatment T4). Growth and yield performance of okra was lowest in treatment T4 as compared treatments T1-T3, an indication that the animal manure positively influenced okra growth and yield performance. Except soil parameters measured, it was observed that the amended treatments did not vary significantly in most of the plant parameters measured. This might be due the synergistic effects of the combined manures applied. From findings of this study, it could be deduced that animal manure application not only promoted the growth and yield of okra but also enhance soil performance relative to the unamended control treatment.

Application of treatments T1 (Mixture of cow dung and pig manure applied at 30 t/ha), T2 (Mixture of pig manure and rabbit manure applied at 30 t/ha) and T3 (Mixture of poultry manure and pig manure applied at 30 t/ha) had significant effects on soil properties as well as plant heights, number of leaves and branches relative to the control treatment (T4). The outcome of this study indicated that treatments T1, T2 and T3 did not vary significantly on their effects on most of the soil and okra plant properties measured. This suggests that application of either treatment T1, T2 or T3 will achieve significantly similar result.

Keywords: Degraded Ultisol, Animal manure, Okra Growth, and Yield

Introduction

Okra (*Abelmoschus esculentus* (L) Moench) is an important crop that is rich in protein (Gulshan et al., 2013). Like other vegetables, okra is a valued crop because it plays critical role in human diet since it is an essential source of vitamins and minerals (Usman, 2015). In Nigeria, vegetable crops (okra) are grown in both the wet and dry seasons but rarely in dry seasons due to irrigation challenges even though dry season farming attract higher profits due to high demand. Due to poor fertility status of most agricultural soils in Nigeria, farmers often apply large amount of chemical fertilizers, especially nitrogen fertilizer, as an assurance against crop failure or yield losses from nutrient deficiencies (Alexander et. al, 2016). Organic manure as soil amendment is currently being advocated as a viable option to chemical fertilizer. The use of animal manure as a source of fertilizer in developing countries has been an aged long practice. However, proper use of animal manure is essential for both production and environmental standpoint. This is because, applying low rates of animal manure can lead to nutrient deficiency and low yields while excess can result to nitrate leaching, phosphorus runoff, increase in lakes eutrophication, and other environmental associated hazards (Gulshan et al., 2013). Study has shown that organic manure application has comparative economic advantage over inorganic (chemical) fertilizers (Usman, 2015). One of main reasons organic amendments (manures) has been advocated for is because nutrients contained in them are released slowly and gradually unlike chemical fertilizers. This makes animal manures to last longer when applied to soil and have longer residual effects on soil properties as well as improve root development and ensure higher crop yields (Gulshan et al., 2013).

The importance of organic manures in crop productivity and soil performance has been documented. For instance, application of poultry, sheep and goat manures was reported to improve the growth parameters of a leafy vegetable (Senjobi et al., 2010). There are also reports on the beneficial effects of organic manure application on soil properties such as bulk density (Unagwu, 2019), soil moisture content (Adeleye et al., 2010), and other soil properties (Gulshan et al., 2013; Unagwu, 2019; Unagwu, 2020). There is a paucity of information on the use of combined animal manures for organic vegetable production. This study examined the effect of varied combined animal manure applied at 30 t/ha on soil properties, and okra growth and yield performance.

Materials and Methods

The experiment was conducted at the Greenhouse Research Station of the Department of Soil Science, University of Nigeria, Nsukka during the 2019 planting season. The experimental design used was a complete randomized design (CRD) with three replications. The treatments consisted of T1 (Mixture of Cow dung and pig manure applied at 30 t/ha); T2 (Mixture of pig manure and rabbit manure applied at 30 t/ha), T3 (Mixture of poultry manure and pig manure applied at 30 t/ha) and T4 (Control, unamended treatment). To a 10 kg air-dried test soil sample collected from the Department of Soil Science Research Farm, 700 g (30 t/ha equivalent) of animal manure was added, thoroughly mixed and incubated for two weeks.

After incubation, okra seeds (Clemson spineless variety) were planted in each treatment pot. After seedling emergence, the seedlings were reduced to one seedling per treatment pot. The treatment pots were manually weeded to keep pots weed free throughout the experiment. Water was supplied daily to avoid wilting and for normal plant development. After two weeks of seed emergence, data on plant height, stem girth, leaf width were taken bi-weekly while data on plant yield parameters and crop yield were taken after plant harvest.

Soil samples were collected for chemical analyses. The soil pH was determined both in water and 0.1 N KCl using glass electrode pH meter. Total Nitrogen was determined by macro-kjedahl method (Bremner, 1996), available phosphorus by Bray II method (Bray and Kurtz, 1945), potassium by flame photometer and organic carbon by Walkley-Black method (Nelson and Somners, 1996). Data collected were subjected to analysis of variance. The means were separated using the Least Significant Difference test at five percent probability level.

Results and Discussion

The baseline characteristics of the test soil was low in organic matter (1.18%), total N (0.7%), available P (10.2 mg/kg), exchangeable K (0.07 g/kg) and soil in pH (H_2O) was 6.5 while that in pH (KCl) was 5.6. There were significant effects on the soil properties following animal treatment application (Table 1). The soil pH value ranged from slightly acidic to neutral (Table 1). The soil pH associated with the control unamended treatment (treatment T4) was significantly lower relative to treatment T1 (Mixture of Cow dung and pig manure applied at 30 t/ha); treatment T2 (Mixture of pig manure and Cow dung applied at 30 t/ha) and treatment T3 (Mixture of poultry manure and pig manure applied at 30 t/ha). Other studies (Acharya et al., 2015, Unagwu, 2019Unagwu et. al, 2020) obtained similar results following organic amendment application. The soil organic carbon content after crop harvest varied significantly because of animal manure application (Table 1). For soil organic carbon (SOC), treatment T1 recorded the highest value ($p < 0.05$; 1.28 %) relative to T2, T3 and T4. Overall, the amended treatments had 23.7 – 68.4% higher SOC as compared with treatment T4. Treatment application had no significant effect on soil N. A similar result was observed for soil K except that treatment T3 had significantly higher soil K than treatment T4 but was not significant different when compared with treatments T1 and T2. The non-significant changes or effects on soil N and soil K can be due to plant nutrient uptake. In contrast, manure application had significant effect on soil P nutrient. Treatments T1-T3 recorded significantly higher soil P value compared with treatment T4. Treatment T3 was associated with the highest ($p < 0.05$; ≈ 42 mg/kg) soil P relative to all other animal manure amended treatments. The residual soil P is in order treatment T4 > T3 ≥ T2 > T1 > T5.

Table 1. Effect of animal manure application on soil chemical properties after crop harvest

Treatments	pH (H_2O)	SOC (%)	Total N (%)	Available P (mg/kg)	Exchangeable K (g/kg)
T1	7.5	1.28	0.06	18.7	0.07
T2	7.5	1.20	0.08	25.7	0.07
T3	7.8	0.94	0.09	41.9	0.10
T4	5.8	0.76	0.05	7.07	0.06
CV	1.3	6.0	41.3	12.5	16.3
LSD (0.05)	0.17	0.11	0.06	4.92	0.03

T1, Mixture of cow dung and pig manure applied at 30 t/ha; T2, Mixture of pig manure and rabbit manure applied at 30 t/ha; T3, Mixture of poultry manure and pig manure applied at 30 t/ha;T4, Control, unamended treatment; SOC, Soil organic carbon; CV, Coefficient of variation; LSD, Least significant difference

Effects of Treatment on Plant Height and Stem Girth

Okra growth (height) varied significantly across the treatments throughout the plant growth period (Table 2). At three (3) weeks after planting (WAP), treatments T1-T3 had significantly taller plant height than treatment T4. A similar trend was observed at 5-9 WAP. The increases in okra growth, with respect to treatments T1-T3, is due to the external nutrient supply via the animal manures applied. There was no observed significant difference in plant height for all the amended treatments. Usman (2015) found increases in tomato growth (height) following application of 20 t/ha animal manure. Treatment application had varied effects on okra stem girth (Table 3). At 3 WAP, treatment T4 had significantly smaller stem girth compared with treatments T2 and T3 but was not statistically different from treatment T1. From 5 - 9 WAP, all the amended treatments (T1-T3) recorded significantly larger stem girth compared with treatmentsT4. Again, as was observed for the plant height, treatment T1-T3 did not differ statistically.

Table 2. Effect of animal manure application on okra plant height

Treatments	3 WAP	5 WAP	7 WAP	9 WAP
T1	20.9	32.7	46.6	52.5
T2	22.1	34.2	48.8	55.1
T3	20.7	32.8	47.17	54.5
T4	17.8	25.1	33.1	37.7
CV	**5.30**	**3.30**	**3.90**	**4.80**
LSD (0.05)	**1.94**	**1.85**	**3.18**	**4.43**

T1, Mixture of cow dung and pig manure applied at 30 t/ha; T2, Mixture of pig manure and rabbit manure applied at 30 t/ha; T3, Mixture of poultry manure and pig manure applied at 30 t/ha;T4, Control, unamended treatment; CV, Coefficient of variation; LSD, Least significant difference

Table 3. Effect of animal manure application on okra stem girth (cm)

Treatments	3 WAP	5 WAP	7 WAP	9 WAP
T1	1.20	2.57	3.33	3.60
T2	1.47	2.63	3.57	3.50
T3	1.40	2.53	3.27	3.60
T4	1.07	1.70	2.07	2.33
CV	12.4	9.1	8.1	6.9
LSD (0.05)	**0.29**	**0.39**	**0.45**	**0.42**

T1, Mixture of cow dung and pig manure applied at 30 t/ha; T2, Mixture of pig manure and rabbit manure applied at 30 t/ha; T3, Mixture of poultry manure and pig manure applied at 30 t/ha;T4, Control, unamended treatment; CV, Coefficient of variation; LSD, Least significant difference

The non-significant difference in the plant height and stem girth observed for treatments T1-T3 could suggest that the amended treatments provided okra plant with required nutrients for its growth and development. Treatment effects on days of flowering and number of branches and fruits, fruit length and girth Treatment T4 had significantly longer days to flowering as compared with treatments T1-T3 (Table 5). Treatments T1-T3 had varied but non-significant difference in their days to flowering. The number of branches recorded, varied significantly with treatment T4 having no branches while treatment T2 recorded the highest (three) number of branches but which was not statistically different as compared with treatments T1 and T3.

Effects of Treatment on Number of Branching and Fruits, Fruit Girth and Length Okra Yield

Treatment application had significant effects on okra yield parameters (Table 5). The number of Branches was significantly higher for the amended treatments relative the treatment T4, which had no branch. For the number of fruits, fruit girth and fruit length, treatments T1-T3 was consistently significantly higher relative to treatment T4 (Table 5). The dry fruit yield was significantly higher for treatments T1-T3 as compared with treatmentT4. Variations in okra yield was thus: T2 > T1 > T3 > T4.

Table 4. Effect of animal manure application on days to flowering and fruiting, number of branching and fruits, fruit girth and length

Treatments	Number of Branches	Number of Fruits	Fruit Girth	Fruit Length	Dry Fruit weight (g/plant)
T1	2.67	3.67	7.13	11.71	1.83
T2	3.00	4.67	7.99	13.07	1.90
T3	2.00	3.33	7.16	12.19	1.57
T4	0.00	1.33	6.32	9.60	0.83
CV	**4.2**	**5.6**	**6.5**	**9.4**	**9.54**
LSD (0.05)	**1.01**	**1.39**	**1.24**	**1.32**	**0.41**

T1, Mixture of cow dung and pig manure applied at 30 t/ha; T2, Mixture of pig manure and rabbit manure applied at 30 t/ha; T3, Mixture of poultry manure and pig manure applied at 30 t/ha;T4, Control, unamended treatment; CV, Coefficient of variation; LSD, Least significant difference

The significantly higher okra yield that is associated with treatments T1-T3 is due to nutrient provisioning via the animal manures applied. Other studies reported similar findings. For instance, Gulshan et al. (2013) reported higher okra dry matter yield following manure application. They attributed the results obtained to nutrient availability and uptake of N and P as evidenced by the high and positive correlation between available N and P, tap root length and root weight. The non-significant variation in all plant measured parameters observed for treatments T1-T3 suggests that irrespective of the manure type, combined animal manure applied at 30 t/ha has almost the same effects on okra growth and yield performance.

Conclusion

Application of treatments T1 (Mixture of cow dung and pig manure applied at 30 t/ha), T2 (Mixture of pig manure and rabbit manure applied at 30 t/ha) and T3 (Mixture of poultry manure and pig manure applied at 30 t/ha) had significant effects on soil properties as well as plant heights, number of leaves and branches relative to the control treatment (T4). The outcome of this study indicated that treatments T1, T2 and T3 did not vary significantly on their effects on most of the soil and okra plant properties measured. This suggests that application of either treatment T1, T2 or T3 will achieve significantly similar result.

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Survey on fungal diseases associated with onion (*Allium cepa* L.) during 2014 irrigation season at University of Maiduguri Students' Research and Demonstration Farm.

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Abstract:

The survey was conducted at University of Maiduguri Students Research and Demonstration Farm on onions cultivated under irrigation. Ten diseased leaves samples were taken randomly from the onion farm and sent to the lab. Fungal pathogens were identified using both macroscopic and microscopic observations. Data obtained were subjected to Analysis of variance using Duncan Multiple Range Test. Result shows that based on point of collection, *Fusarium graminarium* had significant difference between the means of sample no. 8 and sample no. 6. The result also shows that *Rhizopus stolonifer, Aspergillus niger and F. graminarium* had the highest frequency of occurrence (over 50%) while *A. flavus* and *Scopulariopsis fusca* had the least frequency of occurrence (less than 50%). The findings encourages farmers to take keen interest in field sanitation before planting.

Keywords: *Allium cepa,* Sterilization, Fungal diseases, Irrigation

Literature review:

Onion (*Allium cepa*) is a vegetable crop grown almost all over the world. The crop is second only to tomatoes in importance among the vegetables in Nigeria and fifth in the world market, and it is grown for its bulbs (Anon, 2003). World production of onion is put at 66.8 million metric tons (MT) annually on 3.7million hectares of land (FAO, 2007). In Africa, West Africa and Nigeria; 280,059ha, 61,160ha and 41,000 respectively were cultivated with onions in 2004 (FAOSTAT, 2012). The main use lies in flavouring and seasoning of a wide variety of dishes. The distinctive characteristics of onions are due to the presence of alliaceous odour which accounts for its use as food, salad, spice, condiment and in medicine (CNS, 2013). Nutritionally, fresh onion contains about 86.8% moisture, 11.6% carbohydrate, 1.2% proteins, 0.2 – 0.5% calcium, 0.5% phosphorus and traces of iron, thiamine, riboflavin and ascorbic acid (FAO, 2007).

Onion cultivation in Nigeria is confined to the semi-arid Northern Guinea Savannah zones. The bulk of onion production is from the dry season cropping system particularly under irrigation in the Northern state (Amans, 1996; Friesen and Klass, 2002). The irrigation frequency is between 5 – 7days and the number of irrigation per growing season is about 15 – 20 times. In addition, good drainage is also very important as onions are badly affected by water-logged conditions (NAERLS/CIRAD, 2009).

Most of the diseases are caused by fungi, bacteria, virus and nematodes (Schwartz and Mohan, 2008), whereas disorders may be caused by adverse weather, air pollutants, soil conditions, nutritional imbalances and pest control products (Stauton and Margot, 2008). Therefore this study aims to identify and determine the disease infestation by fungal pathogen associated with onion production under irrigation conditions.

2.0. Materials and Methods

2.1. Experiment site;

The Survey was carried out at the Student's Demonstration Farm/ Orchard, University of Maiduguri (110 5`N, 130 10`E) which lies in the semi-arid zone of Nigeria characterized by short period of rainy season and a long period of dry season. Annual rainfall ranges from 300 – 700mm per annum and temperature range of 25^0C – 40^0C and sometimes above around April and May (BSADP, 2014). Laboratory set up of the experiment were laid out in a Completely Randomized Design (CRD).

2.2. Sample collection;

During the first quarter of 2014 irrigation scheme, Onions were being grown. Ten samples of diseased onion leaves were selected at random from the study area. Samples were properly labelled and packaged in an envelope after which it was taken to the plant pathology laboratory of the Department of Crop Protection, University of Maiduguri for isolation and identification of fungal pathogen in other to determine cases of disease incidence on the farm.

2.3. Medium preparation;

Potato Dextrose Agar (PDA) of 39 grams (g) was weighed accurately as instructed by the manufacturer into a 250 ml Erienmeyer Flask using electronic scale (Model: JCS-A Max/d:610g/0.01g). One hundred milliliter (100 ml) of distilled water was boiled in a beaker on a hot plate and the 39 g of the PDA was dissolved into it gradually with constant stirring using a glass rod to avoid the formation of clumps so as to have a homogenous mixture. The suspension was poured into 100 ml conical flask and the was corked with cotton wool and an aluminum foil. It was sterilize in the autoclave at the temperature of 121^0C at 15 P.S.I for 15 minutes. The medium was allowed to cool down before removing from the autoclave for pouring, or stored in the refrigerator until when needed. Pouring of PDA was carried out by first dispensing three drops of 50% lactic acid to the sterile petri dish to inhibit bacterial contamination. Prior to the preparation, samples were surface sterilized using distilled water and 10% sodium hypotonic solution (commercial bleach) before plating. The aseptic techniques were religiously observed to avoid contamination from other possible sources. Surface and edge of diseased onion leaves were cut and placed into the medium using sterilized scalpel.

2.4. Plating of samples;

Chopped samples was taken from the vegetative parts of the onion leaf and placed in the petri dish containing the acidified PDA medium with the aid of forceps. The medium was set for incubation. Inoculated samples were transferred into an incubator for optimum microbial growth at a temperature of about 28^0C. The petri dishes were incubated and examined after 24 hours interval to observe any possible organism growth around the plated samples. The colonies of microorganism growing in different plates were numbered. Identical colonies growing in different plate were given the same number assuming that these colonies basically represent the same species of organisms. Sub-culturing was basically done to get the pure culture of each fungus colony or species. A piece of pure culture was picked from the petri dishes and placed on the glass slide with the help of sterilize inoculating needle and then three drop of lactophenol cotton blue stain was added and the inoculums was teased out with another inoculating needle and then cover the cover slip and allowed to pass over flame for few seconds to expel air bubbles trapped under cover slip and to enhance the staining to avoid contamination.

2.5. Microscopic and macroscopic observation;

The macroscopic observation such as growth characteristics, colour and nature of fungal colonies were the basis of identification. Fungi were identified by colony characteristics as well as morphological structures such as vegetative and reproductive structures as observed under the microscope with the aid of descriptions provided in the standard reference book of plant pathology (Robert and Ellen, 1998). Micrographs were made from the slides obtained from the identified fungal colony and then snapped via computer aided microscope.

2.6. Data analysis;

All numerical data collected were analyzed using Analysis of variance (ANOVA) and significant means separated using Duncan Multiple Range Test on Statistix 8.0. Computer software.

3.0. Results and Discussion

Table 1: Colonial and morphological characteristics used in ideniying isolated fungi species from the diseased sample

Colonial characteristics	Morphological characteristics	Most probable organism
Colonies on P.D.A. at 25^0c attaining a diameter of 4-5cm	Conidial	*Aspergillus*

within 7days; consisting of a compact white or yellow basal felt with a dense layer of dark brown to black conidiophores.	heads, radiate tending to split into loose columns with age. Conidiophores stipes smooth-walled, hyaline but often in brown colours. Conidiospores often septate, brown, ornamented with irregular warts, spines and ridges.	*niger*
Colony whitish becoming grayish-brown due to brownish sporangiophores and brown-black sporangia	Sporangiospores irregular in shape often polygonal or ovoid, globose, elliptical, striate. Sporangiophores tall, solitary or in group of 2-7 from almost colourless to dark-brown, smooth or slightly rough-walled stolons opposite the branched	*Rhizopus stolonifer*

	rhizoids	
Usually consisting of a dense felt of yellow-green conidiophores	Conidia head typically radiate, later splitting into several loose columns, yellow-green becoming dark yellow-green.	*Aspergillus flavus*
Greyish rose to red, often vinaceous becoming brownish at age. Aerial mycelium floccose, whitish becoming brownish to rose	Conidiophores at first as simple monophialides on the hyphae later strongly branched, sometimes precurrently but not sympodially proliferating. Conidia slender, falcate, curved with pointed and curved apical and pedicellate cells mostly septate	*Fusarium graminearum*
Rough colonies, white to cream coloured	Yeast exhibiting rough colonies as pseudohyphal morphology. The rough	*Scopulariopsis fusca*

	yeast exhibits flocculation (sedimentation of cells)	

The result of the table above shows how fungal pathogens were identified based on physical observation as well as microscopic examination. The classification was done by observing the colony colour, the hyphal and conidial structures from the plated samples, as observations was then compared with reference to standard phytopathological manual. The result shows the presence of *Aspergillus niger, Rhizopus stolonifer, Aspergillus flavus, Fusarium graminearum* and *Scopulariopsis fusca.*

Table 2: Effect of fungi species on sampled diseased onion leaves

Sample	*Flavus*	*niger*	*F. graminarium*	*R. stolonifer*	*S. fusca*
1	20.00a	10.00a	20.0abc	100a	20.0a
2	10.00a	20.00a	30.0abc	100a	0.0a
3	10.00a	10.00a	40.0ab	100a	20.0a
4	20.00a	10.00a	30.0abc	100a	0.0a
5	10.00a	10.00a	20.0abc	90a	20.0a
6	10.00a	30.00a	0.0c	100a	10.0a
7	0.00a	50.00a	10.0bc	100a	10.0a
8	10.00a	40.00a	50.0a	100a	20.0a
9	0.00a	20.00a	10.0bc	100a	0.0a
10	10.00a	20.00a	40.0ab	100a	10.0a
Mean	10.00	22	25	99	11
SE ($\pm$)	11.93	29.1	13.4	4.47	11.92
LSD (0.05%)	26.98	65.74	30.35	10.12	26.98

Means carrying the same letter(s) are not significantly different at 5% level of significance (DMRT)

The result shows that there was significant difference between the means of samples affected by Fusarium graminarium with 8 having the highest occurrence and 6 with the least. However, there was no significant difference among the means of *Aspergillus flavus, Aspergillus niger*, *Rhizopus stolonifer* and *Scopulariopsis fusca.*

Table 3: Effect of fungi on sampled diseased onion leaves based on sterilization

Sterilization	*A. flavus*	*niger*	*F. graminarium*	*R. stolonifer*	*S. fusca*
Surface Sterilized	4.0a	22.0a	12.0b	98.0a	18.0a
Surface Unsterilized	16.0a	22.0a	38.0a	100a	6.0a
SE ($\pm$)	5.33	12.99	6.0	2.0	5.33
LSD (0.05%)	12.1	29.4	13.6	4.5	12.1

Means carrying the same letter(s) are not significantly different at 5% level of significance (DMRT)

The result of this table shows that there was significant difference ($P<0.05$) among the means of *F. graminarium* between surface sterilized and surface unsterilized. However there was no significant difference ($P>0.05$) among the means of *A. flavus, A. niger, R. stolonifer,* and *S. fusca*. The result also indicates that A. niger had the highest frequency of occurrence (29.4%) despite the sterilization technique followed by *F. graminarium* (13.6%). Also *A. flavus* and *S. fusca* had 12.1% respectively with *R. stolonifer* with the least (4.5%).

4.0. Conclusion and Recommendation

Fungi are considered as the most serious and wide spread disease pathogens affecting onions production both in rural and urban farms as observed by Friesen and Klass (2002). The findings of this work reveals that Onions like other vegetables are susceptible to numerous foliar, bulb and root fungal pathogens that can reduce yield and quality, and agrees in line with the work of Shehu and Muhammad (2011). This finding will recommend farmers to take keen interest in field sanitation before planting in order to reduce the inoculum load from crop residues. It is also important that onion seedlings be treated with fungicides before transplanting, as a preventive measure against seed-borne fungal disease infections. Therefore there is the need to reduce to the barest minimum its occurrence and incidence, by adopting various integrated pest management approach, so as to ensure more profit and benefit from production to farmers.

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Comparative Effect of horse Dung and Pig dung on the growth of *Moringa oliefera (lam)* seedlings .

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Abstract

This study compares the effects of pig dung and horse dung on the growth of *Moringa oliefera*. The experiment was carried out at the Federal College of Forestry, Ibadan and lasted for sixteen weeks. Two weeks old seedlings (40) were transplanted into polythene pots thoroughly mixed pig dung and horse dung at 5g, 10g levels of application with 2kg of top soil . Control plants received no treatment. The experiment was laid out in Completely Randomized Design (CRD) with (5) treatments replicated eight times . These following parameters were assessed weekly for a period of (16) weeks: plant height, number of leaves, stem girth and leaflet number. The data collected were subjected to analysis of variance (ANOVA) at 5% level of significance. The result shows that application of 10g of horse dung (T_4) had the best performance with respect to plant height, stem girth, and number of leaflets. While control (T_0) had the best performance with respect to the number of leaves. Based on the result of this study, Treatment T_4 (Horse dung at 10g) is recommended for raising *Moringa oliefera.*

Keywords: *Moringa oliefera*, soil temperature, dung, preference.

Introduction

According to Alessandro, et al (2016) Moringa oliefera is the most widely cultivated species of monogeneric family, the moringaceae, which is indigenous to south Asia, where it grows in the Himalayan foot hills from north eastern Pakistan to northern West Bengal, India. It has been introduced and become naturalized in other parts of India, Pakistan, Afghanistan, Bangladesh, Srilanka, South East Asia, West Asia, the Arabian Peninsula East and West Africa, Southern Florida. It is grown chiefly as an ornamental plant and in fence rows and hedges and has become naturalized during road sides on the coastal plain and tower foot hills *(Muhl et al., 2014).* The rapid growing tree was utilized by the ancient Romans, Greeks and

Egyptians. It is now widely cultivated and has become naturalized in many locations in the tropics. (Ede, 2014)

This fast growing tree is grown for human food, medicine, dye fodder and water clarification (Ede, 2014). It has an impressive range of medicinal uses with nutritional value. In addition to its compelling water purifying powers and high nutritional value, *M. oleifera* is very important for its medicinal values. All parts of the *Moringa* tree are edible and have been consumed by humans. According to (Ndubuaku et al., 2015), the many uses of *M. oleifera* include alley cropping to biomass production, animal forage (leaves treated seed-cake), domestic cleaning agent (crushed leaves), blue dye, wool fencing living trees, fertilizer, juice expressed from the leaves, green manure, ornamental plantings, biopesticides (soil incorporation of leaves to prevent seeds damping off), pulp (wood), rope (bark), tannin for tannin hides (bark and gum), water purification

In the west, one of the best known uses for Moringa is use of powdered seeds to flocculate contaminants and purify drinking water *(Muhl et al., 2014)* .Various parts of this plant such as leaves, nuts, seeds, bark fruit, flower and immature pods acts as cardiac and circulating stimulant, antitumor, antipyretic, anti-inflammatory *(Ndubuaku and Ndubuaku, 2011)*, antiulcer, antispasmodic, diuretic, antihypertensive, antibacterial and antifungal activities and are being employed for the treatment of different ailments in the indigenous system of medicine, particularly in south Asia *(Imoro et al., 2012)*. It is generally known in the developing world as a vegetable, a medicinal plant and a source of vegetable oil *(Adebayo et al., 2017)*. In the light of aforementioned properties of the drumstick tree the following review highlights its vernacular name, distribution, economic and commercial importance along with traditional and culinary uses

Materials and Methods

The experiment was carried out at the back of the Audio visual building, Federal College of Forestry, Ibadan.. Its lies between Latitude 70261 N and Longitude 30361 E. the climate is tropically dominated by rainfall pattern ranging between 1400mm – 1500mm the average temperature is about 31.2^0C and relative humidity is about 65%. The eco-climate of the area is rainfall with two distinct seasons which are dry season, (usually commencing from November to March and raining season from April to October). (FRIN Annual Meteorological Report, 2018)

The seeds of *M. oleifera* used for the experiment were collected from the seed store of Forestry Research Institute of Nigeria, horsedung and pigdung collected at the polo club Eleyele Ibadan sundried for three (3) days and then sieved to facilitate easy mixing with the top soil. The seeds collected were tested for viability before sowing inside a germination box which was filled with washed and sterilized river sand and germination of seeds was first noticed after six days of planting. Watering was done once daily and adequately to enhance germination (Yakubu et al, 2015). Two weeks after healthy seedlings of uniform size (plant height, stem diameter, number of leaves)) were transplanted into the polythene pots of size 14cm x 7cm. The seedlings were laid in completely randomized design (CRD). There are five

(5) treatments T_0 which is the control is 2kg of Top soil, T_1 which is Top soil + pigdung (5g), T_2 – Top soil + pigdung (10g), T_3 – Top soil + Horsedung (5g) and T_4 - Top soil + Horsedung (10g)and replicated 8 times including control making a total of 40 potted plants.

The seedlings were watered daily. The initial readings were taken immediately after transplanting into the polythene pots and subsequent readings were taken forthnightly.

Descriptive statistical tools were used to compare the treatment means in each of the parameters assessed.

Result and Discussion

The result from table 1 showed that in week 1 (considering the mean height in cm of M. oleifera as affected by horsedung and poultry manure) seedling without the use of organic manure (T_0) had the highest height with mean value of 15.88, followed by the seedlings treated with 10g of H.D (T_4) with mean value of 15.50 while seedlings with 5g of H.D (T_3) performed very low with mean value of 13.21. At week 5 seedlings without the use of organic manure had the highest height with mean value of 31.83 followed by the seedlings treated with 10g 0f H.D (T_4) with mean value of 31.00, seedlings treated with 5g of H.D (T_3) performed very low with mean value of 27.05. At week 8 seedlings treated with 10g of H.D (T_4) had the highest height with mean value of 63.83, followed by seedlings without the use of organic manure (T_0) with mean value of 47.25, while seedlings treated with 5g of P.D had the least performance with mean value of 41.63.

The result of table 1 showed that in week 1 (considering the mean stem girth of Moringa oleifera as affected by horsedung and pigdung) seedlings treated with 10g of P.D (T_2) and seedlings treated with 5g of H.D (T_3) had the highest stem girth with mean value of 0.33, followed by seedlings treated with 10g of H.D (T_4) with mean value of 0.29 while seedlings without the use of organic manure (T_0) had the least performance. At week 5 seedlings treated with 10g H.D (T_4) had the highest stem girth with mean value of 1.29, followed by seedlings treated with 5g of H.D (T_3) while seedlings without the use of organic manure (T_0) had the least performance. At week 8 seedlings treated with 10g of H.D (T_4) had the highest stem girth with mean value of 1.94 followed by seedlings treated with 10g of P.D (T2) with mean value of 1.93 while seedlings without treatment of organic manure (T_0) had the least performance with mean value of 1.69.

The result of Table 1 showed that in week 1 (considering the mean number of leaves of Moringa oleifera as affected by horsedung and pigdung) seedling without the use of organic manure had the highest number of leaves with mean value of 26.50 followed by seedlings treated with 10g H.D (T_4) with mean value of 24.13 while seedlings treated with 5g of H.D (T_3) had the least performance with mean value of 23.13. At week 5 seedlings treated with 10g H.D (T_4) had the highest number of leaves with mean value of 109.50, followed by seedlings without treatment of organic manure with mean value of 105.75 while seedlings treated with 5g H.D (T_3) had the least performance with mean value of 91.25. At week 8 seedlings without treatment of organic manure (T_0) had the highest number of leaves with mean value of 207.50, followed by seedlings treated with 5g P.D (T_1) with mean value of 181.38 while seedlings treated with 5g H.D (T_3) had the least performance with mean value of 159.38.

The result of Table 1 showed that in week 1 (considering mean number of leaflets of Moringa oleifera as affected by horsedung and pigdung) seedlings treated with 10g P.D (T_2) had the highest number of leaflets with mean value of 3.50, followed by seedlings treated with 10g H.D (T_4) with mean value of 3.38, while seedlin
10g P.D(T_2) and seedlings treated with 5g H.D (T_3) with mean value of 7.75 while seedlings treated with 5g of P.D (T_1) had the least performance with mean value of 6.63. At week 8 seedlings treated with 10g H.D (T4) had the highest number of leaflets with mean value of 11.38 followed by seedlings treated with 10g P.D (T_2) with mean value of 11.00 while seedlings treated with 5g P.D (T_1) had the least performance with mean value of 10.25.

Conclusions and Recommendation

From this study, it can be concluded that treatment T_4 (10g of horsedung) had the best performance with respect to plant height. Treatment T_4 (10g of horsedung) had the best performance with respect to stem girth, Treatment T_0 which is the control (2kg of top soil) had the best performance with respect to the number of leaves. Treatment T_4 (10g of horsedung) had the best performance with respect to number of leaflets. Based on the result of this study, it is recommended that 10g of horsedung should be used in raising *M. oleifera*.

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TABLE 1: GROWTH PARAMETERS of Moringa oleifera as affected by Horsedung and Pigdung LEVELS OF APPLICATION

Treatments	Mean Height			Mean Stem Girth			Mean Number of Leaves			Mean Number of leaflet		
	Wk1	wk5	wk8	Wk1	wk5	wk8	Wk1	wk5	wk8	Wk1	wk5	wk8
Control	15.88	31.83	47.25	0.25	0.82	1.69	26.50	105.75	207.50	3.25	7.50	10.88
PD 5g	14.75	28.94	41.63	0.26	1.08	1.73	23.38	97.00	181.38	3.00	6.63	10.25
PD 10g	15.38	29.05	43.35	0.33	1.19	1.93	23.50	96.88	165.25	3.50	7.75	11.00
HD 5g	13.12	27.05	41.75	0.33	1.24	1.63	23.13	91.25	159.38	3.25	7.75	10.75
HD 10g	15.50	31.00	63.83	0.29	1.29	1.94	24.13	109.50	177.00	3.38	8.00	11.38

PD- Poultrydung

HD- Horsedung

Assessment of Farmers' Perceptions of Pro-Vitamin A Cassava (Yellow Roots) in Abia State, Nigeria.

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Abstract

This study was conducted among farmers in Abia State to assess their perceptions about pro vitamin A cassava. Multi stage sampling technique was used in the study. Six out of the seventeen local government areas(LGA) in Abia state were purposively selected for this study as follows; Arochukwu, Bende, Umunneochi, Umuahia north Umuahia south and Isialangwa north Local Government Areas. Two communities and twenty cassava farmers were selected in each of the LGAs. The farmers were interviewed using structured questionnaire to elicit information about their perceptions of Pro vitamin A cassava in terms of benefits. Data collected were analyzed with descriptive statistics such as frequency, percentages and mean. A five point Likert type scale was used to achieve the farmers perceptions of pro vitamin A cassava. The result showed a high perception of pro vitamin A cassava among farmers in Abia State. The fufu quality(mean= 4.22) has the highest perceptions, followed by the market demand(mean=4.20) and high profitability(mean=4.10) The major constraints in the use of the technology were lack of inputs fertilizer(81.7%) and herbicides, high cost of labour(71.7%) and lack of finance(65.8%). It was recommended that farm inputs should be made available and affordable to farmers for increased use of pro vitamin A cassava.

Keywords: Farmers, Perceptions, Pro vitamin A cassava

Introduction

Among root and tuber crops, cassava remains the key to food security and poverty reduction in Nigeria as most households are dependent on its production, processing and marketing *(Amadi et al., 2011).* Demand- driven research conducted by scientists at National Root Crops Research Institute (NRCRI) Umudike, Nigeria has led to the development of many improved technologies on cassava with the hope to give the farmers a stable new market along with new production technologies, Among the developed technologies are cassava stem multiplication technology, improved cassava varieties and cassava value addition technologies*(Nwakor ,et al., 2016)*. Recently, cassava genotypes that have high amount of pro-vitamin A, have been developed and transferred to farmers by NRCRI and International Institute for Tropical Agriculture (IITA) Ibadan. This was done to save thousands of people particularly children from vitamin A deficiency related diseases, such as night blindness, stunting, predisposition to common infections and even death. The pro-vitamin A cassava varieties are umucass 36,umucass 37,umucass 38 and others. Farmers have different perceptions and understanding of this development. Some have mot understood the importance or relevance of this technology to the society. The pro vitamin A cassava was developed to improve health, nutrition and food security condition among the people. The questions are,; is this technology acceptable to the farmers?, how do they regard this technology?, and what do they do with this cassava innovation?.

Specific objectives of the study

1 Describe the socio economic characteristics of the farmers

2. Identify the various pro vitamin A cassavas grown by farmers

3. Ascertain the perceptions of farmers about pro vitamin A cassavas.

4 Identify the constraints militating against use of pro vitamin A cassava

Methodology

The study was conducted among farmers in Abia state, Nigeria. The state is made up of seventeen LGAs. Multistage sampling technique was used for the study. Six local government areas of Arochukwu, Bende, Umuahia South, Isialangwa, Umunneochi and Umuahia North were randomly selected, followed by random selection of 2 communities in each LGA. Ten cassava farmers, cassava were purposively selected in these communities. Making it a total number of 120 farmers selected for this study. A well-structured questionnaire with interview schedule was use to elicit information from the farmers .Data collected were analyzed by means of descriptive statistics such as frequency, percentages, means. A five point likert scale type was used to analyze the perceptions of pro vitamin cassava among the respondents (1 +2+3+4+5 =15/5=3.0)..

Results and Discussion

Socioeconomic Characteristics of the Respondents

Table 1: Distribution of Respondents according to Socioeconomic Characteristics

Variable	Frequency	Percentage
Gender		
Female	86	71.7
Male	34	28.3
Total	**120**	**100**
Marital status		
Married	90	75.0
Single	22	18.3
Divorced	8	6.7
Total	**120**	**100**
Age		

21 – 30	32	26.7
31 – 40	28	23.3
41 -50	30	25.0
51-60	20	16.7
61-70	10	8.33
Total	**120**	**100**
Mean	**41.2**	
Qualification		
No formal education	2	1.7
Primary	31	25.8
Secondary	60	50.0
Tertiary	18	15.0
Others	9	7.5
Total	**120**	**100**
Household size		
1-5	84	70.0
6-10	34	28.3
11 -15	2	1.7
Total	**120**	**100**
Mean	**4.5**	

The result in Table 1 shows the socioeconomic characteristics of the respondents. The result shows that majority (71.7%) of the respondents were female and (75.0%) were married, only but (18.3%) were single. Fifty (50%) of the respondents were below 40 years while the remaining 50% were above 40 years of age and the mean age was (41.2) The implication is that many young people were cassava farmers in Abia State and this will lead to increase production and utilization of pro vitamin A cassava in the study area . Majority (50%) of the farmers attended secondary education level whereas many pass through primary (25.8%), only (15%) of the farmers had tertiary education. Majority (70%) of the respondents have a moderate household size of 1-5 while (28.3%) have large household size of 6-10.

Table 2: Distribution of respondents according to the major varieties of pro vitamin A cassava in use

Varieties	Frequency	Percentage
Umucass 36	45	37.5
Umucass 37	14	11.7
Umucass 38	34	28.3
Umucass 44	15	12.5
Umucass 45	2	1.7
Others	10	8.3
Total	**120**	**100**

Source: Field Survey 2019

Table 2 shows the various varieties of pro vitamin A cassava grown by farmers in Abia state. The study revealed that the farmers grew different varieties of pro vitamin A cassava. The major varieties grown were Umucass 36 (37.5%), umucass38(28 .3%), umucass 44(12.5%) umucass 37(11.7%), while umucass 45 (1.7%) was the least variety planted by the respondents. This shows that the farmers were growing provitamin A cassava varieties but still in small proportion.

Table 3 Distribution of Respondents According to their Perceptions about Pro vitamin A cassava

PERCEPTIONS	SA	A	UN	SD	D	TOTAL	S.SIZE	MEAN
Highly profitable	52 (260)	42(168)	10(30)	14 (28)	2 (2)	488	120	**4.10**
Very nutritious	56 (280)	40 (160)	6 (18)	8 (16)	10 (10)	484	120	**4.00**
Early maturity	18(90)	20 (80)	66(198)	8 (16)	8 (8)	392	120	**3.30**
Good garri quality	26 (130)	68(272)	18(54)	2 (8)	4 (4)	468	120	**3.90**
Good for fufu	36 (180)	74(296)	10(30)	0 (0)	0 (0)	506	120	**4.22**
Good for abacha	16 (80)	78(312)	20(60)	0 (0)	6 (6)	458	120	**3.82**
Low starch	22(110)	64(256)	28(84)	4 (8)	2(2)	460	120	**3.83**
High demand	34 (170)	72(288)	12(36)	2 (4)	0 (0)	498	120	**4.20**
Contain vit, A	36(180)	62(248)	14(42)	0(0)	8(8)	478	120	**3.98**
Very watery	26(130)	48(192)	32(96)	2(4)	12(12)	434	120	**3.62**
High storage value	18(90)	58(232)	32(96)	2(4)	10(10)	432	120	**3.60**
Attractive colour	28(140)	48(192)	16(48)	0(0)	12(12)	392	120	**3.30**
Low mortality rate	24(120)	74(296)	16(48)	0(0)	6(6)	470	120	**3.92**
Good canopy	18(90)	62(248)	24(72)	2(4)	14(14)	428	120	**3.60**
High root yield	12(60)	88(352)	16(48)	0(0)	4(4)	464	120	**3.90**
Rapid growth	8(40)	90(360)	16(48)	0(0)	0(6)	454	120	**3.78**
Easy to ferment	14(70)	74(296)	26(78)	0(0)	6(6)	450	120	**3.75**
Generally accepted	5(110)	70(280)	22(66)	0(0)	6(6)	462	120	**3.85**

Grand mean	3.82

Field survey, 2019, SA= strongly agree, A=Agree, UN= Undecided, SD=strongly disagree, D= Disagree

Decision rule:≥3.0 =High, < 3.0 = Low

Table 3 shows there was high perception of pro vitamin A cassava among respondents with all the mean scores greater than 3.0 The result shows that fufu quality of pro vitamin A cassava is good has the with the mean score of (4.22,) followed by high market demand (mean = 4.20, highly profitable (mean 4.10), very nutritious (mean 4.00). The interpretation is that pro vitamin A cassava is highly acceptable for fufu production and it has high demand and profitable. Also farmers perceived pro vitamin A cassava to be early maturity, high fresh root yield and general acceptance to the consumers.. Perceptions of farmers on pro vitamin A cassava in this study was in agreement with *(Esuma et al 2019)* who reported several good qualities attributed to, pro vitamin A cassava as; early maturing(**3.30)**, high fresh root yield(**3.90)** and tolerance to diseases, notably cassava mosaic disease;. The result showed a grand mean score of 3.82 which was higher than the decision mean of 3.0 showed a very good perception about pro vitamin A cassava by respondents.

Table 4: Distribution of Respondents according to constraints to the use of pro vitamin A cassava

Challenges/Constraints	Frequency	Percentage	Rank
Lack of land	68	56.7	6th
Lack of fertilizer	98	81.7	1st
Unavailability of finance	79	65.8	3rd
Lack of herbicide	63	52.5	7th
Poor yield	25	20.8	12th
Inaccessibility of modern processing equipments	72	60.0	5th
High labour cost	86	71.7	2nd
High cost of processing equipments	68	56.7	6th
Pest and diseases	51	42.5	9th
Climate change	38	31.7	10th
Storage problems	28	23.3	11th
Poor marketing	19	15.8	13th
Theft	58	48.3	8th
Low processing value	78	65.0	4th
Inaccessibility of credit facilities	38	31.7	10th

Source: Field survey, 2019 (Multiple response)

Table 4 above presents the challenges/constraints militating against the use of pro vitamin A cassava in the study area. However, lack of fertilizer was ranked 1st, indicating that 81.7 % of the respondents did not use pro vitamin A cassava due to lack of fertilizer while high labour cost(71.7%), and unavailability of finance (65.8%) ranked 2nd and 3rd respectively. Land fragmentation (13.3%) was the least important constraint militating against the use of pro vitamin A cassava in the study area.

Conclusion

The study on farmers perceptions of pro vitamin A cassava showed that farmers in Abia state were planting different varieties of pro vitamin A cassava. There was high perception of pro vitamin A cassava among the respondents. The technology was acceptable among the respondents. The water content of pro vitamin A cassava was perceived to be high by the respondents. The major constraints to the use of pro vitamin a cassava were lack of fertilizer, lack of fund, high cost of labour for cassava production and processing and poor access to processing equipments. Farmers should be encouraged to use the technology through availing farm inputs like fertilizer and herbicides. Also provision of loan and modern cassava processing facilities is recommended .

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EFFECT OF ROW SPACING ON GROWTH, YIELD AND YIELD COMPONENTS OF FOUR VARIETIES OF MAIZE (*ZEA MAYS* L.), IN JALINGO, TARABA STATE, NIGERIA

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Abstract

Plant density and the use of improved varieties are important factors that determine yield. A study was conducted under rain fed condition of 2019 cropping season at the Teaching and Research Farm of Taraba State University, Jalingo to determine the effect of inter-row and intra-row spacing on growth and yield of some maize varieties. The experiment consisted of factorial combination of four maize varieties (Sammaz 17, Sammaz 24, Admiral 'A' and a local cultivar), two inter-row spacing (75 and 80cm) and three intra-row spacing (20, 25 and 50cm) was laid out in a randomize complete block design (RCBD) and replicated three times. The highest 100 seed weight (37.67g) and grain yield (8.02kg/ha) were obtained in Sammaz 24 at the spacing of 75X50cm, and 80X 20cm, respectively. Therefore, the variety Sammaz 24 at the wider spacing of either 75 X50cm or 80X 20cm is ideal for maximum grain yield of maize production in the study area.

Keywords: Plant population, spacing, grain yield, maize, variety.

Introduction

Maize (*Zea mays L.),* one of the major cereals in Nigeria is a member of the grass family, Poacea. It ranks third after wheat and rice as one of the most important cereals in the world (FAOSTST, 2016). However, in Nigeria maize is ranked after sorghum and millet based on the quantity produced and the area under cultivation (Uzozie, 2001). The average maize yield in Nigeria is 1.13 t/ha and this is low when compared to developed countries average yield of 6.2t/ha (ATA, 2014). This low yield might be due to appropriate crop spacing or low access to improved varieties of maize (Shiferaw *et al*, 2010). Furthermore, grain yield of maize is seriously affected by variations in plant population than other members of the grass family, because of its low or lack of tillering ability (Sangoi *et al*, 2002). Although optimum plant density for maximum yield per unit area may vary from one variety to another because of significant interactions (Tokatlidis *et al*, 2005), it is therefore pertinent to determine the optimum plant density for improved maize varieties based on environmental factors and agronomical practices to obtain maximum yield (Abdikeni, 2015). Therefore, the study was initiated to determine the effect of inter and intra-row spacing on growth and yield of some maize varieties.

Materials and methods

The experiment was conducted during the 2019 cropping season under rainfed conditions at the Teaching and Research Farm, Faculty of Agriculture, Taraba State University, Jalingo. The materials for the experiment comprised of three improved maize varieties (Sammag 17, Sammag 24 and Admiral “A” procured from Hamsar Agro-allied Ltd, Nigeria and one local cultivar obtained from a farmer in Jalingo. The experiment was a split plot factorial laid out in a randomized complete block design (RCBD) and replicated three times where the four varieties were randomly assigned to the different levels of inter and intra spacing.

Data Collection: five plants were randomly selected from the middle rows for collection of vegetative and yield data.

Data Analysis: Data collected were subjected to analysis of variance using the general linear model (GLM) and significant means separated using Duncan Multiple Range Test (DMRT).

Results

Table 1: Effect of variety and spacing on plant height (cm) of maize at 4-12 WAP

Treatment	4	6	8	10	12
Variety					
Sammaz 17	52.24a	68.29a	130.20a	165.24ab	173.51a
Sammaz 24	50.49a	64.29a	122.54a	139.33b	158.80a
Admira “A’	50.20a	64.07a	132.27a	168.98a	176.40a
Local cultivar	37.68b	52.36b	126.80b	166.20ab	169.93ab
S.E	3.380	3.349	2.104	6.914	3.854
Spacing					
80 X 25	45.92a	60.92a	126. 05b	159.81a	169.68a
75 X25	48.37a	61.97a	135.70a	165.47a	170.62b
75 X30	48.60a	63.88a	122.18b	154.48a	168.68ab
S.E	0.858	0.872	4.019	3.171	0.558
Interaction (VxS)	*	*	*	*	*

S.E= standard error

Means in the same column followed by the same letter (s) are not significantly different as 5% level of probability.

Results of the effect of variety and spacing on plant height (Table 1) showed that the improved varieties were significantly different (P<0.05) from the local cultivar at 4-6 WAP. However, at 8 WAP, all the varieties were of comparable height. The variety, Admiral "A" produced the tallest plants at 10-12 WAP (168.98 cm and 176.40 cm, respectively). On the levels of spacing, no significant difference was observed at 4, 6 and 10 WAP but at 8 and 12 WAP, 75x25 cm was significantly different from the remaining two spacings and recorded the tallest plants.

Table 2: Effect of variety and spacing on leaf area (cm^2) of maize at 4-12 WAP

Treatments	4	6	8	10	12
Variety					
Sammaz 17	2441.2a	3189.2ab	5920.6a	9352.0a	8806.4a
Sammaz 24	2122.6ab	3574.8a	5704.6ab	8773.1ab	8531.3a
Admiral "A"	1849.6ab	3151.0ab	5099.1b	7725.6b	8798.0a
Local cultivar	1597.8b	2452.0b	5891.2a	9280.4b	9899.3a
S.E	181.197	233.739	191.03	321.48	303.64
Spacing					
80 X25	2018.8a	3167.8a	5461.8a	8943.6ab	8825.3a
75 X 25	2285.9a	3177.7a	5986.6a	9241.5a	9134.9a
75 X30	1705.8a	2929.8a	5513.3a	8163.3b	9066.2a
S.E	167.596	81.009	167.024	375.22	93.86
Interaction (VXS)	*	*	*	*	*

S.E = Standard error, NS = not significant

Means in the same column followed by the same letter (s) are not significantly different at 5% probability.

Results of effect of variety and spacing on leaf area (Table 2) showed that the improved varieties were of comparable leaf area and differed significantly from the local cultivar at 4 and 6 WAP. However, as the number of WAP increased the local cultivar improved exceedingly in leaf area and recorded the widest (9899.3). Generally, no significant difference was observed among the 3 spacing levels. However, 75x25 cm produced the highest leaf area across the weeks. On the other hand, the interaction between variety and spacing was significant throughout the period of the experiment except at 12 WAP where no significant difference was observed.

Table 3: Effect of variety and spacing on leaf area index of maize at 4-12 WAP

Weeks after planting

Treatments	**4**	**6**	**8**	**10**	**12**
Variety					
Sammaz 17	1.44a	1.77a	3.00a	4.55a	4.77a
Sammaz 24	1.457a	2.12a	2.77a	4.66a	4.44ab
Admiral ‘A’	1.267a	1.77a	2.55a	3.911a	4.006
Local cultivar	1.067a	1.57a	2.88a	4.55a	4.77a
S.E	0.092	0.113	0.09	0.172	0.184
Spacing					
80x25	1.383a	1.917a	0.08a	4.60a	4.83a
75x25	1.400a	1.88a	2.75a	4.50a	4.50ab
75x30	1.150a	1.642a	2.583a	4.16a	4.16b
S.E	0.081	0.087	0.146	0.131	0.192
Interaction (VxS)	NS	NS	NS	NS	*

S.E= Standard error, NS= not significant

Means in the same column followed by the same letter (s) are not significantly different at 5% level of probability.

Results of leaf area index (LAI) in Table 3 showed that no significant difference was observed except at 12 WAP where Admiral “A” significantly produced the least LAI (4.00). In the same manner, 75 x 50 cm spacing produced significantly the least (4.16) LAI at 12 WAP. Similarly, no significant difference was observed in the interaction except at 12 WAP where wider inter- row spacing of 80x20cm recorded the least LAI (4.83).

Table 4: Effect of variety and spacing on yield and yield component of maize

Treatments	Cob length (cm)	Cob diameter (cm)	100 seed weight (g)	Grain yield (kg/hec)
Variety				
Sammaz 17	15.00b	15.00b	34.56b	7.95a
Sammaz 24	17.00a	16.22a	37.67a	8.02a
Admiral 'A'	17.00a	13.88c	32.11c	7.10a
L.C	14.66b	12.55d	30.88c	3.93b
S.E	0.001	0.702	0.702	0.324
Spacing				
80 25	14.75a	14.25a	32.67b	6.90a
75 25	14.58a	14.25a	33.75ab	6.85a
75 30	15.25a	14.72a	32.00a	6.49a
S.E	0.2	0.732	0.674	0.42
Interaction (VxS)	*	*	*	*

S.E = Standard error

Means in the same column followed by the same letter(s) are not significantly different at 5% level of probability.

The main effect of variety and spacing had significant effect on yield and its component (Table 4). Accordingly, Sammaz 24 and Amiral 'A' produced significantly higher ear length (17.00cm) while the local cultivar had the shorter length (14.66 cm). Variation in yield component was observe among the genotypes with Sammaz 24 significantly producing the highest ear diameter (16.22 cm), 100 seed weight (37.67) and grain yield per hectare (8.02kg).

Discussion

The variation in plant height and other morphological traits indicated the existence of genetic differences in the planting materials. This observation is in conformity with the result of Azam *et al*. (2007) who reported that different maize varieties varied in phenotypic traits such as plant height. The tallest variety in this study Admiral 'A', might be as a result of high rate of stem elongation leading to greater number of internodes or increased competition for sunlight due to high density as a result of narrow spacing. Higher plant population of 63,333 (75X25cm) had the highest leaf area and this observation is in variance with the result of Nwanne *et al*.(2018) who reported that leaf area increase with increasing plant because of less competition for environmental factors.

Increase in LA1 at wider inter row spacing and narrower intra-row spacing (80 x 20cm) showed that it decrease as plant density increase. This observation is in agreement with the report of Temesgen (2019). However, the increase in LAI with lower intra-row spacing (80X20cm) in this study might be due to more unit area occupied by the leaf crop of the plants. The difference observed in ear length in the current study is in conformity with the finding of Lakew *et al.* (2016) who report significant variation in ear length among maize varieties. The possible reason for thicker ear diameter observed in Sammaz 24 (16.22cm) might be due to large grain size of that variety when compared with the other varieties. However, Gozubenli *et al.* (2001) viewed that variation in ear characteristics of maize are dependent upon genotypic and environmental conditions. 100 seed weight and grain yield per hectare were significantly affected by the interaction of variety and spacing. Accordingly, the highest 100 seed weight (37.67g) and grain yield per hectare (8.02kg) at a wider intra-row spacing of 75X 50cm. The possible justification for this higher yield at wider inter-row and intra-row spacing might be as a result of less competition for nutrient absorption and solar radiation for improved photosynthesis and hence better grain yield (Borras *et al*, 2003). However, Asea *et al*. (2014) showed that plant populations that are higher than the optimum normally result to competition among the maize plants leading to thin plants that give low yield while lower plant population usually result in low yields (though with bigger ear) due to reduce number of ear per unit area.

Conclusion

The development of appropriate inter and intra row spacing for different variety is an important agronomic practice for maize production. The variety, Sammaz 24 was the most suitable of the four varieties tested. Wider inter-row spacing and narrower intra-row spacing of 80X20cm was better to achieve optimum yield in Jalingo environment.

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Influence of Organic and Inorganic Fertilizer on the growth of Gmelina arborea Robx seedlings

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Abstract

The influence of cow dung manure, N.P.K 15:15:15 and superphosphate fertilizers on the growth of Gmelina arborea was examined in this study, 40 seedlings of Gmelina arborea were subjected to 1g, 3g and 5g levels of cow dung manure, NPK 15:15:15 and superphosphate fertilizer respectivily. The experiment was laid out in a Completely Randomized Design (CRD) with 10 treatments and replicated four times. The following variables were measured for a period of 10weeks: plant height, stem girth, number of leaves and leaf area.

The result showed that T3 at 5g had the best performance ($p < 0.05$) in plant height, number of obtained, it is therefore recommended that T3 superphosphate fertilizer at 5g level of application should be adopted for early seedling growth and also to ensure a successful plantation establishment of Gmelina arborea. This finding of the research also agreed with the work of Uguse (2010) who recorded 69.6 cm of T. indica seedlings height grown with. NPK 15:15:15, also This is in accordance with the study of Anderson (2008) NPK 15;15;15on the growth of *K . senegalensis.*

Key words -: Gmelina arborea, N.P.K fertilizer, Cowdung, Seedlings, Plantation.

Introduction

Forest covers nearly one third of the earth's land area but that figure keeps dropping. Deforestation is said to be a paradox, this is because the burning and logging of forest continue for economics reason, yet the demand for forest products keep increasing leading to intensified forest management to increase production in order to meet the projected wood requirement in Nigeria. The plantation of the promising indigenous tree species is being intensively managed to obtain a satisfactory yield level through hormonal treatment (John, 2015).

Trees are generally vital to human existence as they provide some service to the world. These services include absorbing and storing of carbon dioxide (green house gas). preventing soil losses and flooding, recycling nutrient, regulating rain fall, providing a home for endangered animals, it also provides fascinating scenery and a place for recreation (Sumpam et al, 2013).

Forest in Nigeria is rich in both fauna and flora species and they are known to be traditionally protected for timber production and exploitation. Forest resources and other types of natural resources are an integral part of the rural economy providing subsistence income, food and service to the people. Forest also serves as reservoir for many plants resources, varying species and life form (Yakubu et al, 2015).

*G. arborea*i a member of the family verbanaceae and native to South East Asia and Burma where it grows in drier part of the mixed evergreen forest in the Eastern parts. The tree has opposite leaves with erect and not very regular shaped stem. It has deep root system forming a long, thick and frequently forked tap root with so many lateral roots; it has a thin bark of about 4cm thick, that is smooth with light grey colour sometimes yellow inside (Gabriel, 2010).

G. arborea flakes when old and expose a smooth pale coloured bark beneath. The leaf simple, broadly ovate, cordiate in connect at base, glamour above and hairy beneath. The petiole is more than leaf as long as the blade. The lateral veins are often 3 – 5 pairs or more.

G. arborea grows very well where the extremes of temperature range from 600F – 950 and the atmosphere humidity not below 40%. It thrives well in a rainfall range 500 – 800 over a period of six month and in drain. Fairly stiff loan solid containing particles of coarse quartz sand (Cheng-Wei et al, 2014). This study investigated the effect of cowdung and N.P.K fertilizer on seedling growth of the tree species.

The aim of this study is to investigate the effects of organic and inorganic fertilizers on the growth of *G. arborea* seedlings as well to determine the best fertilizer for raising *G. arborea* seedlings.

Materials and Methods

The materials used are: Hand trowel, hoe, vernier caliper, watering can, polythene pot, cutlass, rain boot, sieve (i.e. used to sieve the soil), wheel barrow, soil, shovel, glove, head pan, field notebook and meter rule.

The soil samples were collected from the *G. arborea* plantation near the school College Hall at Federal College of Forestry Jericho, Ibadan Oyo State situated in the Western outskirt of Ibadan on latitude 102N and longitude 30054E with the climate condition of tropical and annual rainfall of 112 – 152cm (Metrological station) of Federal College of Forestry, Ibadan. The experimental soil was air dried and passed through 2mm sieve to remove extraneous materials. 200 seeds of *Gmelina arborea*were collected from the seed store in Olokemeji Forest Reserve Abeokuta, Ogun State, (Odeda Local Government). The cow dung manure was collected at Federal College of Forestry Jericho Hill Ibadan, Oyo State. The superphosphate and N.P.K 15:15:15 fertilizer were purchased at IAR&T (Moor Plantation) Apata road Ibadan. *G. arborea* seeds were soaked in cold water for 3 days, broadcast in the germination box and placed under propagator. The experiment was watered twice in a day; the germination was monitored and recorded. The sprouted seedlings were later carefully and gently pricked and transplanted into polythene pots. The topsoilis mixed with the following treatments, superphosphate fertilizer, cowdung manure and N.P.K 15:15:15 at 1g, 3g and 5g concentration levels with control (topsoil alone). The treatments were replicated four times hence, a total of 40 seedlings were used for the experiment.

The experimental design used was Complete Randomized Design (CRD). There were 10 treatments e.g. T0=Control.T1=Superphosphate fertilizer at 1g level of application. T2= Superphosphate fertilizer at 3g level of application. T3= Superphosphate fertilizer at 5g level of application. T4= N.P.K 15: 15: 15 at 1g level of application. T5= N.P.K 15: 15: 15 at 3g level of application. T6= N.P.K15: 15: 15 at 5g level of application. T7=Cow dung manure at 1g level of application. T8=Cow dung manure at 3g level of application. T9=Cow dung manure at 5g level of application.and 4 seedlings per treatment making a total of 40 seedlings altogether.

Data generated were subjected to means, and analysis of variances (ANOVA) and least significant difference test to separate means at 5% level significance.

Results and Discussion

In Table 1, weeks 2, 4 and 6, showed that 5g (T3) superphosphate fertilizer ssssss produced the highest mean height with the average values of 18.4cm, 29.0cm and 44.9cm respectively while top soil only (To) had the least means of 15.0cm, 18.s9cm, 27.6cm, 33.2cm and 36.7cm for 2, 4, 6, 8, and 10 weeks respectively. The treatment was significantly different from one another ($p<0.05$).

However, at week 8, 1g NPK 15: 15: 15 had the highest mean height of 58,4cm. While 3g NPK 15: 15: 15 had the highest of 67.9cm at the 10th week. From Table 2, at week 2, 4, 6, and 10, 5g superphosphate fertilizer (T3) produced the highest mean height of 18.4cm, 13.000cm, 17.000cm and 21.000cm respectively while top soil only (T0) had the least means of 15.0cm, 10.000cm, 12.000cm, 14.000cm and 15.00 for 2, 4, 6, 8, and 10weeks respectively. The treatments were significantly different from one another ($p<0.05$). consequently at week 8, T6 of 5g NPK 15:15:15 had the highest mean height of 20.500cm From Table 3 at weeks 2, and 4 top soil only (T0) produced the highest mean stem diameter of 0.120cm, 0.170cm, 0.248cm and 0.320 respectively while T9 (cow dungmanure at 5g level of application) had the least mean value of 0.073, at 10th week. At week 6 and 8 had the highest mean value of 0.418cm and 0.500cm, while at week 10 1g level of application had the highest mean value of 0.500cm.From Table 4,it was shown that at weeks 4 and 10, 1g superphosphate fertilizer (T1) produced the highest mean height of 57.233cm and 114.633 respectively while top soil only (T0) had the least mean of 17.870cm, 24.108cm, 33.450cm, 33.225cm and 41.530cm for 2, 4, 6, 8, and 10 weeks respectively. The treatments were significantly different from one another ($p<0.05$).

Moreover, at week 6 and 8, 3g NPK 15:15:15 had the highest mean height of 72.048 and 85.190 while 1g NPK 15:15:15 had the least mean of 27.535cm in the 10thweek. This finding of the research also agreed with the work of Uguse (2010) who recorded 69.6 cm of *T. indica* seedlings height grown with. NPK 15:15:15, also This is in accordance with the study of Anderson (2008) NPK 15;15;15on the growth of *K . senegalensis*

Conclusion and Recommendations

This study investigated the influence of cow dung manure, NPK 15:15:15 and superphosphate fertilizer on the growth of Gmelina arborea seedlings. The result showed that T3 superphosphate fertilizer at 5g level of application performed best in terms of plant height, (18.370cm), leaf production (13.000cm) and stem diameter (0.170cm), while superphosphate fertilizer at 1g level of application only performed best with respect to leaf area. Based on the findings, 5g of super phosphate fertilizer is recommend for timber production since it favorably support vigorous height increment and the stem diameter of the seedlings of G. arborea

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TABLE 1.1; MEAN HEIGHT (CM) OF *Gmelina arborea* WITHIN 10 WEEKS OF TREATMENT.

Treatment	Week2	Week4	Week6	Week8	Week10	
T1		17.00	26.150	36.500	46.37	51.750
T2		17.250	27.475	38.500	48.125	50.650
T3		18.370	29.025	44.925	56.375	60.525
T4		17.625	27.625	42.650	58.425	64.375
T5		15.875	25.050	41.450	55.225	67.875
T6		15.500	25.100	39.000	52.300	61.300
T7		17.425	26.950	39.550	511.950	59.150
T8		16.375	24.250	35.875	44.475	52.800
T9		15.750	24.075	34.375	39.675	42.650
T0		15.000	18.650	27.625	33.150	36.725
LSD 5%		1.164	2.273	4.318	6.355	7.131

Table 2: MEAN NUMBER OF LEAVES OF *Gmelina arborea* WITHIN 10 WEEKS OF TREATMENT

Treatment	Week2	Week4	Week6	Week8	Week10
T1	9.000a	12.00b	15.500bc	18.000bc	20.000ab
T2	8.000a	10.5000c	14.500cd	17.00cd	19.000bc
T3	9.000a	13.000a	17.000a	19.500a	21.000a
T4	9.000a	13.000a	16.500ab	19.500a	21.500a
T5	8.000b	11.500b	16.500ab	19.500a	20.500ab
T6	9.000a	13.000a	16.500ab	20.500a	21.500a
T7	8.000b	11.500b	14.000de	16.000de	17.500d
T8	8.000b	11.500b	14.000de	16.000de	17.000d
T9	8.000b	11.500b	14.000de	15.500e	16.000de
T0	7.000c	10.000c	12.000f	14.000f	15.000e
LSD 5%	0.354%	0.5776	1.0240	1.468	1.994

Table 3 MEAN STEM DIAMTER (cm) OF *Gmelina arborea* WITHIN 10WEEKS OF TREATMENT

Treatment	Week2	Week4	Week6	Week8	Week10
T1	0.075	0.113	0.358	0.423	0.460
T2	0.083	0.113	0.330	0.385	0.413
T3	0.088	0.153	0.393	0.415	0.500
T4	0.088	0.153	0.375	0.393	0.455
T5	0.095	0.158	0.418	0.500	0.493
T6	0.088	0.133	0.338	0.410	0.430
T7	0.083	0.135	0.325	0.358	0.420
T8	0.078	0.135	0.300	0.348	0.378
T9	0.073	0.120	0.285	0.318	0.355
T0	0.120	0.170	0.248	0.275	0.320
LSD 5%	0.377	0.000	0.001	0.038	0.001

Table 4 MEAN LEAF AREA (cm3) OF *Gmelina arborea* WITHIN 10WEEKS OF TREATMENT

Treatment	Week2	Week4	Week6	Week8	Week10
T1	18.083d	57.233a	69.155ab	76.573a	114.633a
T2	19.458cd	37.368a	47.763d	63.220a	67.048cd
T3	25.530ab	54.325a	55.005c	84.563a	90.830b
T4	27.535a	55.538a	63.893b	71.688a	80.630bc
T5	26.010a	57.067cd	72.048a	85.190a	88.663b
T6	20.065cd	46.730b	70.618ab	64.753a	79.690bc
T7	17.123d	38.383cd	51.965ed	65.100a	71.480cd
T8	17.620d 3	4.148d	48.130cd	49.310a	73.193cd
T9	22.448bc	42.228bc	37.078e	49.693a	60.730d
T0	17.870d	25.108e	33.450e 3	3.255a	41.530e
LSD 5%	3.204	5.701	7.957	49.800	14.677

INFLUENCE OF FERTILIZER APPLICATION METHODS ON THE GROWTH AND YIELD PERFORMANCE OF TOMATO *(Lycopersicon esculentum (L) Mill)*

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Abstract

The study investigated the influence of two methods of fertilizer (N.P.P 15:15:15) application [soil and foliar] on the growth and yield of Lycopersicon esculentum L (Roma sp.). The experiment consists of seven (7) treatments with four replicates, and was arranged in a Completely Randomized Design (CRD). The *Lycopersicum esculentum* seeds were collected at seed store of National Horticutural Research Institute and raised in the germination box for two weeks before transplanted into the polythene pot. Treatment 0 represents the control experiment (top soil), Treatments 1,2,3 consists of 0.125g, 0.25g and 0.5g respectively of N.P.K 15:15:15 applied as pellets to the soil while treatments 4,5,and 6 are 0.125, 0.25g and 0.5g respectively of N.P.K 15:15:15 dissolved in water and applied as liquid to the foliage of the plant. The parameters assessed were plant height, stem girth, leaf numbers, number of branches, days to flowering and number of fruits. The plant height, leaf number and stem girth were recorded beginning from week 1 after transplanting(WAT), also the days to flowering was recorded four (4) weeks after transplanting. It was concluded that the treatment 5 had the highest mean value in all parameters at the end of the experiment. Also when comparing the effect of the two method of fertilizer application, the foliar method proves to be the most effective by supplying the plant the needed nutrient in a very short period of time. From the results, it was recommended that the treatment of 0.25g of N.P.K, applied in the liquid to the foliage of the plant recorded the highest mean value in all the parameters assessed.

Keywords: ***Lycopersicum esculentum*, N P K ,Nutrient, Foliar, growth yield.**

Introduction

Tomato is one of the world’s most important vegetable crops. It originated from west South America and domestication is thought to have occurred in Central America. It is Known as one of the most important vegetable cultivated because of its importance as food, tomato has been breed to improve productivity, fruit quality and resistance to biotic and a-biotic stress. The tomato plant has many interesting feature such as fleshy fruit, sympodial shoot and compound leaves. It is used as condiments in dishes in human nutrition. Tomato is used in preservation products like ketch up, sauce, chutney, soup paste (Adekoya et al., 2011).

Tomato is widely cultivated in tropical, subtropical and thus ranks third in terms of world vegetable production (FAO, 2006). Tomato thrives best when the weather is clear and rather dry, a uniformly moderate temperature about 23^0 to 25^0 Celsius needed. A high pressure of about 27cmHg causes pollen sterility and high night temperature adversely affects flower initiation thereby reducing yield. Low soil temperature retards the growth of the seedlings and absorption of minerals. The crop can be cultivated in altitude varying from zero sea levels to 500 to 700ft with annual rainfall of 165mm and above. A well-drained fertile soil with good moisture retaining capacity and relatively high soil nutrient are most suitable and also a slightly acidic soil with a ph 5.8 to 6.5 is desirable. Tomato is a horticultural crop that is usually produced at subsistence level due to some ecological and economic factors. It is grown in the southern part of Nigeria in small holding under rain fed condition, while it is grown extensively under irrigation in the north (Nwite et al., 2016). Tomato is the most consumed vegetable in most countries becoming the main source of nutrient and providing an important nutritional value to the human diet. Tomato is a rich source of minerals like iron, phosphorus and pigments called Beta-carotene and lycopene. Soil application of fertilizer is the processing of adding fertilizer to the soil to supply plant nutrient. Only 10% of the fertilizer applied to the soil is used up apart from the fact that it takes longer time before the granules dissolve and the plant use it up, most of it is lost to leaching thereby denying the accurate amount needed for germination (Tomas and Czako, 2014). Inorganic fertilizers are fertilizers that are highly acidic, so when it touches any part of the root, it leads to scotching.

Foliar feeding is a technique of feeding plant by applying liquid fertilizer directly to their leaves. The absorption takes place through the stomata and epidermis. Foliar application of fertilizer is the most efficient way to increase crop yield. Study shows that foliar feeding can increase crop yield from 12% to 25% when compared to soil application of fertilizer *(Marwanto et al., 2018)*. When fertilizers are foliar applied, more than 90% of the fertilizer is utilized. Foliar application is an effective method of correcting soil deficiencies and overcoming soil inability to transport nutrient (Sekar, 2013). In view of this, there is need to study the impact of different methods of fertilizer application on the growth and yield performances of tomatoes.

Material and Methods

The experiment was carried at the Agricultural Technology Department Farm, Federal College of Forestry, Ibadan. The College is situated at Jericho Quarters under Ibadan North West Local Government area of Oyo State. The area lies between Latitude 70261 N and Longitude 30361 E *(Kayode et, al 2013)*. the climate is tropically dominated by rainfall pattern ranging between 1400mm – 1500mm the average temperature is about 31.2^0C and relative humidity is about 65%. The eco-climate of the area is rainfall with two distinct seasons which are dry season, (usually commencing from November to March and raining season from April to October). (FRIN Annual Meteorological Report, 2018)

The seed procured from moor- plantation, Ibadan, Oyo State were soaked in water for 5minutes with the water from borehole tap in the college. The tomato seeds were raised in germination box at the nursery for 2 weeks before transplanting into the polythene pots, the seedlings selected for transplanting were the most vigorous in the germination box. It was ensured that the seedlings had green leaves and intact roots with the balls of earth to avoid shock on getting to a new environment. Transplanting was done early in the morning. The fertilizer used in this research was N.P.K 15: 15: 15. The fertilizer was applied using the two methods of fertilizer application; the soil application, and foliar application. The fertilizer was applied at the rate of 0.125g, 0.25g and 0.5g with each treatment having four (4) replicates. The top soil used was sieved, weighed and transferred into the polythene pots; the weight of the soil used for this research was 5kg. The experimental design used for the experiment was a complete randomized design (CRD). It consists of seven (7) treatments 4 replicates making a total of 28 experimental units.

R = Replicate
T_0 = Control
T_1 = N.P.K 15:15:15 at 0.125g level of soil application
T_2 = N.P.K 15:15:15 at 0.25g level of soil application
T_3 = N.P.K 15:15:15 at 0.5g level of soil application
T_4 = N.P.K 15:15:15 at 0.125 level of foliar application
T_5 = N.P.K 15:15:15 at 0.25g level of foliar application
T_6 = N.P.K 15:15:15 at 0.5g level of foliar application

The parameters assessed are number of leaves which were manually counted and recorded, plant height which was measured from the soil level to the apex of the vine using measuring tape, number of branches, stem girth measured using manual vernier caliper at the base of the plant, time difference of flowering period, fruit yield are counted and weighed.

Result and Discussion

Table 1: Influence Of Fertilizer Application Methods On The Growth Parameters of Lycopersicon esculentum.

Treatments	Mean Height			Mean Stem Girth			Mean Number of Leaves			Mean Number of branches		
	Wk1	wk3	wk6	Wk1	wk3	wk6	Wk1	wk3	wk6	Wk3	wk5	wk6
Control	21.40	38.73	51.23	0.11	0.69	1.08	43.50	75.00	132.25	3.75	7.75	11.25
S.A 0.125g	24.18	37.78	56.23	0.17	0.60	1.51	30.25	79.75	133.25	4.50	8.50	11.75
S.A 0.25g	18.80	45.55	58.95	0.15	0.47	0.92	37.25	71.00	139.00	4.75	9.00	13.50
S.A 0.5g	20.35	42.08	55.68	0.12	0.67	1.52	28.75	87.75	133.75	5.25	8.75	13.00
F.A 0.125g	37.50	45.15	63.70	0.37	0.73	1.33	44.75	86.75	139.50	6.25	11.25	15.25
F.A 0.25g	20.35	44.48	66.53	0.22	0.83	1.74	35.75	94.25	141.25	6.75	11.50	15.50
F.A 0.5g	20.68	52.98	58.18	0.24	0.76	1.32	29.00	80.75	141.00	5.50	10.50	14.00

S.A- Soil application
F.A- Foliar application
CO- Control

The result from table 1 above shows that there is significant effect in the two methods of fertilizer application on height development of tomato. At week 1 (considering the impact of two methods of fertilizer application on the plant height in cm of tomato) the highest mean was observed with seedlings treated with 0.125g of foliar application (T_1) with mean value of 37.50cm, it is significantly different from all others while the lowest mean was observed from seedlings treated with 0.25g of soil application (T_2) with mean value of 18.80 cm. At week 3 the highest mean was observed from seedlings treated with 0.5g of foliar application (T_5) with mean value of 52.98cm, while the lowest mean was observed from seedlings treated with 0.125g of foliar application (T_1) with mean value of 37.78cm. At week 6 the highest mean was observed from seedlings treated with 0.25g of foliar application (T_5) with mean value of 66.53cm while the lowest mean was observed from seedlings raised with top soil only (T_0) with mean value of 51.23 cm.

At week 1 (considering the methods of fertilizer application on the stem girth in mm of tomato) the highest mean was observed from seedlings treated with 0.125g of foliar application (T_4) with mean value of 0.72mm, while the lowest mean was recorded for seedlings raised from top soil only (T_0) with mean value of 0.11mm. At week3 there was no significant difference across the treatments but the highest mean was recorded for seedlings treated with 0.25g of foliar application (T_5) with mean value of 0.83mm, while seedlings treated with 0.25g of soil application (T_2) had the lowest mean with mean value of 0.47 mm. At week 6 the highest mean was recorded for seedlings raised with 0.25g of foliar application (T_5) with mean value of 1.74mm, and is not significantly different from all others except T_2 (0.25g of foliar application) with a mean value of 0.92mm.

At week 1 (considering the methods of fertilizer application on the number of leaves of tomato) the highest number of leaves was observed from seedlings treated with 0.125g of foliar application (T_4) with mean value of 44.75, and was not significantly different from T0, T_2 and T_5, while the lowest was observed at T3 (0.5g of soil application) with mean value of 28.75. At week 2-6 it was observed that there was no significant difference across the treatments but the highest mean was recorded at T5 (0.25g of foliar application) with mean value of 94.25. At week 6 the highest mean was observed at T5 (0.25g of foliar application) with mean value of 141.25 and the lowest was observed at T0 (Control).

The result presented at table 1 shows that there was significant effect in the two methods of fertilizer application on the number of branches of tomato. At week 3 (considering the influence of two methods of fertilizer application on the number of branches of tomato) the highest number of branches was recorded at 0.25g of foliar application (T_5) having a mean value of 6.75 and it was not significantly different from T_3, T_4 and T_6 and the lowest was observed at the T_0 (control) having 3.75. At week 6, the highest mean was recorded at T5 (0.25g foliar application) and it was not significantly different from T_2, T_3, T_4 and T_6.

Table 2: Influence of Fertilizer Application Methods on Yield And Yield Components of Tomato

TREATMENT	DAYS TO FLOWERING	NUMBER OF FRUIT	WEIGHT OF FRUIT (KG)
T0 Control	66.50	4.50	38.89
S.A 0.125g	73.00	4.25	36.27
S.A 0.25g	73.50	4.25	35.97
S.A 0.5g	76.50	5.25	54.67
F.A 0.125g	64.00	7.50	68.56
F.A 0.25g	60.50	7.75	72.05
F.A 0.5g	69.50	7.00	71.32

The result presented in table 2 showed that there was significant impact in the two method of fertilizer application on the yield and yield components of tomato.
Four days to flowering, the least mean was recorded from T_5 (0.25 foliar application) having 60.50 and it was significantly different from all others except T_4 (0.125 foliar application) and the highest value was recorded at T3 (0.5g soil application) and it was significantly different from all others except T_4 and $T_{5.}$ For the number of fruit the highest mean was recorded at T5 (0.25 foliar application) having 7.75 and it was significantly different from T4, T5 and T6. For the weight of fruit, the highest mean was recorded at T5 (0.25 foliar application) having 7.75 and it is not significantly different from T4 and T6 while the lowest was observed at T2 (0.25 soil application) having 35.97 and it is not significantly different from T0 and T1.

Conclusion

From the study, it can be concluded that foliar method of fertilizer application was better when applying fertilizer to tomato plant because it gives highest mean value of plant height, number of leaves and stem girth respectively. Also application through foliar method produced highest mean value with respect to total yield of the plant. Therefore, the adaptation of foliar application of fertilizer is recommended for tomato farmers.

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Table 3: Influence of Two methods of Fertilizer Application on the Plant Height(cm) of TSomato

TREATMENT	WK1	WK2	WK3	WK4	WK5	WK6
T^0 Control	21.40^{bc}	30.55c	38.73^{b}	44.05^{c}	44.05^{c}	51.23^{b}
T1 (0.125g of soil application)_	24.18^{b}	37.10^{ab}	37.78^{b}	41.03^{b}	51.80^{abc}	56.23^{b}
T2 (0.25g of soil application)	18.80^{c}	38.60^{ab}	43.55^{ab}	48.38^{ab}	49.65^{abc}	58.95^{b}
T3 (0.5g of soil application)	20.35^{bc}	34.03^{b}	42.08^{ab}	47.13ab	47.80^{abc}	55.68^{b}
T4 (0.125g foliar application)	37.50^{a}	39.20^{a}	45.15^{ab}	49.85^{ab}	50.33^{abc}	63.70^{a}
T5 (0.25g of foliar application)	20.35^{bc}	30.60^{b}	44.48^{b}	47.30^{ab}	58.83a	66.53^{a}
T6 (0.5g of foliar application)	20.68^{bc}	30.40^{b}	52.98^{a}	56.80^{a}	57.25^{ab}	58.18^{b}

Note: Mean value with the same letter are not significantly different at 5% probability

Determining the optimal hierarchical clustering algorithm on diseases of cassava (*Manihot esculenta*)

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Abstract

This study compared four (4) agglomerative hierarchical clustering techniques namely Single-linkage, Complete-linkage, Average hierarchical and Ward's minimum variance on disease scores of twenty-four cassava genotypes to know which algorithm is most appropriate for classification. Data on the severity and incidence of cassava mosaic disease, cassava bacterial blight and cassava anthracnose disease were collected and analyzed. Proportion of Non-Overlap (APN), Average Distance (AD), Average Distance between Means (ADM) and Figure of Merits (FOM). were used to compare the performance of each clustering technique. The analysis was done using the open source R environment version 3.6.2 (OptCluster package). The result showed that Ward`s minimum variance was the best technique for the classification when the clustering algorithm gave three (3) clusters as the optimal number of clusters.

Keywords: Cluster analysis, Hierarchical, Clustering, Cassava Diseases, Classification

Introduction

Cluster analysis is a multivariate analysis technique that seeks to organize information about variables so that relatively homogenous "groups" or "clusters" can be formed. The clusters formed are internally homogenous and externally heterogeneous. That is, variability within a group is minimum and variability between groups is maximum (Samson & Mataimaki, 2017). Cornell, *et al*. (2007) used cluster analysis in clustering binary data from multimorbidity clusters, thereby clustering binary data from a large administrative medical database.

Determining the best clustering algorithm is a fundamental difficulty in unsupervised clustering analysis. The unsupervised technique of clustering organizes data by assigning similar observations together into the same group when little or no other information is known about the data. The algorithm of clustering can be broken down into three steps: pre-processing, cluster analysis and cluster validation (Handl et al., 2005). Cluster validation is very important in determining the optimal clustering algorithm given a data set.

Handl et al. (2005) has recommended multiple validation method for comparing different clustering algorithms. A high performing clustering algorithm is one that groups the data in such a way that it retains some internal quality control of the clusters and the groups should be stable (Sekula, 2015). Validation measures are the quantities that measures these qualities of clustering algorithm and provide scores for validity of the cluster technique. Various measures of clustering validations have been introduced in the literature, but our focus in this work is on four stability measures namely; Average Proportion of Non-Overlap (APN), Average Distance (AD), Average Distance between Means (ADM) and Figure of Merits (FOM).

Material and Methods

The data were obtained from the Genetic Resource Unit (GRU) of the National Root Crops Research Institute, Umudike Abia State, Nigeria. The data used comprised of incidence and severity of the diseases counted and scored were cassava mosaic disease (CMD), cassava black bacteria (CBB) and cassava anthracnose disease (CAD) of twenty-four newly developed cassava genotypes at nine months after planting.

The method of analysis used is the agglomerative hierarchical clustering technique where emphasis was on four methods of calculating distance; complete-linkage method, single-linkage method, ward`s minimum variance method and average method. The stability validation measures used were Average Proportion of Non-Overlap (APN), Average Distance (AD), Average Distance between Means (ADM) and Figure of Merits (FOM). APN measures range from zero to one and a better performing cluster is indicated by smaller values. The stability measures of AD, ADM and FOM range from zero to infinity and a better performing cluster is indicated by smaller values (Datta & Datta, 2003). The data were analysed using the open source R software environment version 3.6.2.

Single Linkage Method: This is the distance between the closest members of the two clusters. The distance $D(X,Y)$ between X and Y is described by the following expression

$D(X,Y) = \min_{x\in X, y\in Y} d(x,y)$ (Samson & Mataimaki, 2017).

Where, $d(x,y)$ is the distance between element $x \in X$ and $y \in Y$;

X and Y are two sets of clusters.

The Complete Linkage Method: This is the distance between the members that are farthest apart (most dissimilar). The distance $D(X,Y)$ between X and Y is described by the following expression

$D(X,Y) = \max_{x\in X, y\in Y} d(x,y)$ (Samson & Mataimaki, 2017).

Where, $d(x,y)$ is the distance between element $x \in X$ and $y \in Y$;

X and Y are two sets of clusters

The Average Linkage Method. This method involves looking at the distances between all pairs and averages all of these distances. This is also called UPGMA - Unweighted Pair Group Mean Averaging. The distance is computed as $d_{12} = \frac{1}{kl}\sum_{i=1}^{k}\sum_{j=1}^{l} d(X_i, Y_j)$

The Ward's Linkage Method. Here, distance is computer as $d(x_i, x_j) = \sum\sum(x_i - x_j)\,(x_i - x_j)^1$ so that, a distance matrix is form by $D = d_{ij}$ where x_i and x_j are the observation point of the variable x. at each step in the analysis, union of each possible pair of cluster is considered and two clusters whose fusion result in the minimum increase in the error sum of square are combined. The aim of ward's method is to minimize the total within group sum of squares (Samson & Mataimaki, 2017).

Results and Discussion

The optimal values of the stability validation measures for clustering algorithm are shown in Table 1. When the clustering algorithm was stopped at three clusters, Ward`s minimum variance method appears the top choice for the four stability measures considered (APN, AD, ADM and FOM). The analysis showed that the ward method is most suitable for the classification with the lowest APN value of 0.0111, AD value of 1.1353, ADM value of 0.1768 and FOM value of 0.6572. Average linkage performed worst with highest APN, AD, ADM and FOM values of 0.1364, 2.1793, 0.6807 and 0.8906, respectively. This result agrees with Laura and David (2009) that Ward`s method almost always performs having the highest mean Rand index but disagrees with that of Samson Agboola (2017) who reported single-linkage and complete linkage clustering as the best algorithm for disease classification.

Table 1: Testing of stability validation measures of four distance measuring methods in agglomerative hierarchical clustering technique analysis.

	Complete	**Single**	**Ward**	**Average**
APN	0.0263	0.0263	0.0111	0.1364
AD	1.6618	1.6696	1.1353	2.1793
ADM	0.3447	0.3369	0.1768	0.6807
FOM	0.8125	0.8217	0.6572	0.8906
Scores	**1.7445**	**0.7500**	**0.1534**	**0.5410**

Conclusion

This research work was aimed at using agglomerative hierarchical clustering for classification diseases of newly developed cassava genotypes. We applied four distancing techniques and the result showed that Ward method was the best technique.

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Studies on Fruit Characteristics and Seedlings Emergence among Some Accessions of *Dacryodes edulis* from Some Selected States of South Eastern Nigeria.

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Abstract: This work analyzed Studies on fruit Characteristics and Seedlings Emergence Among Some Accessions of *Dacryodes edulis* from Some Selected States of South Eastern Nigeria. Data obtained for this study were analyzed and mean separation was done using LSD .Fruit length varied from 4.46cm – 7.22cm . AC1 had the longest fruits , while AC2 had the lowest fruits (4.46cm), while fruit width varies from 6.54cm – 12.6cm. AC5 had the widest fruits , while AC2 had the narrower fruits .

Fruit weight, also varied from 15.78g – 45.2g/fruit with AC3 having the heaviest fruits (45.17g),while AC2 had the smallest fruit (15.78g). AC5 had the heaviest seeds (44.54g) and AC2 the least seed weight(15.78g) ,AC3 had the heaviest fruit pulp (32.78g) while AC2 had the least fruit pulp (8.87g) . Bigger pulp and fruit weight is of interest to farmers and consumers alike and therefore will be an important trait for selection. Depulping the fruits of *Dacryodes edulis* leads to about twice more seedling emerging at 3WAP than where the fruits are not depulped. AC2 depulped had significantly more seedling emerging while non-depulping AC3 and AC6 had the lowest seedling .

Key Words: Fruit characteristics, Seedling emergence, Depulping and Non Depulping.

Introduction

Dacryodes edulis (G. Don) H.J. Lam. is a traditionally important, indigenous fruit tree of West and Central Africa (Kengue, 2002). This wider range may result from anthropogenic transfer of planting material (Leakey *et al*., 2002). Nutritionally, *Dacryodes edulis* is the most commonly consumed and grown of the 19 fruit species of the genus *Dacryodes* (Burseraceae) found in the region. Two varieties of this species: *Dacryodes edulis* var. edulis (cultivated type) and *Dacryodes edulis* var. parvicarpa (wild type) have been identified by Okafor (1983) on the basis of their fruit size.

Fruits of *Dacryodes edulis,* which are commonly known as African pear, African plum, native pear, butterfruit, safou, 'Ube' (in southeast Nigeria) and 'Eleme' (in the southwest Nigeria) are very nutritious (Leakey, 1999). The fruits form an important part of the diet of people in West and Central Africa being rich in vitamins and containing 63.5% fat, 24.2% protein and 9.2% carbohydrate (Mbofung *et al*., 2002). The protein content of *Dacryodes* *edulis* is greater than that of maize (10%), rice (8%), sorghum (11%) or wheat (8–13%), but lower than that in peanut (48%) and soybeans (40%). The fruits are rich in minerals and have some medicinal properties. In addition to the use of safou fruits as a staple food, there is growing interest in preparing fruits into preserves like jams, jellies, and in the extraction of the oil for cooking or use in the margarine, soap and perfume industries (Sonwa *et al*., 2002). The kernels have been found suitable for use as animal feeds.

Dacryodes edulis trees are also important for the provision of shade. This medium sized tree is consequently commonly found in home gardens and in smallholder cocoa farms in Cameroon (Leakey and Tchoundjeu, 2001), while in Nigeria, trees are predominantly planted in the compound farm and in crop fields. The fruits, which ripen in the rainy season (May–November), are harvested when they change colour from whitish-green to pink to dark blue – purple - black. The fruits have an attractive, oily, slightly sour taste when cooked, but have a relatively short shelf-life when raw, although this can be prolonged by drying using traditional knowledge. In Cameroon, the fruit is typically roasted, but in Nigeria, the fruits are usually boiled in salted water. It is usually eaten with freshly roasted or boiled maize, cassava or plantain. Recent studies have examined opportunities to extend the shelf life of fruits (Kalenda *et al*., 2002), and to process the fruits into more durable products (Mbofung *et al.,* 2002).

The socio-economic importance of *Dacryodes edulis* has recently been documented (Schreckenberg *et al.*, 2002a). Trees are predominantly planted as shade trees in association with cocoa or coffee, where they are also a source of income, as their fruits are widely traded locally and regionally (Ndoye *et al.,* 1997) and even internationally

This therefore gave the impetus for this study and hence the objectives of this study are:

1. To understand the variation in fruit characteristics among *Dacryodes edulis* accessions.

2 . To determine the effect of fruit size, depulping and non-depulping on seedling emergence among the *Dacryodes edulis* accession.

Materials and Methods

Source of Material for *Dacryodes edulis*

Table 1: Accessions list showing place of collection, State, longitude and latitude

Accessions	Place of collection	State	longitude	Latitude
AC1	Ugwuana	Imo	$5^0 4^1$N	5^0 22E
AC2	Ahiaeke	Abia	7^0 32^1E	$5^0 29^1$ N
AC3	Egbelubi	Imo	$5^0 4^1$N	5^0 22E
AC4	Orlu	Imo	$5^0 7$ ^{1}N	$7^0 6^1$E
AC5	Ngwa	Abia	$5^0 25$ E	$6^0 14$ N
AC6	Okpala	Imo	$5^0 3^1$N	5^0 22E

Table 1 above shows the place of collection, State , longitude and latitude where *Dacryodes edulis* seeds were sourced from.

Experimental location

The study was carried out at the Eastern Research Station of Forestry Research Institute of Nigeria, Umuahia ,Abia State. Umuahia is located on low land rainforest zone of Nigeria, It lies between longtitude 7^0 32^1E and Latitude $5^0 29^1$ N, at 122 metres above sea level, with annual rainfall ranges of 180mm to 220mm. The air temperature varies from 22^0 to 32^0,while the relative humidity varies from 51% to 86% (Nwankwo *el at* .,2009)

Experiment 1: Fruit Characteristics Studies for *Dacryodes edulis*

(a) **Fruit length:** The Fruit length was obtained by measuring the length of the fruit with the aid of sowing thread and metric ruler.

(b) Fruit width: The width of the fruit was obtained by measuring the diameter of the fruit with the aid of sowing threat and metric ruler.

(c) Fruit weight: The fruit weight was determined with the aid of sensitive weighing balance.

(d) Pulp weight: The pulp weight was obtained with the aid of sensitive weighing balance after separating the pulp from the seeds.

(e) Seed weight: The seed weight was determined with the aid of sensitive weighing balance after separating seeds from the pulp.

Emergency and Seedling Growth of *Dacryodes edulis*

This study was carried out to investigate the effect of depulping and non-depulping on emergence and seedling growth of *Dacryodes edulis*. The experiment was carried out as a 2 x 6 factorial in a completely randomized design (CRD), replicated three (3) times. The factor A was the while factor B was *Dacryodes edulis* accessions.

Data Analysis

Data collected from fruit length, fruit width, fruit weight ,pulp weight and seed weight were subjected to analysis of variance (ANOVA) , using the GenStat Discovery Edition 3 (GenStat, 2007) and mean separation was done using LSD.

Results

Fruit Characteristics of Dacryodes edulis

Analyses of variance for all traits were highly significant (P< 0.001).

Fruit length varied from 4.46cm – 7.22cm . AC1 had the longest fruits , while AC2 had the lowest fruits (4.46cm), while fruit width varies from 6.54cm – 12.6cm. AC5 had the widest fruits , while AC2 had the narrower fruits .

Fruit weight, also varied from 15.78g – 45.2g/fruit with AC3 having the heaviest fruits (45.17g) ,while AC2 had the smallest fruit (15.78g). AC5 had the heaviest seeds (44.54g) and AC2 the least seed weight(15.78g) ,AC3 had the heaviest fruit pulp (32.78g) while AC2 had the least pulp (8.87g) . Bigger pulp and fruit weight is of interest to farmers and consumers alike and therefore will be an important trait for selection .

Table 2:Fruit Characteristics of some accessions of *Dacryodes edulis*

Accessions	Fruit width (cm)	Fruit length (cm)	Fruit weight (g)	Seed weight (g)	Pulp weight (g)
ACI	8.00	5.82	18.30	7.87	10.45
AC2	6.54	4.46	15.78	6.91	8.87
AC3	11.10	7.22	45.17	12.39	32.78
AC4	9.28	6.36	34.19	9.74	24.45
AC5	12.27	6.35	44.54	15.04	29.50
AC6	9.10	4.55	28.02	11.43	16.50
LSD0.05	0.7143***	0.3020***	2.331***	1.271***	2.044***

ns = not significant,* = $P<0.05$,** = $P<0.01$,*** = $P<0.001$

Experiment 2: Seedling emergence studies in *Dacryodes edulis.*

Effects of depulping and non-depulping on seedling emergence of *Dacryodes edulis.*

Depulping and non- depulping had no significant effect on seedling emergence of *Dacryodes edulis* accessions on 2weeks after planting 2(WAP). The accessions effects and interaction between accession an depulping and non-depulping was not significant($P>0.005$). At 3 WAP, depulping an d non-depulping and the interaction between accession and depulping and non – depulping had significant effects on seedling emergence ($P<0.05$) while the accessions effect was not significant .

Depulping the fruits of *Dacryodes edulis* leads to about twice more seedling emerging at 3WAP than where the fruits are not depulped. AC2 depulped had significantly more seedling emerging while non-depulping AC3 and AC6 had the lowest seedling emergence (Table 3).

Table 3: Effects of depulping and non-depulping on seedling emergence of *Dacryodes Edulis*.

	2WAP Treatment			3WAP Treatment		
Accesions	Depulping	Non- depulping	Mean	Depulping	Non- depulping	mean
AC1	10.0	0.0	5.0	26.7	16.7	21.7
AC2	0.0	3.3	1.7	30.0	23.3	26.7
AC3	0.0	3.3	1.7	20.0	13.3	21.6
AC4	10.0	0.0	5.0	20.0	20.0	20.0
AC5	6.7	6.7	6.7	23.3	16.7	20.0
AC6	0.0	0.0	0.0	26.7	13.3	20.0
Mean	4.4	2.2		26.12	17.22	
LSD 0.05 treatment=4.78ns			4.93*			
accession=8.27ns			8.53ns			
treatment X accession=11.70ns			12.06*			

ns = not significant,* = P<0.05,** = P<0.01,*** = P <0.001

Discussion

This study was done to provide quantitative data on the variability of *Dacryodes edulis* fruit traits. This study provides a firm base for domestication of the species. The high level of intraspecific variability is typical of an outbreeding tree species, and suggests that there is considerable opportunity for selection of elite trees for multiplication as cultivars (Leakey *et al.,* 2002). The continuous variation in the fruit size (length, width) as well as the fruit weight and pulp weight in this study and similar study in Nigeria (Anegbeh *et al.,*2003), questions the validity of the suggestion that there are discrete varieties of *Dacryodes edulis* (Okafor 1980, 1983; Okorie 2001).

Seed size is an important parameter for plant growth and yield. Seed size affected the proportion of germination,Large seeds had an advantage of seedling establishment in low soil moisture condition due to larger root system (Leishman and Westoby, 1994). Based on the result obtained from this study, it was observed that AC2 depulped performs better in terms of early germination and seedling growth while non-depulping AC3 and AC6 had the lowest seedling emergence .

Conclusion

In conclusion, this study describes a methodology for describing and selecting superior phenotypes for cultivar development. The fruits of *Dacryodes edulis* have been found to have a wide range of variation in commercially important characteristics, which could be subjected to genetic selection.

Similarly, this study has established that the germination and seedling growth of *Dacryodes edulis* are significantly affected by seed size. Pending further investigation, it is concluded that seed size have influence on the seed germination and seedling growth of species in the nursery.

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Yield response of Sweet Potato (*Ipomea batatas* (L.) Lam) to different tillage practices in Ishiagu, Southeastern Nigeria

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Abstract

A field experiment was conducted at the research site of Federal College of Agriculture, Ishiagu during the 2019 rain fed cropping season to determine the 'yield response of sweet potato (*Ipomea batatas* (L.) Lam) to different tillage practices in Ishiagu, Southeast Nigeria.' This is aimed at getting the tillage practice that will give the highest yield of sweet potato all things being equal. A randomized complete block design (RCBD) was used with four (4) treatment and three (3) replications. The treatments are: T1- bed, T2- ridge, T3 - mound and T4 - zero tillage. Agronomic parameters were taken and statistically analyzed. The results of the experiment showed that there were significant differences between treatments on the agronomic parameters. Specifically, the Bed and Mounds (Heap) tillage practices showed the best performance on the yield variables than the other tillage practices. Based on the results of the experiment, it was recommended that Bed and Mounds (Heap) tillage practices should be adopted by farmers in the production of sweet potato.

Keywords: Tillage Practices, Growth, Yield, Sweet Potato

Introduction

In Nigeria, sweet potato is produced exclusively by peasant farmers with its attendant poor yield (Udealor *et al*., 2006; Ugonna *et al*., 2013; Dabels and Kwis, 2013). According to them, factors responsible for farmer`s low yields among others are: pest infestation which reduces the market value, inappropriate tillage practices, lack of knowledge on the appropriate and rate of fertilizer needed by the crop, lack of access to and knowledge of improved varieties *et cetera*. Appropriate tillage systems improve aeration, water transmission, root growth and nutrient uptake (Ojeniyi, 1992). Tillage is the post- clearing physical manipulation of soil aimed at modifying its structure (Osunbitan *et al.,* 2005; Ojeniyi, 1992) for crop productivity. Several literatures for instance are available on the effects of tillage on grain crops (Ogban and Babalola, 2009 and 2002; Ogunremi *et al*., 1986) but information on the influence of tillage practices on sweet potato is very scarce, especially in the humid tropics (Agbede and Adekiya, 2009). Therefore, the present study seeks to fill that gap by investigating the effect of different tillage practices on the growth and yield of sweet potato.

Materials and Method

Experimental Site

The Experiment was conducted at the research and teaching farm at Federal College of Agriculture, Ishiagu during the 2019 cropping season. Ishiagu is located at longitude 07^0 46'E and latitude 05^0 45'N with a mean annual temperature of 29^0 C and mean annual rainfall of 1350mm (Nwite *et al.*, 2008). Ishiagu is relatively a primary economic production community with extractive mining activities and farming as the major occupation. Though other forms of occupation exist. Such include teaching profession within the primary, secondary and tertiary institutions in the community and civil servant that work in the local government. Within the community farming practices, is the production of sweet potato either as sole crop or as an intercrop of maize/okra (Anyata, 2001).

Experimental Design Layout and Treatment

Experimental Design

The experimental design was a randomized complete block design (RCBD) with five (4) treatments to be replicated three (3) times. The treatments include: T_1 - Ridge, T_2- Heap, T_3 - Bed andT_4- zero tillage (undisturbed soil).

Agronomic Practices

The experimental site was cleared manually of vegetation so as not to disturb the soil. Traditional hoe was used for the tillage practices on the site. Poultry droppings were used as organic basal application for soil amendment at the rate of 10 tons per hectare (Mac Robert *et al*., 2007). Tillage and planting activities were done within 2 m × 2 m of the experimental plots in a randomized manner (to give a plot area of $4m^2$ each) with spacing between plots at 1m spacing and 0.5m spacing between the blocks which gives a total of twelve (12) plots. Vines of improved sweet potato TIS/8164 (red flesh) were collected from National Root Crops Research Institute, Umudike, Abia State, Nigeria. The sweet potato vines were cut into 30 cm long with about five (5) nodes and were planted at a spacing of 50 cm x 50 cm. This gave a plant population of 16 plants per plot of 2 m × 2 m. Weeding was carried out at 3 and 6 weeks after planting before the vines and leaves cover the ground.

Growth and yield parameters measured include:

Establishment Counts

This was determined by the ratio of established plants per plot expressed in percentage.

Number of leaves per Plant

The numbers of leaves of each sample of plant were counted at 3, 5 and 7 WAP.

Main Vine Length (cm) Per Plant

This was measured using a meter rule to determine the length from the ground to the apex of the main vine at 3, 5 and 7 WAP.

Yield (kg) was taken from all the tagged plots at harvest by weighing the harvested sweet potato tuber per plot using the weighing scale. The value obtained was converted to tons per hectare.

Data Analysis

The data collected was subjected to statistical analysis using analysis of variance (ANOVA) according to the procedure for randomized complete block design (RCBD) as described by Steel and Torrie (1980). The treatment means were separated and compared using fisher's least significant difference (F-LSD) at 5% probability level.

Results and Discussion

Establishment count of Sweet Potato after planting

Table 1 shows the establishment count of Sweet Potato after planting. The table showed that Treatment 2(Ridge) and treatment 3 (Heap) gave the highest establishment count of Sweet Potato after planting with a value of 15.00 each. This was followed by treatment 1 (Bed)with a value of 9.33. Treatment 4(Zero tillage) recorded the least establishment count with a value of 9.00 of Sweet Potato. The result of the analysis of variance (ANOVA) and fisher's least significant difference (F-LSD) at 5% probability level indicated that there were significant differences among the treatments.

Table 1: Number of establishment count of Sweet Potato after planting

Treatment	Establishment Count
T1	9.33
T2	15.00
T3	15.00
T4	9.00
LSD	2.12***

Number of Leaves of Sweet Potato weeks after planting

Table 2 shows the number of leaves of Sweet Potato weeks after planting (WAP). The table showed that treatment 3 (Heap) produced the highest number of leaves of Sweet Potato at 3, 5, 6 and 7 weeks after planting (WAP). This was followed by treatment 1 (Bed) at weeks 3, 6 and 7 but produced the highest number of leaves of Sweet Potato at 4 weeks after planting (WAP). The least number of leaves of Sweet Potato was recorded in treatment 4 (Zero tillage) across the treatment. The result of the analysis of variance (ANOVA) and fisher's least significant difference (F-LSD) at 5% probability level indicated that there were significant differences among the treatments.

Table 2: Number of Leaves of Sweet Potato weeks after planting

Treatment	3WAP	4WAP	5WAP	6WAP	7WAP
T_1	25.00	31.58	34.90	45.75	55.67
T_2	23.92	30.33	37.25	44.42	50.17
T_3	26.42	30.33	41.00	48.08	55.67
T_4	13.92	21.25	30.50	37.92	46.08
LSD	1.25***	2.12***	2.23***	1.52***	2.34***

Vine Length of Sweet Potato weeks after planting

Table 3 above shows the vine length of Sweet Potato weeks after planting (WAP). The table showed that treatment 1 (Bed) produced the highest vine length of Sweet Potato at 3, 4 and 5 weeks after planting (WAP). This was followed by treatment 2 (Ridge) at weeks 3, 4and 5. Treatment 3(Heap) recorded the highest vine length of Sweet Potato at 6 and 7 weeks after planting (WAP) and was followed by treatment with vine length values of 68.00 cm and 77.00 cm. The least vine length of Sweet Potato was recorded by treatment 4 (Zero tillage) across the weeks after planting (WAP) with values of 25.50 cm, 33.67 cm, 44.85 cm, 50.50 cm and 59.67 cm. The result of the analysis of variance (ANOVA) and fisher's least significant difference (F-LSD) at 5% probability level indicated that there were significant differences among the treatments.

Table 3: Vine Length of Sweet Potato weeks after planting

Treatment	3WAP	4WAP	5WAP	6WAP	7WAP
T_1	43.92	52.33	59.50	68.00	77.00
T_2	40.56	49.74	57.34	65.59	74.92
T_3	37.19	48.33	56.98	69.69	81.96
T_4	25.50	33.67	44.85	50.50	59.67
LSD	1.32***	2.22***	1.48***	1.22***	3.12***

Weight of Sweet Potato after harvest

Table 4 above shows the weight of Sweet Potato after harvesting. The table showed that treatment 1 (Bed) produced the highest weight of Sweet Potato after harvesting with a value of 2.30kg. This was followed by treatment 3 (Heap) with a value of 1.20kg. Treatment 2 (Ridge) ranked third with a value of 1.07 kg of Sweet Potato. The least weight of Sweet Potato was recorded by treatment 4 (Zero tillage) after harvest with value of 0.87. The result of analysis of variance (ANOVA) and fisher's least significant difference (F-LSD) at 5% probability level indicated that there were significant differences among the treatments.

Table 4: weight of Sweet Potato after harvest

Treatment	Weight
T_1	2.30
T_2	1.07
T_3	1.20
T_4	0.87
LSD	1.53

Discussion

The results of the agronomic parameters (such as the: establishment count, number of leaves, vine length (cm) and yield (kg) of Sweet Potato) from the study followed a similar productivity trend of tilled treatments having improved agronomic parameters than the zero tillage. These results corroborated similar study by Hoogmoed, (2009), Hulugalle *et al*., (2005) wherein they averred that tillage practices influences soil porosity which invariably leads to the change in soil aeration and or air transfer and water soluble into the soil which affect crop yield. Tillage operation also affect bulk density, penetration resistance, changes the specific gravity of soil, apparent tolerance and thermal conductivity, moisture content, nutrient availability and uptake which invariably impact positively on the rooting efficiency of root and tuber crops and ultimate yield (Al-Kaisi and Licht, 2004) unlike when the soil is on zero tillage where there were decrease in soil porosity with its attendant negative effect on crops yield because such soil nutrients are held immobile and unavailable for crop uptake.

Conclusion and Recommendation

Tillage practice is very essential for plant growth and optimum yield, as it determines the availability of soil nutrients for crop uptake. The yield components of sweet potato were significantly increased by the different tillage practices. The study showed that all the tilled plots gave higher growth and yield performance than the zero tillage.

However, based on the performance of the crop, Bed and Mounds (Heap) tillage practices should be adopted by farmers in the productions of sweet potato because they ranked first and second in crop yield followed in succession by the ridged plots. For further studies, the marginal costs and benefits of tillage should be factored into the analysis.

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The effects of Potassium fertilizer on potassium uptake and performance of maize on soils of Osun State, Southwestern Nigeria

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Abstract

Potassium (K) is abundant in most soils, but a major amount of this soil K is unavailable to plants. A trial was carried out to evaluate the effects of K fertilizer on K uptake and performance of maize (Zea mays) on Soils of Osun State. The three treatments were K, ok and control using 100 g NPK, 100 g NP fertilizers and the control (without fertilizer application). These treatments where applied in a complete randomized design (CRD) and was replicated three time in the green house. Six composite soil samples were collected from 0 – 30 cm depth from Ife, Modakeke, Ife-Ijesha, Edun-Abon, Ede and Ibodi communities The result indicated that the levels of K uptake by the maize plant in response to K fertilizer application was inversely proportional to the level of K fertilizer applied to the soils. Generally, there was response to K fertilizer application.

Keywords: K fertilizer, Maize. Soils. Performance, Uptake

Introduction

Potassium is one of the essential elements for plant growth and development (Lakrudzala, 2013). It is one of the primary nutrients in addition to Nitrogen and phosphorus which are required by plant in large amounts. Owing to the importance of K in plant nutrition and growth, it has been studied extensively (Ndukwe et al., 2012). K plays significant roles in the physiological processes of protein formation, transportation of water, nutrients and carbohydrates, photosynthesis, N utilization, stimulation of early growth and in resistance of plants to insects and diseases. (Lakrudzala, 2013). Consequently, it promotes the transportation of assimilates, control of stomata opening, enzyme activation in plants especially those responsible for energy transfer and formation of sugars, starch and protein as well as promotion of microbial activities (Al-Zubaidi et al, 2008). Potassium fixation is a widespread phenomenon in most soil and accounts significantly for the availability of applied K to plants. Although this phenomenon is a direct consequence of the presence of 2:1 clay minerals, recent studies have shown that the phenomenon also occurs in tropical soils with insignificant content of 2:1 silicate clays. Soil K and availability could be altered due to changes in soil management and land use practice. For instance, it has be reported that variation in available K distribution have been indicated in soils of varying land use systems (Ayele, 2013). Also, the knowledge of potassium status of soils provides useful information for appropriate K fertilizer management. It has been observed that some soils that test high in K may respond to K fertilization contrary to expectation. This is an indication that there are other forms of K contributing K needs of crops than the exchangeable K. Non-exchangeable K has been shown to also contribute significantly to plant K uptake. This has been ascribed to the fixed K. Also, there is little information on the availability of K to growing plants in the soils .Therefore, this study investigated the effects of K fertilizer on K uptake and performance of maize on soils of Osun State.

Materials and Method

Four cropping periods trial was carried out in the green house to evaluate the effects of K fertilizer on K uptake and performance of maize *(Zea mays L. Var.hybrid super oba ll)* on soils of Osun State. The experimental design was a complete randomized design (CRD) with 3 replications. Three treatments namely:*K, o K and control using: 100g NPK fertilizer, 100g NP fertilizer and control without fertilizer application were applied in a bucket contain of 2kg soil.* Six composite soil samples were collected from 0 – 30 cm depth from Ife, Modakeke, Ife-Ijesha, Edun-Abon, Ede and Ibodi communities. Soil samples were collected based on the land use of the areas. The fallow practices in the area as in other parts of the tropics are the traditional shifting cultivation and their related bush fallow rotations (slash and burn agriculture). Hence, soil samples were collected from locations were fertilizer have not been applied. . Each soil sample was replicated 3 times. Before planting, the soils were treated with (k) and (o k) solutions and control without fertilizer. The K solution contained N, P, and K while the o K contained N & P no K as NaN03 Na_2 HPO4.12$H_2$0 and KC were mixed with the Soil before planting. Each treatment was replicated 3 times giving a total of 9 bucket or plots/sample and 56 bucket or plots/ State. All the soil samples were air dried, crushed and sieved through a 2 mm mesh and analysis were done according to the Tropical Soil Biology and Fertility (TSBF) programme handbook of method as described by Anderson and Ingram (1989). Exchangeable K in soil was determined by using neutral Ammonium acetate (IN NH_4OA_C) solution as extractant, and subjecting the extract to flame analyser. Then the exchangeable K in the filtrate was determined with the flame photometer (Black1965). IN HNO3 was used to determine the fixed K in the soil samples. The total K was extracted by 5ml of HF and 0.5ml of HC104. The extracted K was determined with flame photometer. At planting 75 percent of the field moisture capacity (FMC) was maintained by adding water to buckets till harvest to maintain the quantity initially added. 7 maize seeds were planted in each bucket and were later thinned down to 5 and 3 plants were harvested/plot. The plant dry matter yield were collected and weighed. Harvesting of the maize seedlings was carried out four weeks after sprouting. Watering was discontinued two days before harvesting. All data collected were subjected to statistical analysis.

Result and Discussion

Table 1 showed soil K status of the soils before planting, Total K content of the soil ranges from 5.10 – 51.16 *cmol* kg^{-1}. This is low relative to values of 66.61 – 113 *cmol* kg^{-1} reported by Ajiboye et al. (2018) in soils of Southwestern Nigeria. The fixed K of the soils varied from 0.24 -1.46 cmol kg^{-1} for Ife and Modakeke soil samples. This range is within the range of (1.0 - 1.45) *cmol* kg^{-1} reported for Southweastern Nigeria. The exchangeable K of the soils were within range according to Enwezor, (1999) who reported critical exchengable value of 0.2 *cmol kg*$^{-1}$ and varied from 0.35*cmol kg*$^{-1}$ for Ife and 0.61 for Modakeke soil samples. It is interesting to note that Ibodi and Ede soils had comparable levels of fixed and exchangeable K but differed in the amount of total K. Generally, all the studied area of the soils of Osun State were low in K hence, the soils are expected to respond positively to K fertilization. Reports of K deficiency in Southwest Nigeria soils have been reported by Adetunji and Adepetu (1993).

Average plant dry matter yield for both the three treatments are shown in Table 2. Generally, there was significant difference ($p < 0.05$) among the treatments. Decrease in yield as the time of cropping increased was observed among all the soil samples and all the treatments. For o K treatment, the dry matter yield of the first cropping was the highest (2.00g) while the yield of the fourth cropping was the lowest with a mean weight of 0.65g. The same trend occurred in the yield of the cropping for all the K and the control treatments with highest mean value of 2.96 and 1.94g and lowest mean value of 0.95g and 0.69g respectively. This could be due to the nutrient uptake by the plants that led to decrease in nutrient content in the soil as cropping sequence increases. The yield obtained from the K treatment was generally higher than the yield obtained from o K and control treatments. This suggests that there was an inadequate amount of available K in the soil and hence a high response to fertilizer application in the K treatment. This agrees with T.P Akonde et al. (1995) who reported maize significant response to K fertilization.

As shown in Table 3, the average K content of maize tissue (%) decreased from the first to the fourth cropping. However, the amount in the K treatment was higher than in the o K and control treatments. This explains why K deficiency showed up in some of the o K treatment very quickly. For instance, the mean K content of the first cropping o K treatment was 2.00%, control was 0.13% while that of the K pots was 4.29%. This marked difference confirmed the earlier suggestion that the o K treatment contained inadequate amount of K. it also confirmed the high response to K fertilizer applied in the K treatment. Gradual decrease was also observed in the K content in o K treatment and control but in the K treatment the decrease in K content was very slight from the first cropping sequence to the third cropping. This is due to the fact that there was still a good amount of the added K fertilizer. However, the fourth cropping of the K treatment showed a pronounced decline in percent K content in tissue. This is attributed to continuous cropping due to K fertilizer application in the soil. In many cases in the soil, it may be the first cropping after fallow that will enjoy luxury consumption of K and the following crops will suffer as a result of insufficient amount of K in the soil (Ohio, 2016).

Table 4 showed the average K uptake by maize plants. In the K treatment, K uptake was highest for the first cropping sequence, it reduced gradually in the second and third cropping sequences but dropped sharply in the fourth cropping sequence. For all the soil samples and in all the four successive cropping, the K uptake was higher in K treatment than in o K and control treatments with mean K treatment value of 91.12, 72.12, 51.2 and 9.55 mgk respectively when compared with the o K and control treatments with mean values of 35.5.

15.5, 12.75 and 1.13mgk and 20.1, 13.50, 10.87 and 2.00mgk respectively. This result indicates that at the fourth cropping sequence the soil K available to the crop had become very low. The wide difference between K uptake in o K, control treatments and K treatment shows that K fertilizer application markedly increased the K supply to the plant from soil which agrees with what Ohio, (2016) reported. Also the K uptake by the maize plants seems to reflect the level of soil available K much better than dry matter yield or K concentration in the crop tissue.

Conclusion

Generally, there was insufficient available K in the soils of Osun State of Southwestern Nigeria. There were significant response to K fertilization in the study area. Result of the study indicates that under intensive cultivation, soils of Osun State of Southwestern Nigeria needs K fertilizer for optimum maize performance.

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Table 1: K Status of the soils studied

Soil location No	Soil	S	Exch. K(*cmol kg*$^{-1}$)	FixedK(*cmolkg*^{11})	TotalK (*cmol kg*$^{-1}$)
1	Ife		0.35	0.24	40.92
2	Modakeke		0.61	1.46	53.07
3	Ife-Ijesha		0.56	0.74	47.96
4	Ibodi		0.45	0.31	38.37
5	Edun-Abon		0.46	0.87	51.16
6	Ede		0,45	0.31	5.10

Table 2: Average Dry Matter Yield (g/pot of 2 plants).

Soil Name	-K Pots Cropping					+ Pots Cropping					Control				
	1st	2nd	3rd	4th	Mean.	1st	2nd	3r	4th	Mean	1st	**2nd**	**3rd**	4th	Mean
Ife	1.10	1.60	0.82	0.66	1.05	1.60	2.87	1.18	0.73	1.60	2.15	0.54	0.78	1.14	0.77
Modakeke	1.80	1.95	0.94	0.70	1.35	3.60	1.90	0.90	0.89	1.82	2.27	1.39	1.09	0.33	1.27
Ise-Ijesha	2.82	1.53	1.34	0.71	1.60	3.60	2.27	1.45	1.08	2.10	3.24	0.15	1.45	0.58	1.36
Ibodi	1.60	1.80	1.09	0.61	1.28	2.89	2.50	1.32	0.93	1.91	1.78	0.91	0.14	1.42	1.06
Edun-Abon	2.19	1.95	1.22	0.62	1.50	3.24	1.47	1.47	0.89	1.94	1.18	1.89	1.20	0.18	1.11
Ede	2.27	1.82	0.68	0.62	1.35	2.82	1.23	1.03	1.19	1.57	1.03	1.68	0.18	0.46	0.84
Mean	2.00	1.18	1.00	0.65		2.96	2.15	1.23	0.95		1.94	0.92	0.81	0.69	
LSD (0.05%)	0.4	0.11	0.13	0.21		0.6	0.7	0.32	0.22		0.22	0.22	0.31	0.16	

Table 3: Potassium Concentration in Tissue (%)

Soil Name	-K Pots Cropping					+ Pots Cropping					Control				
	1st	2nd	3rd	4th	Mean	1st	2nd	3rd	4th	Mean.	1st	2nd	3rd	4th	Mean
Ife	1.17	0.67	0.38	0.14	0.59	3.73	3.03	3.06	0.80	2.66	0.24	1.10	0.24	0.16	0.12
Modakeke	2.30	1.13	0.85	0.17	1.11	5.04	2.94	2.96	0.96	2.97	0.18	1.36	1.50	0.08	0.78
Ise-Ijesha	2.68	2.25	0.85	0.21	1.50	3.81	3.14	2.69	1.08	2.68	0.16	1.74	1.21	0.16	0.81
Ibodi	2.14	1.17	0.31	0.15	0.94	3.88	4.42	3.35	1.01	3.16	0.15	1.48	0.10	0.13	0.47
dun-Abon	1.83	1.96	0.79	0.20	1.20	4.40	3.50	3.10	1.09	3.02	1.10	1.17	1.82	0.17	1.07
Ede	1.89	1.48	0.46	0.17	1.00	4.90	2.60	3.44	0.98	2.98	1.85	1.74	1.12	0.10	1.20
Mean	2.00	1.44	0.61	0.17		4.29	3.27	3.10	1.50		1.12	1.10	0.48	0.12	
LSD (0.05%)	0.2	0.32	0.16	0.04		0.25	0.2	0.6	0.8		0.13	0.10	0.13	0.07	

Table: 4 Potassium Uptake (mgk/Pot of 2 Plants)

-K Pots Cropping					+ Pots Cropping					Control				
1st	2nd	3rd	4th	Mean	1st	2nd	3rd	4th	Mean	1st	2nd	3rd	4th	Mean
18.7	5.5	4.1	0.9	7.3	87.0	44.0	49.0	6.4	46.6	22.1	3.4	7.5	0.2	4.7
44.9	10.6	15.4	1.2	18.0	106.5	55.8	45.4	8.5	54.1	17.1	26.1	16.5	0.1	9.9
41.0	30.2	24.1	1.5	24.2	96.8	71.2	55.3	11.7	58.7	14.0	20.0	09.2	0.2	7.2
38.4	12.7	5.0	0.9	14.3	96.9	111.0	51.2	9.4	67.1	12.2	11.1	13.2	0.1	6.4
35.8	23.9	17.3	1.3	19.6	100.6	75.3	64.6	9.7	67.1	39.4	12.0	11.1	0.8	10.6
34.3	10.1	10.4	1.0	14.0	96.9	32.0	50.4	11.6	47.8	14.3	10.2	12.3	10.2	7.8
35.5	15.5	12.72	1.13		91.12	72.12	51.2	9.55		20.1	13.50	10.87	2.00	
0.8	3.1	2.5	0.01		3.6	12.00	27.8	2.9		3.1	3.8	3.5	0.20	

Effect of Cow Dung Manure on the Performance of Sweet basil (*Ocimum basilicum L*) in Jalingo, Nigeria

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Abstract

A Field Experiment was conducted in 2018 and 2019 cropping seasons at the Teaching and Research Farm, Taraba State College of Agriculture, Jalingo to evaluate the effect of Cow dung manure on agronomic parameters of sweet Basil. The treatments evaluated were cow dung manure at 0, 3.0, 6.0, and 9.0 t/ha. The treatments were replicated three times and arranged in a randomized complete block design (RCBD). Data was subjected to two way analysis of Variance (ANOVA) and differences in treatment means were determined at p<0.05. Results indicated that the best treatment was obtained at 9.0 t/ha of Cow dung manure. Basil plants in this treatment were tallest (48.7cm), highest number of primary branches (8.7), secondary branches (78), longest leaves (10.9cm), widest leaves (6.0cm), highest fresh leaves (274.0 g), heaviest dry leaves 72.5 g), highest fresh herbage yield (13.5 t/ha) and highest dry herbage yield (2.5 t/ha) in 2018, While in 2019 it was 49.2cm 8.9, 79.2 11.2cm, 6.5cm, 276.3 g, 72.8 g, 13.9 t/ha and 2.9 t/ha respectively.This performance trend indicates that the best agronomic parameters could be obtained for Basil plants by applying 9.0 t cow dung manure/ha in the study area.

Keywords: Basil; Cow dung manure; Jalingo; Nigeria; Performanc

Introduction

Sweet Basil (*Ocimumbasilicum L.*) is an annual herbaceous aromatic spice and medicinal plant belonging to the family Lamiaceae (Abeway*et al.,* 2018). The genus of *Ocimum*, of the family *Lamiaceae*(Labiate) includes 60 species with numerous varieties (Khalid *et al.*, 2006). Basil consists of more than 150 species distributed in the tropics and sub tropics of the world. The most widely cultivated species in the world are *O. basilicum., O. gratissimum, O. xcitriodorum, O. americanum, O. minimo and O. tenuiflorum.* The leaves of *Ocimum basilicum.* They are grown widely throughout temperate and tropical regions of the world for their essential oil product (Abeway *et al.,* 2018). Sweet basil (*O. basilicum L.*) is most widely used due to its high economical value, popularity and demands among the economically important species of *Basil* (Garjila, 2016).

The commercial product obtained from basil are fresh and dry herbs used as seasoning, while its extracts are essential oil are exploited in the food and perfume industries (Katarzyna*et al.,* 2019). Basil leaves are widely used for flavouring purposes in soups, meat pies, fish dishes, certain cheeses, tomato salads, cooked cucumber dishes, cooked peas, squash and string beans as well as vinegars and oils (Pushpangadan and George, 2012; Garjila, 2016). Dried ground basil is also used to flavour butter and is sometime sprinkled in tea or coffee to add flavour. The herb complements meat, vegetables, cheese and egg dishes (Etana, 2007; Mesfin *et al.,* 2009).Organic products, based on philosophical preference and conviction or in response to an increasing market opportunity, exclude or prohibit the use of conventional crop inputs common to modern farming. (Khalid *et al.,* 2006). Research and improvement efforts are therefore needed to explore the potential of sweet basil for enhanced productivity, crop diversification and a better nutritional environment. There is dearth of research studies and necessary information for crop improvement on sweet basil. Therefore, the objective of this study was access and determine the use of organic manure as a substitute to inorganic fertilizer which is not readily available and not cost effective, and to determine the quantity of organic manure (cow dung) that will give optimum yield in the study area.

Materials and Methods

The field experiments was carried out in 2018 and 2019 cropping seasons at the Teaching and Research Farm of the Crop Science Department, Taraba State College of Agriculture, Jalingo (Latitude 8^0 50’N and Longitude 11^0 50’E). The treatments applied to *O. basilicum* were 0, 3.0, 6.0, and 9.0 t/ha cow dung with the zero manure as control.. The experiment was laid out in a randomized complete block design (RCBD) with each treatment replicated three times. The Cow dung manure was sourced from the College Dairy Farm was well composted under shade for four weeks prior to transplanting of basil plant seedlings. Before applying the manure, composite soil samples were taken from the gross plot area for routine analysis in the laboratory using the procedure by Black (1965). The nutrient contents of the manure were also analyzed.Seeds of *Ocimum basilicum L.* were sourced from farmers seed banks in Jalingo and raised in nursery before transplanting to the field. The seedlings were transported to the main prepared field (unit plots) measuring 2m × 3m ($6m^2$) one plant per stand spaced 20cm × 50cm apart, at four weeks old in the nursery. Manual weeding was carried out at three and six weeks after transplanting. Harvesting was carried out by cutting the plant 5cm above the ground with sharp knife eight weeks after transplanting. Data collected on five tagged plants used for sampling were plant height, primary and secondary branches, leaf length and width, fresh and dry leaf weight of plants, fresh and dry herbage yield t/ha. Data collected for parameters studied were subjected to analysis of variance (ANOVA) for RCBD using GENSTAT (2011) and mean separation was carried out using the least significant difference (LSD) at 5% probability level.

Results and Discussion

Soil and Cow dung manure analysis

The result revealed that, the soils were sandy loam with slightly acidity levels in both cropping seasons and lower nitrogen (N) than sodium (Na).The Cow dung analyzed showed that it contained higher phosphorus followed by K and Na while the N content was low.

Growth and Yield parameters

The influence of cow dung manure on plant height of sweet basil in 2018 and 2019 are shown in table 1. The result showed that there were significant differences ($p<0.05$) in plant height throughout the sampling period of 4 and 6 weeks after transplanting (WAT) in both cropping seasons. The application of 9.0 t/ha of cow dung manure in both cropping seasons produced taller plants than the other levels with average heights of 41.3 and 48.8cm in 2018 at 4 and 6 WAT; 42.0 and 49.2cm in 2019 at 4 and 6 WAT. The control produced shorter plants in both cropping seasons at 4 and 6 WAT respectively. The increase in plant height is attributed to increase in the fertility of the soil as a result of the application of cow dung manure which supplied phosphorus, nitrogen, potasium and other chemicals which enhanced the growth of the plant. This result is in agreement with Kumara *et al.,* (2007) and Ani *et al.* (2019) who reported increase in plant height as a result of organic manure application.

Application of cow dung manure significantly ($p<0.05$) influenced the production of branches by increasing the number of primary and secondary branches in both cropping seasons and the leaf index. The application of 9.0 t/ha of cow dung manure produced the highest number of primary and secondary branches (8.u and 78.7 in 2018 and 8.9 and 79.2 in 2019). Longest leaves (10.9cm and 11.2cm) and widest leaves (6.0cm and 6.5cm) were also obtained in plants treated with 9.0 t/ha of cow dung manure in 2018 and 2019 cropping seasons respectively (Table 1). This result is similar to the findings of Ani *et al.* (2019) who reported a similar trend.

The application of 9.0 t/ha of cow dung manure significantly ($p<0.05$) produced the heaviest fresh leaf weight per plant (274.0 and 276.3g) and dry leaf weight per plant (72.5 and 72.8g) in both cropping seasons of 2018 and 2019 respectively. The control produced the lowest fresh and dry weight per plant. A similar trend was obtained with the application of 9.0 t/ha which produced the highest fresh herbage yield per hectare (13.5 and 13.9 t) and dry herbage yield (2.5 and 2.9 t/ha) in 2018 and 2019 seasons respectively, while the control plots produced the lowest fresh/dry leaf weight per plant and fresh/dry herbage yield per hectare (Table 2). This is similar to the findings of Khalid *et al*. (2006) and Ani *et al.* (2019) who reported that the application of organic fertilizer increased the biomas yield of the main crop and total essential oil yield of davana plant.

Conclusion

Sweet basil growth and yield indices were maximized at the highest concentration of organic manure used as test, indicating that further yield improvement could still be obtained at rates higher than 9.0 t/ha of cow dung manure. However, farmers could adopt this organic fertilizer (cow dung manure) rate to maximize the optimal performance of sweet basil, while further trials using higher organic manure are recommended to ascertain the best organic fertilizer rate for optimum performance of this crop in the study area.

Table 1: Growth parameters of *Ocimumbasilium L.* as influenced by different levels of cow dung manure

Treatment CDM t/ha	Plant height (cm) 2018 4WAT	2018 6WAT	2019 4WAT	2019 6WAT	Number of Primary branches/plants 2018	2019	Number of secondary branches/plant 2018	2019	Leaf length (cm) at 6WAT 2018	2019	Leaf width (cm) at 6 WAT 2018	2019
0 (Control)	26.0	34.3	26.5	34.8	5.1	5.7	42.7	42.9	3.8	3.9	1.6	1.8
3.0	37.3	40.7	38.2	40.9	6.4	6.9	54.3	54.8	6.3	6.6	3.1	3.5
6.0	40.7	46.7	40.8	47.2	7.9	8.2	64.0	64.5	8.8	9.1	5.0	5.2
9.0	41.3	48.7	42.0	49.2	8.7	8.9	78.7	79.2	10.9	11.2	6.0	6.5
LSD (0.05)	1.23	2.04	1.24	2.06	0.6	0.5	3.4	3.8	1.4	1.6	1.2	1.2

WAT = Weeks after transplanting; CDM = Cow dung manure.

Table

Table 2: Vegetative yield parameters of *Ocimumbasilium L.* as influenced by different levels of cow dung manure

Treatment Cow dung manure t/ha	Fresh leaf weight/plant (g) 2018	2019	Dry leaf weight/plant (g) 2018	2019	Fresh herbage yield t/ha 2018	2019	Dry Herbage yield t/ha 2018	2019

0 (Control)	89.7	90.5	11.9	12.1	1.8	1.9	0.8	0.9
3.0	122.7	124.2	26.3	26.8	3.5	3.7	1.3	1.6
6.0	164.3	165.4	44.0	44.3	8.4	8.7	2.0	2.3
9.0	274.0	276.3	72.5	72.8	13.5	13.9	2.5	2.9
LSD (0.05)	23.2	2.36	11.3	11.5	1.3	1.5	0.3	0.4

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Response of groundnut (*Arachis hypogaea* L.) to weed control treatments using dimethametryn in Anyigba, Kogi State

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Abstract

In the 2019 cropping season, field trial was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Kogi State University, Anyigba to evaluate the response of groundnut (*Arachis hypogaea*) to weed control treatments using dimethametryn. In this study, the treatments consisted of dimethametryn applied post-emergence at three rates (0.11, 0.16 and 0.23 kg a.i/ha); hoe weeding at 3 and 6 weeks after planting (WAP), weed free and a weedy check. The groundnut variety used was Samnut 24.Results indicated that the application of dimethametryn at 0.23 kg a.i/ha was most effective as plants treated concentration out yielded plants subjected to other weed control treatments with respect to number of pods/plant, number of seeds/pod and the seed yield/ha. However, the results under dimethametryn at 0.23 kg a.i/ha in these parameters compared favourably with that on manual hoe weeding at 3 and 6 WAP and the weed free check plots.

Introduction

Groundnut (*Arachis hypogaea* L.) otherwise known as peanut is a legume crop of the family leguminosaea and is widely grown for its edible seeds. It is cultivated in both tropical and subtropical regions and constitutes an important source of vegetable oil in the world as well its products being harnessed for both domestic and industrial uses (Kombiol *et al*., 2012). Groundnut meal, a by-product of oil extraction is an important ingredient in livestock industry. Its haulms are nutritious and serve as important feed source for farm animals. Groundnut oil is composed of mixed glycerides and contains a high proportion of unsaturated fatty acids particularly oleic (50-56%) and linoleic (18-30%) acids (FAO, 2011).

Nigeria is a major producer of groundnut accounting for 25 percent of world exports (IFPRI, 2012). It is widely consumed in Nigeria as roasted, fried or boiled (Adebesin *et al*., 2011) and its oil used for the manufacture of confectionaries, margarine and mayonnaise (Hulme and Mosley, 1996).

Groundnut has contributed immensely to the development of the Nigerian economy and especially in area of employment generation among the rural groundnut farmers and processors alike. In spite of its enormous value in the Nigerian economy, its economic production is severely hampered by intense weed *competition*. Farmers in the study area have widely accepted the use of herbicides as a method of weed control. One of the commonest herbicides in the area is dimethametryne. The objective of this study therefore, was to determine the rate of dimethametryn that is safe and effective for weed control as well as resulting in optimum seed yield of groundnut in Anyigba.

Materials and Method

The field trial was conducted at the Students Teaching and Research Farm of the Faculty of Agriculture, Kogi State University, Anyigba during the 2019 cropping season. The experiment was carried out using a randomized complete below design (RCBD) replicated three times. The trial consisted of six weed control treatments; dimethametryn applied at 0.11, 0.16 and 0.23 kg a.i/ha; hoe weeding at 3 and 6 weeks after planting (WAP) ; weed free and a weedy check.

Groundnut variety used in this study was Samnut 24 and was obtained from the Institute of Agricultural Research (IAR) Zaria. The experimental field measured 11m x 6m (66 m^2) and divided into three blocks, each measuring 6m x 3m ($18m^2$) with 1m alley way between blocks. Data collected on number of days to 50% flowering, number of pods/plant, number of seeds/pod and seed yield (kg/ha) were subjected to analysis of variance (ANOVA) and the treatment means compared using the Least Significant Difference Test (LSD) at 5% level of probability where there were significant differences between treatments.

Results and Discussion

Observed results indicated that irrespective of the weed control treatments, plants attained 50% flowering status almost at the same time. Plants on the weed free plots and those that received herbicide treatments attained 50% flowering status 38 days after planting (DAP) while it was 36 DAP for plants in the weedy check plots (Table 1). The attainment of 50% flowering stage almost at the same time could be attributed to the use of the same variety. This corroborates the findings of Maduka (2014) where maize plants tasselled within a short spate of time owing to the use of a single variety having the same genetic constitution.

There were significant differences ($p<0.05$) among the six weed control methods evaluated with respect to the number of pods/plant, number of seeds/pod and the seed yield per hectare. Results obtained on these parameters on plots that received 0.23 kg a.i/ha of dimethametryn, hoe weeded and weed free were similar and significantly higher than those subjected to other weed control treatments (Table 2). However, the highest seed yield per hectare was recorded in plots treated with 0.23 kg a.i/ha of dimethametryn though comparable to the plants in plots hoe weeded twice and without weeds (weed free). The weedy check plots recorded the least in these parameters. The significantly higher seed yield in plots treated with 0.23 kg a.i/ha of dimethametryn, hoe weeded and weed free could be attributed to better weed control resulting in optimal utilization of available plant growth resources on account of little or complete absence of competition for those resources with weeds. This corroborates the findings of

Mahadi *et al*.(2012) who reported impressive growth and yield parameters of maize in an absolutely depressed weed situation during the critical period of weed interference.

Conclusion

Based on the results obtained in this trial, it can be concluded that groundnut growers be encouraged to adopt the use of dimethametryn at 0.23 kg a.i/ha as an alternative to manual hoe weeding.

Table 1.Effect of weed control treatments on Days to 50% flowering of groundnut during 2019 cropping season at Anyigba.

Weed control treatment	Rate (Kg a.i/ha)	Days to 50% flowering
Dimethametryn	0.11	38
Dimethametryn	0.16	38
Dimethametryn	0.23	38
Hoe weeding at 3 and 6 WAP		37
Weed free		38
Weedy check		36
$LSD_{(0.05)}$		NS

Table 2. Effect of weed control treatments on number of pods/plant, number of seeds/pod and seed yield/ha of groundnut during 2019 cropping season at Anyigba.

Weed control Treatments	Rate (kg a.i/ha)	Number of pods/plant	Number of seeds/pod	Seed yield (kg/ha)
Dimethametryn	0.11	19.6	2.6	1919
Dimethametryn	0.16	19.4	2.6	1921
Dimethametryn	0.23	28.8	4.02493	
Hoe weeding at 3 and 6 WAP		30.4	3.8	2479
Weed free		29.0	3.42397	
Weedy check		4.5	1.0 53.3	
$LSD_{0.05}$	1.12	0.20	30.14	

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Growth potential of Moringa oleifera under different sowing media as a means of forest regeneration

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Abstract

Desertification and erosion are the most prominent factors responsible for biodiversity loss as well as soil degradation in the savanna regions. These resultant negative effects can be minimized through regeneration/ afforestation programs. However, to achieve the aim of any regeneration program, seed collection and germination are the two major parameters that must be taken into consideration with a view to identifying the most appropriate way of raising seedlings under different media (potting mixture) in the nursery. Moringa oleifera is one of the most useful tropical trees with a relatively easy means of propagation which can either be through sexual and asexual means and its low demand for soil nutrients and water. For this study, germination and early growth assessment of Moringa oleiferawas conducted to determine the most suitable medium for seedlings establishment of the specie. Four different media were used for the experiment; Top soil, Clay soil, River sand and equal proportion of Saw dust and Top soil thoroughly mixed. The experiment was laid in a Completely Randomised Design (CRD) with five replicates. Data on plant height, number of leaves and stem girth were generated and subjected to Analysis of variance and significant mean were separated using Duncan's Multiple Range Test at 5% level of significance. The result obtained showed that the seeds planted into River sand had the highest mean values for all parameters assessed while the seeds planted in Top soil gave the lowest values. The seeds planted in the Top soil and sawdust mixture did not germinate at all. It was then recommended that the best quality of *Moringa oleifera* seedlings are raised in river sand.

KEYWORDS: Regeneration, Germination, Moringa oleifera, Sowing media, Seedlings

Introduction

Regeneration is a biological process that can be assisted and managed to increase forest cover and achieve the recovery of the native ecosystem or some of its functions (Chazdon, *et al*., 2017). Ecological restoration relies on regeneration processes for achieving forest ecosystem recovery. Regeneration can also be a component of forest and landscape restoration, among other types of interventions. In addition to enhancing resilience and supplying multiple forest products and ecosystem services, regeneration can be highly effective for recovering local biodiversity, species interactions and movement within landscapes. During regeneration, local biodiversity is enriched by establishment of trees and shrubs from seeds, root sprouts, stumps, or coppices and regeneration of local genetic resources adapted to local soil and climate conditions (Chazdon, *et al*., 2017). However, to achieve the aim of any regeneration program, seed collection and germination must be taken into consideration, although germination of seeds is often very difficult for many useful species principally because of dormancy (Abubakar and Zubairu, 2015). In view of this, it is necessary to identify the most appropriate way of raising seedlings under different potting media (potting mixture) in the nursery.

Germination simply refers to a series of changes whereby an embryo grows into a seedling (Raven, *et al*., 2005). It involves absorption of water by the seed and splitting of seed testa giving rise to plumule (which grows upward and develops into stem and branches) and radicule (that grows downward and develops into root system). Regardless of individual seed variety as well as ecological conditions of plants natural habitat, there are three conditions necessary for germination; these include moisture, temperature, and atmospheric oxygen (Baskin, 2001). Seeds absorb water from the soil by a process of imbibition which leads to the swelling and breaking of the seed coat (Nwoboshi, 1982). Following imbibition process, hydrolytic enzymes (hydrolase) are activated which break down the stored food substance into metabolically useful chemicals. Atmospheric oxygen is obtained by the seeds from the soil pore spaces, which is often used in aerobic respiration to supply energy until it grows out leaves. Early growth assessment is of paramount importance in the choice of species to plant in any regeneration programme because if the choice is not properly conducted, experience has shown that no matter how carefully the crop is subsequently tended, the final result will be poor and mostly unprofitable, therefore in any regeneration programme attempt should always be made to plant the right species in the right place (Nwoboshi, 1982).

Moringa is one of the most useful tropical trees. The relative ease with which it propagate through both sexual and asexual means and its low demand for soil nutrients and water after being planted make its production and management easy. Introduction of this plant into a farm which has a bio-diverse environment can be beneficial for both the owner of the farm and surrounding eco-system. Almost every part of plant is of value for food, seed is to be eaten like a peanut in Malaya, thickened root used as substitute for Horseradish and the foliage eaten as green. A better knowledge of conditions for raising Moringa oleifera would go a long way in hastening regeneration establishment. Moreover, it has been noted that qualities of seedlings are usually influenced by the composition of the growing media (Salami, 2002; Baiyeri, 2003; Baiyeri and Mbah, 2006). Therefore, it is pertinent to ascertain the best growing media in order to ensure optimum growth performance of the species. This study therefore investigated the germination and development of Moringa oleifera seedlings under different growth media.

Materials and Methods

Study Area

The study was conducted for a period of eight weeks because of the fast growing nature of moringa oleifera at the Weaning shed (Ornamental garden) of Forestry Research Institute of Nigeria. The area is located on longitude 07^{o}23'18" N to 07^{o}23'43" N and latitude 03^{o}51'20"E to 03^{o}23'43". The climate of the area is West African monsoon with dry and wet seasons. The mean maximum temperature of the area at the period of the study was 31.11ºC, minimum 22.76ºC while the mean daily relative humidity was about 71.8% E (Metrological report, 2018).After the site preparation, all the media used were thoroughly prepared to avoid cross contamination from impurities. The River sand was washed with water and sterilized to remove organic matter and nutrient residues. Other potting media used for the experiment viz; Top soil, Clayey Soil and Sawdust were carefully handled in line with international best practices suitable for the experiment. The media was transferred to a 4kg size plastic experimental containers and taking to the experimental site and moistened continuously for five (5) days before planting so as to hasten the germination rate and at the same time provide homogeneity of the media.

Seeds of *moringa oleifera* were obtained from Seed section of Forestry Research Institute of Nigeria. 20 observation Pots (polythene bags containing potting mixtures) were used for early growth assessment i.e. four treatments replicated 5 times each. The whole experiment was conducted in a controlled condition; therefore data analysis was conducted descriptively. Viability test was carried out on the seeds using the floatation method which is based on the observation that empty or nonviable seeds float while viable seeds sink or settle down to the bottom of the container (Pamela, 2012). In this experiment, the seeds of *Moringa oleifera* were soaked into a 400 ml beaker containing water and observed for 10 minutes to identify the viable seeds. Also, in this experiment the viable seeds were soaked in 400 ml beaker containing 200 ml of water (at room temperature) for 24 hours to break the dormancy and hasten the germination.

Watering was carried out twice daily (morning and evening) while weeding was done anytime weeds were noticed in each polythene pots. The plant height was measured with the use of meter rule in centimeters, the stem girth was measured with the use of vernier caliper in millimetersand number of leaves were taken by counting leaves produced. The parameters were measured at a week interval after 2 weeks of complete germination and stopped at 9th week. Statistical Analyses Quantitative data was analyzed using the ANOVA procedure and means separated using the Duncan Multiple Range Test (DMRT) at 5% probability (Cary, 2002).

Experimental design and layout

Completely Randomized Design was used on the field and the treatments were represented as follows:

SA T1 → Top Soil

SB T2 → Clay Soil

SC T3 → River Sand

SD → T4 → Sawdust (weathered) + Top Soil (control) 50/50 volume.

KEY:

T1 = Treatment 1, SA = Replicate 1

T2 = Treatment 2, SB = Replicate 2

T3 = Treatment 3, SC = Replicate 3

T4 = Treatment 4, SD = Replicate 4

Experimental layout

T_3SC_4	T_4SD_9	T_4SD_2	T_4SD_{10}
T_2SB_4	T_2SB_8	T_1SA_8	T_1SA_{10}
T_1SA_3	T_2SB_1	T_2SB_{10}	T_3SC_1
T_3SC_2	T_1SA_5	T_1SA_9	T_3SC_8
T_4SD_4	T_2SB_7	T_3SC_{10}	T_4SD_7

Results and Discussion

Complete germination of the seeds was achieved between 6-8 days except for the seeds in T4 (top soil and sawdust) which didn't germinate at all. All germinated seedlings from each treatment were assessed and observations were recorded weekly after 2 weeks of complete germination.

Table 1 shows the physicochemical properties of all the sowing media. Table 2 shows the mean seedlings height (cm) of *Moringa oleifera* treatment at 5% probability of DUNCAN test at different weeks of assessment. From seven weeks after planting (7WAP) there was significant difference among the treatments used. At 7WAP, T3 plants significantly varies from T2 and T1 with values 39.88cm, 25.28cm and 8.7cm respectively. At 9WAP there was increase in the difference with T3 mean value being 53.58cm and that of T2 being 33.70 cm with T1 given the least mean value of 11.24cm. T3 (River sand) had the highest mean seedling height for all three different assessment week followed by T2 (clay) while T1 (topsoil) had the least height. Therefore, seeds of *Moringa oleifera* sprouted, germinated and grew better in potting mixtures prepared with river sand. This finding is in accord with Amaglo (2006), who reported that "*Moringa oleifera* prefers a well-drained sandy soil".

Table 1: Physicochemical properties of the media used

	% sand	% silt	% clay	pH H_20	pH $CaCl_2$	OC	OM %	P	TN	Cl^-	K^+	Na^+	Ca^{2+}	Mg^{2+}

						%								
Media 1	70	19	11	6.2	6.0	2.22	3.82	10.81	0.19	297.78	0.22	0.16	3.0	2.76
Media 2	36	21	43	6.2	6.0	0.51	0.87	12.34	0.05	99.26	0.21	0.17	1.4	1.15
Media 3	83	3	13	7.2	6.6	0.82	1.41	6.97	0.07	226.88	0.29	0.14	1.3	1.28

Table 2: Analysis of Variance test of *Moringa oleifera seedlings* Height at different assessment week

Trt	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP
T1	1.44^{c}	5.20^{b}	5.80^{b}	6.62^{b}	7.50^{b}	8.78^{c}	9.70^{c}	11.24^{c}
T2	12.54^{b}	20.20^{a}	20.50^{a}	21.18^{a}	25.38^{a}	25.28^{b}	28.16^{b}	33.70^{b}
T3	19.90^{a}	25.60^{a}	27.32^{a}	30.64^{a}	36.14^{a}	39.88^{a}	43.76^{a}	53.58^{a}
T4	0.00^{c}	0.00^{b}	0.00^{b}	0.00^{a}	0.00^{b}	0.00^{c}	0.00^{c}	0.00^{c}
LSD @5%	5.0430	9.0620	9.1817	10.6936	12.2286	13.9640	15.3508	17.5667

T1 (top soil), T2 (clay soil), T3 (sandy soil), T4 (top soil and sawdust mixture), T (treatment), wap (weeks after planting)

Mean values with same alphabets are not significantly different from each other. $P \leq 0.05$

Table 3; Analysis of Variance test of *Moringa oleifera seedlings* Number of leaves at different assessment week

Trt	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP
T1	6.20^{b}	10.80^{b}	17.60^{b}	22.80^{b}	29.20^{b}	41.40^{bc}	50.40^{bc}	59.40^{bc}
T2	33.20^{a}	57.40^{a}	57.80^{a}	72.80^{a}	85.60^{a}	89.80^{ab}	104.00^{b}	118.40^{ab}
T3	43.20^{a}	69.20^{a}	85.40^{a}	100.80^{a}	130.20^{a}	157.40^{a}	175.80^{a}	190.00^{a}

T4	0.00[b]	0.00[b]	0.00[b]	0.00[b]	0.00[b]	0.00[c]	0.00[c]	0.00[c]
LSD @5%	13.5183	23.19140	34,36,80	41.47220	47.20450	69.68720	85.74830	98.19350

T1 (top soil), T2 (clay soil), T3 (sandy soil), T4 (top soil and sawdust mixture, wap (weeks after Planting), T (treatment).Mean values with same alphabets are not significantly different from each other P≤ 0.05

The result in table 3 shows the mean number of leaves of *Moringa oleifera treatments* at different assessment week. Leaflets number showed more significant mean difference at 6WAP- 9WAP. At 9WAP the mean difference of T3 is 190 while that of T2 and T1 is 118.4 and 59.4 respectively. T3 (River sand) had the highest mean leaflets number for all three different assessment week followed by T2 (clay) while T1 (topsoil) had the least number of leaves.

Table 4; Analysis of Variance test of *Moringa oleifera seedlings* stem girth at different assessment week

Trt	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP
T1	0.14[b]	0.18[b]	0.22[b]	0.24[b]	0.26[b]	0.28[b]	0.30[b]	0.32[b]
T2	0.68[a]	0.86[a]	0.98[a]	0.98[a]	1.10[a]	1.22[a]	1.32[a]	1.42[a]
T3	0.66[a]	0.86[a]	1.06[a]	1.20[a]	1.32[a]	1.42[a]	1.52[a]	1.60[a]
T4	0.00[b]	0.00[b]	0.00[b]	0.00[b]	0.00[b]	0.00[b]	0.00[b]	0.00[b]
LSD @5%	0.2400	0.3022	0.3747	0.3969	0.4135	0.4404	0.4691	0.4993

T1(top soil), T2(clay soil), T3(sandy soil), T4(top soil and sawdust mixture), WAP(weeks after planting), T(treatment)

Mean values with same alphabets are not significantly different from each other. P≤ 0.05

There was no significant variation in the stem girth presented in Table 4, however there was slight difference between the mean value of T3 and T2 with values 1.60mm and 1.42mm with T1 having a wide gap difference with mean value of 0.32mm. T3 thrived better than treatments T2 and T1.

Conclusion and Recommendation

Findings from the study revealed that River sand showed a better growth potential for raising Moringa oleifera seedling in the nursery compared to clay soil, top soil and sawdust. This is due to its compositional nature that allows air and water to move in and out of the soil sample easily to enhance seed germination. Seeds raised in T4 (sawdust) is suspected not to have germinated due to the acidic nature of the media involved (sawdust from neem tree). It is therefore recommended that adequate nursery practices should be employed such as watering and other necessary practices on a regular interval to promote the optimum growth of the seedlings within a short period of time and the most effective soil type i.e. River sand should always be used in the nursery to raise Moringa oleifera so as to enhance its growth and consequent survival of the plant when transferred to the field for establishment.

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Propagation and Socio-economic Potentials of *Morinda citrifolia* L (Noni); Miracle Non- Timber Forest Products

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ABSTRACT

Noni is one of the most important fruit which was widely used for its health restorative properties. Over the years of its popularity diminished due to unpleasant smell from the ripened fruit. It is a tropical fruit commonly known as Indian Mulberry with numerous health benefits. Noni is relatively easy to propagate from seeds, stem or root cuttings and air layering. The preferred methods of propagating are by seed and by cuttings made from stem. The review paper thereby x-rayed different propagation methods and socio economic potentials of *Morindacitrifolia*. The species is an economic Non Timber Forest Products which its regeneration must be encouraged.

Keywords: Tropical fruit, *Morinda citrifolia*, Propagation, Health benefits, Regeneration

Introduction

Morindacitrifolia, L. popularly known as Indian Noni or Indian mulberry (Plate 1) is an evergreen small tree bearing flowers and fruits throughout the year. It belongs to family Rubiaceae. It is grown in tropical regions of the world. Morton (1999) reported that the fruits of this tree have a history of use in the pharmacopoeias of Pacific Islands and South East Asia. It is nature's abundance bundled in one fruit. It is the biggest pharmaceutical unit in the universe because it has more than 150 nutraceuticals, several vitamins, minerals, micro and macro nutrients that help the body in various ways from cellular level to organ level (Gerlach, 1996). Noni is one of the important traditional folk medicinal plants that has been used for over 2000 years in Polynesia. It has been reported to have a broad range of therapeutic and nutritional value. The ancestors of Polynesians are believed to have brought many plants with them, as they migrated from Southeast Asia about 2000 years ago (Tabrah and Eveleth, 1966; Gerlach, 1996). Of the 12 most common plants they brought, Noni was the second most popular plant used in herbal remedies to treat various common diseases and to maintain overall good health (Krauss, 1993; Gerlach, 1996).

Plate 1**:** *Morindacitrifolia* fruits under harvesting

Plant Description

*Morinda citrifolia*is a bush or small tree, 3-10 m tall, with abundant wide elliptical leaves (5-17 cm length, 10-40 cm width). The small tubular white flowers are grouped together and inserted on the peduncle. The petioles leave ring-like marks on the stalks and the corolla is greenish white (Morton, 1992). The Noni fruit (3-10 cm length, 3-6 cm width) is oval and fleshy with an embossed appearance. It is slightly wrinkly, semi-translucent, and ranges in colour from green to yellow, to almost white at the time of picking. It is covered with small reddish-brown buds containing the seeds. The ripe fruit exhales a strong butyric acid-like rancid smell (Morton, 1992; Dixon *et al*., 1999). The pulp is juicy and bitter, light dull yellow or whitish, gelatinous when the fruit is ripe; numerous hard triangular reddish-brown pits are found, each containing four seeds (3-5 mm) (Dittmar, 1993). The fruit can grow in size up to 12 cm or more and has a lumpy surface covered by polygonal-shaped section. The seeds, which are triangular shaped and reddish brown, have an air sac attached at one end, which makes the seeds buoyant. The mature Noni fruit has a foul taste and odour. Noni is identifiable by its straight trunk, large, bright green and elliptical leaves, white tubular flowers and its distinctive, ovoid, "grenade-like" yellow fruit (Dixon *et al*., 1999).

The plant germplasm

Noni is relatively easy to propagate from seeds, stem, or rooted cuttings and air layering. The preferred methods of propagation are by seeds and cuttings made from stem (Nelson, 2001). Micro propagation using tissue culture is the other possibility of multiplication of planting material.

Seeds: Seeds are extracted from the fruits and sowing can be done immediately after extraction. Hot and wet conditions are required for maximum germination. Under green house condition or raising seedling in the warmest part of land provide better environment for better seed germination (Singh *et al*., 2007). Seeds after drying in shade for 3 or 4 days can be stored in air-tight containers at room temperature. However, the storage studies are yet to be taken up (Singh *et al*., 2007). The treatment with hot water at 40 ºC for a period of 24 hours and a treatment with Tretra-oxo-sulphate (vi) acid at 50 % concentration for 5 minutes was able to overcome the seed dormancy (Singh, 1993). The highest germination ofseeds were obtained where the seeds were nicked and then treated Gibberllicacid (GA) at 1000ppm for a period of 24 hours (Singh, 1993). Seeds treatment with hot water at 40 ºC combined into sea weed,(*Ascophyllum riodosum*) Biozyme and the treatment with Tretra-oxo-sulphate (vi) acidacid 50%for 5 minute combined with Biozyme were able to break seek dormancy aswell as better health and vigour to the germinated seedlings (Singh *et al*., 2007). Seed germination studies of soaking seeds for 24 hours with Gibberlic Acid (GA) at 800 ppm increased the germination percentage to91.06% as against mere water treatment (51.4 %). The inter action of seedsoaking and treatment by GA 800 ppm increased high percentage of seedlingsand number of leaves (Singh, 1993) and Singh *et al*., 2007). Pretreatment of seeds with $NaHClO_3$ (5% available chlorine for 30 minutes) increased the germination up to 84%. However, the growth parameters were good in KNO_3 (150 ppm) (Sudha and Singh, 2007).

Vegetative Propagation: The importance of vegetative propagation is to getbest planting materials with highest genetic quality (Sudha and Singh, 2007). Singh *et al*.,(2007) have suggested the use of growth regulators like Naphthalene AceticAcid (NAA), Indole Butyric Acid (IBA) for quick and better rooting invegetative propagation. Vertical and lateral stem cuttings with sap flow at thetime of cutting with vigorous growing points are the best suited for vegetativepropagation. Subramani, *et al*., (2007) compared different types ofcutting viz., tip, semi hard, and hard wood cuttings with different number of nodes (2,3, and 4) and reported that hard wood cuttings with 4 nodesperformed better and gives more success percentage and healthy plantingmaterials. It is better to avoid the cuttings without sap flow for vegetativepropagation. It is also better to avoid hallow stem cuttings since the percentageof recoverable seedlings are low and take 5 days more than non hallowcutting which took only 15 days and survival was 79.4% (Singh *et al*., 2007).In an another study Sudha*et al*., (2007) had found that both in hollow andnon hollow cuttings, IBA 6000 ppm showed significantly higher rootingvalues than IBA 2000 ppm. Root initiation and percentage of sprouting weremaximum in non-hollow cuttings compared to hollow cuttings.

Root hormones may help to promote the vegetative growth of cutting. Soakingof the cuttings with 4000 ppm Indole Acetic Acid ((IAA) and NaphthaleneAcetic Acid (NAA) separately and in combination promoted root and shootgrowth and establishment besides increasing percentage of rooting, lengthand number of roots, length of longest primary root when cutting is dipped in 4000 ppm of Indole Butyric Acid (IBA)(Singh *et al*., 2007). Thesprouting of cuttings under closed mist propagator chamber was earlier (15 days) andsurvival of cuttings was 83.3 % while in covered poly house it was 20 dayswith 60 % sprouting at 33.5 ºC and 80 % RH. Under open conditions withoptimum light intensity of 44382 lux and maximum temperature of 31.9ºC, minimum 27.03 ^{o}C and relative humidity 77.1%. The growth of vegetative propagated plants under open grew faster and put up 4 branches in 32 days and reached reproductive stage (Singh *et al*., 2007).

General Use of Morinda

The roots, stems, bark, leaves, flowers, and fruits of the Noni, *Morinda citrifolia* are all involved in various combinations in almost 40 known and recorded herbal remedies (Bruggnecate, 1992). Additionally, the roots were used to produce a yellow or red dye for tapa (cloths) and fala (mats). Whilenoni fruit is most famous for its role in Polynesian, Melanesian, and Southeast.Asian material medical, there are also numerous ethno botanical reports of itsuse as food (Terra, 1996). Some reports have indicated itsuse was limited to times of famine (Krauss, 1993). This, however, is notcorrect. The fruit was reported to have been eaten often by Rarotongans, was a favorite ingredient in curries prepared by Burmese, and the AustralianAborigines were known to be very fond of the fruit. There has thusbeen ample human experience with eating Noni fruit to validate its safety forhuman consumption), while the fruit was eaten for health and food (Aragones*et al*., 1997).

Traditional Food Use

Morinda citrifolia fruit has long history of use as a food in tropical regionsthroughout the world. Documentation of the consumption of the fruit as afood source precedes the twentieth century. An 1866 publication in Londonexplained that *M. citrifolia* fruit was consumed as a food in the Fiji islands. Later publications described the use of this fruit throughout the PacificIslands, Southeast Asia, Australia and India. In Samoa, Noni fruit was commonfare and in Burma it was cooked in curries or eaten raw with salt. In 1943, Merrill described *M. Citrifolia* as an edible plant in a technical manual ofedible and poisonous plants of the Pacific Islands, in which the leaves andfruits were used as emergency food. In 1992, Abbott reported that Noni hadbeen used as food, drink, medicine and dye. *Nicobarese* tribe is known to have consumed this fruit raw with salt as well as cooked as vegetable (Singh *et al*., 2007).

Medicinal use of Morinda

The Polynesians utilized the whole Noni plant for herbal remedies. The fruit juice is in high demand in alternative medicine for different kinds of illnessesuch as arthritis, diabetes, high blood pressure, muscle aches and pains, menstrual difficulties, headaches, heart disease, AIDS, cancers, gastric ulcer, sprains, mental depression, senility, poor digestion, arteriosclerosis, bloodvessel problems, and drug addiction. Scientific evidence of the benefits of theNoni fruit juice is limited but there is some anecdotal evidence for successfultreatment of colds and influenza (Solomon, 1999). According to Dixon *et al*., (1999). Noni was a traditional remedy used to treat brokenbones, deep cuts, bruises, sores and wounds. Morton (1992) gave numerous references for medicinal uses of Noni. In addition, Polynesians are reported to treat breast cancer and eye problems. The species of Morinda especially M. citrifolia has been reported to have abroad range of health benefits for cancer, infection, arthritis, asthma, hypertension, and pain (Wang *et al*., 2002). The leaves, seeds, bark, fruits and roots of Noni have been used in various topical remedies in South PacificIslands and South East Asia (Wang *et al*., 2002). It is reported to have antibacterial, anti fungal, analgesic, hypotensive, anti-inflammatory and immune enhancing effects (Wang *et al*., 2002). Murugesh (2007) reported that Noni hasa broad range of therapeutic effects such as analgesic, anti-inflammatory,antihypertensive, immune enhancing, anticancer, antibacterial, antiviral, antifungal, anti-tuberculosis, anti-protozoa, antioxidant, anti-stress and also sedative properties, Also Noni is effective in cough, nausea, colic, enlarged spleen, joint disorders such as gout and arthritis, senility, poor digestion,arthrosclerosis and drug addiction. These beneficial effects of Noni arestrongly documented and well authenticated by valid scientific literatureevidences. Also Noni has a strong cancer preventive effect. The varioustherapeutic benefits of Noni are due to the enriched phyto-constituents. Thehigh therapeutic profile and safety potential of Noni has made it a popularhealth enhancer and food supplement worldwide.

Conclusion

The socio-economic economic values cannot be overemphasized. It has myriad of medicinal importance that attract higher levels of exploitation by human race. Its regeneration is therefore essential towards its sustainability.

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Growth and Yield Assessments of two Varieties of Groundnut (*Arachis hypogeal*) Intercropped with Maize (*Zea mays L*)

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Abstract

The temporal way of increasing food production include adoption of modern varieties and practicing of approved cultural techniques. However, following the appropriate intercropping system is one of the important approach of cropping system emerged as an important tools for increasing crop production. Better intercropping production could be achieved with the choice of appropriate crops. Combination of groundnut and hybrid maize in intercropping system may increase the production and fulfill the demand for maize and groundnut. In this context, the study was conducted to examine the performance of two varieties of groundnut (bunch Spanish and semi spread groundnut) under intercropping system with maize and sole cropped for higher productivity and profitability. The experiment was conducted under rainfed condition in a degraded soil at Alaye village, near Ikire in Irewole Local Government Area of Osun State. From the findings of the study, it was observed that groundnut sole cropped of semi spread variety performed much better in term of the following parameters assessed (plant height, number of leaves, number of branches, stem girth, and weight of yield) followed by sole cropped of bunch variety compared to the groundnut intercropped with Maize. Nevertheless, the groundnut intercropped with Maize performed relatively well in term of yield. However, owing to benefits accrued to intercropping Groundnut with maize, it is therefore, recommended that farmers are advised to grow groundnut on intercropped basis.

KEYWORDS: Intercropping, Groundnut, Maize, Productivity, Profitability

Introduction

Sustainable agriculture is a type of agriculture that is more efficient in the use of limited available resources for the benefit of human and its environment, coupled with the fact that it's economically justified and socially desirable. Objectives of sustainable agriculture is closely associated with its definitions among which are provision of food security along with increased quality and quantity with consideration for the the needs of future generations in terms of conservation of water, soil and natural resources, maintaining and improving farmers profitability, together with the conservation of biodiversity (Chaniyara *et al.,* 1999). In conventional farming and monocropping systems, although high yield per unit area is providing nutritional needs of growing populations in some areas, but these systems requires direct and indirect costs and energy which arise from fossil fuels. In terms of ecology and environment, monocropping has been implicated in causing series of serious problems among which are excessive use of resources such as water, soil, forests, pastures and natural resources which does not only put them at risk, but also linked to environmental pollution by industrial activities, chemical fertilizers and pesticides (Chaniyara *et al.,* 1999). One of the key strategies in sustainable agriculture is through ecosystems restoration and its effective management. Intercropping therefore, is one of the ways to increase diversity in an agricultural ecosystem and is an example of sustainable agricultural systems. It involves growing of two or more crops on the same piece of land over a period of time to promote crop interaction and also maximizes chance of productivity by avoiding dependence on only one crop (Poathik and Malla, 1979). Various intercropping pattern of legumes and non-legumes have been a central feature of many agricultural system in the tropic (Willey, 1997 and Citat, 1987) and thus been described as a principal means of intensifying crop production and to improve return from limited land holding (Stock *et al.,* 1991). In the tropic, maize and groundnut are often intercropped (Ross *et al.*, 2005).

Maize (*zea mays L*) is one of the oldest food crop and is a fully domesticated plant. Modern maize does not grow in the wild, cannot survive in nature but completely dependent on human husbandry (Rathore *et al.,* 1981). It is top ranking cereal in grain yield per hectare and is second to wheat in total production. Maize is of great economic significant worldwide both for human and animal consumption and is also used for a large number of industrial products. Groundnut (*A. hypogea)(L*) also known as peanut is an annual wet season plant grown in many tropical, subtropical and temperate counties of the world (Halima, 2000). It is used as edible oil to make cake, biscuit and bakery in the food industries. Recently the area of groundnut is being decreased due to the competition with crops like wheat, tomato, rice, and mustard (Biswas *et al.,* 1997).

The temporal way of increasing food production include adoption of modern varieties and practicing of approved cultural techniques. However, following the appropriate intercropping system is one of the important approach of cropping system emerged as an important tools for increasing crop production. Better intercropping production could be achieved with the choice of appropriate crops (Santallama *et al.,* 2001). Combination of groundnut and hybrid maize in intercropping system may increase the production and fulfill the demand for maize and groundnut. In this context, the study was conducted to examine the performance of two varieties of groundnut under intercropping system with maize and sole cropped for higher productivity and profitability.

Materials and methods

The experiment was conducted under rainfed condition in a degraded soil at Alaye village, near Ikire in Irewole Local Government Area of Osun State, located approximately at 7°21′40″N 4°11′00″E, within the rainforest zone of Southwestern Nigeria. The area is characterized by equatorial climate with dry and wet seasons and relatively high humidity (FMANR, 1990). The experiment was laid out in RCB design with four treatments and four dispersed replications involving two different varieties of groundnut seed (bunch Spanish and semi spreading groundnut variety) and one variety of maize purchased at National Cereal Research Institute (NCRI) Ibadan. The four treatments were T1 - IT89KD -288 variety of groundnut sole planted, T2 - IT89KD -391 variety of groundnut sole planted, T3 - IT89KD -288 intercropped with maize, T4 - IT89KD -288 intercropped with maize. The experimental plot consist of 8x12m^2 area and was prepared by ploughing twice followed by laddering, after which the plot was divided in to (4) plots at 2x7m each plot was divided into four (4) beds at 1.5mx7m, and other agricultural practice such as application of organic fertilizer (Cow dungs) were uniformly applied to the beds and left for two weeks before planting commenced. The organic fertilizer was applied as basal at the time of final land preparation. However, soil sample in the area was collected for physical and chemical analysis prior to the land preparation to ascertain the nutrient status of the soil before the experiment. The samples collected were taking to the laboratory and routine soil analysis was carried out.

Groundnut seeds were planted at the recommended plant spacing of 50cm between row and 50cm within rows as sole plant and 75cmx 30cm when intercropped with maize. The maize seeds was planted at spacing of 60cm x 30cm. both groundnut and maize were planted at two seeds per hole. On each of the plot were at least a variety of groundnut planted and eight plots out of the 16 plots was maize intercropped with each of the variety of the groundnut. Each of the treatment was replicated four (4) times as follows;

Parameters assessed on a weekly basis prior to maturity are: height of maize, height of each variety of groundnut, stem girth, number of branches, number of leaves, yield of each variety of groundnut and maize in kg. Data generated were subjected to analysis of variance (ANOVA) to determine the significance of the method of planting under investigation. Means, height, length, weight of yield were separated using least significant difference (LSD) at 5% of significance.

Result and discussion

Five (5) soil samples each (Top soil and Subsoil) collected across the study area were subjected to routine soil analysis. Table 1 shows summary of the results of the average chemical properties of top and subsoil across the study area, the soils fall within the neutral to slightly acid class (Landon, 1991). Generally, there was higher accumulation of bases in the surface of the soils compared with the subsoil in the area with values ranged from 3.24- 9.22 cmol (+) kg^{-1}, the values of Exchangeable Sodium Percentage (ESP) in all the soils are generally low (<15%), the critical limit for sodicity (Brandy and Weil, 1999). The soils are therefore not sodic. The soil organic matter (SOM) content ranged from 1.07 to 4.81% and decreased generally in the sub soil. Exchangeable acidity values ranged from 0.1 to 1.4 cmol (+) kg^{-1} soil with little variation across the area. Effective cations exchange capacity (ECEC) was generally low with values ranging from 3.38 to 9.42 cmol (+) kg^{-1} soil. The soil total nitrogen level is critically low with all the values less than 1g/kg. Extractable Micronutrients contents of the soils indicated that Cu ranged from 0.2 to 7.7 mg/kg, Fe from 80.0 to 520.0 mg/kg, Zn was 0.36 to 1.52 mg/kg, Co from 0.12 to 13.46 mg/kg and Mn was 0.90 to 7.1 mg/kg (Table 1).

The electrical conductivity (EC) of the soils were generally less than 2 dS/m in all the soils and this is an indication that the soils are neither saline nor sodic (Brady and Weil, 1999).

Seed yield of groundnut and grain yield of maize were significantly differed by different treatments. Groundnut yield was significantly highest from sole crop due to more number of rows and higher yield attributes. The yield of groundnut reduced in intercropping situation. Among the groundnut intercrop yields, seed yield of groundnut increases with wider row spaces of maize but significantly lower than sole crop because of unavailability of light and nutrient. The result was similar to the findings of Herrara and Harwood, (1974) who reported significant reduction in legume yield intercropped with non-legume shady plants. Significantly highest grain yield of maize was obtained from sole crop. There was a trend to decrease gross yield of maize with the increase of spacing.

It was evident from the result that sole groundnut plant (bunch variety) had the highest value of plant height with an average of 16.78cm followed closely (semi spread variety) sole planted with average of 16.75cm. semi spread variety intercropped with maize had least performance in terms of height with an average of 13.24cm. In terms of leave production, bunch variety of (sole) cropping produce the highest number of leaves per plant with an average of 41.78 leaves followed closely by semi spread variety with an average of 40.78 leaves. Semi spread variety intercropped with maize produced the least number of leaves with an average of 32.97 leaves. Semi spread variety (sole cropping) performed best in terms of stem diameter with an average of 0.46cm followed by bunch variety planted closely with an average of 0.44cm. semi spread variety intercropped had the least performance in tem diameter with an average of 0.39cm. Bunch variety (sole cropping) had the highest number of branches per plant with an average of 13 branches followed closely by semi spread variety with an average of 12 branches while semi spread variety intercropped with maize had the least performance in term of branches count with an average of 10 branches.

However, the resulting weight yield from the above parameters assessed showed that intercropping system has a significant influence on yield. This effect was not as effective in the groundnut intercropped with maize since the values obtained from these intercrops are statistically similar. The values of weight of yield obtained from Groundnut with Maize intercrop were also similar which indicated that the effect of intercropping system were not effective in the intercrop. This agrees with the findings of Atilola (2007), who reported non-significant effect of groundnut intercropped with maize on growth and yield parameters of groundnut. The significant reduction in yield observed from the intercrop plots may be attributed to inter specific competition among the plants for space, nutrients, light, water etc. Fusuo and Li, (2003) reported reduced intercrop yield in maize / Bean intercrop, Soybean / Maize or Soybean / Sorghum intercrop and Soybean / Maize intercrop respectively, when they investigated the effect of component density on the yield of Sorghum or Maize intercrop with Soybean or Beans.

This observation therefore suggests that the inclusion of maize resulted in reduction in growth and yield of groundnut. Conversely, the higher the growth in plant height and yield indices as well as significant in the yield of pods suggesting that groundnut thrives better on sole cropping than intercropping.

Conclusion and recommendation

From the findings of this study, it was observed that groundnut sole cropped in semi spread variety performed much better in term of the following parameters assessed (plant height, number of leaves, number of branches, stem girth, and weight of yield) followed by sole cropped of bunch variety compared to the groundnut intercropped with maize. Nevertheless, the groundnut intercropped with maize performed relatively well in term of yield. However, owing to certain benefits accrued to intercropping, groundnut with maize such as legumes ability to combat erosion and raise soil fertility levels, flexibility of profit, minimization of risk in case of crop failure, soil conservation and soil fertility. These improvement are of great benefit to smallholder farmers at maintaining soil productivity over a long period of time and above all in terms of economic benefit it is therefore, recommended that farmers are advised to grow groundnut on intercropped basis.

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TABLE 1: Chemical properties of the cluster soil samples in the study area (Top soil and Subsoil)

Top soil

Horizon	Depth (cm)	pH (H_2O)	pH (KCl)	ΔpH	Exchangeable bases (CmolKg^{-})	Total (N)	OM (%)	Exchangeable Acidity	Sum of bases	Extractable micronutrients (ppm)

Top soil	0 – 15				Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}			Avail P	Al^{3+}	H^{+}		Mn	Co	Fe	Cu	Zn
Mean		5.94	5.5	-0.44	2.38	0.44	0.31	0.39	0.08	3.60	22.37	1.02	1.00	3.51	5.74	8.49	316.80	2.28	0.82
Min		5.1	4.69	-0.76	1.66	0.36	0.13	0.22	0.05	0.54	14.53	0.4	0.7	2.73	1	6.81	120	0.9	0.43
Max		6.57	6.23	-0.08	3.56	0.57	0.47	0.47	0.1	2.21	32.62	1.9	1.3	4.29	12.8	10.86	500	4.2	1.52
Stdev		0.56	0.69	25	0.81	0.09	0.14	0.10	0.02	0.68	6.66	0.59	0.3	0.72	5.85	1.81	174.34	1.25	0.45

Sub soil

Horizon	Depth (cm)	pH (H_2O)	pH (KCl)	ΔpH	Exchangeable bases ($CmolKg^{-}$)				Total (N)	OM (%)		Exchangeable Acidity		Sum of bases	Extractable micronutrients (ppm)				
Sub soil	15 – 30				Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}			Avail. P	Al^{3+}	H^{+}		Mn	Co	Fe	Cu	Zn
Mean		6.03	5.65	-0.38	2.9	0.47	0.27	0.34	0.10	1.13	16.29	0.84	1.40	3.98	2.78	9.14	221.60	1.46	1.35
Min		5.42	4.7	-0.72	2.14	0.25	0.17	0.22	0.06	0.64	12.51	0.6	0.5	3.07	1.1	5.12	76	0.5	0.94
Max		6.85	6.72	-0.13	4.04	0.79	0.53	0.47	0.14	1.88	24.34	1.4	2.7	5.22	8.6	11.36	420	2.7	1.67
Stdev		0.57	0.76	0.25	0.74	0.22	0.15	0.10	0.03	0.50	5.16	0.34	0.92	1.001	3.26	2.48	177.05	0.95	0.31

N= 5

Evaluation of watering volume and frequencies on *Parkia biglobosa* seedlings

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Abstract

Water is a universal resource that sustains life and it's integral to maintain productivity of the land. Biomass harvested and utilization for energy can affect water quality and quantity. Water quantity is the timing and total yield of water from a watershed, and it's measured by total yield and peak flow over a specified period of time. This study assessed effect of frequency of watering (everyday, 3 days and 5 days) and quantity of moisture supplied (50ml, 100ml and 150ml) on the growth performance of *Parkia biglobosas* seedlings. The variables measured were; seedlings height, collar diameter and leaf production. Data were subjected to a 3×3 factorial experiment in completely randomized design (CRD). Factor A was 3 watering regimes (1 day, 3days and 5days interval) and Factor B was 3 water quantities (50ml, 100ml, and 150ml). Watering everyday to pot capacity gave the best performance in terms of height, collar diameter, and leaf production with 9.71cm, 3.25mm and 5 leaves respectively. Analysis of Variance (ANOVA) indicated that there was no significant effect (p>0.05) of watering regimes on the height of *P. biglobosa* seedlings.

Keywords: *Parkia biglobosa,* Seedling height, collar diameter, leaf production, watering regime.

Introduction

Parkia biglobosa (Jacq. Benth), commonly known as African locust bean, belongs to the family Leguminosaea- Mimosoideae. The tree often grows to a height of 20m. This widespread savannah tree species is also distributed in some parts of tropical rainforest (Hall *et. al.*1997). *P. biglobosa* is dependent on its characteristic dominance on a geographical region. It was however, noted that it is highly distributed or rather occurs in the southern transition zones of the Sahel. Specifically, the species is native to Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Cote d'Ívoire, Democratic Republic of Congo, Gambia, Ghana, Guinea, Guinea-Bissau, Mali, Niger, Nigeria, Sao Tome et Principe, Senegal, Sierra Leone, Sudan, Togo, Uganda and exotic to Antigua and Barbuda, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Puerto Rico, St Lucia, St Vincent and the Grenadines, Trinidad and Tobago, Virgin Islands (US) (Hall *et. al.*, 1997). The bark of the tree is thought to have some medicinal properties. The species produce indehiscent and fleshy pod-like fruit hanging in clusters or bunches at the end of the club shaped fruit base, with edible seeds (beans), which is the most valuable product of the tree (Keay, 1989). The fruit is a legume, slightly indented between the seeds at maturity.

The seeds are embedded in a yellowish, mealy, sweet edible pulp (Aliero *et. al.*, 2001). The seeds are reported to retain viability for a long time (Sabiiti *et. al.*, 1992). The seeds are used extensively as flavoring and nutritious additives to soups and stews (Popoola *et. al.,* 1995). *Parkia biglobosa* is a traditionally important economic tree species, with multipurpose potentials (fodder, human food, medicine). It contains high tannin and phenolic compound, about 54% fat and 30% protein as well as vitamins and minerals (Sabiiti and Cobbina, 1992). The species is also used in agroforestry because of its ability to fix atmospheric nitrogen in soil. Despite being economically valuable, *P. biglobosa* is not widely planted in most regions of Nigeria. The seedlings of this economically important tree species are rarely seen growing in the wild. The existing trees are ageing and fast disappearing. It is therefore imperative to intervene to save this important tree from extinction. Artificial regeneration and subsequent improvement (domestication) appears to be a very viable option of saving the species from extinction and ensuring that its products are supplied on sustained basis.

Materials and Methods

The study was carried out at the Tree Improvement Nursery and Silviculture Nursery of the Department of Sustainable Forest management, Forestry Research Institute of Nigeria, Jericho Hill, Ibadan, Nigeria (FRIN). FRIN is located within longitude 07^{0}23'18"N to 07^{0}23'43"N and latitude 03^{0}51'20"E to 03^{0}51'43"E. Mean annual rainfall is about 1548.9 mm, falling within approximately 90 days. The mean maximum temperature is 31.9^{0}C, minimum 24.2^{0}C while the mean daily relative humidity is about 71.9% (FRIN, 2014).

Experimental Procedure

This study employed a 3×3 factorial experiment in completely randomized design (CRD). Factor A was 3 watering regimes (once daily, 3days and 5days interval) and Factor B was 3 water quantities (50ml, 100ml, and 150ml). A total of nine experiments were replicated 10 times. A total of ninety (90) seedlings with good vigour and relatively uniform growth were randomly selected from germinated seeds raised with forest top soil. They were transplanted into 4kg capacity poly pots filled with forest topsoil at (4) four weeks after germination. Three watering regimes (once daily W1, 3days interval W2 and 5days interval W3) were applied to the seedling and differing volume of water (50ml Q1, 100ml Q2, and 150ml Q3) using measuring cylinder modifications of Akinyele (2007). The experiment was monitored for a period of (16) sixteen weeks.

Results and Discussion

Effect of watering frequency on the growth of *Parkia biglobosa* seedlings

Seedlings that were watered daily (W1) had the highest mean value of seedling height (9.71cm), collar diameter (3.25mm) and highest number of leaves with same value under the seedlings watered within 3 days interval (W2) having 5 number of leaves respectively while seedlings watered within 5 days interval (W3) had the least performance in terms of all parameters assessed (Table 1).

Table 1: Mean Values for the Effect of Frequency of Watering on the Growth of *P biglobosa* Seedlings

Watering Regime	Plant Height (cm)	Collar Diameter (mm)	Leaf Production
W1	9.71 ± 0.42	3.25 ± 0.20	5 ± 0.22
W2	8.70 ± 0.42	2.72 ± 0.20	5 ± 0.22
W3	8.52 ± 0.42	2.75 ± 0.20	4 ± 0.22

Mean±SE followed by the same superscripts in column are not significantly different (p>0.05)

Effect of water volume on the growth of *Parkia biglobosa* seedlings

Seedlings grown under 150ml (Q3) had the highest mean value of seedling height (9.61cm), collar diameter (3.07mm) and highest number of leaves with same value under the seedlings grown with 100ml (Q2) having 5 number of leaves respectively while seedlings watered with 100ml (Q2) had the least seedling height (8.38cm), collar diameter (2.81mm) and seedlings watered with 50ml (Q1) performed least in leaf production with 4 leaves (Table 2).

Table 2: Mean Values for the Effect of Water Volumes on the Growth of *P. biglobosa* Seedlings

Water Quantity	Plant Height (cm)	Collar Diameter (mm)	Leaf Production
Q1	8.93 ± 0.42	2.85 ± 0.14	4 ± 0.22
Q2	8.38 ± 0.42	2.81 ± 0.14	5 ± 0.22
Q3	9.61 ± 0.42	3.07 ± 0.14	5 ± 0.22

Mean±SE followed by the same superscripts in column are not significantly different (p>0.05

Interaction Effect of Frequency of watering and Quantity on the Growth of *P. biglobosa* Seedlings

The best performance was revealed under the seedlings grown with 150ml daily (W1Q3) in terms of all parameters assessed with seedling height (10.02cm), collar diameter (3.39mm) and number of leaves (5) while the least height performance was observed in the seedlings grown with 50ml within 5 days interval (W3Q1) with (7.8cm), least collar diameter was recorded in seedlings grown with 100ml within 3 days interval (W2Q2) with (2.52mm) and least number of leaf were recorded under W2Q1, W3Q1 and W3Q3with 4 number of leaves (Table3). The result from this study revealed that there was no significant effect of watering regimes and quantity on the height and leaf production of *P. biglobosa* seedlings. This is in correlation with the work of Elhadi *et al.* (2013), who reported that irrigation frequencies did not affect the height and collar diameter of five tropical trees in the nursery (*Acacia tortilis* subspecies *raddiana*, and subspecies *spirocarpa*, *Acacia ehrenbergiana*, *Azadirachta indica* and *Eucalyptus* *microtheca*) and also with the work of Bolanle-Ojo (2014), who reported that different watering regimes applied did not significantly affect the leaf production of *A. heterophyllus* seedlings.

Table 3: Mean Values for the Interaction Effect of Frequency of watering and Quantity on the Growth of *P. biglobosa* Seedlings

Frequency of Watering	Quantity of Water	Plant Height	Collar Diameter	Leaf Production
W1	Q1	9.97 ± 0.79	3.23 ± 0.23	5 ± 0.31
	Q2	9.15 ± 0.73	3.14 ± 0.28	5 ± 0.35
	Q3	10.02±0.78	3.39 ± 0.21	5 ± 0.32
W2	Q1	8.97 ± 0.76	2.74 ± 0.22	4 ± 0.39
	Q2	7.87 ± 0.75	2.52 ± 0.25	5 ± 0.38
	Q3	9.26 ± 0.74	2.92 ± 0.26	5 ± 0.37
W3	Q1	7.85 ± 0.72	2.58 ± 0.27	4 ± 0.36
	Q2	8.13 ± 0.71	2.78 ± 0.29	5 ± 0.35
	Q3	9.57 ± 0.73	2.90 ± 0.24	4 ± 0.38

Mean±SE followed by the same superscripts in column are not significantly different (p>0.05)

Conclusion

According to Awodola and Nwoboshi (1993), water is a significant factor in tree growth and development in the tropics. The knowledge of the responses of the seedlings under conditions of restricted moisture may provide an indication of its responses to increased water stress. Also the evaluation of the morphological and physiological growth of plants at periods of restricted moisture is useful for the isolation of plants with seedlings characteristics acceptable for afforestation in drought prone environments (Akinyele, 2007). The result from this study revealed that varying watering regimes had effects on the early seedling growth of *P. biglobosa*. The results revealed that *Parkia biglobosa* will grow maximally when watered everyday. Therefore, *Parkia biglobosa* can be raised in the nursery with any of the watering regime and quantity of water applied without causing any adverse effect on the seedling growth ,it can be included in afforestation candaidate species for its adaptation to variation in moisture demand.

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Response of African Eggplant (*Solanum macrocarpon* L.) Cultivars to Different Nitrogen Fertilizer Rates in the Southern Guinea Savannah

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Abstract

The effect of nitrogen rates at 0, 20, 40, 60, 80 and 100 kg ha^{-1} on the growth and yield components of African eggplant cultivars were studied during the 2018 rainy season at the Teaching and Research Farm of the Niger State College of Agriculture, Mokwa (09^{o}211' N and 5^{o}135' E, 201 m above sea level) in the southern guinea savannah region of Nigeria. Seeds of 'Yaalo' and 'Gautan Daachi' cultivars were sown by broadcasting in well prepared nursery beds and were regularly watered. The seedlings were transplanting to the main field using the Randomized Complete Block Design (RCBD) with three replications. Nitrogen application rates at 20 to 80 kg ha^{-1} significantly (P < 0.05) increased the plant height as compared to the control. 'Yaalo' plants were significantly taller than those of 'Gautan Dachi'. Significantly (P< 0.05) highest fruit yield was obtained from 'Yaalo' plants treated with 60 kg ha^{-1}. Therefore, it is recommended that N fertilizer be applied at 60 kg ha^{-1} for enhanced plant growth and fruit yield in 'Yaalo' cultivar.

Keywords: African eggplant, Cultivar, Fruit, Nitrogen fertilizer, Yield.

Introduction

African eggplant (*Solanum macrocarpon* L.) is a local vegetable that is cultivated mainly for its leaves and fruits with many benefits. It is readily available, cheap, and nutritious with nutritive value. It could be used to prepare soup. Kausshik *et al*. (2009) maintained that *S. macrocarpon* could be used to treat tuberculosis, convulsion, boost infertility and insomnia in women in traditional way. The low fertility status of most Nigerian soils hampers the production of *S. macrocarpon* to consumers' taste. Different sections of crops are being cultivated by farmers and application of inorganic fertilizer has been established to be important in its cultivation (Makinde *et al*., 2010) but the extent of *S. macrocarpon* response to nitrogen fertilizer application in the southern guinea savannah has not been well studied and documented. Furthermore, studies have shown that N application rates varied across locations. Therefore, there is need to determine the optimum rate of N for African eggplant in the Mokwa region of the southern guinea savannah. The aim of the study is to ascertain the optimum nitrogen fertilizer level that would be required for growth and fruit yield and to determine the variations in the agronomic characters of two cultivars of African eggplant in Mokwa.

Materials and Methods

The experiment was carried out in the 2018 Raining season at the Teaching and Research Farm of Niger State College of Agriculture, Mokwa, (09^{o}211' N and 5^{o}135' E, 201 m above sea level), Southern Guinea Savannah Agro Ecological Zone of Nigeria. The annual rainfall ranged from 1100 mm to 1300 m. The rainfall which peaks in September normally begins in April and ends in October. The temperature ranges between 25 and 27.5 ^{0}C with relative humidity between 60 and 80 % in January (Anon, 2017). The site was cleared of all vegetation and was manually leveled and ridged 75cm apart. The area was then marked into plots. Plants of the two cultivars ('Yaalo' and 'Gautan Daachi') were subjected to six nitrogen fertilizer levels; 0, 20, 40, 60, 80 and 100 kg N ha^{-1} (with urea as source). This gave a 2 × 6 factorial arrangement which was fitted into randomized complete block design (RCBD) with three replications. Each plot measuring 4 m × 2.25 m (9 m^{2}) containing four ridges spaced at 0.75 m apart. Seeds of the two cultivars were sown by broadcasting in well prepared nursery beds and were regularly watered. Seedlings were transplanted 50 cm apart on the ridges at one per stand. Weeding was carried out twice (at 5 and 9 WAT) manually by the use of hoe while insect pest were controlled by the use of Best Action insecticide (Cypermerthrin 30 g/L + Dimethoate 250 g/L EC) at I litre per hectare. Half dose of nitrogen fertilizer was applied at 2-split doses; at two and five weeks after transplanting (WAT) by banding method 15 cm away from the plant. Data was collected from growth and fruit yield components of the plants. All data obtained were subjected to analysis of variance (ANOVA) using SAS statistical software package (SAS Institute, 2012. Cary, NC). Main effects were compared using the Least Significant Difference (LSD) at 5 % levels of probability and Duncan Multiple Range Test (DMRT) test at 0.05 level of probability.

Results

Physical and chemical properties of the soil of the experimental sites

The result of soil analysis of the pre-planting soils used as shown in Table 1 indicates that the soil was sandy-loam. Total N, phosphorous, potassium and organic carbon of the soil were low using the standard developed by Anon (2017), hence need for this study at the site.

Table 1: Physical and chemical characteristics of soil of experimental site at a depth of 0 -15 cm at pre- planting stage at Mokwa in 2018 raining season

Soil properties	Soil test analysis
Particle size distribution (gkg^{-1})	
Sand	820
Silt	150
Clay	30
Soil textural class	Sandy-loam

Soil pH (H_2O 1:1)	6.8
Soil pH (0.01 M $CaCl_2$)	5
Organic carbon (g/kg)	30
Available P (mg/kg)	5.29
Total Nitrogen (g/kg)	0.36
Exchangeable bases (Cmolkg^{-1})	
Ca^{2+}	1.56
Mg^{2+}	0.88
K^+	0.17
Na^+	0.09
Exchangeable acidity (Cmolkg^{-1}) Al^{3+} +H^+	0.07

Plant heights at 4, 6, 8, 10, 12 and 14 WAT

Plant heights were significantly ($p < 0.05$) greater in 'Yalo' than in the 'Gautan Daachi' cultivar from 8 to 14 WAT. Plants to which N fertilizer was applied and those without N fertilizer were generally similar in height at 4 WAT. However, from 6 to 14 WAT, the height differences among plants fertilized with 20 – 80 kg N ha^{-1} were mostly insignificant. These values generally resulted in significantly ($p < 0.05$) taller plants compared to 0 and 100 kg N ha^{-1}(Table 2). At 10 – 14 WAT, both cultivars had significant increases in plant height when 20 kg ha^{-1} was applied compared to 0 kg ha^{-1}. Further increases in N rate up to 80 kg ha^{-1} however did not result in significant increase in the height of 'Gautan Daachi' plants whereas application of 60 kg ha^{-1} still significantly increased plant height in 'Yalo' compared to the value obtained at 20 kg ha^{-1}. Application of N at 100 kg ha^{-1} resulted in significantly reduced plant height (Table 2).

Table 2: Effect of cultivar and nitrogen rates on plant height (cm) of African eggplant (*Solanum*

***macrocapon*) at Mokwa in 2018 rainy season**

	Weeks after transplanting (WAT)					
Treatment	4	6	8	10	12	14
Cultivar						
'Yalo'	7.86	22.96	56.55	71.2	75.03	83.28
'Gautan Daach'	7.27	20.41	50.93	56.94	58.96	65.23
Lsd (0.05)	NS	NS	NS	NS	NS	NS
Nitrogen rates (N) Kg ha^{-1}						
0	7.31^{a-c}	17.57b	35.38B	41.78c	43.46c	53.60c
20	8.20^{ab}	25.93a	57.94a	68.47b	72.73a	77.88a
40	1.10^{bc}	23.12a	58.11a	71.66ab	76.04a	80.32a
60	7.40^{a-c}	21.37ab	64.90a	76.09ab	79.12a	84.33a
80	8.47^{a}	25.44a	62.84a	76.69a	77.71a	84.54a
100	8.20^{ab}	16.71b	43.22b	49.72c	52.92b	64.81b
SE+	0.45	1.76	2.77	2.79	2.74	2.69
Interaction (C × N)	NS	NS	NS	NS	NS	NS

Means with the same letter (s) within the same column are not significantly different at $P < 0.05$ according to Duncan Multiple Range Test (DMRT),NS = Not Significant; * = Significant at $P < 0.05$ level of probability;

** = Significant at $P < 0.01$ level of probability.

Fruit yield and yield components

There was no significant cultivar effect on number of flowers formed per plant, number of productive branches per plant, number of early fruit per plant, number of fruits produced per plant and average fruit yield per plant. However, greater percentage per plant of 'Gautan Daachi' produced fruits significantly earlier than 'Yalo' plants. It further demonstrated that 'Yalo' cultivar produced higher yield per hectare than 'Gautan Daachi' (Table 3). [1]. Number of fruiting branches per plant was not significant among 0 to 80 N ha^{-1} kg. Application of 100 kg N ha^{-1} resulted in a significant reduction in the number of fruiting branches compared to 20 – 80 kg N ha^{-1}. Percentage of plants with early fruit was significantly higher with the application of 20-40 kg N ha^{-1} than at 60 – 100 kg N ha^{-1} (Table 3). Total number of fruits per plant was significantly higher at 40, 60 and 80 kg N ha^{-1} than when N was not applied (control). Average fruit yield per plant was significantly higher at 60 kg N ha^{-1} than all other N rates except 80 kg N ha^{-1}. The highest fruit yield per hectare was recorded at 60 kg N ha^{-1}.

Table 3: Effect of cultivar and nitrogen rates on fruit yield and yield components of African eggplant

***(Solanum macrocapon*) at Mokwa in 2018 rainy season**

	Fruit yield and yield components					
Treatment	NOFF	NOPB	NOEF	NF/P	AFY/P (g)	FY (t/ha^{-1}
Cultivar (C)						
Yalo'	22	5	3	14	924.18	13.85
Gautan Daach'	23	5	3	15	927.16	9.75
Lsd (0.05)	NS	NS	NS	NS	NS	NS
Nitrogen rates (N) (Kg ha^{-1})						
0	19b	4ab	2a	11b	661.30c	9.28c
20	22ab	5a	2a	14ab	839.60bc	13.96ab
40	24a	5a	3a	16a	937.40b	10.59c
60	25a	5a	2a	18a	1196.20a	15.28a
80	23ab	5a	3a	16a	1069.7ab	11.66a-c
100	22ab	3b	2a	14ab	849.90bc	7.04c
SE+	9.22	1.49	0.35	1.43	84.61	1.58
Interaction (C x N)	NS	NS	NS	NS	NS	NS

Means with the same letter (s) within the same column are not significantly different at $P < 0.05$ according to Duncan Multiple Range Test (DMRT), NS = Not Significant; * = Significant at $P < 0.05$ level of probability; NOFF: Number of flowers formed; NOPB: Number of productive branches; NOEF: Number of early fruits; AFY/P: Average fruit yield/plant; FY: Fruit yield

Discussion

Low soil fertility is one of the main factors for the low productivity of vegetables, Najafva *et al.,* (2008), however, the fertility of the soil can be enhanced by application of organic and inorganic fertilizers but use of any fertilizer type depends on several factors such as soil type, crop and socio-economic conditions of the famers. Application of N at 60 - 80 kg ha^{-1} resulted in significantly taller plants compared to the values obtained at 0, 20 and 40 kg ha^{-1} at 10 – 14 WAT. Nitrogen is the main constituent of all amino acids in protein and lipids acting as structural compounds of chloroplast and therefore the yield-limiting factor for plant growth (Basela and Mahadeeen, 2008). The significant increase in the number of productive branches and the number of flowers formed/plant due to application of nitrogen fertilizer in this study agrees with the findings of Aminifard *et al*. (2010) who evaluated the effect of different N rates on growth and yield of eggplant. They recorded the greatest flower number at N application of 100 kg ha^{-1} and number of lateral branches at 50 kg ha^{-1} due to higher nitrogen content while the least numbers were recorded in the control. The superiority of 'Yalo' over 'Gautan Daachi' cultivar in respect of earliness of fruiting at 60 to 80 kg N ha^{-1} rates and also the significantly greater number of flowers/plant obtained in the former over the later at 80 and 100 kg N ha^{-1} rates might be due to the attribute of the former's genetic superiority in utilizing the fertilizer towards its physiological development. Akambi *et al*. (2007) also recorded significant interaction between nitrogen and fertilizer and cultivar on some lettuce growth parameters. However, differences between cultivars were tied to adaptability. The enhance fruit yield with increase in N rates in this study is in agreement with the findings of Oloniruha (2009) which showed that fertilizer application generally increased fruit production in African eggplant (*S. macrocapon*). Akambi *et al*. (2007) similarly reported that increasing the N levels of the fertilizers to 50 kg N ha^{-1} significantly increased the yield lettuce while a decrease was observed at the highest rate of nitrogen (150 kg N ha^{-1}). This result is also consistent with that of Aujla *et al.* (2007) which showed that increasing the rate of N fertilizers increased the yield of eggplant fruit.

Conclusion and Recommendation

It is concluded from this study that 'Yalo' cultivars was superior as compare to that of 'Gautan Daachi'. Fruit yield was significantly higher in 'Yalo' than in 'Gautan Daachi'. The application of N at 20 to 80 kg N ha^{-1} enhanced plant height as 100 kg N/ha and compared to the control, whereas, fruit yield was higher at N rate of 60 kg N ha^{-1} (15.3 t ha^{-1}). Based on the results of this study, it is recommended that N rates of 60 kg N ha^{-1} will be adequate for enhanced plant growth and fruit yield. Breeders can factor in a good number of the yield components into their breeding programme for improved crop yield.

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Pro Vitamin A Cassava as Engine for Nutrition and Food Security in Nigeria

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Abstract

This paper on pro vitamin A cassava as an engine for nutrition and food security in Nigeria seeks to review the agronomic, economic and potentials of the crop and increased popularization and promotion of the crop in Nigeria. It relied on information from secondary sources such as documented relevant review literature on pro vitamin A cassava, NRCRI Annual Reports and field experience of Researchers. The pro- vitamin A cassava varieties would play a great role in the agricultural policy of the Federal Government of Nigeria to serve in the development and processing of products such as garri, fufu, starch, high quality cassava flour for value added products (cake, chin-chin, doughnut, bread, bons), sweeteners and fuel ethanol, nutritional benefit and food security. This paper therefore reviews in brief the nutritional potentials of pro vitamin A cassava in alleviating vitamin A deficiency (VAD) and its capacity to enhance food security in Nigeria.

Keywords: Pro Vitamin A Cassava, Nutrition, food security

Introduction

Cassava (*Manihot esculenta*) is an essential root crop grown in Nigeria and its potential to fight hunger and food insecurity is documented. Cassava has the capacity to bridge the gap in food security, poverty alleviation, and environmental protection (Amadi, *et al*; 2017, Abdoulaye *et al*, 2014). Although cassava roots are very rich in energy, containing mainly starch and soluble carbohydrates, its nutritive value is low (Ilona, 2012). Cassava is a valuable source of energy; typically it is a poor source of vitamin A carotenoids (Edoh *et al*, 2013). Millions of Nigerians, irrespective of age, sex or geographic location consume less vitamin A than the body needs while women and children remain the most vulnerable (Egesi *et al*, 2014). A sustainable way of mitigating vitamin A deficiency is by breeding food staples such as cassava to produce vitamin A by itself, a process known as biofortification (Ilona, 2012). Deficiencies in key minerals and vitamins pose a very serious problem to human health and development. Micronutrient deficiencies (Vitamin A, iron, iodine, zinc and folic acid) are prevalent among women and children in low and middle-income countries like Nigeria (HarvestPlus, 2016). According to UNICEF/WHO/World Bank, (2017) in 2016, 22.9 per cent of underage-5 children worldwide were stunted, one-third of these stunted children were found in sub-Saharan Africa within which West and Central Africa accounts for 33.5 per cent. Vitamin A deficiency (VAD) has been identified as one of the major factors of early childhood mortality (Ilona, 2012).

Progressively, in order to relieve resource poor farmers, families, households, rural poor and Nigerians from this problem of vitamin A deficiency and poor yield, the HarvestPlus project which is a global consortium of scientists whose aim is to breed and disseminate important staples such as cassava for better nutrition and supported scientists from the National Root Crops Research Institute (NRCRI), Umudike, International Institute for Tropical Agriculture (IITA), Ibadan collaborated to develop cassava varieties with enhanced levels of beta carotene, capable of adapting to wider range of ecological conditions and farming systems (Egesi *et al*, 2014). The pro- vitamin A cassava varieties would play a great role in the agricultural policy of the Federal Government of Nigeria to serve in the development and processing of products such as garri, fufu, starch, high quality cassava flour for value added products (cake, chin-chin, doughnut, bread, bons), sweeteners and fuel ethanol (Egesi *et al*, 2014), nutritional benefit and income generation. This paper therefore reviews in brief the nutritional potentials of pro vitamin A cassava in alleviating vitamin A deficiency (VAD) and its capacity to enhance food security in Nigeria.

Pro Vitamin A Cassava Varieties and their Attributes

Table 1: Pro-vitamin A cassava varieties released in 2011 and 2014 and their attributes

Genotype: NRCRI/IITA	Year Released	Yield (t/ha)	DMC (%)	TCC (µg/g)	Attributes of the pro vitamin Varieties
UMUCASS36/TMS 01/1368	2011	26.6	24.8	8.2	Vitamin A cassava, yellow roots, moderate CMD resistance and high yielding (> 25 t/ha)
UMUCASS37/TMS 01/1412	2011	29.0	26.3	6.4	Vitamin A cassava, yellow roots, high CMD resistance, early bulking and high yielding (> 25 t/ha)
UMUCASS38/TMS 01/1371	2011	20.0	28.5	5.7	Vitamin A cassava, yellow roots, moderate CMD resistance and high yielding (> 25 t/ha)
UMUCASS 44/TMS 07/0220	2014	36.4	36.0	10.8	Vitamin A cassava, yellow roots, moderate CMD

					resistance, high yielding (> 25 t/ha), early bulking, stay green and drought tolerance
UMUCASS 45/ TMS 070593	2014	34.0	40.2	11.7	Vitamin A cassava, yellow roots, moderate CMD resistance, high yielding (> 25 t/ha), early bulking, stay green
UMUCASS 46/ TMS 070593	2014	32.0	33.0	10.9	Vitamin A cassava, yellow roots, moderate CMD resistance, high yielding (> 25 t/ha), early bulking, stay green and drought tolerance.

Source: IITA, (2017) *DMC – Dry Matter Content; TCC – Total Carotene Content

Production of pro vitamin A cassava

Pro-vitamin A cassava is a genetically improved cassava variety containing B-carotene which has the potential for the alleviation of vitamin A deficiency in low income population. Pro vitamin A cassava is a shrub with an average height of one meter and has palmate leaf formation. The stem is the planting material from which the root and shoot grow. It produces bulky storage roots with a heavy concentration of B-carotene (NRCRI, 2012). The new genotypes were developed to improve yield of cassava and nutritional status of poor rural farmers. The agronomy practices of cassava involve the following steps: **Selection of cassava stem**: select or use improved, healthy and disease /pest free cassava stems of 10-12 months old. **Preparation /Treatment of cassava ste**m: cut selected cassava stems into 3 nodes stakes with sharp object and treat with available fungicide / insecticide at the rate of 10g/20L of water for Tecto 60; 1kg/5L water for neem powder, or 4 ml/101 of water for Basudin etc. allow to stay for 10mins in the solution before removing them. Protect your hand by wearing hand gloves. **Planting:** Plant when there is enough moisture in the field (ridge and mound) in a slanting position, Plant at a spacing of 1mx 0.5m, 1mx0.8m, 0.5mx0.5m or 0.8mx 0.5m etc. **Field maintenance (weeding control):** spray the field or farm with pre-emergence herbicide such as Primextra at 5 litres per hectare immediately after planting or a day after planting. Carry out manual weeding using hoe at 8-12 weeks after planting if herbicide is not available**. Fertilizer application:** apply fertilizer NPK fertilizer: 20:10:10 at 8-10 weeks and at the rate of 400-600kg/ha usually after the first weeding. Poultry manure can also be used at 2000-4000kg/ha plus agrolyzer. Apply by hand method. **Harvesting**: Harvest at 8-12 months after planting (NRCRI, 2012, Amadi *et al*, 2018).

Processing of pro vitamin A cassava

Pro vitamin A cassava roots have a short shelf life and begin to deteriorate only 2–3 days after harvesting. There are several ways of processing cassava depending on the product and locality. The success achieved by increasing yield requires to adequately following with increased processing of the roots into various products, since the roots are liable to high deterioration. Ilona (2016) reveals that adding value to pro vitamin A cassava products is bound to cause a glut. Pro vitamin A cassava is processed into primary and secondary products. The primary products are gari, fufu, abacha, tapioca, chips, starch, high quality flour, root meal, etc. The secondary products, also known as value added products include; bread, Chin-chin, cake, doughnuts, meatpie, strip, flakes, biscuit, etc. Dry pro vitamin A cassava chips and pellets can also be used as animal feed.

Fufu (a)	**High Quality Flour (b)**	**Cassava Tapioca (c)**	**Garri (d)**
Fresh cassava Root	Fresh Cassava Root	Fresh Cassava Root	Cassava root
↓	↓	↓	↓
Peeling	Peeling	Peeling	Peeling
↓	↓	↓	↓
Washing	Washing	Washing	Washing
↓	↓	↓	↓
Steep in water (48hrs)	Grating	Boiling	Grating
↓	↓	↓	↓
Washing	Dewatering	Slicing	Fermentation
↓	↓	↓	↓
Grating	Pulverization	Soaking	De-watering
↓	↓	↓	↓
Dewatering (2hrs)	Drying	Washing	Sieving
↓	↓	↓	↓
Pulverization	Milling	Drying or Wetting	Toasting
↓	↓		↓
Sun drying	Sieving		Bagging
↓	↓		

Milling Bagging

↓

Sieving

↓

Fufu flour

Fig.1: flow chart for pro vitamin A cassava utilization forms, adapted from NRCRI, (2015)

Nutritional benefit of pro vitamin A cassava

Nutrition is the ability of living organisms to feed very well. The adoption and consumption of pro vitamin A cassava products is very essential especially among the rural poor households. This can help to achieve the focus on eradicating vitamin A deficiency (VAD), address the adverse health effects of vitamin A deficiency and other nutrient required for maintaining immune function through a cheaper cost effective sustainable means accessible to even the rural poorer households in Nigeria. Otherwise, pro vitamin A cassava has the capacity to boost immune, eradicate vitamin A deficiency and prevent diabetes as well. When foods are deficient in essential micronutrients such as vitamin A, Fe & Zn etc., some body cells remain hungry and fail to grow to full capacity and this is referred to as hidden hunger (Ilona, 2016). Pro vitamin A cassava is a lucrative business crop that has diverse economic and health importance and should be highly valued at the national and international market, at the same time promoting entrepreneurship and income.

Pro vitamin A cassava as a food secured crop

Food security is very important to the development of a nation like Nigeria. Food security occurs where the quantity and quality of food is accessible sufficient and available to the citizens of a country. Reducing food insecurity continues to be a major public policy challenge in developing countries like Nigeria. Almost 1 billion people worldwide are undernourished, many more suffer from micronutrient deficiencies, and the absolute numbers tend to increase further, especially in Sub-Saharan Africa (FAO, 2008). It is obvious to note that pro vitamin A cassava is food in diverse processed forms. Popularizing, promoting and commercializing pro vitamin A cassava value added products promotes human capacity with a view to increase production, nutrition status, income generation, employment and even foreign exchange earnings as well as enhances national food security.

Conclusion

Pro vitamin A cassava is an important crop with nutritious and health benefits. Pro vitamin A cassava production should be encouraged by sensitizing farmers and consumers properly on the potentials of the crop especially in the southern part of Nigeria where the research institute that has the mandate to research into the crop is located. There is urgent need to increase the nutritional information and extension activities as well. The information on the nutrition and health benefits content and length of nutritional campaigns remains an important factor in boosting the value chain, more income generation and immensely contribute to food security in Nigeria.

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Response of pepper (*Capsicum frutescens* L.) transplanted at different seedling ages to periods of weed interference

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Abstract

Initial slow growth of transplanted pepper makes them highly vulnerable to weed interference with consequent high yield loss. Timely and adequate weeding therefore is a necessity for enhanced productivity of pepper. Field trials were conducted in the early and late wet seasons of 2012 at the Federal University of Agriculture, Abeokuta, Nigeria. The objectives were to determine the productivity of pepper transplanted at different stages of growth and to determine the critical period of weed interference in the crop. Split-plot arrangement in a randomized complete block design with three replicates was adopted in the trials. The main plot treatments were ages of pepper seedlings at transplant, 4 and 6 weeks after sowing (WAS). Sub-plot treatments consisted of ten periods of weed interference. Data collected on pepper stand count, fruit count and weed dry matter production were subjected to analysis of variance and treatment means were separated using Duncan's Multiple Range Test at $P \leq 0.05$. The results showed that six-week old pepper seedlings at transplant performed better in establishment and yield than the four-week old. Twelve weeks weed free situation is needed in transplanted pepper for yield loss less than 5 %.

Introduction

In Nigeria, pepper (*Capsicum spp.* L.) is massively produced from the Northern States even though it grows well in the South West States and to a lesser extent in South Eastern States. China is the largest producer of pepper with 10million tonnes. It is followed by Mexico and Turkey with 1.9 tonnes and 1.5 tonnes, respectively. Nigeria and Ghana top tropical production with 715,000 tonnes and 270,000 tonnes, respectively as largest producers (IP, 2012). Pepper is used to make hot fresh sauce by crushing the green immature fruits or by cutting into small pieces and mixing them with lime juice, salt and peanut butter. Pepper fruits are usually used industrially as an ingredient of many products including canned fish, ginger beer and some pharmaceutical products (Grubben and El Tahir, 2004). Pepper seedlings are slow to establish resulting in initial poor competition with weeds for light, water, and nutrients hence delay in maturity and reduction in fruit yield. Weeds germinating during the first 6 to 8 weeks after transplanting can have serious consequences while the late emerging ones at 8 to 10 weeks could have less adverse effect on yield (Smith *et al.*, 2008). Of all the constraints limiting pepper production, weeds appear to have the most deleterious effect. (Adigun *et al.,* 1987). Weeds have been reported to cause yield reduction of between 43 and 90% (Lagoke *et al.,* 1988; Adigun and Lagoke 1996).

Materials and Methods

The experiments were conducted in the early and late wet seasons in 2012 at the Teaching and Research farms of the Federal University of Agriculture, Abeokuta (7^0, 20'N and 3^0, 23'E) altitude 140m above seas level. The experimental site is located in the forest-savanna transition zone of south-western Nigeria. The site received a total rain fall of 978.4 mm and 833.9 mm from April to October of the early wet season and June to December for the late wet season, respectively (Figure 1).

The experiments in both seasons were laid in a split-plot arrangement in a randomized complete block design in three replicates. The two main plot treatments were 4 and 6 weeks old pepper seedlings. The period of weed interference, consisting of two sets were assigned to the subplots. In the first set, the sub plots were kept weed free initially for 3, 6, 9 and 12 weeks after transplanting (WAT) of pepper seedlings, and subsequently left weed infested until final harvest. In the second set, the subplots were left weed infested initially for 3, 6, 9 and 12 WAT, and subsequently kept weed free until harvest.

The experimental site in each crop cycle was ploughed and harrowed at two weeks interval to destroy established vegetation, weed seedlings and produce a level, smooth and weed-free fields. Transplanting of 4-week and 6-week old pepper seedlings into appropriate plots, according to the treatments, was done at inter-row and intra-row spacings of 60 cm and 50 cm, respectively at one seedling per stand. Hoe weeding was carried out according to the treatment requirement using West African hand hoe. The weeding operation on each plot was preceded by collection of weed samples from $0.3m^2$ using systematic random sampling on the plots.

Weed samples were collected from quadrat size of 0.6m x 0.5m before every weeding according to the treatments. The samples were separated into grasses, broadleaves and sedges before oven drying at 70^0C until a constant dry weight was obtained and weighed. The samples taken from each plot were cumulatively added to the weed weight at the final harvest and used to determine total dry matter per treatment. Pepper stands and fruits were counted at harvest from the net plot ($5.4m^2$). Data collected were subjected to Analysis of Variance (ANOVA) according to the procedures of GENSTAT. Significant means were separated using Duncan's Multiple Rage Test at 5 % level probability.

Results and Discussion

Total cumulative weed dry matter increased with weed-infestation period from 3 WAT to 12 WAT and decreased with weed-free period from 3 WAT to throughout in both seasons (Table 1). The plots weed-infested for 12 and 15 WAT in both seasons as well as those kept weed-free for 3 WAT in the late season, in addition, had the highest total cumulative weed dry matter production. These were followed by values produced on the plots kept weed-free initially for 3 WAT and 6 WAT only in the early and late wet seasons, respectively. Generally, weed infestation in the early wet season was more than in the late wet season. The earlier emergence and subsequent establishment of weeds on the pepper during the early wet season compared with the late season could be attributed to conducive climatic conditions viz: rainfall and relative humidity which favoured rapid emergence of weeds and their subsequent growth. In contrast, early weed growth was not favoured at the commencement of the late wet season trial because of low soil moisture content as a result of dry spell within the first 10 days of transplanting. Furthermore, the additional land cultivation which occurred in the late season further destroyed new flushes of weeds, thereby reducing subsequent population that infested the crop. Similarly, Adigun *et al.* (1992) have attributed similar apparent and more serious effect of weeds on pepper to rapid weed growth occasioned by conducive climatic conditions such as temperature, rainfall and relative humidity.

Six-week old seedlings produced higher number of pepper stands in the late season and total fruit count in both seasons compared with the 4-week old (Table 1). The higher values in the six-week old pepper seedlings might be because the six-week old pepper seedlings had better developed root system to extract nutrients from the soil as well as more leaves that enhanced the ability of the plant to trap more light for photosynthesis compared with the four-week old. It had also been earlier reported that six-week old pepper seedlings at transplant had better productivity than the four-week old (Renuka and Perera, 2002; Shukla *et al.* 2011). Stand count significantly decreased with increasing period of weed infestation until 12 WAT and final harvest in the early season and late season trials respectively (Table 1). Generally, there were more pepper stands at harvest in the late wet season than in the early wet season. The higher intensity of rainfall which resulted in more pepper stand loss through lodging in the early wet season than late wet season was partly responsible for this. This result agrees with earlier report by Sanogo (2006) that loss of pepper plant stands occurred as a result of *Phytophthora capsici* infection which spread easily in the soil under high moisture content.

In the two trials, pepper plants kept weed free for 12 WAT and throughout had similar total fruit count that were higher than those of all the other weed interference periods except in the late wet season when count on plots weed infested for 3 WAT was comparable to the maximum (Table 1). In the early wet season, total fruit count decreased significantly with increase in weed infestation period up to 9 WAT and increased with weed free periods up to 12 WAT (Table 1). In this study, pepper plants kept weed free initially for 9 WAT in both seasons as well as those left weed infested initially for 3 WAT and subsequently kept weed free throughout had higher number of fruit than those kept weed free initially for 3 WAT only and those weed infested for 6 WAT and more. This is because pepper needs a weed free situation beyond the first three weeks after transplanting for acceptable performance of the crop. Adigun *et al.* (1992) had earlier reported that early removal of weeds at 3 WAT may not obviate subsequent high infestation of weeds. Uncontrolled weed resulted in 93.5 and 89.7 % reduction in total fruit count compared with maximum of plots kept weed free throughout crop life cycle in the early and late wet seasons, respectively.

Highest pepper fruit loss of 38.95% and 30.63 %, occurred from 3 to 6 WAT and 9 to 12 WAT in the early and late wet seasons, respectively (Figures 1 and 2). The early onset of the critical period in the early wet season could be attributed to early weed infestation as a result of favourable environment for the weeds. In similar trials conducted in the wet season at Samaru and under irrigation in the dry season at Kadawa, Adigun *et al.* (1992) observed that the period between 3 and 6 WAT was most critical when sweet pepper initially weed infested had the greatest fruit loss. However, the same authors observed that the period between 6 and 9 WAT was most critical when irrigated pepper had the greatest fruit loss due to initial weed infestation.

Conclusion

This study showed that six-week old pepper seedlings at transplant resulted in better establishment and higher fruit yield than the four-week old. Thus pepper seedlings should be better transplanted at 6 weeks old. Also 12 weeks weed free period enhanced desired fruit yield of higher than 95 % in transplanted pepper.

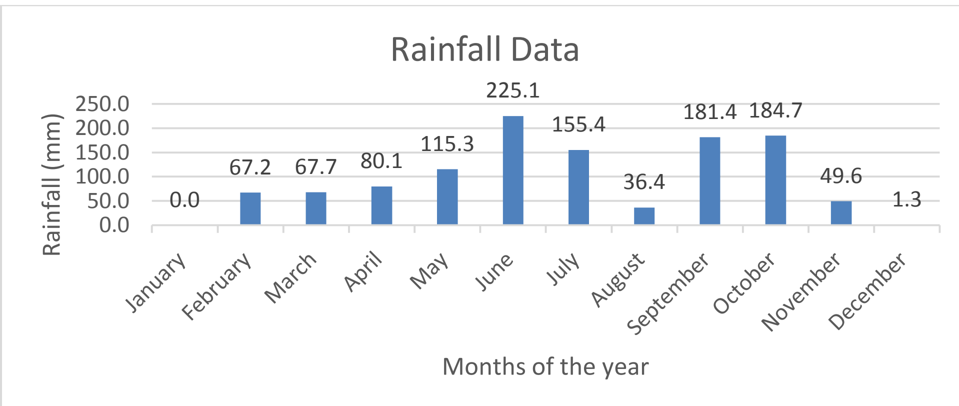

Figure 1: Monthly weather data during the experiment at Federal University of Agriculture, Abeokuta, Ogun State in the early and late cropping seasons of 2012.

Source: Department of Agro Meteorology and Water Resources Management, Federal University of Agriculture, Abeokuta, Ogun State

Table 1: Effects of age of seedling at transplant and period of weed interference on pepper stand, fruit count and weed biomass in 2012 early and late planting seasons at Abeokuta

Treatments	Pepper Stand Count at Harvest (x000/ha)		Total Fruit Count at Harvest (x000/ha)		Total Cumulative Weed biomass (kg/ha)	
Age of seedling at transplant (A)	Early	Late	Early	Late	Early	Late
4 WAP	19.98	23.54 b	566.2b	736.7b	6068	5679
6 WAP	19.62	24.52 a	675.3a	802.3a	5923	5754

SE	0.46 ns	0.24	17.27	0.75	133.8	185.6
Period of Weed Interference (P)						
Weed infested for 3 WAT	24.28 a	27.78 a	850.0bc	1145.1a	1955 f	1871 d
Weed infested for 6 WAT	21.50 b	24.07 b	388.9e	835.4c	4207 e	4130 c
Weed infested for 9 WAT	9.47 c	20.87 c	151.1f	576.9d	8106 c	6522 b
Weed infested for 12 WAT	8.91 cd	17.59 d	133.3f	221.0e	10923 a	10053 a
Weed infested throughout	6.58 d	12.96 e	76.7f	119.3f	10795 a	10431 a
Weed free for 3 WAT	25.92 a	26.75 a	565.6d	564.6d	10009 b	9994 a
Weed free for 6 WAT	26.03 a	27.16 a	802.2c	860.5c	7246 d	7313 b
Weed free for 9 WAT	24.89 a	27.57 a	924.4b	1067.9b	4458 e	4698 c
Weed free for 12 WAT	25.92 a	27.06 a	1148.9a	1144.9a	2045 f	1898 d
Weed free throughout	24.48 a	27. 26 a	1186.7a	1159.5a	211 g	255 e
SE	0.82	0.54	49.07	30.04	236.44	277.02
SE Interaction (AxP)	1.55 *	4.91 *	69.40ns	19.01ns	334.38	81.47

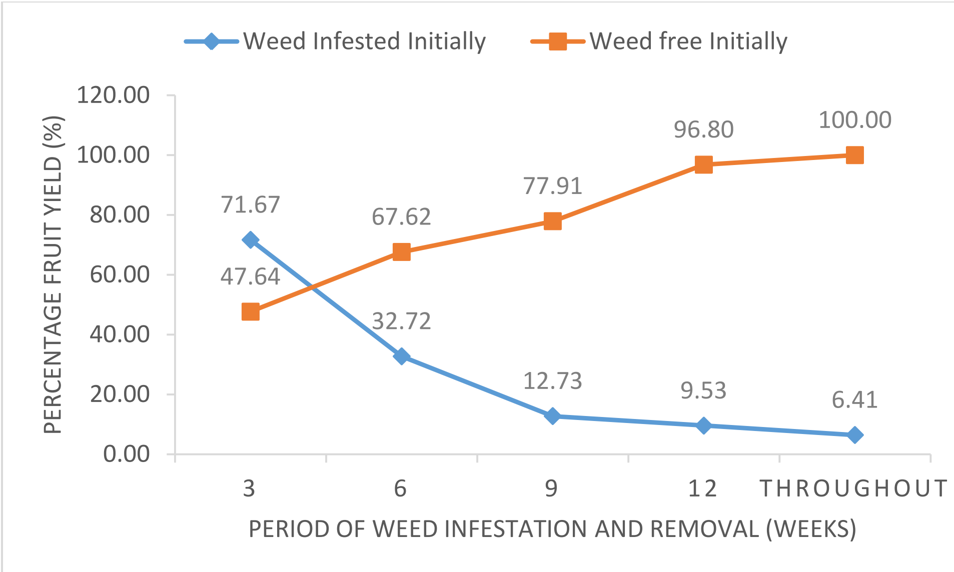

Figure 1: Effect of period of weed infestation and removal on percentage total fruit count of in 2012 early wet season

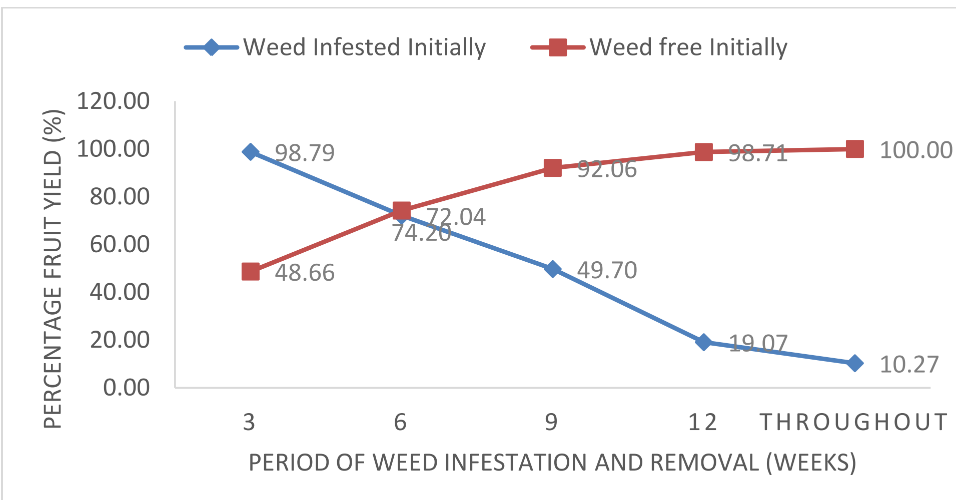

Figure 2: Effect of period of weed infestation and removal on percentage total fruit count of in 2012 late wet season at Abeokuta

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Root Nodules Activity, Growth and Yield of Cowpea as influenced by NPK and Poultry Manure application

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Abstract

This Green House study was carried out in Akanu Ibiam Federal Polytechnic, typical of the tropical rain forest zone to investigate the combined effect of Poultry manure and NPK fertilizer on the biological activities of root nodules, growth and yield of cowpea. The experiment consisted of 27 treatments, corresponding to three rates (0,1 and, 2, t/ha) poultry (PM) and three rates of NPK (0, 1, and 2t/ha), arranged factorially in a completely randomized design (CRD) with three replications. Post-harvest soil samples were collected from each pot and subjected to soil chemical analysis according to standard methods. Results showed that the treatments both single and interaction significantly ($P<0.05$) influenced the percent nodule activity. While nodule activity increased with poultry manure application, a decreased trend was observed with increased NPK application. Similarly, number of nodules and pods increased with increase application of poultry manure. Treatment combination of 2tonha^{-1} poultry manure and 1tonha^{-1} NPK gave the most appreciable improvement on biological percent nodule activity, number of nodules and yield of cowpea and is therefore recommended.

Keyword: Nodule activity, Cowpea, Poultry manure and NPK fertilizer

Introduction

Nitrogen is the most important nutrient element required by crops (Brady and Weil, 2008). Wide spread deficiency of nitrogen has been reported in many tropical soils, especially in the humid tropical zones due the high leaching that accompanies the heavy tropical rains (Osodeke, 1996). This has made nitrogen one of the most limiting nutrient element in tropical soils and therefore necessitates continues external nitrogen fertilizer inputs to ensure sustained crop production. One of the most viable and cost effective means of enriching the soil with nitrogen is through the biological nitrogen fixation by the Rhizobia inhibiting the root nodules of leguminous plants (Azu *et al*., 2018). Rhizobia are groups of bacterial that forms association with roots of legumes and fixe free atmospheric nitrogen converting them to useable forms (Brady and Weil, 2008). The Rhizobium activity which is enhanced by the presence of leguminous plant and organic matter is determined by colour of the interior of the nodules. Reports have shown that legumes are self fertilizing groups of plants in terms of nitrogen input (Osodeke, 2002). Azu *et al*.,(2018), reported significant increase in the number of nodules in some legumes due to organic manure input. This study only related the number of nodules with manure application, but failed to give information on the root nodule activity which is of most important as it provides an index on the nitrogen fixing capacity of the Rhizobium within the root nodule. This study was therefore designed to determine the nodule activity in cowpea in soils treated with different rates of NPK fertilizer and poultry manure in Unwana, southeastern Nigeria.

Materials and Methods

A pot experiment was carried out in the Green House of Akanu Ibiam Federal Polytechnic Unwana, tropical rain forest zone of Nigeria (coordinates: latitude $5^{0}48'$N and longitude $7^{0}55'$E). The air temperature is generally high all year round and the current temperature range is 32^{o}C -21^{o}C with total annual rainfall exceeding 3,500 mm (Njoku *et al*., 2006). Soil samples were collected with the soil auger from the Polytechnic multi-purpose farm at 0-20cm depth. This was air dried, sieved with 2mm sieve, after which sub-samples of 5kg each were weighed into 12L capacity plastic buckets perforated at the bottom to allow for air and water movement. The experiment consisted of 27 treatments, corresponding to three rates (0,1 and, 2, t/ha) of poultry (PM) and three rates of NPK (0, 1, and 2t/ha), arranged factorially in a completely randomized design (CRD) with three replications. Seeds of cowpea were obtained from the National Seed Service, Umudike, Abia State. Planting was done two weeks after soil amendment. Two seeds were sown per hole in each bucket and later thinned down to one seedling per stand after two weeks of germination. At 10 weeks after sowing (WAS), the plant from each pot was uprooted, cleaned and washed to remove soil particle. Each nodule was cut open with a clean blade and the interior colour recorded. The interior colour gives an indication of the nitrogen fixating abilities of the Rhizobium within the nodules and the colours can be red, brown, black, white or green. Active nodules are those whose interior colours are pink, red, brown or white. The percent nodule activity was obtained mathematically with:

$$\% \text{ Nodule Activity} = \frac{\text{N0 of Active Nodules}}{\text{Total N0 of Nodules}} \times \frac{100}{1}$$

Soil Chemical Analysis: Post-harvest soil samples were collected from each pot and the following chemical analysis were carried out:Soil pH (Udo, *et al*.,2009), org. C (Pansu and Gautheyrous, 2006), total N (Udo *et al.,* 2009), Available P (Bray and Kurtz, 1945) ECEC (Udo, et al.,2009)and base saturation was obtained mathematically with:

$$\text{B5(\%)} = \frac{\text{Total cations}}{\text{ECEC}} \times \frac{100}{1}$$

Statistical Analysis: Data generated from the study were subjected to analysis of variance (ANOVA) and the means separated using FlsD.0.05.

Result and Discussion

Physical and chemical properties of the soil and poultry manure used for the study

Table1. Some physical and chemical properties of the soil and PM used for the study.

Properties	Values	PM
Sand (%)	38.41	-
Silt (%)	26.77	-
Clay (%)	34.82	-
Texture	Clayey – loam	-
pH (H_2O)	4.10	7.10
pH ($Cacl_2$)	3.92	6.65
Org. C. (%)	1.43	4.11
Org. M (%)	2.47	
Total N (%)	0.16	2.90
Av. P (mg/kg)	9.27	22.12
Ca (cmol. /kg)	2.03	6.00
Mg (cmol. /kg)	1.10	3.13
K (cmol. /kg)	0.12	1.12
Na (cmol. /kg)	0.01	0.12
Exc. Acidity	2.19	-
ECEC	5.45	-
B.S%	59.82	

The physical and chemical properties of the soil used for this study is shown in Table 1 below. The textural class was a clayey – loam with pH values of 4.10 and 3.92 in water and $Cacl_2$ respectively. Both organic carbon and organic matter were low (1.43 and 2.47 %) respectively. Generally, the soil was low in nitrogen, available phosphorus, and basic cations indicating low fertility. Results showed that the pH value of the PM was high. Organic carbon, organic matter, basic cations, available P and nitrogen were appreciably high in the PM, indicating its potentials as soil fertility management resource. Thus, it is expected that, the high nutrient content in PM will have the potentials of establishing greater improvement on both the physical and chemical conditions of the soil under study and the yield of cowpea.

Effect of poultry manure and npk on soil chemical properties

The effect of poultry manure and NPK fertilizer is presented in table 2 below. Results showed that the amendments significantly influenced the soil properties both as lone and combined treatments. Relative to control, pH improved with treatment applications and the rate of improvement increased when the two materials were combined.

Table 2. Effect of Poultry manure and NPK on soil chemical properties

Treatments	Soil Properties										
PM + NPK	pH		OC	OM	TN	AP	TEB	TEA	ECEC	BS	
	H_2O	$Cacl_2$	%	%	%	mg/kg		Cmol/kg			%
0 + 0	5.12	4.58	1.02	1.76	0.11	12.54	4.27	2.06	6.33	67.49	
0 + 1	5.02	4.22	1.14	1.98	0.34	12.20	4.31	2.14	6.46	66.81	
0 + 2	5.01	4.39	1.14	2.14	0.47	11.45	3.98	2.23	6.21	64.04	
1 + 0	5.76	5.04	1.48	2.55	0.18	17.97	4.67	1.42	6.10	76.65	
1 + 1	5.20	4.62	1.48	2.56	0.38	25.42	4.92	1.07	6.00	82.11	
1 + 2	5.65	4.83	1.46	2.53	0.81	19.92	4.27	1.36	6.63	75.94	
2 + 0	6.40	5.81	1.86	3.22	0.31	27.08	4.80	0.90	5.69	84.21	
2 + 1	6.10	5.19	1.62	2.81	0.48	31.55	5.11	0.97	6.08	84.05	
2 + 2	6.01	5.00	1.53	2.64	0.88	23.94	4.69	1.10	5.80	80.99	
Mean	**5.59**	**4.65**	**1.42**	**2.47**	**0.44**	**20.23**	**4.56**	**1.47S**	**6.032**	**75.81**	
LSD(0.05)PM	0.069	NS	0.205	0.383	0.031	0.927	0.050	0.082	0.156	1.100	
LSD(0.05)NPK		O.069	NS	NS	NS	0.031	0.927	0.050	0.082	0.156	1.100
(PM X NPK)	0.120	1.053	0.355	NS	0.053	1.606	NS	0.143	0.270	1.906	

Treatment combination of 2tonaha^{-1} PM and 1 tonsha^{-1} gave the best result. Other studies have reported better improvement on soil pH when mineral and organic manures are combined (Azu et al., 2018; Ano and Asumugha, 2000). Apart from organic matter and total exchangeable bases where interactions were not significant, all other soil fertility variable studied showed significant effect with interaction between the two fertilizer materials.

Effect of Poultry manure and NPK fertilizer on the Number of pods, nodules and nodule activity.

Improvements on the number of pods consequent of poultry manure and NPK fertilizer application were observed in this study (Fig.1). However, these increases were not proportional to rate of amendments. The lone application of poultry manure consistently increased the number of pods, but increased addition of NPK as lone treatment resulted in a decreasing trend. Other studies have reported similar trend in yields of legumes when organic and inorganic fertilizers are applied singly in a farming system (Osodeke, 2002; Azu, 2017; Azu, 2018). The abundance of organic matter and nutrients especially organic phosphorus in poultry manure which limits fixation of phosphorus (Azu *et al*., 2018) might have factored more in fruit and seed formation (Brady and Weil, 2008) as seen in this study. It was also observed that the plants responded better in terms of pod production as a result of the interactions between the two amendments. Consequently the pot that had 2tha-^{1} poultry manure and 1tha^{-1} NPK had the highest number of pods.

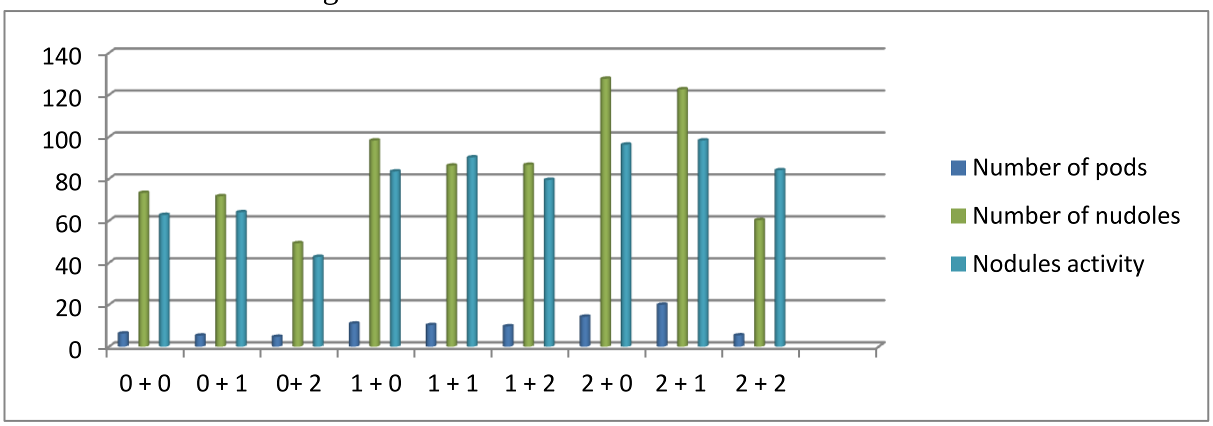

Figure 1. Number of pods, nodules and nodule activity as influenced by PM and NPK addition

Similarly, the number of nodules followed the same trend with number of pods. Value ranged from 127.7 (in pot that had only 2tha^{-1} poultry manure) and 49.30 (in pot that had 2tha^{-1} NPK only), (Fig 1). This showed a clear evidence of the superiority of poultry to NPK fertilizer in nodule formation and thus nitrogen economy of the soil. Panda et al., (2012) have similarly reported a boost in the effectiveness of rhizobium in legumes. In addition to other elements, the abundance of organic phosphates in poultry manure and when mineralized enriches the soil with available P that enhances nodulation in legumes (Osodeke, 2002; Azu, 2017; Naveenkumar *et al.*, 2015). Therefore the nodules produced by the plant that had 2tha-1 poultry manure were significantly higher than the other. Nodulation in legumes has been known to require initial nitrogen to boost the process, after which continuous addition of mineral nitrogen may adversely affect the nitrogen fixing organisms, thus compromising the process of nodulation (Naveenkumar *et al.*, 2015). The nodule activity which was determined by colour of the interior of the nodules is presented in fig 1. Significant effects on nodule activity with the addition of poultry manure and NPK fertilizer as lone and combined treatments were observed. Also, lone application of poultry manure was superior to lone application of NPK in improving the nodule activity in the plant, showing the importance of organic matter in Rhizobial activity (Brady and Weil, 2008). High application of mineral nitrogen fertilizers has been reported to have negative effect on nodulation (Pommeresche and Hansen, 2017). However, the interaction between the two amendments showed superior effect on nodule activity compared to lone application of each, thus the highest nodule activity of 98.30% was obtained in the pot that had 2tha^{-1} poultry manure and 1tha^{-1} NPK. Previous works on organic and inorganic fertilization on the soil have found superiority of combined application of organic and inorganic fertilizer to single application of ether of them on rhizobial activity (Pommeresche and Hansen, 2017, Azu *et al.*, 2017).

Conclusion

Results showed that the combined application of poultry manure and NPK increased the yield of cowpea. On the other hand, nodule activity increased consistently with increased poultry manure application. However, 2tha-1 poultry manure and 1tha-1 NPK was superior in influencing both the yield properties and nodule activity in cowpea and is therefore recommended. Thus farmers are encouraged to take a closer look at the root nodules and become more familiar with the process of nitrogen fixation and its relevance in organic farming and to improve on the process using organic means.

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Antifungal potential of some plant extracts on anthracnose disease of *Leucaena leucocephala*

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Abstract

Anthracnose and leaf spot are two of the major diseases of *Leucaena leucocephala* and losses due to these diseases have an enormous impact on its production. *L. leucocephala* is a medium sized fast growing tree which belongs to the family Fabaceae. It is planted as a shade tree for cash crops; for soil fertility improvement; erosion control; site preparation in reforestation and also used as fodder for cattle. The study aimed at assessing the efficacy of aqueous and ethanol plant extracts; *Azadirachta indica, Chromolaena odorata* and *Zingiber officinale* for control of anthracnose in *L. leucocephala* caused by *Colletotrichum gloeosporioides*. The extracts were prepared by weighing 25, 50, 75 and 100 g of thoroughly crushed leaf materials of the three tree plant species were soaked in 100 ml of distilled water and 100 ml of ethanol to obtain 25, 50, 75 and 100 % concentration each respectively. The diameter of radial growth of *C. gloeosporioides* on the control plates was measured at regular intervals of 24 hours for 5 days and the mean was calculated which was used to calculate the percentage inhibition. The results show that the plant extracts and the solvent used has antimicrobial activity against the test organism, though there was variation in their efficacy. Increase in extracts concentration led to increase in percentage inhibition. Ethanol extracts had higher percentage inhibition as against aqueous extracts. *A. indica* exhibited the highest antifungal activity on the test pathogen. It can therefore be inferred from this study that these plants have antimicrobial properties which can help in combating *C. gloeosporioides* and serve as an alternative to inorganic pesticides.

Keywords: Antimicrobial, plant extracts, antifungal activity, pesticides

Introduction

Leucaena leucocephala is a medium sized fast growing tree which belongs to the family Fabaceae and has multiple common names by which it is known such as White Lead tree, White Popinac, Jumbay, and Wild Tamarind (Meena Devi *et al*., 2013). It is native to Southern Mexico and Northern Central America and now it has naturalized in many tropical and sub-tropical locations. It is estimated to cover 2-5 million ha worldwide (Awe *et al*., 2013) since it spreads naturally like a weed. It grows up to 20m height with leaves looking like that of tamarind having white flowers tinged with yellow, and having long flattened pods. Seeds are dark brown with hard shining seed coat. It is planted as a shade tree for coffee, cacao, and other cash crops; for soil fertility improvement; erosion control; site preparation in reforestation and used for a variety of other purposes including timber and fuel wood (Aderibigbe *et al*., 2011). The protein-rich leaves and legumes are widely used as fodder for cattle, water buffalo, and goats. The leaves and seeds are also used as human food in Central America, Indonesia, and Thailand but are not recommended for extensive human consumption because of the mimosine toxic component (Aderibigbe *et al*., 2011).

Medicinally, it has been used for its antimicrobial, anthelmintic, antibacterial, anti-proliferative and antidiabetic, anticancer, cancer preventive, diuretic, anti-inflammatory, antioxidant; antitumor, antihistaminic, and also for its nematicide, pesticide, anti-androgenic, hypo- cholesterolemic, and hepatoprotective properties (Zayed and Benedict, 2016). The kernel of seeds contains more than 20% oil and it can be used as a bio energy crop. The seeds may also be used as concentrates for dairy animals, as manure, as a protein source, as an oil seed and as a potential source of commercial gum (Meena Devi *et al*., 2013).

Anthracnose and leaf spot are one of the major diseases of the crop under high rainfall conditions. No precise estimates of losses due to these diseases are known. About nine species of Colletotrichum have been recorded on legume crops worldwide, including *C. capsici, C. coccodes, C. crassipes, C. dematium, C. destructivum, C. gloeosporiodes, C. lindemuthianum, C. trifolli* and *C. truncatum* (Devanshi, 2017).

Since the use of synthetic or inorganic pesticides is known to pose threats to ecosystems, environment and humans, there is need for research on alternative methods which are safer, more efficacy, economical, and eco-friendly to control plant diseases.

The study therefore aimed at assessing the efficacy of plant extracts for control of anthracnose in *L. leucocephala* caused by *C. gloeosporioides* and to analyze the consistency of the best treatments in relation to different concentrations.

Materials and Methods

Study area and sources of materials used

The experiment was carried out at the pathology section of Forestry Research Institute of Nigeria (FRIN), Ibadan. Oyo state. Fresh leaves of three tree which are; *Azadirachta indica, Chromolaena odorata* and *Zingiber officinale* were collected from FRIN, Ibadan, and identified by a botanist. After thorough washing with distilled water, leaves were air-dried, ground with a warring blender into fine powder and stored in clean dry bottles.

Preparation of aqueous and ethanol solvent extracts

The extracts (*Azadirachta indica, Chromolaena odorata* and *Zingiber officinale*) were prepared by weighing 25, 50, 75 and 100 g of powdered leaf materials, soaked in 100 ml of distilled water and 100 ml of ethanol to obtain 25, 50, 75 and 100 % concentration each respectively. Materials were left for 7 days at room temperature. After that, extracts were filtered through 4 layers of sterile muslin cloth followed and centrifugation at 3,500 rpm for 20 minute. The supernatants solution was collected and stored in sterile containers.

Isolation and identification of pathogens.

Infected necrotic leaves of *L. leucocephala* were collected from the field. The diseased portions of the leaves were cut into 0.5 cm pieces and surface sterilized by 1% sodium hypochlorite solution for 1 min and then thoroughly rinsed with sterilized distilled water. These pieces were aseptically placed on potato dextrose agar (PDA) plates and incubated at 25±2°C for 7 days. The fungal colonies was sub-cultured on PDA plates till pure cultures of the pathogens were obtained. Identification of *C. gloeosporioides* were done using morphological and microscopic characteristics.

Determination of the efficacy of plant extracts used against *C. gloeosporioides*

Evaluation of extracts against *C. gloeosporioides* was carried out using pour plate method (Adepoju *et al*., 2014). Two millilitre (2 ml) of each extract was aseptically added to 20ml of sterilized and cooled PDA in a Petri dish, which has been gently agitated and allowed to solidify. Mycelial discs of *C. gloeosporioides* were prepared using a sterilized 5 mm diameter cork borer from the tips of 7 days old fungal culture and placed in an inverted position on the extract-amended PDA. Each treatment was replicated three times while the petri plates without extract but with 2 ml of sterile distilled water served as control. Plates were incubated at room temperature for 7 days. The radial mycelia growth was recorded at 7 days after inoculation (DAI), when the upper surface of the control treatment was fully covered with the mycelia of the pathogen.

Determination of Percentage Inhibition

The diameter of radial growth of *C. gloeosporioides* on the control plates was measured at regular intervals of 24 hours for 7 days and the mean was calculated and designated as X. The radial growth on each experimental plate was also measured and the mean calculated and designated as Y. The percentage inhibition of the pathogen by the test extracts was calculated using the formula described by Choudhary *et al.,* (2017) as follows:

$$\mathbf{I} = \frac{\mathbf{X-Y}}{\mathbf{X}} \times \mathbf{100\%}$$

X= mean radial growth on control plates. Y= mean radial growth on experimental plates

Data collected were subjected to analysis of variance to determine significant differences among the treatments.

Results and Discussion

Aqueous extract

The antifungal activity of aqueous extracts of all the three plants; *A. indica*, *Chromolaena odorata* and *Z. officinale* were significantly different ($p > 0.05$) and also significantly higher ($p < 0.05$) at 100% extract concentration (Table 1). All extracts used had higher antimicrobial activity than the control which is sterile distilled water. While the lowest percentage inhibition was recorded at 25% conc. Of all the extracts used, *A. indica* had the highest percentage inhibition and percentage inhibition increased with increase in concentration

Ethanol extract

The antifungal activity of ethanolic extracts of all the three plants; *A. indica*, *Chromolaena odorata* and *Z. officinale* were significantly different ($p > 0.05$) and also significantly higher ($p < 0.05$) at 100% extract concentration (Table 2). All extracts used had higher antimicrobial activity than the control which is sterile distilled water. While the lowest percentage inhibition was recorded at 25% conc. Of all the extracts used. *A. indica* had the highest percentage inhibition and percentage inhibition increased with increase in concentration.

Table 1: Antimicrobial activity of aqueous extracts of *Azadirachta indica, Chromolaena odorata* and *Zingiber officinale* against Mycelial Growth of *C. gloeosporioides*

Percentage mean zones of inhibition of aqueous extracts

Concentration (%)	***Azadirachta indica***	***Chromolaena odorata***	***Zingiber officinale***
25%	50.88^{d}	23.08^{d}	15.03^{b}
50%	52.49^{c}	27.54^{c}	18.33^{a}
75%	61.24^{b}	30.30^{b}	20.91^{a}
100%	63.41^{a}	32.09^{a}	23.36^{a}
Control	0.00^{e}	0.00^{e}	0.00^{c}

Means with the same alphabets across columns are not significantly different ($P \leq 0.05$)

Table 2: Antimicrobial activity of ethanolic extracts of *Azadirachta indica, Chromolaena odorata* and *Zingiber officinale* against Mycelial Growth of *C. gloeosporioides*

Concentration (%)	***Azadirachta indica***	***Chromolaena odorata***	***Zingiber officinale***
25%	68.68^{c}	30.44^{c}	16.67^{b}
50%	72.51^{b}	36.63^{b}	18.80^{b}
75%	74.27^{b}	48.09^{a}	21.77^{b}
100%	84.23^{a}	48.83^{a}	27.35^{a}

Control	0.00^{d}	0.00^{d}	0.00^{c}

Means with the same alphabets across columns are not significantly different (P≤0.05)

The results show that the plant extracts and the solvent used has antimicrobial activity against *Colletotrichum gloeosporioides*, though there were variations in their efficacy. The differences observed in the antimicrobial activity of the plant extracts can be attributed to variations in the strength of the active ingredients present in each plants, the solubility of the active compounds in the solvent used and also the presence of inhibitors (Adeniyi and Joseph, 2015).

A. indica had the highest percentage inhibition on the test pathogen, this corroborates the findings of Leontopoulos *et al*., (2017) that reported that both aqueous and non-aqueous extracts of *A. indica* tissues present an excellent potential disease control against important soil borne pathogens. Since plants are rich in a wide variety of secondary metabolites with antimicrobial properties, such as tannins, terpenoids, alkaloids and flavonoids (Bankole *et al*., 2018). Nduagu *et al*., (2008) also reported that the potency of *A. indica* can also be attributed to the presence of the compound Azadirachtin.

Adjei (2011) also reported that both aqueous and ethanol extracts of *A. indica* and *C. odorata* proved to be fungitoxic on *Botryodiplodia theobromae* when used to inhibit its mycelial growth.

Zingiber officinale also had significant effect on *Colletotrichum gloeosporioides*, though not as high as other extracts used. This is in line with the findings of Alves *et* al. (2015) in his research on control of anthracnose in bell pepper using garlic, ginger, and mallow aqueous extracts. He reported that ginger extracts exhibited high degree of efficacy for most of the isolates of *Colletotrichum* species.

Conclusion

Researches has proven over the years that many plants have antimicrobial properties which helps in combating pathogenic organisms hence improving plant health, productivity and human health at large and as such these extracts can be used in lieu of pesticides since they are environmentally friendly.

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Feed Intake and Growth Performance of Growing Kano Brown Bucks Supplemented with Urea or Poultry Litter Treated Maize Cob Diet

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Abstract

A study was conducted at the Teaching and Research farm of the Department of Animal Science, Bayero University Kano to evaluate feed intake and growth performance of Kano Brown Bucks supplemented diets containing maize cob treated with urea or poultry litter. Nine Kano Brown bucks with an average initial weight of 9.4 kg aged between 7-8 months were randomly allocated to three dietary treatments each comprising three replications. The experimental animals were allowed to grazed freely in the day time and upon return in the evening were offered 3% of their body weights as supplement. Animals placed on treatment A were supplemented with diet comprising maize cob treated with 2.5% per 100 kg urea while animals on treatment B were supplemented maize cob treated with poultry litter at 0.75% per 100 kg inclusion level while animals on treatment C were not offered any form of supplementation and served as the control. Feed intake was monitored daily throughout the experimental period which lasted four weeks and the results revealed significance ($P<0.05$) in terms of dry matter (94.7-90.2%), ash (3.0-6.0%), crude protein (23.0-20.0%), crude fibre (30.4-34.5%), ether extract (4.5-3.4%), nitrogen free extract (38.9-35.7%), acid detergent fibre (41.5-47.5%) and neutral detergent fibre (62.5-73.0%). Animals supplemented with maize cob treated diets with urea showed higher mean feed intake of (0.99 kg). There was no significant ($P>0.05$) difference in terms of live weight gain. However, animals supplemented with urea treated maize cob maintained their weights relative to animals on treatment B and the control which decreased in weight. It is therefore concluded that supplementing maize cob treated with urea or poultry litter would maintain the weight of growing Kano Brown bucks during the peak period of rainy season. It is thus recommended that similar studies be conducted on small ruminants throughout the seasons to ascertain the optimal season in which supplementation would be effective.

Introduction

Cost of feed accounts for about 70% of the total cost of livestock production. The use of conventional feedstuff such as maize, soybean cake, fish meal and others as supplement to low quality feed may not be cost effective in present day Nigeria owing to their high cost, irregular supply and the competition both with humans and monogastric animals (Akinmutimi, 2004). It is in this respect that non-conventional energy and protein feed materials of farm and agro-industrial wastes origin are presently being utilized for livestock production in Nigeria.

According to Kossila (1985), Crop residues have been estimated to account for about 24 percent of the total feed energy suitable for ruminant livestock in both developed and developing countries. "Agricultural waste" is increasingly being viewed as a valuable resource though they are usually fibrous, with poor quality nutrients which make their digestibility low. In Nigeria, there are more than 21 million tonnes of crop by-products produced annually, among them is the corn crop residues which include; green corn, corn Stover, corn stalk and corn cobs. Biochemically treated maize cob meal is a high-quality feed that contains a high concentration of energy, protein and some mineral elements. The use of urea or ammonia, lye solution and poultry litter to upgrade the nutritive value of straws and other low quality crop residues have been used worldwide in the last three decades. Urea and poultry litter are the most commonly used. Inexpensive non-protein nitrogen (NPN) is an alternative source and attractive protein replacement compared with tremendously expensive natural proteins. Using urea and poultry litter to upgrade the nutritive value of maize cobs could help to enhance the utilization of maize cobs as protein rich resources for small ruminants when feed scarcity is high and of serious concern.

Objectives of the Study

The objectives of the study were to evaluate:

- **i.** The feed intake and weight gain of Kano Brown bucks supplemented with diets containing maize cob treated with urea or poultry litter.
- **ii.** The growth performance of Kano Brown bucks supplemented with maize cob treated with urea or poultry litter.

Materials and Methods

Description of the Study Area

The study was carried out at the Teaching and Research farm of the Department of Animal Science, Bayero University Kano. Kano State is situated in the Sudan Savannah Agro-ecological zone of Nigeria. It lies approximately between latitudes 10°30'N and 12°38'N, and longitudes 7°45'E and 9°29'E. The area is characterized by wet and dry climate. The wet season lasts from May to mid-October with a peak in

August while the dry season extends from mid-October of one calendar-year to mid-May of the next. The annual mean rainfall is between 800 mm to 900 mm; and variations about the annual mean values are up to ± 30%. The mean annual temperature is about 26°C (Falola, 2002; Olofin, 2008).

Experimental Animals

Nine (9) growing Kano Brown bucks between the age of 7-8 months were sourced from the Department of Animal Science, Bayero University Kano livestock farm with an average weight of 9.4 kg. The bucks were distributed into three Treatment groups and nine Replicates, with each Treatment group having three Replication. Treatment A and B were offered supplement while Treatment C were allowed to graze with no supplementation which served as a control. All the animals were tagged for ease of identification

Experimental Feed

The test materials (maize cob) and poultry litter were obtained from the Centre for Dryland Agriculture farm. Bayero University, Kano. The maize cob was chopped into smaller pieces so as to ease intake and the poultry litter were shade dried as a processing method. Two diets (Treatment A and B) were formulated with Treatment A having maize cob treated with 2.5% per 100 kg urea and treatment B maize cob treated with 0.75% per 100 kg poultry litter.

Table 1: Gross Composition of the Experimental Diet

Ingredients	**Inclusion level(%)**	
	Treatment A	**Treatment B**
Maize cob	3	3
Poultry litter	0	0.75
Urea	2.5	0

Feeding of Experimental Animals

The experimental animals were allocated into three treatment groups. Animals placed on treatment A were supplemented with maize cob treated urea, those on treatment B were offered maize cob treated with poultry litter while those on treatment C were without any form of supplementation. The supplement were given to the bucks in the metabolic pen measuring 2m* lm. All experimental animals (bucks) were allowed to graze in the morning hours and in the evenings the bucks in treatment A and B were offered 3% of their body weight. The following morning, left over was weighed and intake was computed as the difference between feed offered of the experimental diets (Kg) and leftover (kg). This was throughout the experimental period which lasted for four weeks.

Results

Proximate and Fibre Fraction of Experimental Diets

The results of proximate and Fibre Fractions of the Experimental Diets is presented in Table 2. Results obtained indicated increase in crude protein content by treating with urea. However, treating maize cob with urea or poultry litter reduced crude fibre, acid detergent fibre, neutral detergent fibre while nitrogen free extract content was increased.

Table 2: Proximate and Fibre Fractions of Experimental Diets and untreated maize cob

Parameters (%)	Treatments		
	A	B	C
Ash	3.00^{b}	6.00^{a}	7.00^{a}
Dry matter	94.75^{a}	90.25^{b}	90.50^{b}
Crude protein	23.02^{a}	20.24^{b}	21.33^{ab}
Crude fibre	30.47^{c}	34.59^{b}	38.39^{a}
Ether extract	4.55^{a}	3.45^{c}	3.90^{b}
Nitrogen free extract	38.97^{a}	35.73^{a}	29.38^{b}
Acid detergent fibre	41.50^{c}	47.50^{b}	52.50^{a}
Neutral detergent fibre	62.50^{c}	73.00^{b}	76.50^{a}

a,b,c means in the same row with different superscript are significantly different($P<0.05$)

Key: Treatment A= Urea treated maize cob, Treatment B= Poultry litter treated maize cob and Treatment C= untreated maize cob

Weekly live weight changes of Growing Kano Brown bucks supplemented urea or poultry litter treated maize cob diet.

Results obtained with respect to growth performance revealed that bucks supplemented with maize cob treated with urea had decrease in weight at week one and two which later increased and was maintained at weeks three and four. The results on growth performance for experimental bucks supplemented with poultry litter treated maize cob revealed similar trend of decrease in weight at week one and two while there was increase at week three and four. Results of the control based animals showed a contrary trend with weight maintained at week one and two while decrease was observed at week three and four.

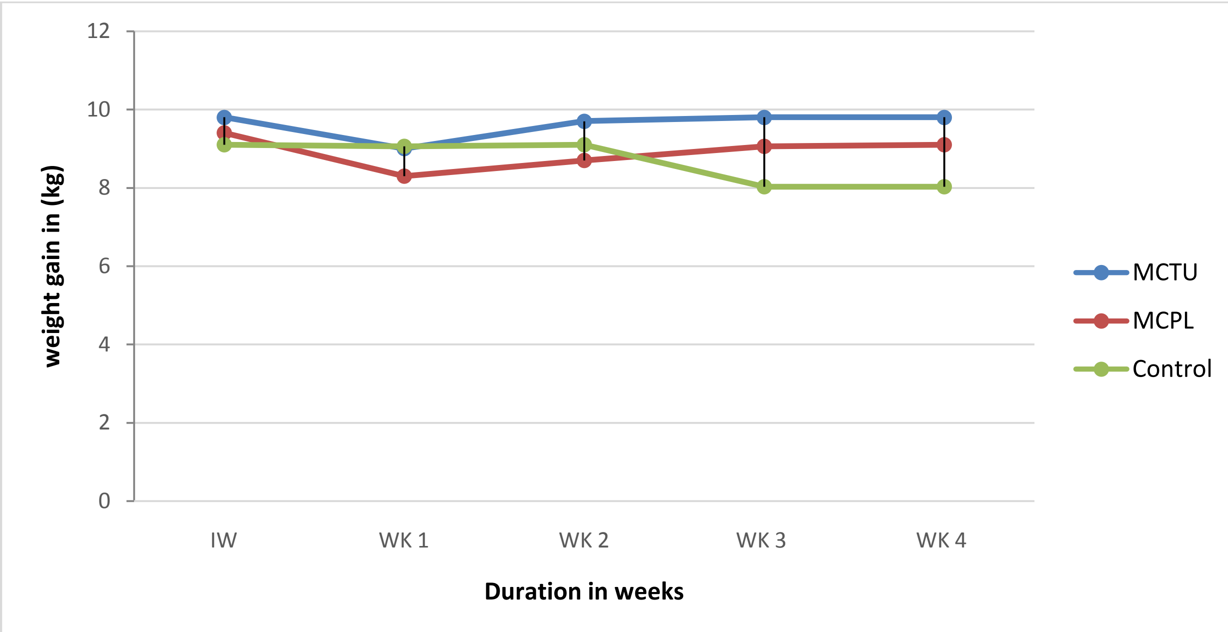

Figure 1: Weekly live weight changes of Growing Kano Brown bucks supplemented urea or poultry litter treated maize cob diet

Key

MCTU – Maize cob treated with urea

MCPL –Maize cob treated with poultry litter

Feed intake by Growing Kano Brown bucks supplemented urea or poultry litter treated maize cob diet.

The result on feed intake is presented in table 3. The result showed that experimental animals supplemented with urea treated maize cob diet had a relatively higher feed intake compared to those supplemented with poultry litter treated maize cob diets.

Bucks	**Feed intake (kg)**
Supplemented urea maize cob	1.01
Supplemented poultry litter maize cob	0.43

Table 3: Feed intake by Growing Kano Brown bucks supplemented urea or poultry litter treated maize cob diet

DISCUSSION

Proximate and Fibre Fractions of Experimental Diets

The concentration of proximate principles in untreated maize cob or urea treated maize cob obtained in the present study was almost comparable with the value reported by Akinfemi, Babayemi and Jonathan (2009); Adebowale (1985); Oji, Etim and Okoye (2007). The fibre fractions analysis of untreated maize cob or urea treated maize cob were in agreement with the observations of Akinfemi *et al*. (2009). But, the NDF value of untreated and urea treated maize cob was higher than that reported by Adebowale (1985).

Feed Intake

The values obtained in the present study was in agreement with the findings of Abdel Hameed *et al.*, (2013) who observed higher feed intake in maize husk treated urea than maize husk untreated but in disagreement with findings of Adebowale *et al.*, (2013) who observed higher intake in corn cob treated poultry litter silage diet by west African Dwarf goats.

Growth Performance

The result of the study with respect to liveweight changes by Kano brown bucks supplemented urea and poultry litter treated maize cob is in agreement with the findings of Adebowale *et al*. (2013) who fed corn cob silage treated with urea and poultry litter to West African Dwarf goats and observed higher weight gain in goat fed corn cob treated with urea silage diet than goat fed corn cob treated poultry litter silage diet.

Summary

The result of the study revealed that animals supplemented with maize cob treated diets with urea showed higher feed intake. While in terms of weight gain, bucks supplement urea treated maize cob had maintained their weight compare to treatment B and control which decreased in weight.

Conclusion

It is therefore concluded that supplementing maize cob treated with urea or poultry litter would maintain the weight of Growing Kano Brown Bucks during the peak period of rainy season. It is recommended that similar studies be conducted on small ruminants throughout the seasons to ascertain the optional season in which supplementation would be of effect.

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Assessment of Farmers' Perception of the Effects of Oil Spillage on Root and Tuber Crops Production in Bayelsa State, Nigeria

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Abstract

The study assessed farmers' perception of the effects of oil spillage on root and tuber crops production in Bayelsa State, Nigeria. Multi-stage sampling procedure was employed in the selection of 150 root and tuber crops farmers for the study. Data were collected through the use of structured questionnaires and were analyzed using descriptive statistics. The result revealed that 53.3% of the farmers were female, 76.7% were married and 61.3% of the farmers were members of cooperative society. Perception of the effects of oil spillage on farmers' farm land showed grand mean of 4.4, farmers' perception of the effects of oil spillage on their health showed grand mean of 3.7 and farmers' perception of the effects of oil spillage on crop production showed 3.9. This indicated that farmers had negative perception about oil spillage on their farm land, crop production and on their health. The study concluded that farmers had negative perception of effects of oil spillage on root and tuber crops production in Bayelsa State, on both farm land, health of the people and crop production. It is therefore, recommended that government and oil firms around the areas should partner together and give support to the farmers to enable them improve in production of root and tuber crops, improve their health and farm lands.

Key words: Farmers, Perception, Oil spillage, Root and Tuber Crops Production

Introduction

Agriculture has contributed immensely to the economic stability of Nigeria and constitute the largest economic activity in the Rural area where almost 50% of the population reside. It is an important sector in economic development and poverty alleviation drive for many developing countries in West Africa. The production of root and tubers crops is very important in agricultural sector. They are staple food crops, being the source of daily carbohydrate intake for the large populace of the world. The term refers to any growing plant store edible materials in subterranean root, corm or tuber (Oke, 1990).

The consequences of oil spillage on agricultural production, the environment and humans are enormous. Anejionu *et.al., (*2015) observed the negative effects of oil pollution on agriculture and lamented that most of the farmlands are destroyed and rivers polluted leading to the death of fishes; and most farmers and fishermen are thrown into confusion and joblessness. In fact, the germination, growth performance, and yield of crops are stifled by oil spillage (Osuoke, 2014). The issue of environmental sustainability cannot be over emphasized in the Bayelsa State as this is fundamental to the overall wellbeing and the development of the area especially the wellbeing of future generations which is an important aspect of environmental economics. According to Owolabi (2014), the Niger-Delta region of which Bayelsa State is part of, is dominated by rural communities which were endowed with favourable natural conditions, depend chiefly on farming and fishing. Poor people are vulnerable to environmental dynamics because social, political and economic exclusion indicates they are left with few choices about where they live. Hence, they bear the adverse effects of natural hazards, biodiversity loss and forest depletion, pollution and negative impact of industrialization vis-à-vis oil exploration. Irrespective of the studies by (Inoni, Omotor, and Adun, 2013); There is need to investigate and assess farmers' perception of effects of oil spillage on root and tuber crops production in the study area, which may serve as guide for extension work for future agricultural development and food production in the study area. Hence, the study to assess farmers' perception of effects of oil spillage on root and tuber crops production in Bayelsa State. Specific objectives are to describe the socioeconomic characteristics of the farmers; ascertain farmers' perception of effect of oil spillage on farm land; ascertain farmers' perception effect of oil spillage on health of the people; ascertain farmers' perception effect of oil spillage on crop production; determine challenges faced by farmers in the area and determine remedies to improve the production of root and tuber crops in oil spilled area.

Methodology

Multistage sampling procedure was adopted in the study. Bayelsa State is situated in Niger Delta region located between Latitude $04°15^1$N and $05°23^1$N and between Longitude $05°22^1$E and $06°45^1$E. It is one of the six states that make up the south-south geopolitical region of Nigeria and has boundaries with Rivers State in the east, Delta State in the North and Gulf of Guinea in the West and South. It has a total land area of 21,100sq.km with a population density of 188 persons/km^2 (Bayelsa State Government, 2010). The first stage was purposive selection of five Local Government Areas (LGAs). This is because of the high level of oil production activities in the area and the fact that agricultural production is the major occupation of the people. The second stage involved a random selection of two communities from each LGA making a total of 10 communities. The third stage involved a random selection of one village from each of the community giving a total of 10 villages that were involved in the study. The final stage involved a random selection of 15 smallholder farmers of root and tuber crops from each of the selected villages giving a total sample size of 150 farmers used for the study. List of ADP registered small scale farmers served as sample frame. The primary data were collected using structured questionnaire and data were analyzed using descriptive statistics such as frequency, percentages and mean score.

Results and Discussion

Table 1 shows the socioeconomic characteristics of respondents. The result revealed that 53.3% of the respondents were females. This indicated the dominance of females in staple food production in the study area, there is evidence that women's role in agriculture is growing, with women increasingly involved in production for the market (FAO 2011). With regard to marital status, 76.7% of the respondents were married. The result also showed that 50.7% of the farmers had farm size ranges from 1-2ha. This is in consonance with Nnabuenyi (2013) who observed the negative effects of oil spillage on agriculture and lamented that most of the farmlands are destroyed and rivers polluted. This implied that there will be scarcity of land to cultivate crops. The result also showed that most of the farmers (33.3%) were experienced in farming between 3-6 years and 7-10 years respectively. Most of the respondents (72%) were visited by extension agents. The extension agents are very important personnel because they supply information on the mode of application or use of recommended technologies to the farmers (Ekpe and Obeten, 2002).

Table: 1 Distribution of Respondents according to Socioeconomic Characteristics n = 150

Variables	Frequency	Percentages
Sex		
Female	80	53.3
Male	70	46.7
Marital status		
Single	35	23.3
Married	115	76.7
Member of cooperative		
Yes	92	61.3
No	58	38.7
Farm size		
<1	67	44.7
1-2	76	50.7
3 and above	7	4.6
Farming experience		

1-2	23	15.3
3-6	50	33.3
7-10	50	33.3
11 and above	27	18.0
Extension agent visit		
Yes	108	72.0
No	42	28.0

Source: Field survey, 2016

Table 2 shows farmers' perception of the effect of oil spillage on farmers' farm land. The gravity of the effects of oil spillage on farm land was great. This was evidenced by the fact that all the parameters under consideration were significant. The greatest effect on the farm land was low land productivity with mean of 4.9. Other effects of the oil spillage on the farm land included degradation of farm land and increased soil toxicity with mean 4.7 respectively, reduction of soil fertility with mean of 4.6, increase soil temperature with mean 4.3, poor soil aeration with mean 4.2 and destruction of soil structure with mean 4.1. The grand mean score showed 4.4, indicating negative perception of the effect on the farm land. This result is in line with Ahmadu and Egbodion (2014) who examined the effect of oil pollution on farm land, the results showed that the major significant effects of oil spills on staple food crop production perceived by the farmers included increased soil temperature and toxicity, reduction of soil fertility and low land productivity.

Table 2: Farmers' Perception of the Effect of Oil Spillage on their Farm Land (n= 150)

Variables	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Mean
Reduction of soil fertility	103(515)	47(188)	0(0)	0(0)	0(0)	4.6*
Poor soil aeration	75(375)	55(220)	0(0)	20(40)	0(0)	4.2
Degradation of farm land	98(490)	52(208)	0(0)	0(0)	0(0)	4.7*
Increase soil temperature	51(255)	45(180)	39(117)	15(30)	0(0)	4.3*
Increase soil toxicity	112(560)	38(152)	0(0)	0(0)	0(0)	4.7*
Destruction of soil micro-organisms	63(315)	42(168)	21(63)	24(48)	0(0)	3.9*
Destruction of soil	76(380)	32(128)	23(69)	19(38)	0(0)	4.1*

structure						
Low land productivity	135(675)	15(60)	0(0)	0(0)	0(0)	4.9*
Grand mean						4.4

Source: Field Survey, 2016 Negative perception ≥ 3.00. Positive perception ≤ 3.00. Bench mark mean of 3.00.

Table 3 shows distribution of respondents according to farmers' perception of the effect of oil-spillage on their health. The result identified contamination of surface water with mean 4.8 as the most significant perception. This is closely followed by the respiratory disorder with mean 4.4. Others are gastroenteritis with mean 3.8, skin disorder with mean 3.7, cancer and eye disorder were with mean of 3.6 while the least important perception is child mortality with mean 2.8. The grand mean showed 3.7. It implies that there are numerous consequences of oil spillage to the health of farmers. This finding is in consonance with the studies in many parts of the world that suggest that living near oil spills and petroleum production sites is an environmental stressor that can have adverse effects on health, well-being, and quality of life (Tasman, 2013).

Table 3: Farmers' Perception of the Effect of Oil Spillage on their Health (n =150)

Variables	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Mean
Fever	6(30)	54(216)	84(252)	5(10)	1(1)	3.4*
Gastroenteritis	18(90)	100(400)	20(60)	12(24)	0(0)	3.8*
Respiratory disorder	76(380)	66(264)	6(18)	2(4)	0(0)	4.4*
Cancer	24(120)	54(216)	70(210)	2(4)	0(0)	3.6*
Death	26(130)	38(152)	52(156)	26(52)	8(8)	3.3*
Eyes disorder	14(70)	82(328)	46(138)	8(16)	0(0)	3.6*
Contamination of surface water	134(670)	14(56)	2(6)	0(0)	0(0)	4.8*
Skin disorder	10(50)	90(360)	46(138)	4(8)	0(0)	3.7
Child mortality	32(160)	18(72)	28(84)	42(84)	30(30)	2.8
Grand mean						3.7

Source: Field Survey, 2016 Negative perception ≥ 3.00. Positive perception ≤ 3.00. Bench mark mean of 3.00.

Table 4 shows distribution of respondents according to their perception on the effect of oil-spillage on root and tuber crops. The effect of oil spillage on crops was enormous. This was evidenced by the fact that all the parameters under consideration were significant. The most significant effect on root and tuber crops planted was crop failure with mean 4.5. Other effects included stunted growth and crop leaves appears burnt were with mean of 4.2, yellowish of leaves, poor crop yield, rotten tuber and wilting of crop were with mean of 3.9 while outbreak of disease was the least with mean 3.1. The grand mean was 3.9. showing negative effect of oil pollution on crop yield. This result is in line with Ahmadu and Egbodion (2014) who examined the effect of oil spills on crop, the results showed that the major significant effect of oil spills on root and tuber crops production perceived by the farmers include total crop failure which was the most significant effect of the oil spillage on the crops, followed by poor yield, rotting of the cassava tubers, stunted growth, yellowing of the crop leaves and wilting of crops.

Table 4: Farmers' Perception on the Effect of Oil Spillage on Root and tuber Crops (n=150)

Variables	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Mean
Yellowing of leaves	22(110)	104(416)	22(66)	2(4)	0(0)	3.9*
Stunted growth	48(240)	90(360)	10(30)	2(4)	0(0)	4.2*
Crop failure	94(470)	44(176)	10(30)	2(4)	0(0)	4.5*
Poor crop yield	100(500)	38(157)	8(24)	2(4)	2(2)	3.9*
Rotten tuber	44(220)	66(264)	30(90)	2(4)	8(8)	3.9*
Wilting of crop	44(220)	74(296)	18(54)	6(12)	8(8)	3.9*
Crop leaves appear burnt	48(240)	86(344)	12(36)	4(8)	0(0)	4.2*
Outbreak of crop disease/pest	8(40)	26(104)	96(288)	16(32)	2(2)	3.1*
Grand mean						**3.9**

Source: Field Survey, 2016 Negative perception ≥ 3.00. Positive perception ≤ 3.00. Bench mark mean of 3.00.

Conclusion

The study concluded that farmers had negative perception of effects of oil spillage on root and tuber crops production in Bayelsa State, on both farm land, health of the people and crop production. It is therefore, recommended that government and oil firms around the areas should partner together and give support to the farmers to enable them improve in production of root and tuber crops, improve their health and farm lands.

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Evaluation of water use efficiency on the growth and yield of tomato (L*yconpersicon esculentum*) under greenhouse condition

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Abstract

The study was carried out to evaluate water use efficiency of tomato ((*Lyconpersicon esculentum,*UC82B) under greenhouse condition with specified objectives to compare the yield of tomato under various water conditions. Five (5) treatments were conducted in the greenhouse, this includes plant height and stem diameter under treatments water conditions (T1 T2 T3 T4 and T5), data were recorded base on the treatment (120% was applied for T1,100% of water was applied on T2,80% of water on T3,60% of water was applied for T4 and 40% of water was applied for T5).Graph were used to determine the average plant height and diameter of tomato, it was shown from study that the plant height of tomato as indicated in T1 has the maximum value of 5.64cm and T5 has the minimum value of 3.47cm ,base on the stem diameter T1 also has the maximum value of 3.07cm and T5 has the minimum value of 2.36cm.The result indicate that T1 has the maximum value of 2.2yields(ton/ha) and T5 has the minimum value of 1.5yield(ton/ha).The result further indicate that T5 has the maximum 46.81Water Use Efficiency (WUE)(kg/m3) and T1 has the minimum value of 20.37 Irrigation Water Use efficiency (IWUE) (Kg/m3) respectively. The study concluded that the volume of water absorbed by the plant determined the growth and yield of tomatoes, the higher the volume of water supplied, the higher the growth and the yield of tomatoes in the greenhouse. The study recommended that adequate and regular water should be supplied for proper evapotranspiration of tomatoes in the greenhouse so as to enhance the growth and the yield of the tomatoes.

Keywords: Water Use, Efficiency, Tomato, Growth, Yield and Greenhouse.

1.0 Introduction

Tomato (*Lycopersicon esculentum.* UC82B*)* exhibit medicinal qualities as evident in its flavonoid, carotenoids, Vit, A, Xanthins, luteinmVit. C and potassium contents (GURA, 1995; AVRDC, 2005). The present World fresh tomato fruit production stands at 100 million metric fresh tons. However, Nigeria ranked the 13th among the fifteen top countries accounting for 1.7% of the World index (FAO, 2010) compared with China of production capacity rated 33.9% despite Nigerian's good weather that accommodates and support vegetables cultivation especially tomato. Generally, tomato production in Africa was 300,000 ha, about 7.7% of the World total and rated the 8th largest exporter of the 10 World leading continents. Strikingly, tomato production in Nigeria appears very low in terms of yield per hectare (20 t/ha) (Balarabe, 2012),compared with Brazil (60.7 t/ha), China (48.1 t/ha), USA (81.0 t/ha) and Italy (50.7 t/ha). This trend in Nigeria could possibly be due to unavailability of inputs like improved seeds, fertilizer, irrigation and greenhouse facilities. (Balarabe, 2012).

Tomatoes are not tolerant of chilling injury with commercial cultivars sensitive to temperatures below 15°C throughout all stages of plant development (Foolad and Lin 2001). Temperatures in the original South and Central American environment produce an average minimum day temperature of 19oC with an average minimum night temperature of 15°C (Picken *et al.*, 2006). The soils in the native range of the tomato are relatively dry. Although tomatoes now thrive in temperatures between 10°C and 30°C they are not frost tolerant and are generally not tolerant of waterlogged soil conditions (Picken *et al* ., 2006).

The amount of water required for Tomato (*Lycopersicon esculentum.* UC82B) farming has not been giving proper attention, many farmers have access to low amount of water required for its production, water is essential andnecessary for tomato farming in the greenhouse, substandard water channel and has led to low production of tomato (*Lycopersiconesculentum.*UC82Bin Nigeria (Ozbahce and Tari, 2010). The level of irrigation system and strategy adopted in the greenhouse, this result to stunted growth of tomato, and quantity of tomato in the greenhouse. Most subsistence farmers cannot cover this cost up front, of water system require for greenhouse, even though this cost is substantially less than traditional method of irrigation in the greenhouse.

The main objective of this study is to evaluate water use efficiency of tomato under greenhouse condition, to achieve this, the plant height; stem diameter and yield of tomatoes under treatment of various water conditions were considered.

There is need to determine the amount of water required for tomato farming in the greenhouse, the irrigation need to be considered in other to obtained desirable, good, quantity and quality amount of tomato (*Lycopersiconesculentum.*UC82B) in the greenhouse, the amount of water required for greenhouse system need to be determine. The project will serve as a means to sensitize people on greenhouse system as an economical means of irrigation methods under tomatoes production.

2.0 Materials and Methods

The study was conducted in a greenhouse structures of Federal College of Forestry Mechanization, Afaka Kaduna, Igabi local government area, which is located in northern guinea savanna in the northern region of Nigeria. It also falls within a coordinates 10^{o} $47^{'}$ N and 7^{o} 40E.

Greenhouse Structure: A green house (also called a glass house, or if with sufficient heating, a hothouse) is a structure with walls and roofs made chiefly of transparent materials, such as glass, in which plants requiring regulated climatic conditions are grown. These structures vary in sizes form small sheds to industrial-sized buildings. The area of the greenhouse used for this study is 300 m^2.

Tomatoes seed: Tomato is the product planted in the greenhouse house, the tomato seed is red in colour, spherical in shape and has a tendency of germination.

Compost Manure: These are collected poultry dung filled in an open pit and watered continuously for about a period of seven month in order to decompose completely.

Cement Bags: These are empty bags containing the planting medium (sand)

Sand: It is the planting medium used for the research.

Measuring Cylinder: A graduated cylinder, measuring cylinder or mixing cylinder is a common piece of laboratory equipment used to measure the volume of a liquid. It has a narrow cylindrical shape. Each mark line on the graduated cylinder represents the amount that has been measured.

Wheel Barrow: Used to convey sand into the greenhouse.

Fertilizer: N.P.K 15:15:15 was applied to the plant to enhance the yield and growth of the plant.

2.1 Design Method

Forty- five empty cement bags were collected and perforated inside the greenhouse. A shovel and wheelbarrow were used to collect and transport sand to the green house where it was mixed thoroughly on a clean surface with compost manure to ensure uniformity of soil for better yield and good farm management practices, so as to obtain a better result at the end of the research. Then, the perforated cement bags were filled with the soil to a depth of about 40-45cm. These Forty Five (45) bags were arranged in a five (5) columns and in nine (9) consecutive rows. The five columns represented the five (5) treatments T_1, T_2, T_3, T_4, and T_5 with three (3) replicate. The tomatoes seed was transplanted on 16th June, 2019 around 8:00am and at a sowing depth of 2.5-4cm to avoid late emergence.

2.2 Morphological and Phonological Parameters

***Plant height (cm)*:** Individual stand of tomato plant was tagged in order to ease locating the plant taking the readings. A ruler was used to measure the heights of various plants from the ground to the tip of the leaves (all measurement in cm).

Fruit diameter: Fruits from tagged plants in each plot were randomly selected at each picking and their length (cm) was measured between two polar ends with the help of Vernier caliper

***Days of fruit picking*:** Day of the first picking was recorded at time of fruit ripening.

***Stem diameter*:** Individual stand of tomato plant was tagged in order to ease locating the plant taking the readings. Vernier caliper was used to measure the diameter of various stem (all measure in cm).

2.3 Calculations

Monthly Evapotranspiration (mm)

June=4.17,   July=3.82, August =3.69, September =3.97, October =4.74

Note: T = treatment, r = radius, d.p = decimal places, L= litres, ET_O = Evapotranspiration

T_1 =120%, T_2=100% (Control), T_3=80%, T_4=60%, T_5=40%,

D= 31.7cm, monthly

ET_O (JULY) = 3.82mm,   r= $\frac{31.7\text{cm}}{2}$=15.8

Area = πr^2=3.142 × $(15.85)^2$=789.34cm^2

Depth ≡ETO,   VOL=Area × depth

July =789.34cm^2× 0.382cmConversion $Cm^{3\rightarrow}$litre (÷ 1000)

$\frac{301.53}{1000}$ = 0.30153=0.300L to 3.d.p

Table 1:   Volume of Water Use On Different Treatment Of Three Month

Month	**Treatment Volume (L)**				
	120%	**100%**	**80%**	**60%**	**40%**
July	0.360	0.300	0.240	0.180	0.12
August	0.340	0.290	0.232	0.174	0.116
September	0.372	0.310	0.248	0.186	0.124

3.0 Results and Discussion

The tomato was planted in the bed for about 4 weeks after germination, the tomato was later planted in the cement bags in the greenhouse, data was recorded after two weeks of transplanting in the greenhouse system. Five (5) treatment were conducted in the greenhouse, these includes (T_1, T_2, T_3, T_4, and T_5), data were recorded base on the treatment (120% was applied for T_1, 100% of water was applied on T_2, 80% of water was applied for T_3, 60% of water was applied for T_4 and 40% of water was applied for T_5 respectively.

Water Use Efficiency (WUE) is defined as the ratio of yield (kg) to its total applied water (m^3). Water use efficiency will be calculated as: ***Water Use Efficiency (WUE) =*** Yield (Kg)

Total water applied (m^3).

(Silva and, Giordano, 2000).

The tables below shows the recorded values of the plant parameters measured on three different replicate for several weeks.

***Monthly Evaporation (ET_O)*:** Monthly Evapotranspiration is an average value of data collected for any month as each month differs in value from each other. Evaporation is an important process in the water cycle because; it is responsible for 15% of the atmospheres water vapour. Without that input of water vapour, clouds could not form and precipitation would never fall. Evapotranspiration is the combined name for the process of evaporation and transpiration. It varies because of a multitude of factors like wind, temperature, humidity and water availability. When water vapour is released into the atmosphere both processes are involved, so they have been combined into one word to cover all bases.

***Water Consumption of Different Treatment*:** The amount of water used for growing these crops from the day of showing to the harvest period is shown in table .1, .2 and .3. These significant differences among the treatment reflected on its yield. Table 4.4 also, shows the length, diameter, and weight of the harvested tomatoes under the various treatments.

***Yield*:** The sum of all picking crops production was expressed as a total fruit yield. It is a measure of crops capacity to convert water into plant biomass or grain. Yield in term of fresh fruits was largely affected by the level or differences of applied water (Tab.6). The treatment, T1 (120%) showed a higher yield than other treatments due to lower stress. Excessive or discontinuous feeding of water affects negatively the yield even within controlled treatment. It is expressed in kg/m^2 or kg/pot. (FAO, 2012)

***Water Use Efficiency (WUE)*:** This is the ratio between yield and water consumption during the growing period. Treatments with lower supply of water will show higher water use efficiency, although, the difference between treatments was significant. It is expressed in kg/m^3.

Length and Diameter of Tomatoes under different treatment.

From the table2**,** the average length of tomatoes T1 has the maximum value of 5.64cm andT5 has the minimum value of 3.47cm. From the above graph the diameter of tomatoes T1 has the maximum value of 3.07cm andT5 has the minimum value of 2.36cm.

Table 2: Showing Average Length and Diameter of Tomatoes under different treatment.

Treatment %	**Length (cm)**	**Diameter (cm)**
T1	5.64	3.07
T2	4.88	3.01
T3	3.59	2.50
T4	3.86	2.68
T5	3.47	2.36

Water Consumption of the different treatment

From the table 3, T1 has the maximum

average value of 10.8 Litre and T5 has the minimum average value of 3.6 Litre.

Table 3: Water Consumption of the different treatment

Treatment %	Water Consumption (L)
T1	10.8
T2	9.0
T3	7.2
T4	5.4
T5	3.6

Irrigation Water Use Efficiency (IWUE)

This is the ratio between yield and volume of water used. It is expressed in kg/m^3. The irrigation water use efficiency is shown in (Table 4). The maximum and minimum value recorded was 46.8kg/m^3 and 20.37 kg/m^3 under treatments (T5 andT1 respectively).

Table 4: Irrigation Water Use Efficiency (IWUE)

Treatment %	IWUE (Kg/m^3)
T1	20.37
T2	21.11
T3	25.00
T4	29.60
T5	46.80

Relative yield of different treatment

From the table 5, T1 has the maximum average value of 2.2 (ton/ha) and T5 has the minimum average value of 1.5 (ton/ha).

Table 5: Relative yield of different treatment

Treatment %	Yield(ton/ha)

T1	2.2
T2	1.9
T3	1.8
T4	1.6
T5	1.5

Plant Height and Number of Branches

From table 6 the plant height of tomatoes T1 has the maximum average value of 98.1cm and T5 has minimum average value of 86.8. Table 5 also showed the number of branches, T1 has the maximum average value of 98.1 and T5 has minimum average value of 86.8.

Table 6: Average of Plant Height and Number of Branches

Treatment %	Plant height (cm)	No of Branches
T1	50.7	98.1
T2	46.8	94.1
T3	30.9	90.8
T4	38.6	95.8
T5	29.0	86.8

4.0 Conclusion

It could be seen from the findings that the length of tomatoes has indicated that T1 has the maximum average value of 5.64cm and T5 has the minimum average value of 3.47cm, based on diameter T1 also has the maximum average value of 3.07cm and T5 has the minimum average value of 2.36cm. The result indicate that T1 has maximum average value of 2.2 yields (ton/ha) and T5 has the minimum average value of 1.5 yields (ton/ha) respectively. The result further indicated that T5 has the maximum average value of 46.8IWUE (Kg/M^3) and T1 has the minimum average value of 20.37IWUE (Kg/M^3). The study concluded that the volume of absorbed by the plant determine the growth and yield of tomatoes, that means the higher the volume of water supply, the higher the growth and the yield of tomatoes in the greenhouse.

The study recommended that the adequate and regular water should be supplied for proper evapotranspiration of tomatoes in the greenhouse so as to enhance the growth and the yield of the tomatoes. There should also be regular and adequate maintenance of the greenhouse, this will prevent intruders, pests and diseases, and to improve the structural standard of the greenhouse.

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A comparative study of Post-harvest physiological deterioration of twenty-four cassava genotypes

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Abstract
Cassava (*Manihot esculenta*) is the most important root crop in the tropics due to its drought tolerance, ability to grow in poor soils, and resistance to diseases. Cassava is well suited for cultivation by subsistence farmers. However, its use and expansion are constrained by rapid physiological postharvest deterioration (PPD), which often starts within 24 hours after harvest. Presented here is the use of a standard visual assessment (Wheatly) method. PPD of twenty-four cassava roots from different sources of germplasm were evaluated at 5, 10, 15 days after harvest at room temperature using analysis of variance technique (ANOVA). The result showed that genotype NR100433 is "naturally tolerant" to PPD at 15 days after harvest.

Key words: Post-harvest physiological deterioration (PPD): Cassava genotypes.

Introduction
Cassava (*Manihot esculenta***)** is grown in developing countries of Africa, Asia and Latin America. (Gulick, Hershey & Esquinas Alcazar, 1983). The crop is mostly cultivated by the poorer sections of the population as an affordable, nutritional staple food. Cassava can grow under diverse conditions such as low soil fertility, high acidity soil and drought, where other crops like maize cannot grow. There are about 10,000 varieties cassava with different characteristics (Andres & Dimuth, 2011). The crop is one of the most important staple foods with about 93% of the production used for human consumption (Nweke, Spencer & Lynam, 2002). With the rapid increase of the population in the 21st century, it is estimated that food production must be doubled by the year 2025, and will nearly tripled by 2050 in order to meet food needs in the future. Cassava, with its unique advantages is heavily constrained by postharvest physiological deterioration. There are several factors inhibiting cassava production, but the short shelf life of its roots due to Post-harvest Physiological Deterioration (PPD) is a major inhibiting factor (Uarrota *et al.*, 2016). Described as an endogenous disorder unique to cassava storage roots, PPD is characteristically rapid, occurring within 3 days after harvest and reducing considerably the crops root palatability and commercial utilization (Reilly *et al*, 2007). When the storage root is mechanically damaged, during harvest, a blue back discoloration extends from the wound site and spreads throughout. This discoloration is attributed to the oxidation of phenols, mediated by peroxidase(Xu *et al.*, 2013). Proven means of delaying PPD in cassava storage roots and largely maintaining their quality include coating in paraffin wax, storing in plastic bags and freezing at 4°C (Zidenga *et al.*, 2012). But these techniques have not been widely adopted because they are expensive and impractical for such a low-cost commodity. The focus of some breeding programs in Africa, is developing cassava cultivars with delayed PPD onset. Therefore, the specific objective of the study was to assess the rate of Postharvest

physiological deterioration among twenty-four (24) newly developed cassava genotypes on 5, 10 and 15 days after harvest.

Materials and Methods

Twenty-four (24) cassava accessions from the genetic resource unit at National Root Crops Research Institute (NRCRI) Umudike Abia State, were evaluated for PPD onset at 5, 10 and 15 days after harvest (DAH). At twelve months after planting, roots were harvested and commercial sized roots of more than 18cm, with no mechanical damage were selected. The proximal and distal ends were cut till the remaining root section was at least 15cm long. This induces the onset of PPD. The distal end of the root was covered with PVC film to maintain the moisture content and inhibit the development of deterioration from that end of the root. Physiological deterioration developed only from the proximal end. The selected roots where stored at room temperature, away from sunlight, until the day of evaluation. The PPD values were expressed in percentages. The data were logit transformed before analysis and back-transformed using expit transformation. Data were subjected to analysis of variance (ANOVA), and the means were compared by Tukey`s HSD test at 5% probability. Normality of the residuals and equality of variance were also tested as a diagnostic check for ANOVA using Shapiro-Wilk test statistic and Levene test statistics respectively. All analysis was run on the open source R environment, version 3.6.2.

Results and Discussion

The diagnostic check results showed that the residuals are normally distributed (p-value > 0.05) and there is no difference between the variances in the population. See Table 1. The scores of PPD among the twenty-four cassava genotypes on 5, 10, 15 days after harvest were statistically significant by Tukey`s test at 5% probability. This collaborates the findings of Buschmann et al., (2000) that there are variations in degree of development and severity of PPD among cassava genotypes (Table 2). All the cassava genotypes considered except NR060333, CR528-26, NR110176, NR110257 and NR1S10046 had low PPD values (below 20%) at five days after harvest. At ten days after harvest, cassava genotypes CR44-6, MM96JW1, NR060251, NR100325, NR100433, NR110376 and TMS011797 had low PPD score (20% or lower).

At fifteen days after harvest, genotype NR100433 had a PPD score of 9.45% (less than 10%), suggesting that this genotype could be classified as ‘naturally tolerant’ to PPD. TMS011797 had low PPD score of 14.60 % (lower than 20%). The genotype NR100433 with high tolerance to PPD, had white pulp. However, our result does not corroborate the observation of Sanchez *et al*., (2006), who reported a higher tolerance to PPD in genotypes with high carotenoid contents. The result is also in contrast with the findings of Sayre et al., (2011); Gloria and Uritani (1984) who reported that carotenoid level in tissue quenches ROS (reactive oxygen species) produces during PPD and has reported to extend shelf life of cassava roots. The genotype TMS011797, with high tolerance to PPD, had creamy pulp. This result agrees with that of Sanchez *et al*., (2006).

Table 1: Diagnostic test results.

Assumption Test		**5DAH**	**10DAH**	**15DAH**
Shapiro-Wilk	W	0.9904	0.9154	0.9047
	p-value	0.7196	0.0809	0.0504
Levene Test	F value	1.3473	0.3296	0.7585
	p-value	0.2984	0.8538	0.5682

Table 2: PPD evaluation scores of 24 cassava accessions at 5, 10 and 15 days after harvest.

Genotypes	**5DAH**	**10DAH**	**15DAH**
COB-4-27	18.09	43.6	47.68
COB-5-01	2.79	22.55	26.95
CR44-6	5.82	18.5	47.61
CR528-26	34.17	49.7	54.28
MM96JW1	3.54	19.5	24.04
NR060251	7.32	18.49	21.2
NR060333	20.62	32	57.84
NR090142	13.43	25.84	52.24
NR090176	14	33.74	35.29
NR100325	3.12	6.42	20.21
NR100433	3.2	14.64	9.45
NR100449	7.55	31.11	39.81
NR110176	28.36	21.58	24.08
NR110179	4.95	26	35.71
NR110223	13.22	26.72	36.44
NR110228	10.93	32.72	39.94
NR110257	22.84	27.29	38.93
NR110372	17.92	26.44	45.24
NR110376	3.74	17.69	45.75
NR110490	8.32	33.5	54.94
NR1S10046	36.08	26.68	33.57
NR1S1018	1.14	20.49	55.35
TMS011797	13.42	5.09	14.6
TMS051740	6.25	22.13	43.54
LS	***	***	***
HSD	**2.728**	**1.72**	**1.894**

LS= level of significance; alpha level at 0.05; HSD= Honestly Significant Difference

Conclusion

The postharvest physiological deterioration (PPD) variability observe among the twenty-four newly developed cassava genotypes provides a good opportunity for improvement of cassava for PPD tolerance. The genotype NR100433 appeared to have the high PPD tolerance among others at fifteen days after harvest with a score of 9.45%.

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Assessment of fungi Associated with postharvest loss of ginger (*Zingiber officinale*) at 12th month after storage

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Abstract

An experiment was conducted to evaluate the fungi associated with postharvest loss of ginger rhizomes at 12th month after storage in NRCRI Umudike Nigeria, with the aim of developing a method which will permit the storage of ginger rhizomes for several months without loss in quality. The study included four storage methods viz., rhizomes kept in Sand layers on the ground, pit storage lined with sawdust, Bare cemented floor in a storage ban ,washed and placed on a sawdust under a tree shade. The seed rhizomes were treated with Z-force pesticide each replicated four times, with control (no seed treatment of z-force). All the treatments were analyzed for total colony counts of fungi and degree of disease occurrence/incidence. The results from treatment 1-5 showed the total fungi counts of the stored rhizomes ranged from 12.0 x 10^8cfu/g to 9.2x10^8cfu/g (rhizomes kept in Sand layers on ground) and 11.6x10^8cfu/g to 7.4x10^8cfu/g for (pit storage lined with sawdust), 14.1x 10^8cfu/g to 9.6 x10^8cfu/g , 6.5x10^8cfu/g and 4.0x10^8cfu/g and 34.5x10^8cfu/g to 15.5x10^8cfu/g . The result also revealed that the fungi counts decreased gradually with increase in storage time for treatment 1- 4, while treatment5 (control) showed an increase in fungal count ranging from 22.2x10^8cfu/g to 42.1x$10^{8\cdot}$cfu/g. A total of six fungi were isolated from the stored rhizomes. The fungi isolated were *Aspergillus niger*, *Fusarium oxysporum*, *Penicillium sp*, *Rhizopus sp*, *Pythium sp.* The degree of disease occurrence (percentage incidence) showed high frequency for *Aspergillus flavus*, *Aspergillus. niger*, *Fusariumoxysporum*, *Pythium sp* and *Rhizopus sp* in the stored ginger samples with *Fusarium oxysporum* having maximum predominance followed by *Pythium sp* and then *Aspergillus niger*. They were mostly dominant in treatment5 (50.0%, 47.0% and 35%) and treatment3 (30.0% and 20.1%) respectively. The ginger rhizome treated with z-force, washed and placed on a sawdust under a tree shade (treatment 4) was the most effective in maintaining the quality of ginger rhizomes in storage.

Introduction

Ginger (*Zingiber officinale*) is an important cash crop in Nigeria and is among the important and widely used spice crops throughout the world as reported by Hamza *et al.*(2013). Ginger is a multi-functional crop and its rhizome quality affects the economic return of the growers, establishment, growth and yield of the crop. In Nigeria, the ginger crop is named as “the crop against poverty” or “the cash in the bank”.

According to National Root Crop Research Institute (NRCRI, 2005), two varieties of ginger are popularly grown in Nigeria. These are yellow ginger (*Taffingiwa*) and black ginger (*Yaltsunbir*i). But during the storage period, seed rhizome is infested with several pest and diseases besides desiccation and sprouting. In situ storage (delayed harvest) method is prone to rhizome rot and harbour insect pests according to Rai and Hossain (1998). Similarly, in pit storage method, about 25 – 30% rhizomes rot in the pit itself and 10 – 15% rhizome sprout during storage are rendered useless for sowing as reported by Karuppaiyan *et al*., (2008). The recovery of healthy seed rhizome for planting in the coming season reduced considerable low, leading to poor crop's performance in the field. This multifunctional crop often gets spoilt, loses quality and deteriorated by fungi that caused rhizome product loss. Therefore, these problems can be solved by good management practices based on operational research. However, according to Rahman *et al*. (2007) storage of ginger in shaded places is economical. Thus, this research is aimed at assessment of fungi associated with postharvest loss of ginger (*Zingiber officinale)* at the end of 12th months after storage.

Materials and methods

The experiment was carried out in National Root Crops Research Institute, Umudike (NRCRI).

The various storage methods were carried out around the ginger ban environment of NRCRI Umudike.

The Laboratory analysis were carried out at the Microbiology laboratory in NRCRI, Umudike

Storage methods:

The storage methods with z-force treatment on the rhizomes were

Treatment1 = Sand layers on ground

Treatment 2 = Pit storage lined with sawdust

Treatment 3 = Bare cemented floor in a storage ban

Treatment 4 = Washed and placed on a sawdust under a tree shade

Treatment5 = Control (no seed treatment) .

The trial was conducted under ambient temperature and samples were taken from each treatment at 3 months intervals to monitor the quality of changes in stored seed rhizomes. At 3 months interval of storage, 10 ginger rhizomes were collected randomly from the different storage methods for microbial analysis and number of seed rhizomes that spoilt during storage were recorded until a year. At 12^{th} month of storage, the degree of disease occurrence/ incidence of the microbial rot isolated were analyzed.

Percentage incidence% = Total number of identified species x100

Total number of fungal colonies

Microbiological Analysis.

Isolation, characterization and identification of fungi and fungal count were done according to the method described by Ezeama (2007).

Result and Discussion

Fungal isolates

The genera of *Fusarium oxysporium*, *Pythium sp*, *Penicillium sp*, *Rhizopus stolonifer*,*Rhizocotinia Solani* and *Aspergillus sp* were isolated from stored ginger samples as shown (Table 1). These fungal genera were found to be associated with postharvest deterioration of *Zingiber officinale* rhizomes during storage. Results further showed that *Fusarium Oxysporium* was the predominant cause of ginger deterioration during Storage .This may be associated with the fact that *Fusarium Oxysporium* is soil-borne fungi according to NARI, (2004). Isolation of *Fusarium*, *Penicillium*, *Pythium* and *Rhizopus* from spoiled ginger rhizomes in this study is in line with the report Dohroo, (2005) who reported these species as a cause of post-harvest deterioration of ginger.

Percentage (%) incidence of fungi

In general, *Fusarium oxysporium* was found to be responsible for (30%) of deterioration of ginger rhizomes observed, followed by *Pythium sp* (20%) and *Rhizopus stolonifer*(18%). *Aspergillus niger*, *Rhizocotinia solanii* and *Aspergillus sp* were found to be responsible for 18%, 18% and 8%, of the incidence in spoilage observed respectively as shown in (figure1). Dohroo (2005) also reported 50% losses in storage by rhizome rot of ginger caused by *F. oxysporum*. *Penicillium sp* actually grows on ginger causing rot during postharvest storage (Overy and Frisvad, 2005). It has been reported that, storage rot of ginger was caused by *Pythium sp*. *Fusarium oxysporum* and *Sclerotium rolfsii* but the frequency occurrence of *Fusarium oxysporum* was maximum at (50%) among fungi causing storage rot of ginger in storage pits.

Fungal loads (cfu/g)

During storage, fungal load was increased. Deterioration of stored ginger in different samples were caused by diversified fungal groups (Table 2). The fungal count of the stored rhizomes ranged from 12.0 x 10^8cfu/g to 9.0x10^8cfu/g for treatment 1 and 8.5x10^8cfu/g to 6.5 x10^8cfu/g for treatment2, 15.0 x 10^8cfu/g to 9.4 x10^8cfu/g for treatment 3 7.1 x10^8cfu to 5.2x10^8cfu/g for treatment4 and 22.2x 10^8cfu/g to 42.1.x10^8cfu/g for treatment 5.The result revealed that the fungi counts decreased gradually with increase in storage time for treatment1, treatment2, treatment3 and treatment4, while treatment 5 (control) showed an increase in fungal count ranging from 22.2 $x10^8$cfu/g to $42.1x10^8$cfu/g for treatment 5. A number of fungal pathogens have been reported to be associated with the disease from time to time as reported by Mitra and Subramaniam (1928).

Conclusion

The study revealed that the microorganisims isolated during storage were *Aspergillus flavus*, *Aspergillus niger*, *Fusarium oxysporum*, *Pythium sp* and *Rhizopus sp*, with *Fusarium oxysporum* having maximum predominance followed by *Pythium sp* and then *Aspergillus niger*. The frequency of occurrence of these microorganisms was most dominant in ginger stored without treatment of z-force (control). *Fusarium oxysporium* and *Pythium sp* were responsible for the ginger rot in storage. The study also revealed that evaluating different storage methods alone is not enough to control ginger rot in storage. Hence, washed and pretreated ginger with z-force and store on sawdust under a tree shade will extend the ginger seed shelf life in storage. This resulted to minimum incidence of fungal disease which was recorded. Therefore, if viability and good quality of ginger rhizomes are to be produced after storing for 12 months, the act of washing ginger rhizomes and treating them with Z- force and placing it under sawdust before storing under the tree shade is important. Therefore, the ginger rhizome treated with z-force, washed and placed on a sawdust under a tree shade proved to be the most effective in maintaining the quality of ginger rhizomes.

Table1: List of fungi Isolated

Penicillium sp
Rhizopus stolonifer
Fusarium oxysporium
Rhizocotinia Solani
Pythium sp

Table2: Fungal count/load(cfu/g)

Sampling period	Treatment1	Traetment2	Treatment3	Treatment4	Treatment 5
3MAS	**12.0 x10^8**	**8.5 x10^8**	**15.0 x10^8**	**7.1 x10^8**	**22.2 x10^8**
6MAS	**10.0 x10^8**	**7.0 x10^8**	**10.1 x10^8**	**5.6 x10^8**	**35.6 x10^8**
9MAS	**9.0 x10^8**	**6.5 x10^8**	**9.4 x10^8**	**5.2 x10^8**	**37.1 x10^8**
12MAS	**9.2 x10^8**	**7.0 x10^8**	**10.9 x10^8**	**5.8 x10^8**	**42.1 x10^8**

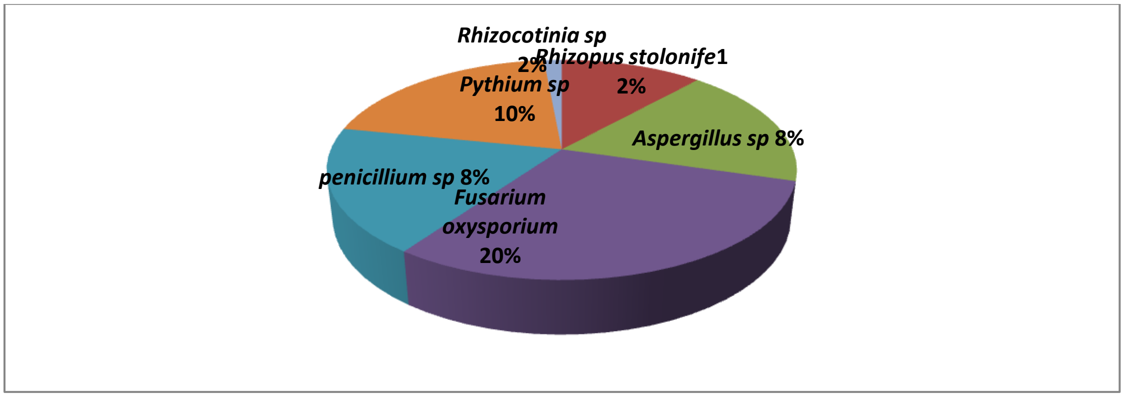

Figure1: Percentage % incidence of fungi /Degree of disease occurrence

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Trends, Growth and Instability of Millet Production in India

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ABSTRACT

Millet is highly regarded as an important food crop due to its high energy content and slower rate of digestion in addition to being drought tolerant and withstanding poor fertile soil condition. The study was based on secondary data from 1980 to 2019 aimed at assessing trends, growth and variability in area, production and yield of millet in India using Compounded Annual Growth Rate, Cuddy Della Vally Index and Decomposition Analysis. This study reveals that total area of millet production decreases with about 3 million hectares from TE1 to TE2 and subsequently drops with another 1 million hectares from TE-2 to TE-3. Even though, production and productivity increase within these periods. Production was observed to be highest in TE-3 period with about 12 million tons, with an average highest productivity of 1036kg/ha. Thus, change in mean yield was found to be the dominant source of change in output in the growth of millet crops in India. The study recommends proper funding, research and technology transfer to millet farmers in the country.

Key words: Millet, Trends, Growth, Instability, Production and India

Introduction

Millets are important crops in the semiarid tropics of Asia and Africa (including India), with 97 % of its production in developing countries (Macdonough *et al*., 2000). The crop is favored due to its productivity and short growing season in arid conditions. Millets are indigenous to many parts of the world (FAO, 1995). The most widely grown millet is pearl millet, which is an important crop in India and parts of Africa (FAO, 1996).

India is the world's largest producer of millet (USDA, 2020). In the 1970s, all of the millet crops harvested in India were used as a food staple. By the 2000s, the annual millet production had increased in India, yet per capita consumption of millet had dropped by 50% to 75% in different regions of the country. As of 2005, most millet produced in India is being used for livestock fodder and alcohol production (Basavaraj *et al.*, 2010). In India, millets are cultivated in an area of 15.48 million hectare producing 17.2 million tons with a yield of 1111 kg/ha (Directorate of Economics and Statistics, 2015).

Globally, the area under millet production decreased marginally from 38.1 million hectares in 1979-81 to 37.6 million hectares in 1990 (Indiastat, 2015). However, production increased by 17 percent, from 25.6

million tons in 1979-89 to 29.8 million tons in 1990 (Indiastat, 2015), with India accounting for 25 percent (FAO, 1991).

The main objective of the paper is to study the trends and variations in area, production and productivity of millet in India over the years and determine the nature of it is production change.

Materials and Methods

The study was based on the thirty-nine years (39) secondary data from 1980 to 2019 obtained from Indiastat. To capture the trend of area, production and productivity of millet the data was classified into triennium ending TE1 (1980-1983), TE2 (2000-2003) and TE3 (2015-2019) respectively. Basic statistics such as mean, standard deviation and coefficient of variability were computed. In modelling time trend for this study, the exponential trend or log-linear as employed by Ahmad *et al.* (2005), Nmadu *et al.* (2009), and Samuel and Patil (2013) was used. The coefficient of variability (CV) which measures instability is a normalized measure of dispersion and is the ratio of standard deviation (σ) to the mean (μ):

Algebraically, $CV = \sigma/\mu * 100$ ... (1)

The growth rates were calculated by fitting an exponential function in time to the data as follows: $Yt = \beta_0, \beta_i^t U_t$ ... (2) Where,

Y = Production, Area and Productivity; t = time trend variable; and, β_0 and $\beta_{i's}$ are regression parameters to be estimated.

The compound growth rate (r) is given by the formula:

$r = \text{Antilog}\ (\beta_i - 1) \times 100$ … (3)

The time it would take to double the rate of growth was estimated as follows:

$Dt = 69/r$ … (4) Where,

Dt = Doubling time; and r = compound rate of growth.

Following Marchenko (2009), a quadratic equation in time variable was fitted to the data to confirm the existence of acceleration, deceleration or stagnation during the same period and it was given as follows:

$Y = \beta_0 + \beta_i t + ct^2$ … (5)

Where c is the regression coefficient used to depict acceleration, deceleration or stagnation. Significant positive values of the coefficient of t^2 indicate acceleration in growth; significant negative values of t^2 indicate deceleration in growth; while non-significance of the coefficient indicates stagnation in the growth process.

Instability index signifies the extents of fluctuation in a given variable over a period of time and was given as follows:

$$I = \sqrt{(R^2 - 1)} * 100 \qquad \ldots(6)$$

Where, I = Instability Index; R^2 = R square

Any change in the output of a crop in physical term depends fundamentally on the changes in the area under the crop and its average yield. To determine the source of production growth and to measure the effect of area productivity and their interaction in increasing crop output, differential equation given by Ayalew (2015) was used:

$\Delta P = A\Delta Y + Y\Delta A + \Delta A\Delta Y$…. (7)

The first term on the righthand side is considered as yield effect, second term as the area effect and the third as the interaction effect. Thus, total change in output can be decomposed into three effects; yield effect, area effect, and interaction effect due to change in yield and area.

Sources of change	**Symbols**	**Components of change**
Change in mean area	$\Delta\bar{A}$	$\bar{A}_1\Delta\bar{Y}$
Change in mean yield	$\Delta\bar{Y}$	$\bar{Y}_1\Delta\bar{A}$
Interaction between changes in mean area and mean yield	$\Delta\bar{A}\,\Delta\bar{Y}$	$\Delta\bar{A}\,\Delta\bar{Y}$
Changes in area – yield covariance	$\Delta COV(A,Y)$	$\Delta COV(A,Y)$

Result and Discussion

Trends in Area, Production and Yield of millet in India

It was observed from Table 1, that the total area of millet production decreases with about 3 million hectares from TE1 to TE2 and subsequently drops with another 1 million hectares from TE-2 to TE-3. However, both production and productivity changes in a dissimilar pattern with that of the area, indicating a significant increase of both the production and productivity of millet within these periods. Production was observed to be highest in TE-3 period with about 12 million tons, with an average highest productivity of 1036 kg/ha. It further reveals that productivity of millet is increasing in the recent periods as revealed in the TE-3. Despite reduction in the total area, production and productivity of millet continue to improve.

Table 1: ***Area, Production and Productivity of crops in India from 1980-2016***

Crops	Area (Mha)			Production (Mt)			Productivity (Kg/ha)		
	TE-1	**TE-2**	**TE-3**	**TE-1**	**TE-2**	**TE-3**	**TE-1**	**TE-2**	**TE-3**

Millet	15	12	11	10	10	12	644	800	1036

*Note. *TE-1 =Triennium ending 1980-83, TE-2= Triennium ending 2000-2003, TE-3= Triennium ending 2015-19.*

Instability in Area, Production and Productivity of millet in India

The instability index reaches 6.49 per cent, 17.1 per cent and 13.2 per cent for area, production and productivity, respectively. The nature of growth was characterized as "stagnations" for the area, production and productivity of millet during this period. By and large, the overall period has indicated a significantly positive growth in millet productivity considering the upshot from 644 Kg/ha in the TE1 to 1036 kg/ha in TE3 period. And conversely, area recorded a significant negative growth indicating that farmers are shifting away from millet production to other cereals crops that commands more demand and/or offers higher return on investment.

Compound growth rate of millet

Table 2 presents the analysis of compound growth trend in area, production and productivity of millet from 1980 to 2015. The result revealed that compound growth rate for area, production and productivity of rice is -0.73, 0.34 and 1.08 respectively. This implies a negative significant growth of area with a stagnation pattern; however, production and productivity were positive although in a stagnant nature too. Further, the instability index for millet within the period was 6.49 %, 17.10 % and 13.20 % for area, production and productivity. Implying that, there is the highest instability in the growth of productivity as against that of production and area. The time period to achieve doubling in millet is estimated at 95, 201 and 64.0 years for the area, production and productivity.

Table 2: Compound growth rate of area, production and productivity of Millet in India from 1980 – 2015

Millet	**CGR**	**Inst.**	**Nat.**	**Doubling**
Area (Million ha)	-0.73*	6.49	Stag	95
Production (Million tons)	0.34^{NS}	17.1	Stag	201
Productivity (Kg/ha)	1.08*	13.2	Stag	64.0

Note: *IST denotes instability index, CGR denotes compound growth rate, Nat. Nature, Acc. Acceleration, Stag. Stagnation, NS not significant, Dec., deceleration * denote 1%, ** denote 5%*

Components of Change in Average Production of millet

It can be observed from Table 3 that change in mean yield, change in mean area, change in mean area and mean yield, and change in yield and area co-variance were 104.71 per cent, -4.51 per cent, -0.99 per cent and 0.67 per cent respectively. Thus, change in mean yield was found to be the dominant source of output in the growth of millet crops in India.

Table 3: Components of Change in Average Production of millet in India

S/No	**Source of Change**	**Components of Change**	**Per cent**
1	Change in Mean yield	41662.19	104.71
2	Change in Mean Area	-1793.13	-4.51
3	Interaction between Changes in mean area and mean yield	-393.60	-0.99
4	Change in yield and area covariance	267.79	0.67
	Total Change in mean production	-12114.34	39789.46

Conclusion

This study reveals that total area of millet production decreases with about 3 million hectares from TE1 to TE2 and subsequently drops with another 1 million hectares from TE-2 to TE-3. However, production and productivity increase within these periods. Production was observed to be highest in TE-3 period with about 12 million tons, with an average highest productivity of 1036 kg/ha.

The crop suffers neglect in terms of research, technology and promotion compared to other cereals like rice, wheat, maize and sorghum which let to reduction in it is production area, production and productivity over the years in India. As a matter of urgency, government, NGO's and research institutions needs to pay special collaboration to emancipate the millet value chain from disappearing further; through proper funding, research and technology transfer to millet farmers in the country.

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Effect of NPK fertilizer level and stake length on the vegetative growth of trifoliate yam (*Dioscorea dumentorum*) in Umudike

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Abstract

The experiment was carried out at Umudike, a rainforest agro ecological zone in the year 2016 and 2017 cropping seasons to study the effect of NPK fertilizer and stake length on the vegetative growth of trifoliate yam. The experiment was laid out as a factorial in a randomized complete block design (RCBD) with three replicates. The treatments comprised five levels of NPK (15:15:15) fertilizer (0 kg/ha, 150kg/ha, 300kg/ha, 450kg/ha and 600kg/ha) and four levels of stake length (0 m, 1m, 2m and 3m). The highest rate of fertilizer application of 450 and 600kg/ha significantly increased vine length compared to the lower rate of 150kg/ha at 3MAP in 2017. Also, 1m stake significantly increased vine length over no staking at 4 or 3MAP in 2016 and 2017. Under the condition of this study however, increasing the length of stake to 1 or 2m increased vine length and is recommended for trifoliate yam vegetative production in Umudike Agro-ecosystem.

Key words: NPK fertilizer, stake length, vegetative growth, dioscorea dumentorum.

Introduction

Trifoliate yam (*Dioscorea dumentorum)* also known as clauster yam is an important food security crop in Nigeria and is grown by poor resource farmers who intercrop it with maize, vegetables, cassava, okra and cowpea. It occupies a prominent position in the diet and farming systems in South Eastern agro-ecological zone of Nigeria, especially Abia State-(Nwankwo *et al.*,2017). Research has shown that it has crude protein content of 11.07%, fibre content of 2.06% and total carotenoid content of 217.73µg/100g, and is as good as a source of carbohydrate as other yam varieties (Nwankwo *et al.*, 2017). The tuber contains high supply of dietary carbohydrate and has higher beta-carotene content than white yam *Dioscorea rotundata*. Most of varieties of trifoliate yam become hard after harvest and inedible which makes the tubers good for the next planting season only.

Okpara *et al.*, (2014) reported that fertilizer needs of yam may depend on the species, technology used to generate planting materials and plant population density, among other factors. Because of the high nutrient needed, yams are planted as the first crops on cleared land or after fallow periods (Ekanayake and Asiedu, 2003). The rate of degradation of soils in southeastern Nigeria has been aggravated by continuous cropping and short fallow period due to high population density. Despite the lack of information on the fertilizer rate in eastern states of Nigeria, some farmers are engaged in its production.

Staking is good in yam production. It increase the light interception of the leaf canopy and in the ventilation around the leaves. Ventilation is particularly important in humid environments where high humidity in the canopy can increase the incidence of fungal leaf diseases, especially anthracnose. Staking also facilitates weeding, especially with thorny varieties (King and Risimeri, 1992). Those that are slow to initiate branches may develop best on tall stakes, where the vital early growth of the vine is uninterrupted. The system of staking depends on local conditions and available materials. The agro ecology in which yam is cultivated is also important in terms of staking requirements of the crop as well as the availability of staking materials. The objective of this study is to determine the effect of NPK fertilizer level and stake length on the vegetative growth of trifoliate yam (*Dioscorea dumentorum*) in Umudike.

Materials and Methods

The study was conducted in 2016 and 2017 cropping seasons at the National Root Crops Research Institute (NRCRI), Umudike, Southeastern Nigeria. Umudike is located at Latitude $5^{o}\ 29^{'}$ N and Latitude $7^{o}\ 33^{'}$ E and on 122m above sea level in the rainforest agro ecological zone annual rainfall ranges between 1800mm - 2200mm. A composite soil sample was taken from the site at a depth of 0-20cm for physical and chemical analyses before cropping. Soil and rainfall data of Umudike are shown in Table 1. The experiment was laid out as a factorial in a randomized complete block design (RCBD) with three replicates. The treatments comprised five levels of NPK (15:15:15) fertilizer (0 kg/ha, 150kg/ha, 300kg/ha, 450kg/ha and 600kg/ha) and four levels of stake length (0m, 1m, 2m and 3m). Each plot size measured 4m x 2m ($8m^2$). Setts of the trifoliate yam (Cultivar *Ona-ohuru*) weighed 150g were planted on ridges on 9 June, 2016 and 10 June, 2017 at a spacing of 1m x 1m which gave a total of 10,000 plants per hectare. Prior to planting, the tubers were treated with insecticide and fungicide to prevent termite attack and rot of the yams. Inorganic fertilizer NPK 15:15:15 was applied at different rates using the band placement method in appropriate plots at 8WAP. Manual weeding were carried out at 4, 8 and 12 WAP. Pre-emergence herbicide (Diuron) was used immediately after planting in 2016 and 2017 at the rate of 250ml per 15L water. It was complemented with manual weeding at 12 weeks after planting (WAP). Data were taken on soil and monthly rainfall data, and vine length, at 3 and 4 MAP from four representative plants per plot. The data were subjected to analysis of variance (ANOVA) according to the procedure for a randomized complete block design using GENSTAT Discovery Edition 3 Statistical Package (2007). The comparison of treatment means for significance was done by the use of least significance difference procedure at 5% level of probability.

Result and Discussion

The soil properties showed that soil texture was loamy sand in 2016 and sandy loam in 2017 (Table 1). The soils were acidic and low in organic matter and nitrogen. Soil potassium was also low in 2016 but high in 2017. Total rainfalls for 2016 and 2017 were 2322.7mm and 2079.8mm, respectively. Trifoliate yam vine length was not significantly affected by NPK fertilizer at 3 and 4 MAP in 2016 (Table 2).

However, at 3MAP in 2017, application of NPK fertilizer at the highest rates of 450 and 600kg/ha produced significantly higher vine length than the lower fertilizer rate of 150kg/ha. On the other hand, at 4 MAP in 2016, 1m stake had significantly longer vine than no staking (Table 3). There were no differences in vine length with respect to the use of the three stake lengths of 1m, 2m and 3m. At 3 and 4 MAP in 2017, however, the use of 2m stake gave significantly higher vine length than the longer 3m stake and no staking. In the results, it showed that stake increased vine length when the height was increased to 1m or 2m which agrees with the findings of Enyinnaya *et al* (1983) and Igwilo (1998) who reported that stakes of 1m height were as good as 2m stakes for supporting vines. According to Chapman (1965), the yam canopies supported on shorter stakes had wider girth than those on taller stakes making for efficient distribution of solar radiation. The high rainfalls of over 2000mm caused flooding in the two seasons and the use of 1m stake is recommended to keep the yam vines away from flood water. Igwilo and Udeh, (1987) revealed that water logging or flooding yam vines caused damage to the leaves.

Table 1: Soil and monthly rainfall data of the experimental site in 2016 and 2017.

Properties	**2016**	**2017**
	Physical properties	
Sand (%)	84.2	67.8
Silt (%)	6.4	10.8
Clay (%)	9.4	21.4
Textural Class	Loamy sand	Sandy clay loam
	Chemical properties	
pH (H_20)	5.1	4.8
OM (%)	1.62	1.66
N (%)	0.084	0.095
P (mg/kg)	34.2	21.0
K (Cmol/kg)	0.113	0.3
	Monthly rainfall data	
Jan	0.0	51.0

Feb	0.0	0.0
Mar	257.7	76.7
Apr	129.3	188.3
May	278.4	134.2
Jun	3 54.1	298.1
Jul	268.7	493.9
Aug	396.2	**222.4**
Sep	312.6	**400.0**
Oct	273.4	**184.2**
Nov	45.0	**31.0**
Dec	7.3	**0.0**
Total	**2322.7**	**2079.8**

Table 2: Effect of NPK fertilizer on vine length (cm) of trifoliate yam at different sampling dates.

	Months after planting (MAP)	
NPK fertilizer (kg/ha)	3	4
	2016	
0	113.7	143.3
150	106.0	153.2
300	132.9	168.5
450	123.7	162.2

600	136.4	161.6
Mean	122.5	157.7
LSD$_{(0.05)}$	**NS**	**NS**
	2017	
0	137.5	127.1
150	115.2	116.7
300	136.5	112.6
450	140.9	124.7
600	159.6	125.1
Mean	138.6	121.1
LSD$_{(0.05)}$	**25.6**	**NS**

Table 3: Effect of stake length on vine length (cm) of trifoliate yam at different sampling dates.

	Months after planting (MAP)	
Stake height (cm)	3	4
	2016	
0	115.4	130.0
1	130.8	187.1
2	114.3	172.1
3	129.7	141.6
Mean	122.5	157.7
$LSD_{(0.05)}$	**NS**	**48.2**
	2017	
0	113.6	109.5
1	146.1	130.2
2	164.1	143.4
3	128.0	101.8
Mean	138.0	121.2
$LSD_{(0.05)}$	**22.9**	**28.9**

Conclusion

In conclusion, under the condition of this study, increasing the height of stake to 1 or 2m increased vine length. Due to the effects of flooding on vines, the use of 1m or 2m is recommended for trifoliate yam vegetative production in Umudike Agro-ecosystem.

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Flowering and Fruiting Studies in Hausa Potato (*Solenostemon rotundifolius*) on the Jos Plateau of Nigeria

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Abstract

Solenostemon rotundifolius known as Hausa potato in Nigeria is a seasonal herb belonging to the family of Lamiaceae and produces many tiny edible delicious tubers. Five seed sets of Hausa potato [designated as HPLL (Long oblong tubers), HPLM (Medium oblong tubers), HPLS (Small oblong tubers), HPOM (Medium oval tubers tubers), and HPOS (Small oval tubers) separated based on the length and shape of the tubers were evaluated in this study carried at the Kuru Sub-station of National Root Crops Research Institute on the Jos Plateau of Nigeria (Lat. 09°44'N, Long. 08°47'E, Altitude 1217m above sea level) to determine the nature and extent of flowering, fruiting and seed set in Hausa potato under cool temperate conditions. Results obtained indicated that HPLL and HPLM produced significantly ($P<0.05$) more stems per plant than HPLS and HPOS. All sets flowered with days to 50% flowering ranging from 102-108 days after planting. HPLM attained 50% flowering at least 4 days earlier than others seed sets. There were no significant differences between the sets in the number of inflorescence and number of flowers. No fruits and seed were formed. Causes of unfruitfulness in this plant deserves further study.

Keywords: Hausa potato, Flowering, Fruiting, Seed, Tuber yield

Introduction

Solenostemon rotundifolius is a small, herbaceous annual, I5-30 cm high, prostrate or ascending, with a succulent stem and somewhat thick leaves having an aromatic smell resembling that of mint. Flowers are small, pale violet in colour, produced on an elongated terminal raceme. Small dark-brown tubers are produced in clusters at the base of the stem (Kay, 1987). It belongs to the mint family lamiaceae or labiatae. It is found all over Africa and is believed to have originated in the savannah region between Togo and Guinea (Harlan *et al.*, 1976). The tubers are eaten as a main starchy staple or part of it in combination with legumes, vegetables or cereals. The crop is popular in the middle belt and North eastern Nigeria. The crop is rich in nutrients as compared with other root and tuber crops and is germane to ensuring food and nutritional security (Kwarteng *et al.*, 2018). Ethnomedicinally, leaves of the crop are used to treat dysentery, blood in urine and eye disorders (Enyiukwu *et al*., 2014). It is also known to lower blood cholesterol levels as well as fend off fungal and viral infections in humans (Kwarteng *et al*., 2018).

However, very little is known about the breeding avenues necessary to improve upon the crop. Also, not much interest has been generated with regards to production of the crop owing to its low yield and small tuber size (Kwarteng *et al*., 2018). Yield can be improved by conventional genetic improvement which depends on a proper understanding of the flowering and fruiting behaviour of the crop. Schipper (2000) reported that it produces flower in abundance but seeds are uncommon. The objective of this work is to assess the nature and extent of flowering, fruiting and seed set in Hausa potato under cool conditions of the Jos Plateau.

Material and Methods

This experiment was carried out at the Kuru Sub-station of National Root Crops Research Institute, Jos Plateau state (*Lat. 09^{o}44'N, Long. 08^{o}47'E, Altitude 1217m above sea level*) Nigeria. Jos plateau possesses a near temperate condition compared to many other parts of Nigeria (Okonkwo *et al*., 2009). Weather details for Kuru in 2012 are presented in table 1. Five seed sets of Hausa potato [designated as HPLL (Long oblong tubers), HPLM (Medium oblong tubers), HPLS (Small oblong tubers), HPOM (Medium oval tubers tubers), and HPOS (Small oval tubers) separated based on the length and shape of the tubers were used. Experimental design was a randomized complete block design. The treatment was replicated four times. Gross plot size was 12m^2 while net plot size was 6m^2. Plant population density was 33,333. Fertilizer was applied at 4 weeks after planting at the rate of 400 kg/ha. Weeds were controlled manually at 4 and 8 weeks after planting.

Data on the following attributes were collected – Plant emergence/plot, number of stems/plant, days to 50 % flowering/plot, number of inflorescence/plant, number of flowers/plant, number of fruits/plant, number of seeds/plant, number of tubers/plant, number of rotten tubers/plant and tuber yield (kg). Data was analysed using genstat discovery edition 3

Table 1: Weather data for Kuru 2012

	Rainfall amount/Day		**Max and Min Temp (^{0}C)**		**Relative Humidity%**	**Sunshine (Hrs)**
MONTH	Amount (cm)	Day	Max (^{0}C)	Min(^{0}C)	%	Hours
JAN	0	0	29	12	17	266
FEB	0	0	31	15	18	309.1

MAR	0	0	32	17	25	243.6
APRIL	95.2	13	30	20	14	186.3
MAY	251.9	17	28	19	63	231.3
JUNE	142.8	11	24	17	66	172.1
JULY	310.7	18	24	17	75	108.3
AUG	197.5	18	24	17	84	133.8
SEPT	242	19	26	17	80	193.2
OCT	196	7	28	17	77	199.6
NOV	0	0	30	13	65	261.4
DEC	0	0	30	12	49	273.1
TOTAL	1436.1	103	28	16	52.75	2577.8

Results and Discussion

Plant emergence per plot and number of stems per plant are presented in table 2. Plant emergence among the seed sets ranged from 47-70% but the differences were not significant. Seed sets HPLL and HPLM produced more stems per plant than sets HPLS and HPOS. Namo and Opaleye (2018) reported that plant emergence and number of branches varied with accessions of Hausa potato.

Table 2: Percentage emergence and number of stems per plant

Treatment	Plant emergence	Number of stems
HPLL	67	50.7
HPLM	70	55.3
HPOM	60	34.7
HPLS	57	24.3
HPOS	47	22.3
LSD0.05	NS	20.9

CV%	32.5	29.7

Flowering and fruiting attributes of Hausa potato are presented in table 3. Days to 50% flowering ranged from 102-108 days after planting. Set HPLM attained 50% flowering at least 4 days earlier than others seed sets. There were no significant differences between the sets in the number of inflorescence and number of flowers. No fruits and seed were formed. Schipper (2000) reported that Hausa potato seldom form seeds.

Table 3: Flowering, Fruiting and Seed Set attributes of Hausa Potato

Treatment	Days to 50% flowering	Number of Inflorescence	Number of flowers	Number of Fruits	Number of seeds
HPLL	106.3	81.7	182	0	0
HPLM	102.0	71.3	147	0	0
HPOM	108.3	77.4	210	0	0
HPLS	108.0	83.4	188	0	0
HPOS	107.0	54.6	75	0	0
LSD0.05	2.34	48.8(NS)	145(NS)	0	0
CV%	1.2	34.8	48.2	0	0

Table 4, shows some tuber yield attributes of Hausa potato. There were no significant differences between the set types in number of rotten tubers, number of tubers per plant and tuber yield per plant.

Table 4: Some yield attributes of Hausa potato

Treatment	Number of rotten tubers	Number of tubers /plant	Tuber yield /plant (kg)
HPLL	62	80.4	0.48
HPLM	102.3	72.8	0.40
HPOM	49.7	57.1	0.37
HPLS	47.3	61.5	0.36
HPOS	66.7	59.3	0.37

LSD0.05	55.92(NS)	40.04	0.21
CV%	45.3	32.1	28.7

Conclusion

Results obtained from this study indicate that Hausa potato flowers profusely but fails to set seed under cool temperate Jos plateau condition. Causes of unfruitfulness in this plant deserves further study.

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Effects of improved giant elephant plantain adoption on productivity and income of small-scale farmers in Umuahia agricultural zone of Abia State

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Abstract

This study examined the effects of giant elephant plantain adoption by farmers in Umuahia Agricultural Zone of Abia State, Nigeria on their productivity and income. Data collection involved the use of primary data through structured questionnaire. A multi- stage random sampling techniques was used in selecting the respondents for the study and a total of 270 farming household engaging in plantain production were used. Data were analyzed using descriptive statistics, productivity indices and logistic regression. Socio-economic characteristics of the farmers (respondents) revealed that males engage in plantain production than females. 46% among them were found to be within 41-50 age limits. The result of their productivity estimate shows that material and labour were highly utilized (22.33 and 3.0 respectively) meaning that output earnig per ₦1 expenditure on material and labour is ₦22.33 and ₦22.33. Also, logistic regression on factors influencing improved plantain adoption shows that extension services was highly significant which shows the importance of adequate extension visits/contacts to farmers for increase in production. Conclusion based on this finding was that, access and use of improved plantain variety with Extension services will boost farmers' production. It was recommended that the government should ensure and provide the need for Farmers' or plantain growers' awareness, teachings and availability of improved varieties for optimal plantain production in Nigeria for local consumption and for export.

Key words: Technology adoption, improved plantain variety, productivity.

Introduction

The importance of technology adoption in agriculture cannot be overemphasized as it boosts productivity of farmers as well as generation of income. One of the major goals of Nigerian agriculture development programs and policies is transition from low productivity subsistence agriculture to a high productivity agro industrial economy through improved technology adoption (Hassen, 2014). Technology adoption in agriculture can be defined as acceptance, willingness to engage in a practice by farmers, which has been introduced or developed for optimum better performance in agricultural production. According to Gebeyehu (2016), adoption of improved inputs such as improved seeds, herbicides, pesticides and fertilizers increased the productivity as well as the income of adopters.

Plantain belongs to the family Musaceae and the genus Musa. It is perennial herbaceous plant, 2 to 9m tall, with an underground rhizome or corm. The principal species are Musa paradisiaca (French plantain), Musa acuminata (Gross Michel and Cavendish) and Musa corniculata (Horn plantain). Plantain thrives on a wide range of tropical and sub-tropical climates. It requires an optimum temperature of 300C, mean monthly rainfall of 100mm, pH 4.5 and 7.5 and sandy loam soils. Plantain originated in South India and moved to South East Africa, from where it spread to Central and West Africa, it is believed to be the oldest cultivated fruit in West and Central Africa (Ekunwe *et al.,* 2010). According to FAOSTAT (2013), it represents the world's second largest fruit crop with an annual production of 2.8 million metric tons and ranks as the sixth most important global food commodity after rice, wheat and maize in terms of gross value of production. Among plantain products are `plantain flower, chips, beer and ethanol. The ripe ones are sliced and fried in oil as "dodo". Unripe plantain meal is usually consumed by diabetic patients to reduce postprandial glucose level. Plantain as a source of food energy and carbohydrate provides a substantial amount of recommended nutrients uptake of potassium and pro vitamin A (carotene) (FAO, 2003).

The demand for plantain outweighs supply because farmers still adhere to the traditional practice of producing their crop in the backyard or where it incidentally grows and the do not have access to improved varieties of plantain (Nwaiwu *et al.,* 2012). It is of the view that, access and use of improved varieties and other production technologies developed by International Institutes of Tropical Agriculture IITA, would raise plantain productivity in the country, thereby reducing poverty, increase in the standard of living and income generation of farmers. Because of the above problem, this study seeks to investigate the effects of improved Giant Elephant plantain adoption on productivity and income of farmers in Umuahia Agricultural zone of Abia State with research questions from correspondents on their socio- economic characteristics, productivity on plantain farming and factors influencing their adoption of improved variety.

Methodology

This study was carried out in Abia State; its capital city is Umuahia. It is located in the southeastern Nigeria and lies between latitude 070 00 and 080 10' North of the equator and longitudes 040 45' and 06' 07' East of the Greenwich Meridian. It was created out of Imo State on August 27, 1991 and occupies a land area of about 5,834km^2. Abia State is bounded to the west by Imo State; Ebonyi and Enugu States to the North; Cross-River and Akwa-Ibom States to the east and Rivers State to the south. The southern part of the State lies within the riverine part of Nigeria. It is a low-lying area, with a heavy rainfall of about 2400mm/year especially intense-from the months of April through October.

The estimated population of the State in 2006 was 2, 845,380 comprising of 1,430,298 males and 1,451,082 females (National Population Commission [NPC], 2006). With a growth rate of 2.7 percent, the 2016 projected population was estimated to be 3, 814,303 comprising of 1,917,350 males and 1, 896,953 females. The population density is about, 580 persons/km2. Agriculture is the major occupation of the people especially in the rural areas involving over 70 percent of the population. Abia State has 17 local government areas which are grouped into three (3) agricultural zones namely; Ohafia, Umuahia and Aba. The State has distinct wet and dry seasons which characterize its humid tropical climate with the dry seasons extended from November to March. It was an annual mean temperature of about 270 300c and a relative humidity ranging from 70% to 80% with January to March as the hottest months (Abia State Government [ABSG], 1996).

Primary data were used for this study with the aid of structured questionnaire from respondents and assistance from Extension Agents. Multi-stage sampling technique was used for selecting the respondents for this study. In the first stage, Umuahia agricultural zone was selected among the three agricultural zones of Abia Sstate, others are Ohafia and Aba. The second stage involved a random selection of three Local Government Areas (LGAs) out of five (5) that make up Umuahia agricultural zone of Abia State which is Umuahia north, Umuahia south and Ikwuano local government areas. The third stage which involved a random selection of 7, 5 and 9 communities respectively from each of selected local government areas making a total of 21. The final stage was a random selection of plantain farm household in each of these communities hence; a total of 227 respondents for this study are targeted as the sample size. Data collected were analyzed using descriptive statistics on socio-economic characteristics, productivity indices on productivity and logistic regression to ascertain factors influencing adoption of improved plantain variety in the study area.

Productivity indices:

This shows the output earning per naira expenditure on the resources used. The resource productivity for labour and materials used were determined as;

Labour productivity (₦) = total revenue / labour input

Material productivity (₦) = total revenue / material input.

Logistic Regression: The logit regression model was used to ascertain the factors influencing the technology adoption of farmers in the study area. Following Pindyck and Rubinfield (1981), the cumulative logistic probability function is specified as:

$$Pi = F(Zi) = F(\alpha + \sum BiXi) = \frac{1}{1 + e^{-zi}}$$

Where, Pi = the probability that an individual would adopt or not given Xi.

e denotes the base of natural logarithms which approximately equal to 2.718.

Xi represents the ith explanatory variables

α and Bi are parameters to be estimated. Following Smith and Todd (2005), Let Y1 be a household outcome if it adopts and Let Y0 be an individual outcome for non-adopter.

The implicit form of the logit model is specified as:

Y = f (X1, X2 ,X3, X4, X5, X6, X7, X8,X9,X10)

While the explicit form is expressed as:

$Y= \beta0+\beta1X1+\beta2X2+\beta3X3+\beta4X4+ \beta5X5+\beta6X6+\beta7X7+\beta8X8+\beta9X9+\beta10X10+ e$

Where;

Y= new or improved technology, adopter =1, otherwise = 0

X1= gender (male =1, female = 0)

X2 = age (years)

X3 = household size (number)

X4 = education (years)

X5 = farm size (hectare

X6 = extension services (number)

X7 = membership of association (yes = 1, otherwise = 0)

X8 = access to credit (yes =1, otherwise = 0)

X9 = access to technology and its information (yes = 1, otherwise =0)

X10 = off- farm income (naira)

While, β0 is constant and β1…β10 are parameters estimate, ε = error term.

Result and Discussion

Table 1: Distribution of respondents socio-economic characteristics (n=227)

Factors	Percentage

	Frequency	
Gender		
Male	170	75
Female	57	25
Age(Years)		
Less than 20	12	5
21– 30	31	14
31– 40	*59*	26
41 – 50	103	46
51 and Above	22	10
Household size		
1 – 4	87	38
5 – 9	102	45
10-13	27	12
14 and Above	11	5
Educational Level		
None formal Education	72	32
Primary	95	42
Secondary	46	20
Tertiary	14	6
Farm size (Ha)		
Less than 0.5	37	16
0.5 – 1.0	129	57
1.0 – 2.0	40	18
2.0 and Above	21	9

Extension visits		
No visits	161	71
Once a month	27	12
Thrice a month	39	17
Membership of Association		
Yes	55	24
No	172	76
Access to Credit		
Yes	40	18
No	187	82
Access to Technology		
Yes	66	29
No	161	71
Off- farm income		
Yes	72	32
No	155	68
Total	227	100

Source: Field Survey, 2019.

The result from Table 1.above shows that majority of the farmers in the study area were males with 70% higher than females which agrees with the findings of Ekunwe and Ajayi (2010) which stated that more males were involved in plantain production than females. A greater number of farmers surveyed fall within the age bracket 41-50 which shows that they are still active in farming. House -hold size was found to be 7 as the mean, implying a good and economic way of maximizing farm returns by using family labour. Some of the farmers had no formal education, 42% had only primary school which is the highest percentage. Farmers with farm size 0.5-1.0 are 129 out of 227 surveyed. This shows that majority of the farmers operate on a small scale (small-holder) According to the plantain farmers, extension visits were inadequate while some had no visits at all with about 71%, hence inability to adopt, or poor adoption of a new agricultural technology. Also, some of the farmers belong to association like cooperative but those that do not belong to any association are higher in number with 76%. For off-farm income, few farmers engage in off- farm income while, other do not engage. Majority of the famers has no access to credit. Access to, and information on improved variety was also inadequate.

Table 2: Productivity Analysis Result

Resource	**Value((₦)**
Total revenue	1913850
Labour input	85700
Material input	545250
Resource Productivity	
Labour productivity	$\frac{1913850}{85700} = 22.33$
Material (Capital) productivity	$\frac{1913850}{545250} = 3.5$

Table 2, shows that, the labour productivity of the farmers was 22.33 meaning that output earning per ₦1 expenditure on labour was ₦22.33, implying that labour was well utilized. Material productivity of the farmers was 3.5. This shows that output earning per ₦1 expenditure on material was ₦3.5 meaning that material was well utilized.

Table 3: Logistic regression on factors influencing improved plantain adoption

Variable	Coefficient	Z-value
gender	-.2764196	0.334
age	-.0141758	0.457
household-size	.0557884	0.47
education	.0242756	0.401
farm size	-.0777497	0.732
extension	.2639655	0.078***
association	-3.055245	0.293
access to credit	.3768009	0.215

access to technology	-.2863267	0.341
off-farm income	-4.53e-07	0.994
(-constant)	-.1447802	08.90
Pseudo R^2 =	0.0285	Chi2 ratio = 8.70***

Source: Data Analysis, 2019. ***Significant at 1%.

As presented in the logit regression table above, Pseudo R^2 = 0.0285, this indicates a relatively good fit for the logit model. The Chi^2 ratio is 8.70 and it is significant at 1%. This implies that the entire logit model is significant. In addition, extension visits of the farmers in the regression above is positive, meaning that extension visits is directly proportional to adoption of improved variety. Therefore, an increase in the number of extension visits will lead to increase in adoption.

Conclusion and Recommendation

Based on the finding of this study, it can be concluded that, use of improved plantain variety with assistance of extension visits to farmers invariably boosts Agricultural production. According to (Agwu and Afieroho, 2007) who maintained that lack of extension visit is one the reasons farmers do not adopt farming innovation leading to low productivity. However, productivity indices result of the plantain farmers shows that both labour and materials were well utilized.

In addition, government through the Ministry of Agriculture, Agricultural Development Programme (ADP) in all states should ensure and provide the need for Farmers' or plantain growers' awareness, teachings and availability of improved varieties for optimal plantain production in Nigeria for local consumption and for export. Extension services particularly should be carried out and adequately rendered to farmers to increase plantain and other food production.

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Effects of different methods of fungicide (Ridomil)application on the growth and yield parameters of X*anthosoma* cocoyam (NXs001)

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Abstract

A study was carried out to evaluate the effect of different methods of application of fungicide (Ridomil) on growth and yield of Xanthosoma cocoyam (NXs 001). The experiment was laid out in a Randomized Complete Block Design (RCBD), with six treatments: soaking of corms in Ridomil solution 24 hrs before planting; soil application; foliar application; soaking + foliar application; soil + foliar application; and Control (No application of Ridomil). Results obtained showed that soaking in Ridomil significantly (P < 0.01) improved plant height (90.70 cm), plant girth (24.30 cm), leaf area index (0.21) and leaf number/plant (6.6) at 6 MAP. Foliar application and Control depressed all growth parameters measured. Soaking in Ridomil treatment significantly (P < 0.05) yielded highest number of corms (48,000/ha), cormels (168,333/ha) and corms + cormels (216,333/ha). Control plots yielded least number of corms (4296/ha), cormels (46,577/ha) and corms + cormels (50,873/ha). Soil + foliar application yielded significantly highest corms yield (5.18 t/ha) which did not differ with corms yield obtained from soaked in Ridomil treatment (4.53 t/ha). Soaked + foliar yielded highest cormels yield (4.8 t/ha) and total tuber yield (9.0 t/ha) which did not differ significantly with comels yield (4.07 t/ha) and total tuber yield (8.6 t/ha) obtained from soaked in Ridomil plots. The higher growth and yield parameters obtained with soaked in Ridomil treatments compared to the control is an indication that the disease without control significantly impacted on growth and yield of Xanthosomas cocoyam. F.oliar application method led to wastage of the fungicide and was unable to target the pathogen which is soil and seed borne. Soaking in Ridomil before planting is recommended as the best application method.

Keywords: Fungicide, Ridomil), application, growth parameters, *Xanthosoma saggittifolum*.

Introduction

Cocoyam isa herbaceous perennial plant which belongs to the family *Araceae* and is grown for its edible roots, although all parts of the plant are edible (Schafer, 1999; Agueguia,2000). In Nigeria, cocoyam (*Xanthosoma sagittifolum*) is an important staple which besides being a food crop, serves as a major source of income for rural households (Onyeka, 2008). Cocoyam (*Xanthosomasaggitifolum*) has been neglected by research and is gradually disappearing in the family culture of most part of the country despite its nutritional advantage over yam and cassava due to cocoyam root rot blight complex (Anon, 1994). Fungicide application seems to be a reliable method of managing cocoyam root rot disease. A study was carried out to ascertain the effect of different methods of fungicide (Ridomil) application on the growth and yield parameters of *Xanthosoma* cocoyam.(NXs 001).

Materials and Methods

A field study was carried out at National Root Crops Research Institute, UmudikeAbia State (Latitude, 05^0 $29^{'}$ N longitude 07^0 $33^{'}$ E and altitude 122 m above sea level) in 2017 cropping season. A randomized complete block design (RCBD) was used as experimental design with four replications. The land was slashed, ploughed, harrowed and ridged before marking out into plots. Planting was done immediately after, on plots measuring 4 m x 5 m and at a spacing of 0.50 m within rows and 1 m between rows using one cultivar of *Xanthosoma* cocoyam (NXs 001). The fungicide (Ridomil) with active ingredient as carbendazim (MBC) was obtained from the local market. Ridomil powder (100 g) was dissolved in 2 litres of water and used as treatment. Treatment methods included; soaking of corms in Ridomil solution 24hrs before planting (soaked–in-Ridomil), direct application of Ridomil solution at the crest of the ridge before planting (soil application), foliar application at 6 WAP usually at the first sign of the disease (foliar application), soaking + foliar application at 6 WAP, soil + foliar application at 6 WAP, and Control (No application of Ridomil). Inorganic fertilizer (NPK 15:15:15) was applied to all the plots immediately after weeding at 6 WAP using side band method. Plots were manually kept weed-free. Data were collected on leaf number/plant, plant height (cm), stem girth (cm) and leaf area index at 3 and 6 MAP. Data on yield and yield parameters were collected on corms and cormels weight (t/ha), total weight of corms + cormels (t/ha), number of corms, cormels and corms + cormels per hectare at harvest. Harvesting was carried out in December. Data obtained were subjected to analysis of variance for an RCBD experiment.

Analysis of physico-chemical properties of the study soil.

Total N was determined by the macro-Kjeldahl digestion method (Bremner and Mulvaney, 1982). Particle size distribution was measured by the hydrometer method as described by Gee and Bauder (1986). Organic carbon was determined by the dichromate oxidation method of Walkley and Black method (Nelson and Sommers, 1982). Organic matter (O.M) was determined by multiplying OC with the conventional Van Bernmeller factor of 1.724. Soil pH (H_2O) was measured (soil/water ratio of 1:2.5) with a digital pH meter (McLean, 1982). Available P was determined by the Bray 2 method according to Bray and Kurtz (1945). Cation exchange capacity

(CEC) was determined by the NH_4OAc displacement method (Thomas, 1982) and exchangeable K in extract estimated by flame photometry. Exchangeable acidity was determined by the titrimetric method after extraction with1.0 M KCl (McLean, 1982). Effective cation exchange capacity (ECEC) was determined by the sum of the exchangeable bases and the exchangeable acidity.

Analysis of variance (ANOVA)

Analysis of variance (ANOVA) for a randomised complete block design (RCBD) was carried out as outlined by Steel and Torrie (1980). Significant treatment means were separated using F-LSD at 5% probability level according to Obi (1986)..

Results and Discusion

Initial soil test results

Results of the initial physico-chemical properties of the study soil are as shown in Table 1. The study soil had a sandy loam texture, and a slightly acidic soil reaction (5.28). Percentage total nitrogen was very low (0.04%) with a moderate value of available phosphorus (32.0 mg/kg). Percentage soil organic matter was low (1.41%).

Effect of different methods of fungicide (Ridomil) application on the growth parameters of Xanthosoma cocoyam (NXs001).

The effect of different methods of fungicide (Ridomil) application on the growth parameters of *Xanthosoma* cocoyam at 3 and 6 MAP are as shown in Table 2. Plant height was significantly ($P < 0.05$) influenced by method of application at both 3 and 6 MAP. Foliar application produced tallest plants (59.05 cm) at 3 MAP which differed significantly with plant heights obtained through other application methods. Soaking in Ridomil before planting and soaking + foliar application produced shortest plants (46.30 and 47.35 cm, respectively) which did not differ significantly from each other. However, at 6 MAP there was a drastic change in the performance of the application methods. Soaking in Ridomil before planting produced the tallest plants (90.70 cm) which did not differ significantly with plant heights due to soaked + foliar application (87.90 cm), soil + foliar application (83.20 cm) and soil application (83.10 cm). The Control recorded significantly shortest plant (67.60 cm) which did not differ significantly with plant height due to foliar application (73.50 cm).

Methods of application did not significantly ($P > 0.05$) affect cocoyam stem girth at 3 MAP. However, at 6 MAP application method significantly influenced cocoyam stem girth. Highest increase in stem girth (24.30 cm) was obtained from plots with soaked-in-Ridomil treatment which differed significantly from values obtained from other treatments, except soil + foliar application treatment (23.10 cm). Foliar application and Control recorded least increase in stem girth of 12.25 and 13.70 cm, respectively.

Highest leaf area index (0.21) and leaf number (6.6) were obtained from cocoyam setts that were soaked in Ridomil before planting. Lowest values of leaf area index were obtained from soil application plots (0.15) and Control plots (0.17). Foliar application and Control plots recorded least leaf numbers/plant (2.6 and 2.8, respectively).

Effect of different methods of fungicide (Ridomil) application on yield and yield parameters of *Xanthosoma* cocoyam (NXs 001)

Yield and yield parameters were significantly (P < 0.01) affected by different methods of fungicide (Ridomil) application (Table 3). Soaking seed setts in Ridomil before planting significantly (P < 0.05) yielded highest number of corms (48,000/ha), cormels (168,333/ha) and corms + cormels (216,333/ha). Control plots yielded least number of corms (4296/ha), cormels (46,577/ha) and corms + cormels (50,873/ha).

Soil + Foliar application method returned significantly (P < 0.05) highest corms weight (5.18 t/ha), which did not differ significantly with corms yield obtained from Soaked-in-Ridomil (4.53 t/ha) and soil application (4.29 t/ha). Foliar application (1.07 t/ha) and Control plots (0.48 t/ha) (Table 3). Cocoyam obtained from Soaked + Foliar application plots and Soaked-in-Ridomil plots yielded highest cormels.

Table 1. Soil physico-chemical properties before treatment application

Properties	Values
Sand (%)	71.20
Silt (%)	10.50
Clay (%)	18.30
Texture[a]	SL
pH(H_2O)	5.28
ECEC[b] (cmol/kg)	6.25
Organic carbon (%)	0.82
Organic matter (%)	1.41

Total N (%)	0.04
Available P (mg/kg)	32.0
Exchangeable K (cmol/kg)	0.04
C/N ratio	20.50

a.SL = Sandy loam; b. ECEC = Effective cation exchange capacity

Table 2: Effect of different methods of fungicide (Ridomil) application on the growth parameters of

Xanthosoma cocoyam (NXs001) at Umudike

Method of application	3 MAP				6 MAP			
	Plant height (cm)	**Plant girth (cm)**	**Leaf area index**	**Leaf number/plant**	**Plant height (cm)**	**Plant girth (cm)**	**Leaf area index**	**Leaf Number/plant**
Soaked in Ridomil	46.35	10.35	0.41	4.1	90.70	24.30	0.21	6.6
Soil application	52.00	10.60	0.53	4.6	83.10	20.55	0.15	5.9
Foliar application	59.05	10.00	0.55	4.1	73.50	12.25	0.18	2.6
Soaked+foliar appl.	47.35	10.97	0.45	4.4	87.90	20.85	0.20	5.8
Soil+foliarappl.	51.90	10.73	0.60	5.2	83.20	23.10	020	5.7
Control	53.15	11.03	0.52	4.7	67.60	13.70	0.17	2.8
LSD $_{(0.05)}$	**3.65***	**NS**	**0.11****	**0.6****	**9.06***	**1.90****	**0.02***	**0.7****

*, ** = Significant at 5% and 1% probability levels, respectively; NS = Not significant at 5% probability level.

Table 3. Effect of different methods of fungicide (Ridomil) application on yield and yield parameters of

***Xanthosoma* cocoyam (NXs 001).**

Method of application	**corms**		**Cormels**		**Corms+Cormels**	
	No/ha	**Yield (t/ha)**	**No/ha**	**Yield (t/ha)**	**No/ha**	**Yield (t/ha)**
Soaked in ridomil	48000	4.53	168333	4.07	216333	8.60
Soil application	40608	4.29	53069	3.97	93677	8.26
Foliar application	9500	1.07	54833	1.63	64333	2.70
Soaked+foliar appl.	22000	4.20	127000	4.80	149000	9.00
Soil+foliar appl.	10444	5.18	105704	2.30	116148	7.48
control	4296	0.48	46577	1.42	50873	1.85
$LSD_{(0.05)}$	**6986****	**0.79****	**34355****	**1.40****	**39029****	**1.37****

** = Significant at 1% probability level.

weights (4.80 and 4.07 t/ha, respectively). Lowest cormels yields were obtained from Control plots (1.42 t/ha), Foliar application plots (1.63 t/ha) and Soil + Foliar application plots (2.30 t/ha). Significantly highest increase in total yield (corms + cormel) yields greater than 8.20 t/ha were obtained from Soaked + Foliar application plots (9.0 t/ha), Soaked-in-Ridomil plots (8.60 t/ha) and Soil application plots (8.26 t/ha). Control plots and Foliar application plots recorded the least total tuber yields of 1.87 and 2.70 t/ha, respectively.

The results showed that soaking planting setts in Ridomil 24 hours before planting significantly improved all the growth parameters. Soaking in Ridomil + foliar application improved stem girth and plant height only, while soil + foliar application improved plant height only. Foliar application and Control depressed all growth parameters measured. It was inferred from the results obtained that soaking in Ridomil gave best performance in measured growth parameters across the measured periods, followed by soil + foliar application. The higher growth and yield parameters obtained with soaked–in-Ridomil treatments compared to the controlis an indication that the disease without control significantly impacted on growth and yield of *Xanthosoma* cocoyam. The inability of the foliar treatment to improve growth and yield parameters when compared to the no control treatment could be connected to the fact that the foliar application method leads to wastage of the fungicide and was unable to target the pathogen which is soil borne and seed borne. Relative performance of the control plots in growth parameters at 3 MAP compared to performance at 6 MAP may implicate the native soil fertility and time interval before manifestation of disease.

Conclusion

Soaking corm setts in Ridomil 24 hours before planting significantly increased growth and yield parameters of cocoyam. Growth and yield parameters were depressed when Ridomil was not applied and when it was applied on the foliar. Consequently, soaking planting materials in fungicide (Ridomil) before planting is recommended as the best application method. It is also recommended that similar work be carried out in many other agricultural areas in the State to confirm the findings.

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Evaluation of Selected Pre-Release Water Yam (*Dioscoreae alata*) Genotypes in On-Farm trials for Disease Resistance and Agronomic Performance in some Nigeria Agro-ecozones

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Abstract

Experiments were conducted to evaluate some genotypes of water yam (*Dioscoreae alata*) and a national check in six agro-ecologies in Nigeria. The yield, field performance and disease reactions of the yams were evaluated with the view to ascertaining best performing water yam genotypes in terms of virgour, yield and disease resistance for release to farmers for cultivation. The experimental design was a Randomised Complete Block Design in three replications. Data were collected on plant vigour, disease incidence and severity of yam anthracnose disease (YAD) and yam mosaic disease (YMV) and, yield. The results showed that the variety TDa020061 had the highest YAD resistance significantly different ($P<0.05$) from TDa98/01174 which is the national check. TDa020061 had the highest YMV resistance which was significantly different ($P<0.05$) from TDa98/01174 ($P<0.05$) which is the control. TDa020061 had mean tuber yield of 17.54 t/ha different which is better ($P<0.05$) than the mean tuber yield better of the national check and the same genotype TDa020061 had the highest yield stability among other genotypes tested yams. From the results of the work TDa020061 is recommended for consideration and release to farmers.

Keywords: Dioscorea alata, Genotype, Yam anthracnose, disease severity, yield.

Introduction

Yam (*Dioscorea alata*) is among the most valued tuber crops in the tropics, and widely distributed in the humid and semi-humid tropics (Obidiegwu *et. al.*, 2010). The west African region is one of the three largest yam producing regions in the world and Nigeria is the largest yam producing country in the world (Aniedu *et. al.*, 2009). Yams have multiple species, around 600 species approximately (Umber *et. al*, 2014). The Yam is scientifically named as *Dioscorea* spp**.** Yam belongs to the family*Dioscoreaceae* (Hahn *et al*., 1987). These Yams are grown in Africa, Asia, South American region, the Caribbean and also in the islands of the South Pacific (Coursey, 1975). Most of the yams grown in Nigeria are from small farm lands (Chinwuba and Odjuvwuederhie, 2006,) and the various spp of yam grown in Nigeria are as follows: *Dioscorea rotundata* (white yam), *Dioscorea alata* (water yam), *Dioscorea cayenensis* (yellow yam), *Dioscorea Dumentorum* (trifoliate or bitter yam),*Dioscorea bulbifera* (aerial yam) *and Dioscorea esculenta* (chinese yam) (Abang, 2003). Yam is a plant consisting of a corm, from which the stem, tuber, and root emerge and grow during the growing season (Belehu, 2005).The plants of Yam are herbaceous annual and perennial crops that are often and mainly climbers or vines (De Clerck and Negreros-Castillo, 2000). The vines are mostly smooth or prickly especially towards the base; reaching up to 10 m of height depending on the variety (Miller, 2003). The tubers of some yams are in purple, brown, gray, black, and pink, white, and orange (Ogunleye and Ayansola, 2014). Yams perform optimally well under warm-sunny conditions at temperatures between 25 – 30^{0}C and do not tolerate freezing environment, a more reason why yams are restricted to the tropics (Sadauki and Olanrewaju, 2012). Yams require large amounts of rainfall (300 – 1200mm) per annum evenly distributed over six to nine months for optimum field performance of yam (Martin and Sadik, 1974). The major yam growing areas include the middle belt regions (Benue, Niger, Nasarawa, kogi and kwara states), Eastern region (Anambra, Imo, Enugu, Abia and Ebonyi states), Mid West region (Edo, Delta and Cross river states) and Western region (Ondo, Oyo, Ekiti and ogun states) (Mignouna, 2015).

Yam prefers deep rich permeable and loose soil texture for tuber development and expansion. Heavy clay soil tends to be water logged resulting in tuber rot and difficulty in harvest (Oshunsanya and Akinrinola, 2013). The optimum soil pH for satisfactory yield production is 5.5 – 7.0 (Adeleye *et. al*., 2010). Yam is best planted with the early rains in all locations where yams are grown. The cultural practices in yam production is fairly the same with little variations in land tillage, sowing, staking, weeding, application of fertilizer and even when fertilizer in not applied (Costas *et al*., 1968). Area / location of production, cultural practices and approach to yam production by the individual, all affect the performance of yam under a farmer's management (Oluwasusi and Tijani, 2013). This work aimed at evaluating some hybrid yam (water yam) genotypes developed by the Africa yam project for their field performance, yield and resistance reactions to some yam diseases with farmers at some yam producing areas of Nigeria.

Materials and methods

Some selected pre-release water yam(*D. alata*) genotypes comprising of TDa 02/00061, TDa1100432, TDa000317, TDa1100245 and TDa100365 with one national check (TDa 89/01174) were planted in 4 locations Igbariam in Anambra State (06^{o}13'19.22'N, 07^{o}4'54.61'E), Ohaji in Imo State (05^{o}24'8.53N, 06^{o}49'28.24'E), Uyo in AkwaI-bom State (05^{0}2'15.86'N, 07^{0}54'47.07'E), Abakaliki in Ebonyi state and Otobi in Benue State (7^{o}6'54.15'N, 8^{o}5'20.17'E).

The experiment was established on different dates at the different experimental locations as follows: Uyo location - 20th March, 2019, Ohaji location - 16th April, 2019, Igbariam location- 17th April, 2019, and Otobi location was planted on 16th May, 2019. This was dependent on how the rains stabilize at each of the locations. The yam setts for planting were each sliced into planting setts weighing 150g weight. The experimental was laid out in randomized complete block design (RCBD) with three replicates. A total of 12 planting yam setts per genotypes were planted in a plot in each replicate with a 1 m x 1 m plant spacing and three replicates were planted per genotype.

Field preparation was done manually using cutlasses and hoes in clearing and making of mounds. All other cultural practices beginning from planting, staking, weeding, fertilizer application to harvesting were carried out as the farmers do in their own locality with little modifications. Planting / sowing was done by using a cutlass to dig on the crest of mounds to a depth of 10-15 cm) and burying the planting sett, and then covered with the removed soil. One national check (TDa98/01174) was planted along with other water yam genotypes. The yams were staked individually using split bamboo stakes measuring two meters on average. Three weeding operations were carried out. The first was chemical weeding using a mixture of glyphosate and premextra herbicides at one week after planting and supported with two manual weeding operations using hoes. NPK 15: 15: 15 was used to fertilize the field at the rate of 400 kg/ha at eight weeks after planting. Harvesting was done manually using hoes and digging poles where the soil was very hard. Data was collected on the Vegetative characteristics (agronomic performance and disease responses to anthracnose and virus), tuber yield and responses to harvest. In agronomic evaluation, data were collected on percentage plant emergence, plant vigour and plant height at two weeks interval from time of planting to three months after planting. Disease incidence and severity data were collected on the plants at one month interval beginning from time of planting until harvest. Other traits data collected include number of marketable tubers, weight of marketable tubers, number of non-marketable tubers, weight of non-marketable tubers, number of rotten and diseased, weight of rotten and diseased, marketable tuber length, marketable tuber width and tuber shape. All data determination was on plot basis and converted to hectare.

Results and Discussion

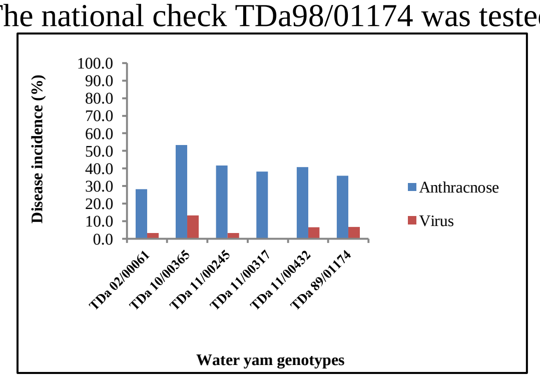
Results of the hybrid water yam (*D. alata)* genotypes evaluated at different yam growing locations with distinct agro-ecologies in Nigeria in 2019 showed that the yam genotypes were all distinct from each other. The yams were evaluated at Essien Udin in Uyo at Akwaibom state, Ohaji in Imo state, Igbariam in Anambra state, Otobi in Benue state and Abakaliki in Ebonyi state. The results showed that the genotypes TDa1100245 had the highest mean establishment count percentage of 97.2 (Table 1) and this was followed by TDa100365 with 95.8% and TDa98/01174 with 90.3 % establishment count. Two water yam genotypes (TDa020061 and TDa1100432 had same establishment count of 86.1% (Table 1). This shows that different agro-ecologies influence yam establishment differently (Sadauki and Olanrewaju, 2012). Yam establishment count is important in yam for easy adoption by famers. One of the problems associated with yam production by many farmers is the issue of establishment of planted yams which directly affects total yield at harvest. As a matter of importance, it is one of the potentials of yam seed to be considered before procuring or planting of yam because a yam field that is planted and which failed to sprout and establish will bring heavy economic losses to the farmer. All the water yam genotypes were very vigorous across all the locations with mean vigour score class of above 4.0 across all the water yam genotypes (Table 1) on a score rating 1 to 5. This result showed that water yam is a sturdy crop that thrives well in many tropical locations. TDa 02/00061 had the lowest anthracnose incidence across all the locations while 11/00317 had the least virus incidence (showing no incidence across the locations) (Fig.1). The anthracnose and virus incidence showed in Fig. 1 do not actually show resistance of the varieties to these diseases rather it shows the percentage of plant stands that expressed symptoms of the diseases. This can help in selection because plants with symptoms have the tendency of becoming epidemic under disease favourable conditions. Anthracnose and virus disease severities that show the resistance or tolerance of the genotypes is showed in Fig. 2. Majority of the *D. alata* genotypes showed very high resistance to the virus disease (Fig. 2). Similar trend was observed for anthracnose and virus on *D. alata* varieties (Fig. 2). This showed that the selected water yam genotypes for the evaluation were highly tested by breeders before going for the on-farm assessment.

Table 1: FEILD ESTABLISHMENT COUNT AND PLANT VIGOUR OF WHITE YAM GENOTYPES AT DIFFERENT AGRO-EC0L0GIES IN NIGERIA

	Establishment count						
	TDa020061	TDa1100432	TDa000317	TDa1100245	TDa100365	TDa98/01174	Mean
Umudike	91.7	83.3	83.3	91.7	100.0	100.0	91.7
Abakaliki	100.0	100.0	83.3	91.7	91.7	66.7	88.9
Igbariam	75.0	83.3	100.0	100.0	100.0	75.0	88.9
Imo	66.7	75.0	100.0	100.0	100.0	100.0	90.3
Uyo	83.3	75.0	83.3	100.0	100.0	100.0	90.3
Otobi	100.0	100.0	83.3	100.0	83.3	100.0	94.4
Mean	86.1	86.1	88.9	97.2	95.8	90.3	
LSD(0.05)	11.01	9.64	10.05	7.32	5.5	8.58	

	Plant vigour						
Umudike	4.6	4.2	3.1	4.5	3.8	4.4	4.1
Abakaliki	5.0	5.0	3.8	4.5	4.6	3.3	4.4
Igbariam	3.8	4.2	4.6	4.6	4.6	3.8	4.2
Imo	3.3	3.8	4.6	4.6	5.0	4.8	4.3
Uyo	4.2	3.8	4.5	4.6	5.0	5.0	4.5
Otobi	5.0	5.0	4.5	4.6	4.2	4.9	4.7
Mean	4.3	4.3	4.2	4.5	4.5	4.4	
LSD(0.05)	0.82	0.77	0.14	NS	0.26	0.33	

The national check TDa98/01174 was tested along with the other genotypes in all the locations



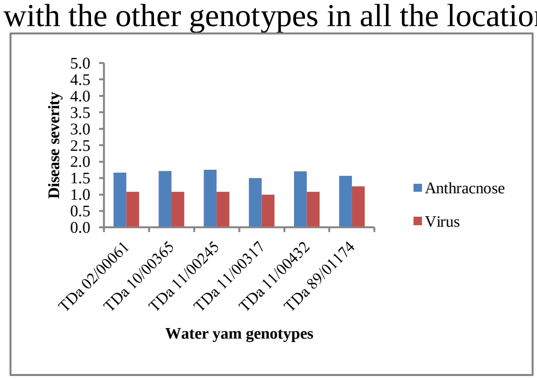


Fig. 1: Mean incidence (%) of major folia diseases of yam evaluated some states in Nigeria.

Fig 2: Mean severity of major folia diseases of yam evaluated in somestates In Nigeria.

Plant disease severity scale:

1 = No disease symptom

2 = Mild symptoms of disease

3 = moderately severe symptoms of disease

4 = highly severe symptoms of disease

5 = Death of plant.

Table 2 showed the mean tuber yield of the water yam genotypes across the experimental locations. TDa020061gave the highest mean tuber yield of 17.54t/ha. This was followed by the national check TDa98/01174 with a mean tuber yield of 16.96 t/ha and TDa000317 with a mean tuber yield of 15.40 t/ha. The implication of these mean yields given by the water yam genotypes across the locations is that the one that yields better than the control will be selected for release to farmers. The discovery is a basis for which these new yam genotypes will be released to farmers.Yield stability of the yam genotypes across the locations is shown in Fig. 3. Results shown in Fig 3 revealed that TDa 020061 had the highest mean stability yield of 4 t/ha across the locations. This is the degree stability in yield and the actual yield of the genotypes. This do not mean that the genotype had the highest yield in all the locations but means that the genotype maintained a yield value that was fairly same in all the locations; that is yields that do not vary much in any of the locations. This is a good potential of yam genotypes because genotypes with high yield stability can perform optimally well under many environmental conditions.

Table 2: Mean tuber yield of yam genotypes across experimental locations (t/ha).

	TDa020061	**TDa1100432**	**TDa000317**	**TDa1100245**	**TDa100365**	**TDa98/01174**
Umudike	17.6	14.7	18.2	19.4	19.5	15.1
Abakaliki	26.2	23.8	21.5	22.8	18.6	23.3
Igbariam	16.5	13.9	17.9	14.1	15.2	16.2
Ohaji	13.9	6.2	4.7	3.9	7.1	14.4
Uyo	16.5	13.2	17.7	18.2	18.2	14.2
Otobi	14.6	16.3	15.2	16.5	8.4	16.7
Mean	17.54	14.70	15.40	15.11	13.51	16.96
$LSD_{(0.05)}$	3.12	5.01	3.33	6.14	5.25	2.74

The national check TDa98/01174 was tested along with the other genotypes in all the locations

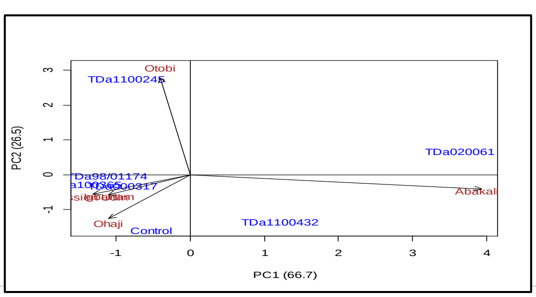


Fig. 3: Yield stability of yam genotypes across some agro-ecologies of Nigeria. The locations are Imo (Ohaji), Anambra (Igbariam), Otobi (Benue), Essien Udin (Uyo) and Abakaliki (Ebonyi).

Conclusion and recommendation

Selected pre-release hybrid yam genotypes developed under yam breeding processes were tested at different agro-ecologies in Nigeria under farmers' conditions and management with a view to select the best performing water yam genotype for release to farmers for adoption and cultivation. TDa020061 had the highest mean yield (17.54 t/ha) across all locations and the same TDa020061 had the highest yield stability across all the locations. The work therefore recommends that TDa020061 be released to farmers for use since it had a better yield than the national check and gave the highest yield stability across all the locations.

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Evaluation of Water Yam (*Dioscorea alata*) Mapping Populations for Resistance to Anthracnose Caused by *Colletotrichum Gloeosporioides* (Penz And Sacc) Using Detached Leaf Assay

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Abstract

Detach leaf assay (DLA), a newly developed method for rapid evaluation of foliar diseases of some crops was tried on yam to assess its efficacy in evaluation of yam anthracnose disease of three water yam mapping populations. The experiment was carried out in Plant Pathology laboratory of the National Root Crops Research Institute, Umudike Umuahia. The technique was used to evaluate three F1 mapping populations of *Dioscoreae alata* for resistance to yam anthracnose disease in the laboratory. Complete randomized design was applied in the evaluation and three replications was established for each treatment. Each *D. alata* population including 1401 series (154 individuals including TDa1401B/1113, TDa1401B/1086, TDa1401B/1315…TDa1401B/1189), 1512 series (120 individuals including TDA-EB-12-1512-10720, TDA-EB-12-1512-13680, TDA-EB-12-1512-27635…TDA-EB-12-1512-38197) and 1506 (58 individuals including TDA-UM-15-1506-20422, TDA-UM-15-1506-25572, TDA-UM-15-1506-37943…TDA-UM-15-1506-28535) were evaluated separately. The results showed that the grouping of the individual yams into categories as highly resistant, resistant, moderately resistant, moderately susceptible and susceptible in each of the F1 populations using DLA had similar trends of placing highest number of individuals in highly resistant or resistant category, moderate number of individuals in the moderately resistant category and a few or no individuals in the susceptible category. The DLA technique is recommended for evaluation of yam for anthracnose disease resistance for its effectiveness in rapid screening, saving time and using minimal space for the **Keywords**: Detach leaf, Mapping population, Resistance, Anthracnose, Resistance.

Introduction

Yams are nutrient-dense tuber crop plants that come in many shapes, skin and flesh colors and tuber lights. They are a great source of fiber, potassium, manganese, copper, and antioxidants.

Apart from being a staple and source of livelihood for many, yams are linked to various health benefits and may boost brain health, reduce inflammation, and improve blood sugar control and some species are specifically grown as health food and/or for medicinal purposes. (Dufie *et al*., 2013).

Plant disease (including many field and storage diseases) infestation has been a major problem, limiting the production of this crop. Many field and storage diseases including yam anthracnose disease which is regarded as the most widely spread of all the field diseases, yam mosaic virus disease that is considered to cause the most severe losses in yams and rots (both dry and wet rots) are considered as the most devastating of all the storage diseases of yam (Amusa *et al.*, 2003).

Plant breeding for disease resistance has been the best method for managing these diseases (Egesi *et al*., 2009), as it benefit is of two great advantages: (i) It enhances the production of yam by reducing losses due to diseases. (ii) Reduces the dependence on fungicides and bacteriocides for management of yam diseases as they are deleterious to yam environments. Yam disease resistance is the ability of yam to prevent or reduce expression of disease symptoms and their effects even in the presence of viable diseases pathogens in the environment yams (hosts) (Bloem *et al*., 2001). It can arise from genetic (hybridization) or environmental factors, such as incomplete penetrance. Disease tolerance is the ability of a yam host to limit the impact of disease on health. It is different from resistance.

The conventional method of breeding for disease resistance is hybridization and selection. The various sequential steps are: screening germplasm for resistance sources, hybridization of selected parents, selection and evaluation of hybrids and testing and release of new varieties. These various processes take a long to get crops released but using the detach leaf assay technique, large numbers of yam genotypes can be screened for disease resistance in a short time using a small space in the laboratory (Nwadili *et al*., 2017).

Methods of disease resistance evaluation have been in existence in yam and other crops even from the times of the early man. With the domestication of plants for agriculture, farmers always selected the plants that withstood adverse environmental factors, including insects and diseases. The plants that were susceptible to pests generally died, and only resistant plants survived until crop harvest. This process led to the natural selection of plant varieties resistant to insect pests and diseases (Denison *et al*., 2003). As a result of this unintentional but continuous selection of plants over several hundreds of years, many landraces selected by farmers evolved as having, or accumulating, genes conferring resistance to insect pests and diseases. In yam, the best examples of this process are some resistance in landraces as Abii and Gbangu cultivated in Eastern and middle belt agro-ecozones of Nigeria respectively.

Field inoculation and resistance identification method is a method used in some cases for identification and selection of resistant individuals among others. Rarely is a researcher able to grow a group of plant genotypes and accurately evaluate pest and disease damage. Without proper planning, either there will be insufficient insect numbers or pathogen inoculums to cause adequate damage at an inappropriate phenological stage of crop growth. Field inoculations / infestations are normally used to evaluate a large number of plant lines at early stages of the resistance evaluation program. In this case, indigenous pathogen or insect is used to inoculate the field to induce symptom expression. Plants that escape damage in the presence of inoculums and favourable environment are identified as resistant materials.

his is a method of raising and evaluating crops for pests and disease resistance in a known disease or pest endemic area. This method permits the exposure of crops to worst scenario such that crops identified as resistant there can withstand whatever conditions it may meet elsewhere (Denbel *et al.*, 2013.).

Detach leaf assay (DLA) is a rapid technique that is used to efficiently screen large number of yam population for resistance to yam anthracnose disease (YAD) (Nwadili *et al.*, 2017) cause by *Colletotrichum gloeosporioides* which mostly attacks *D. alata* more than any other type of yam. The technique involves some stages that include collection of anthracnose infected yam leaf samples from open fields, incubation of pathogens on the right medium usually potato dextrose agar (PDA), isolation and identification of isolates, pathogenesis for confirmation of virulent isolates and YAD resistance evaluation using detach leaf assay (DLA).

The objective of all this was to have an optimum insect pest / disease pathogen density: damage ratio that allows the researcher to observe maximum differences among the resistant and susceptible plants. Several procedures not highlighted in this work can be employed to obtain adequate resistance screening result.

Materials and methods

The trials were done in Plant Pathology laboratory of National Root Crops Research Institute (NRCRI) Headquarters in Umudike, Abia State in 2017.

Sampling for infected yam leaves

Anthracnose infected yam leaves were obtained from 24 yam farms at different locations in Umudike in 2017. The yam leaf samples showed variety of anthracnose symptoms and samples were collected over a period of five months covering the whole duration of yam growing season in Nigeria, to help trap the different strains of the *C. gloeosporioides* responsible for yam anthracnose.

Isolation and identification of isolates

The infected yam leaf samples were surface sterilized in 20% sodium hypochlorite for 1 min and rinsed in four changes of sterile distilled water separately in beakers. The surface sterilized yam leaf samples were cut into pieces of approximately 4 x 4 mm using surgical blades and forceps sterilized to red hot over flame under aseptic condition under laminar airflow hood. The cut pieces yam leaves were cultured for fungal growth by plating four pieces on PDA in Petri dishes with spaces of approximately 5 mm away from each other. After growing the organism on PDA for 4 – 7 days, the organisms were sub-cultured for purification into pure isolates and identified under the microscope based on the morphology and growth pattern.

Pathogenecity test

Forty six different *C. gloeosporioides* were obtained and tested on detached leaves of four varieties of yams (*D. alata*) with known varying anthracnose resistance. Many of the isolates showed different levels of virulence but two were selected based on highest vertical and horizontal virulence on the yams tested. Isolate Um-7 had the highest vertical virulence which did not differ significantly from isolate Um-11 which had significantly higher horizontal virulence than Um-7. The isolate Um-11 was used for the detached leaf assay (DLA) of the three sets of water yam. Copies of the isolates were kept on slants in a 4^oC refrigerator for use at any time required time of evaluation.

Detached Leaf Assay (DLA)

The detached leaf assay is a screening method that has high efficiency in giving good estimate of what happens on the field in relation to YAD. This method involves cutting of young (about 3 months old) healthy yam leaves from growing yam plant to evaluate the yam reaction to anthracnose resistance when inoculated with anthracnose pathogen, *C. gloeosporioides*. The results have been found to be predictive of what happens in the field but the screening is faster thereby rapidly giving the result of plants YAD resistance in a short time.

The detached leaves were surface sterilized using 20% sodium hypochlorite for 1 min and passing them through 4 rinses of distilled water for 1 min each in a beaker. Excess water on the leaf sample was wiped off with sterile paper towel. The detached leaves were placed on a filter paper moistened with distilled water in a transparent plastic plate (take-away) and covered with the lid. These leaves were inoculated with 30µl drop of inoculum at a concentration of 1 x 106 on the abaxial surface. The plates containing the inoculated leaf samples (three replicates) were incubated at ambient temperature (+28oC) and evaluated at day 4, 8, 12 and 16 after inoculation. The resistance of the yams was evaluated based on the severity of anthracnose infection observed on the yams. The ratings or classification was based on five categories (points 1 – 5) where:

1 (0% anthracnose severity) = Highly resistant yam

2 (1 – 25% anthracnose severity) = Resistant yam

3 (26 – 50% anthracnose severity) moderately resistant yam

4 (51 – 75% anthracnose severity) = Susceptible yam and

5 (76 – 100 anthracnose severity) = Highly susceptible.

Results and discussion

The evaluation results of 1401 series showed that 46 yam genotypes representing 35.66% out of 129 genotypes were found to be highly resistant, 71 genotypes representing 55.04% of the mapping population (set of materials from the same parent) were resistant, 8 genotypes (6.20%) were moderately resistant, 4 genotypes (3.10) were susceptible and no genotype showed highly susceptible (Fig. 1). This is expected because in an F1 population because the inheritance of resistance in F1 mapping population progenies within the range latter after the first 40% of the population and concentrates in the first 80% of the progenies (Edward, 2000). This means that the most resistant individuals in an F1 plant populations usually found in the first 40% of the population and the next resistance class in the second 40% just as is observed in Fig 1.

In the evaluation of 1512 series, the results showed that 58 yam genotypes representing 58.54% out of 108 genotypes were found to be highly resistant, 44 genotypes (40.74%) were resistant, 5 genotypes (4.63%) were moderately resistant, 4 genotypes (3.10%) were susceptible and no genotype showed highly susceptible. This second population is an F1 population and a similar trend as seen in Fig. 1 was observed (Fig. 2).

Results obtained from evaluation of 1506 series showed that 25 yam genotypes representing 51.02% out of 49 genotypes were found to be highly resistant, 13 genotypes (26.53%) were resistant, 7 genotypes (14.29%) were moderately resistant, 4 genotypes (8.16%) were susceptible and no genotype showed highly susceptible. Progenies in 1506 mapping population are an F1 progenies. The anthracnose resistance grouping in this population (Fig. 3) follows a similar with the ones in Fig. 1 and Fig. 2. This shows that detach leaf technique is an effective method of disease evaluation in yam.

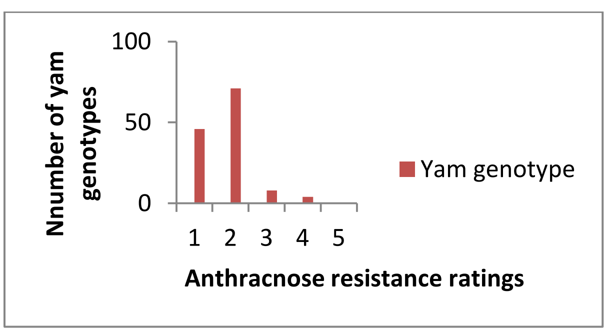

Fig. 1: Evaluation results of 1401yam series
1 = 0% anthracnose severity, 2 = 1 – 25% anthracnose severity, 3 = 26 – 50% anthracnose severity, 4 = 51 – 75% anthracnose severity, 5 = 76 – 100% anthracnose severity.

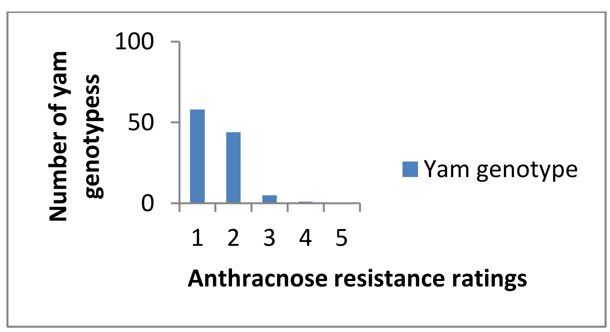

Fig. 2: Evaluation results of 1512 yam series
1 = 0% anthracnose severity, 2 = 1 – 25% anthracnose severity, 3 = 26 – 50% anthracnose severity, 4 = 51 – 75% anthracnose severity, 5 = 76 – 100% anthracnose severity.

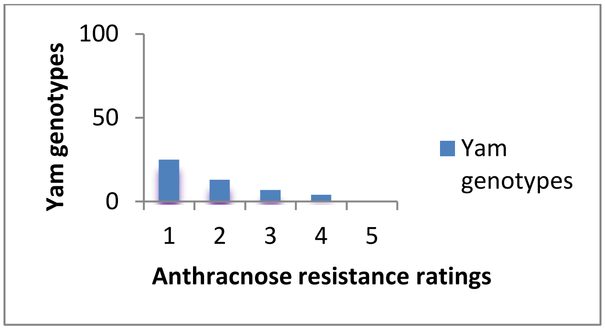

Fig. 3: Evaluation results of 1506 yam series
1 = 0% anthracnose severity, 2 = 1 – 25% anthracnose severity, 3 = 26 – 50% anthracnose severity, 4 = 51 – 75% anthracnose severity, 5 = 76 – 100% anthracnose severity.

Conclusion and recommendation

Detached Leaf Assay (DLA) is a fast screening method for evaluation of yam for YAD resistance in yam. In this work, the method was used to effectively classify the yam genotypes of different mapping populations (set of progenies from same parents) into various plant resistance categories such as highly resistant, resistant, moderately resistant, susceptible and highly susceptible. The method will continue to be important for plant resistance screening especially where it involves large number of populations due to its importance in saving time, space and it is a rapid screening. The method, DLA is recommended for use in the evaluation of YAD resistance in yam.

Acknowledgement

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On farm evaluation of pre-released water yam (*Dioscorea alata*) genotypes for farmer preferred sensory and tuber qualities

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Abstract

With regards to yam (*Dioscorea*) production, Nigeria is considered to be the largest producer worldwide and the genus serves as a major source of food and income for millions of farmers and consumers alike. Of the over 600 species identified to date *D. alata* is the second most produced and utilized yam. Several biotic and abiotic factors affect the production of yams, to which several breeding programs are developing improved varieties to help overcome these challenges. Here we conducted trials with farmers (panellists) across 4 states, covering different agro-ecological zones, to evaluate the tuber, cooking and pounding qualities of five pre-released *D.alata* genotypes(TDa020061, TDa000317, TDa1100245, TDa98/01174, TDa1100432 and TDa100365). The study showed that of the seven genotypes assessed (including the local and national checks), both men and women mostly preferred TDa020061 while TDa1100432 and TDa100365was least preferred. TDa020061 should be considered for release based on these qualities evaluated.

Introduction

In sub-Saharan, the Yam (*Dioscorea* spp)tuber has served as a major source of income for millions of farmers and trader; also as a major source of nutritional and health benefits(Egesi *et al.*, 2007). In many regions, and especially in Nigeria, yams are held to high esteem and are featured during cultural festivities(Oselebe and Okporie, 2008) and there are several ways by which the yam is prepared(Nwankwo *et al.*, 2017). Current studies place the number of yam species at just over 600(Mignouna *et al.*, 2008), with water yam (*Dioscorea alata*) being the second most economically important specie next only to the white yam (*Dioscorea rotundata*)(Sartie and Asiedu, 2011). The threat to yam production include the effects of pests and diseases, climate change, marginal soils, and drought.

Since 2001, the yam breeding programs of the National Root Crop Research Institute (NRCRI) and the International Institute for Tropical Agriculture (IITA) have developed and released several *D. alata*varieties. These varieties have been improved for many economically important traits ranging from disease and pest resistance, improved organoleptic properties, improved yield and early maturity. In this study we evaluate the perception of male and female panellist in different locations, using several criteria based on appearance, texture, aroma, colour, taste, elasticity and the overall impression of tuber, cooking and pounding qualities of seven *D.alata* genotypes.

Materials and Methods

Area of study and planting materials

Seven (7) pre-release *D. alata* genotypes including TDa020061, TDa000317, TDa1100245, TDa98/01174, Okwananwankata, TDa1100432 and TDa100365 were planted and evaluated in 12 locations. The locations were randomly selected in 4 states Anambra (Igbariam), Imo (Ohaji), Uyo (Akwa-Ibom), Ebonyi (Abakaliki) and Benue (Otobi) that cut across several agro-ecological zones in Nigeria. The experiments were established on different dates as seen in Table 1. This was depended on how the weather conditions, like rainfall pattern at each of the locations.

Table 5: Planting dates and location of on farm trials for *D.alata* evaluation

Location	**Date of planting**
Uyo (Akwa-Ibom)	20th March, 2019
Imo (Ohaji)	16th April, 2019
Anambra (Igbariam)	17th April, 2019
Benue (Otobi)	16th May, 2019

Agronomic practices

The yam setts for planting were each sliced into planting setts weighing 150g weight. The experimental was laid out in randomized complete block design (RCBD) with three replicates. A total of 12 setts per genotypes were planted in a replicate with a 1 m x 1 m plant spacing and three replicates were planted per genotype. Field preparation was done manually using cutlasses and hoes in clearing and making of ridges. All other cultural practices such as planting, staking, weeding, fertilizer application and harvesting were carried out as the farmers do in their own locality with little modifications. Planting / sowing was done by using a cutlass to dig on the crest of ridge (10-15 cm) and burying the planting sett, and then covered with the removed soil. The yams were staked individually using split bamboo stakes measuring two meters on average. Three weeding operations were carried out. The first was chemical weeding using a mixture of glyphosate and premextra herbicides at one week after planting and supported with two manual weeding operations using hoes. NPK 15: 15: 15 was used to fertilizer the field at the rate of 400 kg/ha at eight weeks after planting. Harvesting was done 9 months after planting, using hoes and digging poles where the soil was difficult.

Data collection and sensory evaluation

In each of the 12 locations in this study, we identified and invited experienced farmers to serve as panellist from the surrounding villages. These panellists numbered 20 with 10 men and 10 female. Group discussions were held with panellist to list the criteria farmers use for assessing or describing yam genotypes (hedonic test on: appearance, texture, aroma, colour, taste, elasticity and general acceptability) for tuber, cooking and pounding qualities. As much as possible the opinion of male and female panellist were not influenced by the facilitator. Farmers gave votes for each quality assessed and finally gave an overall impression for the genotypes based on these qualities.

Statistical analysis

Based on the overall impression, the genotypes were assigned scores on a scale of 1 - 7 , with 1 having the highest number of votes and 7 having the least number of votes. Using the R package, Plackett-Luce(Turner *et al.*, 2020), the genotypes were ranked and the preferred genotypes for men and women across the trials were determined.

Results and Discussion

To improve the adoption of released materials from breeding programs, studies have shown that farmer participation is imperative(Kimani, 2017). Most recently the importance of gender roles have been implicated in the breeding of root and tubers like cassava(Teeken *et al.*, 2018). For both men and woman across all of the locations, panellist preferred tuber qualities that appeared big, white fleshed and smooth skinned. The preferred cooking qualities was smooth texture, shorter time to cook, good aroma and taste, while the pounding qualities included a malleable, non - sticky and a less lumpy texture. Previous studies have also revealed these qualities are good food qualities in yam(Ezeocha *et al.*, 2015). Overall, men adjudged TDa020061 and Okwananwankata as most preferred with a net score of 100% meaning both genotypes was most preferred in all contests while 60% of the time men preferred TDa000317(Table 2 and Figure 1). TDa1100245 had an equal number of wins and losses, hence the 0% net score. On the other hand, TDa020061 (100%) was most preferred by women, TDa1100245 and Okwananwankata were ranked second at 33.3% and TDa98/01174 was ranked third at 20%. Both men and women adjudged genotypes TDa1100432 and TDa100365 as least preferred.

Table 6: Favourability Statistics of overall impression of *D.alata* quality

Genotypes	Sex of participants	Top Ranked	Bottom Ranked	Net score
TDa020061	Male	100	0	100
Okwananwankata	Male	100	0	100
TDa000317	Male	80	20	60
TDa1100245	Male	50	50	0
TDa98/01174	Male	0	100	-100
TDa1100432	Male	0	100	-100
TDa100365	Male	0	100	-100
TDa020061	Female	100	0	100
TDa1100245	Female	66.7	33.3	33.3
Okwananwankata	Female	66.7	33.3	33.3
TDa98/01174	Female	60	40	20
TDa000317	Female	33.3	66.7	-33.3
TDa1100432	Female	0	100	-100
TDa100365	Female	0	100	-100

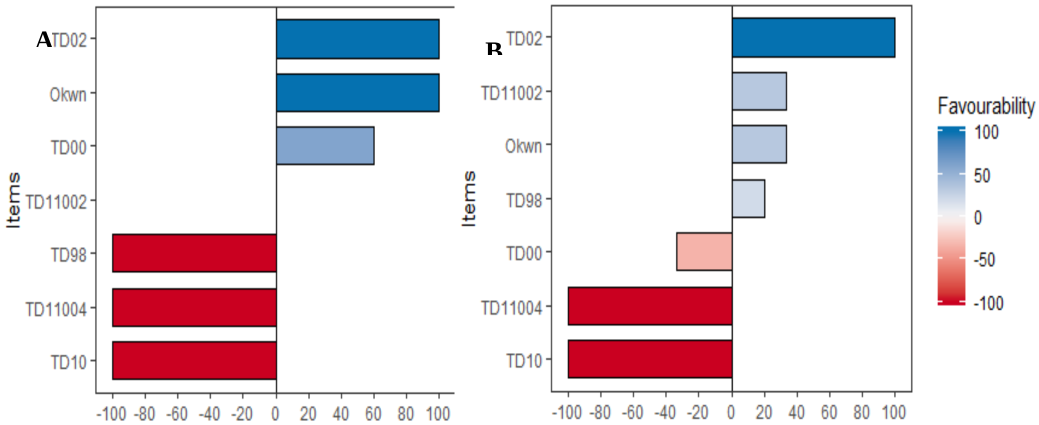

Figure 2: Graphical representation of the overall impression of the *D.alata* genotypes by (A) Men and (B) Women

Conclusion

Selected pre-release new hybrid *D.alata* genotypes developed under yam breeding processes were planted at different agro-ecologies in Nigeria under farmers' conditions and management practices. These genotypes were sensory evaluated based on several tuber, cooking and pounding qualities, with a view to selecting the best performing yam genotype for release to farmers. Across all locations both men and women mostly preferred TDa020061 while TDa1100432 and TDa100365 were least preferred. This study shows the importance of farmers participation as well as the gender response in evaluating crops for release. This better informs how the released varieties will be adopted by the consuming public.

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Effect of Intra-row Spacing and Phosphorus Rate on Growth and Yield of Groundnut (*Arachis hypogaea L.*) in Katsina State, Nigeria

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Abstract

The aim of the experiment was to evaluate the effect of intra row spacing and phosphorus rate on groundnut. The experiment was laid out in a randomized complete block design with three replications. Treatments consisted of intra row spacing (10, 15, and 20cm) and three-levels of single super phosphate (SSP0, SSP20, SSP30, SSP40 Kg/ha). The outcome of the assigned treatments varied on growth and yield parameters tested. Intra row spacing of 2 0cm gave the least pod weight/ha, grain yield, haulm yield, and biomass yield of groundnut, while spacing at 10cm gave higher and comparable pod weight/ha, grain yield, and biomass yield. However, intra row spacing at 15cm gave a higher haulm yield than other treatments. Similarly, the application of phosphorus at 20kg/ha gave higher but comparable haulm yield to 30kg/ha phosphorus application than all the other treatments. Intra row spacing at 10cm and phosphorus application of 20Kg/ha was observed to be the best rate for groundnut production in the study area and therefore recommended.

Keywords: Groundnut, Intra-row spacing, Phosphorus, Growth

Introduction

Groundnut or peanut (Arachis hypogaea L.) belongs to the family *Leguminosae* and sub-family *Papilionoideae* (Waele and Swanevelder, 2001). It originated between southern Bolivia and Northern Argentina from where it spread throughout the New World as Spanish explorers discovered its versatility. Today farmers in Asia and Africa also cultivate it. It is grown under a wild range of environmental conditions in areas between 40 degrees South and 40 degrees north of the equator (CGIAR, 2007).

Groundnut is grown in nearly 100 countries. Major groundnut producers in the world are China, India, Nigeria, the USA, Indonesia, and Sudan (CGIAR, 2007). Developing countries account for 96% of the global groundnut area and 92% of the global production. Asia accounts for 58% of the global groundnut area and 67% of the groundnut production with an annual growth rate of 1.28 % for the area, 2.00% for production, and 0.71% for productivity (FAO, 2004). Because of its high protein, oil, vitamins, carbohydrates, minerals, and fatty acid contents, peanut has high nutritional and commercial value. Groundnut is considered among the most valuable crops rich in protein and occupies the fifth position worldwide as an oilseed crop (El sayed *et al.*, 1992). It contains 45-55% oil, 20-25% protein, 16-18% carbohydrate, and 5% minerals (Gulluoglu *et al.*, 2016).

Although groundnut is important in Nigeria, production has declined since the devastating diseases and pest records of 1965-1967 (Freeman et al., 2000). Several interrelated factors have been identified as the cause of the decline in production, but the most important have been natural disasters such as critic rainfall, drought, and diseases. Other causes include completion from food crops for cash, late planting, inadequate fertilizer, and chemicals, unavailability of improved seeds, etc. Groundnut production in Nigeria has suffered major setbacks from the groundnut rosette epidemics and foliar diseases, aflatoxin contamination, and lack of sufficient and consistent supply of seed of improved varieties. This has significantly affected productivity and thus production and subsequently led to losing its share in the domestic, regional, and international markets. Early or late in the growing season, very low temperatures can lead to immature pods at harvest, whereas increased temperature delay growth and can result in water stress (Vara Prasad et al., 2008). While groundnuts are generally drought tolerant, their sensitivity varies at various stages of development (Boote and Ketring, 1990, ICRISAT, 2002). To regain its competitiveness, groundnut yield would have to increase substantially, using yield-enhancing technologies including varieties tolerant or resistant biotic and abiotic stresses. This study was designed to evaluate the effect of intra row spacing and phosphorus rate with the view of determining the optimum rate for good growth and yield of groundnut in the Sudan savanna agro-ecological zone of Nigeria.

Materials and Methods

The field experiment was conducted during the raining season of 2018/2019 at Teaching and Research Farm of Federal University Dutsin-Ma, Katsina State, at Badole (Latitude 12°23'52.0"N and Longitude 07°27'41.7"E) 605 m above sea level in the Sudan savannah ecological zone of Nigeria. The soil of the experimental site has the following characteristics: % sand (76), % silt (16) and % clay (6) (loamy sand); slightly acidic (H_2O), 5.30; total nitrogen 0.42 (%) and of poor soil fertility (CEC 4.03). Each plot consisted of 5 ridges with a gross area of 12m^2 and the net plot is 3m^2. The experiments were laid out in a randomized complete block design (RCBD) with three replications. The treatments consisted of intra row spacing (10, 15, and 20cm) and three-level of single super phosphate (SSP0, SSP20, SSP30, SSP40 Kg/ha). The site was ploughed and harrowed. The plots were kept weeds free using manual hoe weeding at 2 and 4 weeks after planting. Harvesting was carried out when the plant was fully matured. Data on growth and yield characteristics were measured. Data on plant height, number of leaves, branches, peg, and fruit weight per plant, 100 weight, haulm yield, number of seeds per pod, and grain yield were measured. The collected data were subjected to analysis of variance as described by Snedecor and Cochran (1967), and the significant means were compared using Duncan's Multiple Range Test (DMRT) at a 5 % level of significance.

Results and Discussion

In this study, the effect of intra row spacing on growth and yield parameters varied. The effect of spacing and phosphorus rate on the number of branches and leaves is presented in Table 1. Spacing did not have a significant effect on the number of branches at 4WAS and 8WAS but was significant at 6WAS in which 10cm spacing gave a lower number of branches than all the other treatments which gave higher and a comparable number of branches. At 4WAS, spacing had no significant effect on the number of leaves but spacing at 15cm gave higher but a comparable number of leaves to 10cm spacing at 6WAS and 20cm spacing at 8WAS. The rate of phosphorus application was not significant at 4 WAS and 6WAS for all the parameters taken. At 8WAS, the application of 40 kgP_2O_5/ha gave a lower number of branches and leaves than all the other treatments which gave higher and a comparable number of branches and leaves. The significant number of leaves and branches obtained from the application of 20P_2O_5kg/ha conforms to the result observed by Singh et al., 2011 who stated that because of the essential role phosphorus plays in plant physiological processes, the application of phosphorus to soil deficient in this nutrient leads to an increase in the yield of groundnuts.

Table 1: Plant height as affected by phosphorus rates and intra row spacing during the 2019 rainy season in Dutsinma

	Growth Parameters (cm)					
Treatments	Number of Branches			Number of Leaves		
Spacing (cm)	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
10	4.24	4.87^{b}	6.44	19.04	27.85^{ab}	33.25^{b}
15	4.57	5.79^{a}	7.72	20.12	30.63^{a}	39.08^{a}
20	4.45	5.38^{ab}	6.83	19.02	26.91^{b}	34.75^{ab}
SE±	0.194	0.252	0.645	0.783	0.957	1.535
Phosphorus (kg/ha)						

$0P_2O_5$	4.39	5.41	7.03^{ab}	18.96	28.56	35.65^{ab}
$20P_2O_5$	4.47	5.81	8.34^{a}	18.22	29.59	38.63^{a}
$30P_2O_5$	4.46	5.31	7.03^{ab}	20.53	29.22	36.24^{ab}
$40P_2O_5$	4.34	5.88	5.58^{b}	19.71	26.48	32.25^{b}
SE±	0.225	0.291	0.745	0.893	1.116	1.772

In a column, figures without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per Duncan's New Multiple Range Test (DMRT), WAS= Week after sowing

The effect of intra row spacing on pod weight/ha, grain yield, haulm yield, and biomass yield significantly differ as presented in Table 2. Intra row spacing of 20cm gave the least pod weight/ha, grain yield, haulm yield, and biomass yield of groundnut, while spacing at 10cm gave higher and comparable pod weight/ha, grain yield, and biomass yield. This result agrees with the findings of Ahmad et al. (2007) who reported that there is higher yield in close spaced compared to wide-spaced groundnut systems usually attributed to higher plant population densities that effectively utilize water, nutrient, and perhaps more importantly light. Also, close-spaced systems have been shown to give greater ground cover, leaf area indices, crop growth rates, and higher yield when compared to conventional wide row crops (Adigun 2001; Dalley *et al.,* 2004). Taylor (1980) also observed that in a season of high water supply, seed yield in narrow row yielded 17% more than in wider rows. Plant density is an important factor for growth and pod production rate, pod, and kernel yield in groundnut (Silvertooth, 1999). However, intra row spacing at 15cm gave a higher haulm yield than other treatments. Similarly, the application of phosphorus at 20kg/ha gave higher but comparable haulm yield to 30kg/ha phosphorus application than all the other treatments. There was no significant effect of phosphorus rate on pod weight/ha, grain yield, and biomass yield of groundnut. This can be attributed to uncontrolled interrelated factors encountered during the experiment such as waterlogging, uneven distribution of rainfall throughout the rainy season of 2019.

Table 2: Pod weight/ha, grain yield, haulm yield, and biomass yield as affected by phosphorus rates and intra row spacing during the 2019 rainy season in Dutsinma.

Treatments	Yield Parameters (cm)			
	Pod Weight/ha	Grain Yield	Haulm Yield	Biomass Yield
Spacing (cm)				
10	36045.03[a]	1752.16[a]	23669.08[b]	31013.22[a]
15	23230.21[ab]	1698.48[a]	29143.31[a]	26866.05[ab]
20	11111.11[b]	1182.14[b]	22407.41[b]	18673.38[b]
SE±	4381.3916	159.063	2377.201	3221.727
Phosphorus (kg/ha)				
$0P_2O_5$	15837.82	1484.87	18910.36[c]	20544.59
$20P_2O_5$	20716.05	1389.06	31506.17[a]	28848.89
$30P_2O_5$	21975.31	1882.04	28148.14[ab]	23827.78
$40P_2O_5$	35319.29	1421.11	21728.39[bc]	28848.89
SE±	5058.6497	183.651	2741.808	3715.852

In a column, figures without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per Duncan's New Multiple Range Test (DMRT), WAS= Week after sowing

Conclusion

Based on this study, it can be concluded that a narrow spacing of 10cm and phosphorus application of 20kg/ha can be used to obtain high growth and yield of groundnut. It is recommended that further research should be carried out to access the effect of phosphorus fertilizer on the productivity of groundnut in Sudan Savanna of Nigeria.

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Influence of Nitrogen and Poultry Manure Application on the Productivity of Celosia (*Celosia argentea* L.)

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Abstract

The experiment was carried out to determine the influence of nitrogen and poultry manure application on the productivity of celosia (*Celosia argentea* L.). Field experiment was conducted in the dry season of 2016/2017 at the Teaching and Research Farm of Federal University of Dutsin-Ma, Katsina State. The treatments consisted of three levels of nitrogen (0, 40 and 80 kg N ha^{-1}) and four levels of poultry manure (0, 5, 10 and 15 t ha^{-1}) arranged in a randomized complete block design and replicated three times. The treatments were arranged in a randomized complete block design with various factorial combinations and replicated three times. Application of 40 and 80 kg N ha^{-1} was not significant on growth and yield performance of celosia. This could be that the maximum rate of nitrogen was not attained that would have exerted influence on celosia growth and yield. Fertilization with poultry manure significantly increased number of leaves per plant, plant height per plant, stem girth per plant, and fresh shoot yield of celosia. Application of 10 t ha^{-1} of poultry manure seems to be appropriate for growth and yield of celosia in the study area. Application of 5, 10 and 15 t ha^{-1} of poultry manure produced 280.4, 433.3 and 480.7% increases in fresh shoot yield of celosia when compared with no poultry manure application, respectively.

Keywords: Nitrogen, poultry manure, transplanting, productivity, celosia.

Introduction

Celosia (*Celosia argentea* L.) belongs to the pigweed family ‘Amaranthaceae’. It is an important leafy vegetable grown mainly in southwestern Nigeria, which is popular for its succulent leaves that is rich in protein, vitamins and minerals (Akanbi *et al*., 2007). It is a vegetable of high economic importance especially during the dry season, most rural vegetable farmers get reliance on it as a source of income (Akinfasoye *et al*., 2008). Celosia argentea is commonly found in the traditional mixed and inter-cropping systems of the tropics as seen on small patches of pure overcrowded stands (when drilled) or single plants (when transplanted) at regular or irregular spacing (Akanbi *et al*., 2007). Its leaves and young shoots are important in soup and stew makings. Again, celosia leaves can be kept dried and preserved for the dry season usage (Aruna, 2009). Medicinally, it can be used to treat ailments like diarrhea, abscesses, eye problems, cough, dysentery, diabetes, eczema, menstruation problems, gonorrhea, infected sores, liver ailments, muscle troubles, skin eruptions, wounds and snakebites (Schippers, 2000).

There is a rapid decline in tropical soil fertility and crop productivity has become a major challenge which has obstructed the quest to achieve food sufficiency in the tropics. It has become so difficulty for Nigerian savanna soils to support worthwhile crop production in absence of any soil improving strategy that will boost soil fertility status either through organic or inorganic fertilizer addition (Adesoji *et al.*, 2018). Our cropping systems depend heavily on input of chemical fertilizers because of their glaring advantages like easy to handle, faster release of soil nutrients and effective in fertility delivery (Adesoji, 2015). However, over-dependence on exorbitant mineral fertilizers may cause environmental risks like pollution of water and increased production of greenhouse gases, leading to worldwide climate change (Arisha and Bardisi, 1999). It has reported to influence nutrient imbalances, nitrate pollution, microbial activities, soil acidity and fatal threats to man (Akanbi, 2002; Babajide *et al*., 2008). Hence, it is very penitent to provide alternative sources of nutrients like poultry manure which is good generator of organic manure for effective and efficient crop production. Poultry manure has capacity to improve the soil organic matter (OM) content and in turn release the plant nutrients in available form for plants to use (Okoli and Nweke, 2015). This study therefore was carried out to assess the influence of nitrogen and poultry manure application on growth and yield performance of *Celosia argentea*.

Materials and Methods

The field experiment was conducted at the Teaching and Research Farm of Federal University Dutsinma, Katsina State (latitude 12°23'52.0"N and longitude 007°27'41.7"E) with an altitude of 605m in the Sudan savanna ecological zone of Nigeria. The soil of the experimental site was loamy sand. The treatments consisted of three levels of Nitrogen fertilizer (0, 40 and 80kg N ha^{-1}) and four level of poultry manure (0, 5, 10 and 15t Poultry manure ha^{-1}). The trial was laid out in a randomized complete block design (RCBD) with three replications. The gross plot size was 2.5m x 2.0 m (5 m^2) and the net plot was 2.5m x 1m (2.5m^2). The field was ploughed and harrowed to a fine tilth and marked out manually into raised beds used that measures at about 2.5m x 2.0m (5m^2) size, constructed with hand-held hoes in basin form for irrigation purposes. The poultry manure was collected from the animal farm of Federal University Dutsin-Ma.

The variety of *C. argentea* TLV8 (local green) was sowed in a prepared nursery. The seedlings remained in the nursery for four weeks with routine management like watering and weeding when necessary. Seedlings were transplanted and sown two plants per hole in the field and were thinned to one plant per stand and seedlings were supplied to missing stands a week after transplanting (WAT). Weeds were controlled manually using a hand hoe as at when due and regular watering (twice per week) was maintained. Plant growth was monitored in-situ from five randomly sampled plants per plot using conventional growth indices such as the number of leaves, plant height, and stem girth at 4 and 6WAT. However, the fresh shoot yield was taken at 6 WAT only.

Data collected from the observations were subjected to statistical analysis of variance (ANOVA) as described by Gomez and Gomez (1984) using SAS package version 9.0 of statistical analysis (SAS Institute, 2002). The differences among treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955). Effects were considered statistically significant at 5% level of probability.

Results and Discussion

Application of nitrogen was not significant on the number of leaves per plant and plant height per plant (Table 1). Application of poultry manure had a significant effect on number of leaves and plant height of celosia per plant at 4 and 6WAT (Table 1). Application of 15 t ha^{-1} of poultry manure significantly increased the number of leaves per plant at 4 and 6WAT but there was no significant difference between its application and that of 5 and 10 t ha^{-1} of poultry manure at 4WAT (Table 1). The lowest number of leaves was obtained for the control treatment which was statistically similar to 5 and 10 t ha^{-1} at 4 and 6WAT (Table 1). Application of 15 t ha^{-1} produced significant taller plants than any of the poultry manure rates at 4 and 6WAT but at par with the application of 5 t ha^{-1} at 4 WAT (Table 1). Plots that received poultry manure produced significantly higher plant height per celosia plant than plots that received no poultry manure. There was no significant effect on stem girth and fresh shoot yield for plots that received nitrogen fertilization.

Application of poultry manure had a significant effect on stem girth of celosia per plant at 4 and 6WAT (Table 2). Application of 15 t ha^{-1} of poultry manure at 4 and 6WAT significantly increased stem girth but at par with the application of 5 and 10 t ha^{-1} at 6WAT. There was no significant difference between application of 5 and 10 t ha^{-1} of poultry manure on plant girth at 4 and 6WAT (Table 2). Application of poultry manure had a significant effect on fresh shoot yield of celosia per plant. Application of 10 t ha^{-1} of poultry manure at harvest significantly increased fresh shoot yield per plant (Table 2) but there was no significant difference between application of 10 and 15 t ha^{-1}. Application of 5, 10 and 15 t ha^{-1} of poultry manure produced 280.4, 433.3 and 480.7% increases in fresh shoot yield of celosia when compared with no poultry manure application, respectively. Plots that received poultry manure produced significantly higher plant girth and fresh shoot yield than plots that received no poultry manure. Interaction between nitrogen and poultry manure was not significant on the parameters measured of celosia in this experiment.

Table 1: Influence of nitrogen and poultry manure application on number of leaves per plant and plant height (cm) per plant of Celosia at 4 and 6 WAT.

Treatment	No. of leaves plant^{-1}		Plant height plant^{-1}	
	4WAT	6WAT	4WAT	6WAT
Nitrogen (N) kg ha-1				
0	22.33	133.97	11.10	26.84
40	15.95	105.61	10.48	24.59
80	17.99	95.89	10.36	23.07
SE±	2.13	12.89	0.52	1.68
Poultry manure (P) t ha^{-1}				
0	12.19^{b}	69.74^{b}	7.98^{c}	16.88^{c}
5	19.29^{ab}	108.37^{b}	11.25^{ab}	24.27^{b}
10	19.33^{ab}	107.59^{b}	10.52^{b}	25.44^{b}
15	24.22^{a}	161.59^{a}	12.83^{a}	32.75^{a}
SE±	2.45	14.89	0.60	1.94
Interaction				
PxN	NS	NS	NS	NS

NS: Not significant at 5% level of probability. SE±: Standard Error. Means followed by the same superscript(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

Table 2: Influence of nitrogen and poultry manure application on stem girth (mm) at 4 and 6 WAT and fresh shoot yield (kg ha^{-1}) of celosia

Treatment	Stem girth plant^{-1}(mm)		Fresh shoot yield (kg ha^{-1})
	4WAT	6WAT	
Nitrogen (N) kg ha-1			
0	4.06	11.10	16446
40	3.79	9.82	14728
80	3.79	9.44	12224
SE±	0.21	0.91	1493.7
Poultry manure (P) t ha^{-1}			
0	2.70^{c}	6.20^{b}	3629^{c}
5	4.13^{b}	10.78^{a}	13806^{b}
10	3.81^{b}	10.47^{a}	19355^{a}
15	4.88^{a}	13.05^{a}	21074^{a}
SE±	0.24	1.05	1724.8
Interaction			
PxN	NS	NS	NS

NS: Not significant at 5% level of probability. SE±: Standard Error. Means followed by the same superscript(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

Discussion

Similarities observed among nitrogen levels on all parameters measured could be that the soil total nitrogen of the experimental field was adequate for the growth of celosia. Hence, fertilizing the soil with nitrogen produced a statistically similar effect on the celosia irrespective of the various rates of the added nitrogen. This could be that the maximum rate of nitrogen was not attained that would have exerted influence on celosia growth and yield. Therefore, explaining the observed decrease with increasing level of nitrogen in all the parameters measured. Similarly, Van Eerd and O'Reilly (2009) attributed the not significance of nitrogen application to sufficient soil mineral N over the growing period. It could also be that the rate of nitrogen was not adequate to exert significant influence on the measured parameters. Rayar, (2000) noted that mineral fertilizers, in particular, induce soil acidity, reducing CEC and buffering capacity of the soil, thereby leaving the soil with nutrient imbalance. Akinfasoye *et al*., (2008), also reported that soil pH affects nutrient release and uptake by plants. This could also be due to leaching of the nitrogen fertilizer in the soil as a result of the type of irrigation carried out in the plots.

Significant increases observed on number of leaves per plant, plant height per plant and stem girth per plant could be attributed to the ability of poultry manure to increase the organic matter (OM) content of the soil and in turn releases the plant nutrients in an available form for the use of plants. This could also be attributed to the ability of poultry manure in building better soil structure because of its high organic matter and hence, more moisture retention. Eifediyi *et al*. (2010) reported that manure can increase water holding capacity and reduced the incidence of erosion thereby making more nutrients available to the soil. Therefore the full access to the nutrients by plants treated with poultry manure than others because water serves as a transporting medium for nutrients as stated by Acquaah (2005). The significant increase observed on fresh shoot yield following poultry manure application could be attributed to the positive effect of poultry manure on all the growth parameters measured per plant which culminated in marked increase observed on the yield. The significant fresh shoot yield obtained after poultry manure fertilization could have caused improvement in the soil organic matter and the release mineralized nutrients content for increased vegetative growth resulting in high photosynthetic activities which resulted into higher fresh shoot yield observed in plants that received poultry manure. Adediran and Banjoko (2002) reported the enhancement of crop yield through the application of manure.

Conclusion

Based on the results obtained from this study, it can be concluded that the application of 40 and 80 kg N ha^{-1} did not significantly influence the growth and yield of celosia. Poultry manure fertilization at the rates of 5, 10 and 15 t ha^{-1} exerted significant influence on growth and yield performance of celosia. However, the application of 10 t ha^{-1} of poultry manure seems to be more appropriate for the production of celosia in Sudan savanna ecological zone of Nigeria.

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Effects of Collection Time on Phytochemical Screening and Antibacterial Activities of *Chromolaena odorata* Leaf Extracts

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Abstract

A natural product is a chemical compound or substance extracted from plants and animals that usually have a pharmacological activity for use in pharmaceutical drug discovery and design. *Chromolaena odorata* (siam weed) is a species from *the Asteraceae* family. The phytochemical screenings were carried out on *C. odorata* leaves ethanolic extracts of the samples collected at different times (7 am, 10 am, 1 pm, 4 pm, and 7 pm) with the aim to know the effect of collection time on the phytochemical screening and antibacterial activities. The collected samples were soaked in 95% ethanol for 7 days in a separate aspirator bottle. The phytochemicals screening and antibacterial analysis were carried out on ethanolic extracts of *C. odorata* leaf using standard methods. The result of phytochemicals screening showed a significant difference in the time of collection. All the extracts contained phytochemicals like alkaloids, flavonoids, tannins, resins, saponin, and phenols. The antibacterial analysis revealed activities on the microorganisms used varied from time to time. The composition pattern of the leaf extracts obtained in the morning (7 am) and afternoon (4 pm) collections of *C. odorata* revealed moderate significant differences in antibacterial analysis.

KeyWords: *Chromolaena odorata,* secondary metabolites, phytochemistry, antibacterial activity.

Introduction

Natural products from plants which are called secondary metabolites are the end products of primary metabolites such as carbohydrates, amino acids, and lipids; they synthesize a large variety of chemical substances known as secondary metabolites. These include alkaloids, steroids, flavonoids, glycosides, terpenes, tannins, saponins, and so on (Newman *et al*., 2007). The primary metabolites (carbohydrates, lipids, and protein) are a kind of metabolite that is directly involved in the growth, development, and reproduction of organisms. Primary metabolite plays an important role in metabolic activity in the body and, they are present in large amount in the body of the living things. A secondary metabolite (phytochemical) is organic compounds that are not direct involvement in the growth, development, or reproduction of an organism like primary metabolites, the absences of secondary metabolite does not result in immediate death, but rather in long term impairment of the organism's survival. (Finar, 1975) They are often played an important role in plant defense against herbivory and other interspecies defenses. Human uses secondary metabolites as medicines, flavorings, and recreational drugs (Newman *et al*., 2007; Phan *et al*., 2001).

C. odorata Leaf (siam weed) is a perennial member of the composite family. This species is a native of central and South America. Its range extends from the south-east U.S.A and Mexico through the Caribbean islands to South America and reaches as far as northern Argentina (Pessaarakli, 2001). In China, *C.odorata* can be found in Guangdong Guangxi, Hainan, and Yunnan provinces (Pavia *et al*., 2006; Finar, 1975). This species considered one of the world's worst tropical weeds. It spreads rapidly in lands used for forestry pasture and plantation crops such as rubber, coffee, coconut, and cashew (Newman *et al*., 2007). This is probably the largest family of flowering plants, with more than 25,000 species worldwide, growing from sea level to the highest mountain peaks. It is absent only from Antarctica. In southern Africa, it is also one of the biggest families of flowering plants with about 246 generate and 2300 species. Many of the species have economic value. They show remarkable variation in growth form and general morphology because they occur in so many different localities and habitats (Umukoro, 2006). Traditionally, a decoction of the leaf is used as a cough remedy, as an ingredient with lemongrass and guava leaves for the treatment of malaria, and the juice out of the crushed leaves is applied to cuts to stop bleeding (Akinmoladun *et al*., 2007). Fresh leaves or a decoction of *C.odorata* have been used throughout Vietnam for many years as well as in other tropical countries for the treatment of leech bite, soft tissue wounds, burn wounds, skin infection and promote healing (Phan *et al*., 2001). An aqueous decoction of the roots is used as an antipyretic and analgesic remedy, and a leaf extract with salt is used as a gargle for sore throat and colds (Phan and Akinmoladun, 2001). In traditional medicine, it is used as an antifungal antispasmodic, antiprotozoal, antitrypanosomal, antibacterial, antihypertensive, anti-inflammatory, astringent, diuretic, and hepatotoxic agent (Owoyeye *et al* 2006), Akinmolodun *et al*., 2007). The crude ethanol extract of the plant had been demonstrated to be a powerful antioxidant to protect fibroblasts and keratinocytes in vitro. Their results showed that the phenolic acids present (protocatechuic, P- hydroxybenzoic, P – coumaric, ferulic and vanillic acids) and complex mixtures of lipophilic flavonoid aglycones (flavanones, flavonols, and flavones) were major and powerful antioxidants to protect cultured skin cells against oxidative damage (Phan *et al*., 2001).

C. odorata plays an important role in contributing to affordable healthcare. Also, study has shown that the yield and amount of constituent of plant materials can be influenced by harvest time, ecological, and climate conditions (Muller-Riebau *et al.*, 1997). As a result of this justification, this study focuses on the effect of time on the phytochemical screening and antibacterial activity of *C. odorata*

Materials and Methods

C. odorata leave were collected in the premise of The Polytechnic, Ibadan, Oyo State, Nigeria at different Time (7 am, 10 am, 1 pm, 4 pm, and 7 pm) on the same day. The plant samples of *C. odorata* were taken to Botany Department, University of Ibadan for proper identification and authentication. The weighed grounded *C. odorata* leaves samples were soaked in 95 % ethanol for 7 days in a separate aspirator bottles. After the seven days, the solutions were decanted and the filtrates were then concentrated to get the crude extracts through the distillation process. The phytochemicals screening were carried out on the extract from each sample collected at different time (7 am, 10 am, 1 pm, 4 pm, and 7 pm) using the standard methods to screen the phytochemicals present in *C. odorata* leaves extract. Antibacterial activities were also conducted on the ethanol extracts of the plant samples collected at 7 am and 4 pm using pour plate method. One gram of the crude sample of ethanolic was weighed and dissolved into the 5 mls of the solvent (ethanol), this gave 200 mglml and 2.5 mls was taken into another 2.5 ml of the solvent to gives 100 mglml. This dilution was done to the 6th test tube to gives 6.25 mglml; the 7th and 8th test tubes were negative and positive control. An overnight culture of each organism was prepared by taken a 100pful of the organism from the stock inoculated each into the sterile nutrient agar of 5mls each incubated for 18-24hrs at 37^{O}C in the incubator (i.e. overnight). From overnight culture 0.1ml of each organism was taken and put into the 9.9mls of sterile distilled water to get 1:100(10-2) of the diluted of the organism. From the diluted organism (10-2) 0.2ml was taken into the prepared sterile nutrient agar, which was at 48^{O}C, then aseptically poured into the sterile petridishes (plates) allowed seating for about 60 minute. Using a cork –borer of 5mm diameter, there walls were made accordingly. The plates were duplicated for each of the organism. The plates were allowed to stand on the bench for about 2hours to allow the graded concentrations of the sample to diffuse properly into the nutrient agar, i.e pre-diffusion. The plates were incubated uprightly in the incubator for 18-24hrs at 37^{O}C in the incubator.

Result and Discussion

The present study carried out on the ethanolic extracts of the plant samples of *C. odorata* (leaves) revealed the presence of medicinally active constituents. The phytochemical characters of the five samples collected at different times are summarized in the table1, Tannins, flavonoids, saponins, alkaloids, and phenols were present in all the samples. Glycosides and steroids were absent in all the samples. This shows that plant sample extracts revealed that the leaves were rich in alkaloids, flavonoids, tannins, resins, saponin, and phenols. The time of collection did not affect phytochemical screening of the ethanolic extracts of *C. odorata* leaves but there will be significant differences if the amount (quantity) of each of the phytochemicals (alkaloids, flavonoids, tannins, resins, saponin, and phenols) present were to be determined; this correlates with the report of Muller-Riebau *et al.*, 1997 which reported that the yield and amount of constituents of plant materials can be influenced by harvest time. Comparing the table 2 and 3, Staphylococcus aureus at 4 pm has the highest activity of 26 concentration of 200mg/ml compare to that of 7 am which had an activity of 18 at the same Concentration, and at the least concentration of 6.25mg/ml, there was a reaction at 4 pm which did not occur at 7 am. There are no differences in the activity of *Escherichia coli* but the activity of *E.coli* started in the morning even at the least concentration. The activity of *Bacillus subtilis* was 16 at 7 am which was low but at 4 pm the activity was 24. At the least concentration, both had no inhibition *Pseudomonas aeruginosa* had the activity of 24 at 7 am at the highest concentration of 200 mg/ml. At the least concentration of 6.25 mg/ml, the activity started at 4 pm but had no effect at 7 am and also at 4 pm, at the least concentration of 6.25 mg/ml activity started at 4 pm but had no effect at 7 am. *Salmonella typhi* showed the activity of 18 at 7 am at the concentration of 200mg/ml but showed the activity of 20 at 4 pm. both had no effect at the least concentration of 6.25 mg/ml. *Klebsiella pneumonia* revealed the activity of 26 at 7 am at the concentration of 200mg/m while the activity at 4 pm is 18. The activity was more at 7 am than at 4 pm.

Table 1: Phytochemical Screening of Ethanolic Extracts of *Chromolaena odorata* leave collected at different Time (Leaves)

Phytochemicals	7.00 am	10.00 am	1.00 pm	4.00 pm	7.00 pm
Alkaloids	+	+	+	+	+
Tannins	+	+	+	+	+
Glycosides	-	-	-	-	-
Flavonoids	+	+	+	+	+
Resins	+	+	+	+	+
Steroids	-	-	-	-	-
Samponins	+	+	+	+	+
Phenols	+	+	+	+	+

Key: +ve means present - ve means absent

Table2: Antibacterial Activities of Ethanolic Extract of *Chromolaena odorata* Leave collected at 7.00 am

Dilution (Mg/ml)	S.A	E.C	B.S	P.A	S.T	K.P
200	18	26	16	24	18	26
100	14	24	14	20	16	20
50	12	18	12	14	14	18
25	10	14	10	12	10	14
12.5	-	12	-	10	-	10
6.25	-	10	-	-	-	-
-ve	-	-	-	-	-	-
+ve	38	38	40	40	38	38

Table3: Antibacterial Activities of Ethanolic Extract of *Chromolaena odorata* Leave collected at 4.00 pm

Dilution mg/ml	S.A	E.C	BS	P.A	S.T	K.P
200	26	26	24	24	20	18
100	22	18	20	20	18	16
50	18	16	16	18	14	14
25	16	14	12	14	12	12
12.5	12	10	10	12	10	10
6.25	10	-	--	10	-	-
-ve	-	-	-	-	-	-
+ve	38	36	38	36	38	38

Key-Ve means DMSO (Solvent) +Ve means Gentamicin (10uglml) (control)

S.A- *Staphylococcus aureu* K.P- *klebsiella pneumonae* E.C-*Escherichia coli* B.S- *Bacillus subtilis* S.T-*Salmonella typhi*

Conclusion

The *C. odorata* leave extract collected at 4 pm showed more activities than that of the sample collected at 7 am. The study revealed that *C. odorata* leaves extract can use as potential antibacterial remedies for infections caused by the microorganism used. The composition pattern of the leaf extracts obtained in the morning (7am) and afternoon (4pm) collections of *C. odorata* revealed moderate significant differences in antibacterial analysis.

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Enhancing natural rubber Production through adoption of improved technologies by small-holder rubber farmers in Edo South Sensational District for Edo State of Nigeria

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Abstract

The study examined enhancing natural rubber production through adoption of improved rubber technologies in Edo Senatorial district of Edo State. Multi-stage sampling procedure was used to randomly select 150 respondents in the study area based of their involvement in rubber farming/production in the six community using well-structured questionnaire. Data obtained were analyzed using both descriptive (such as frequency counts, percentages, means) and inferential (such as multiple regressions) statistical tools. Results show that respondents were aware of intercropping, Nig 800 series, Conventional spacing and pruning method by holding/dibbling. However, the level of adoption of these improved technologies was high for intercropping (100%), Nig 800 series (92.7%) and conventional spacing of 6.7m x 3.4m (49.6%). It is therefore recommended that, more awareness should be created on the use of improved rubber technologies in the study area by the respondents. Also respondents should be encouraged to take advantage of all the improved rubber technologies in order to boost/increase and enhance production of Rubber in the study area.

Introduction

Nigeria was among the world's leading rubber producers before the oil boom in the 1960's. Nigeria was the biggest producers of natural rubber in Africa and ranked sixth in the world, contributing about three percent of the world output between 1957 and 1960 (Aguw, 2006.) consequently, it contributed immensely to the Nigerian economy within these periods. It has been observed that there has been a great decline in rubber production in Nigeria over the past three decades both in the area under study and other areas where rubber is produced. Non adoption of improved farm practices by farmers is one of the major reasons for low productivity in agriculture, and natural rubber production is not an exception. In spite of the problems of the decline in natural rubber production, research in rubber has evolved improved technologies that may stem the decline in rubber production (Ugwa and Abubakar 2006). It is against this background that the study was conducted on enhancing natural rubber production through adoption of improved rubber technologies by small-holder rubber farmers in Edo State.

Objectives: the objectives of the study are as follows:

1. describe socio-economic characteristics of respondent
2. Ascertain respondents awareness of the use of improved rubber technologies
3. Determine the extent of adoption of improved rubber technologies
4. Examine the factors affecting adoption of improved rubber technologies

Methodology: Study Area

The study was conducted in Edo South Senatorial Zone. Edo state is made up of tree senatorial zones namely:- Edo South, Edo Central and Edo North.

Sampling Techniques and Sampling Size

A Multistage sampling techniques was employed as follows. In the first stage; one senatorial zone was purposely selected from the three zones. In the second stage: three local government areas were selected from the zones. These were: Ovia North-East, Ovia South-West and Uhunmwonde. In the third stages: six communities (i.e) two each from the three local Government areas were purposively selected based on their involvement in rubber production. In the last stages: from the list of the registered farmers provided by the ministry of agriculture, twenty-five (25) rubber farmers were randomly selected in each community, making a total 150 rubber farmers used for the study.

Method of Data Collection and Analysis

Primary date was obtained with the use of structure questionnaire to elicit information from rubber farmers.

Data were analyzed using both descriptive (such as frequency counts, percentages, means) and inferential (such as multiple regressions) statistical tools.

Multiple Regressions Model as follows:-

$Y = f(x_1, x_2, x_3, x_4, x_5, x_6\, x_7\, x_n, u_i,)$……………………………………..(1)

Where

Y = Adoption score of the rubber farmer

x_1 = Farming experience in years

x_2 = Household size (total number of people in house)

x_3 =Contact with extension agents (number of times visited)

x_4 =Educational level (years spent in school)

x_5 = Age of farmers (years)

x_6 =Income (naira)

x_7 =farm size (ha)

x8 =innovation (number of innovation aware of)

Ui = The error term

Results and Discussion

From table 1 below, the age group (above 40 years) has the highest percentage (39.5%) and was the majority with mean of 38.7. Farmer's age has been found to influence adoption in several ways. Older farmers may have more experience, technical knowledge and resources; this makes them skeptical about trying a new practice faster (Abolagba et al, 2003). Majority of the respondents (64.9%) has household size of nine (9) and above. This may likely hindered adoption since more family members put pressure on the household leads to devise means of sustenance or livelihoods by engaging in productive ventures. Meanwhile, having large family size by implication may suggest availability of farm labour among farmers. Majority of rubber farmers (83%) have attend at least three levels of formal education. This shows that the farmers are literate and with this level of education it was expected that the level of adoption of innovations or technologies would be appreciative. Majority (71.5%) of the respondents have farm size of between less than 1.5-2.5 hectares. This shows that must rubber farmers sampled are smallholders. From the result on farmers income (Table 1) 55.3% have a monthly income of less than N20, 000. This is low considering the socio-economics realities of farmers' environment. Income of farmers has been found to be a critical factor in agricultural production and adoption of innovations. Majority of (60.6%) respondents has farming experience of above 31 years. The longer the rubber farming, experience the more they acquired skills, knowledge about rubber farming practice (Igbinosa, 2008).

Table 1 : Distributions of Respondents by socio-economic characteristics

Variables	Frequency	Percentage	mean
Age (years)			38.7
21-30	5	3.5	
31-40	27	19.7	
41-50	24	17.5	

51-60	27	19.7	
>60	54	39.5	
Household size			9.5
1-4	2	1.5	
5-8	46	33.5	
9-12	62	45.3	
13-16	20	14.6	
>16	7	5.1	
Educational level			
No formal education	23	16.8	
Primary education	35	28.5	
Post primary education	72	52.6	
Tertiary education	7	5.1	
Farm Size			1.6
<1.5	24	17.5	
1.6-2.5	74	54.0	
Income			11, 241
<10,000	21	15.3	
10,000 – 20,000	55	40.2	
>20,000	61	44.5	
Farming Experience (years)			21.9
<20	32	23	
21-30	22	15.8	
31-40	27	19.4	
>40 years	58	41.7	

Table 2: awareness of improved rubber technologies by respondents. Those technologies farmers were aware of are: intercropping (100%), Nig 800 series (94.9%), conventional spacing (52.6%) and planting method by holing/digging (10.9%). Awareness is a necessary step in the process of

adoption of a technology or an agricultural practice, and extension agents play a dominant role in creating awareness about any agricultural practices.

Table 2: Distribution of respondents based on awareness of improved rubber technologies

Technologies	Aware		Adopted	
	frequency	percentage	frequency	percentage
Intercropping	137	100	137	100
NIG 800	130	94.9	127	92.7
Spacing (6.7m x 3.4m)	72	52.6	68	49.6
Holing/dibbling	15	10.9	14	10.2
Weeding	3	2.2	1	0.7
Fire trace	0	0	0	0
Pruning	0	0	0	0
Thinning	0	0	0	0
Cover cropping	0	0	0	0

Table3 below, the technologies adopted by respondents the technologies adopted intercropping (100%), Nig 800 series (92.7%) and conventional spacing (49.6%). Researchers pointed out that conventional spacing that enable farmers to intercrops in avenue for additional income and weed control (Igbinosa, 2008). Also, it was found that farmers adopted Nig 800 series because is resistance to wind, diseases of rubber and it produce more latex.

Table 3: Respondents distribution based on improved production technologies

Technologies	Adopted	Frequency	Percentage
Intercropping	adopted	137	100
Nig 800 series	-	127	92.7
Spacing (6.7m x 3.4m)	-	68	49.6
Holing/dibbling	-	14	10.2
Weeding	-	1	0.7
NIG 800 Service	not adopted	0	0

Fire trace	-	-	-
Thinning	-	-	-
Cover cropping	-	-	-

Table 4: Multiple Regression results of factors influencing farmers' adoption of improved rubber technologies.

Variables	Linear	Double-log	Semi-log
Constant	2.219	0.857	0.792
	(1.151)	(1.015)	(0.321)
Farming Experience	0.330	0.07056^{xxx}	0.801^{xxx}
	(0.259)	(0.022)	(0.290)
Household Size	-0.003	0.08821	0.211^{xx}
	(0.005)	(0.067)	(0.104)
Times Visited by extension agents	-0.040	-0.286	-0.102
	(0.036)	(0.304)	(0.83)
Educational Level	-0.002	-0176^{xxx}	-0.0520^{xxx}
	(0.040)	(0.075)	(0.168)
Age	-0.077	0.02107^{xxx}	0.03406^{xxx}
	(0.043)	(0.006)	(0.019)
Income	0.013	-0.07581	-0.06746^{xxx}
	(0.058)	(0.075)	(0.021)
Farm Size	0.986	0.330	0.08821
	(0.040)	(0.259)	(0.067)
R^2	0.921	0.241	0.316
Adjusted R^2 (R^2)	0.848	0.201	0.279
F-Value	5.967	8.532	7.826

At 10%, 5% & 1% Significant

From the table 4 above, adoption of improved production technologies by small holders rubber farmers were detained using multiple regression analysis where three functional forms (Linear, Double-Log and Semi-Log,) were tired using ordinary Least squares techniques (OLS.) the estimated in terms of the statistical significance of the coefficient, the signs of the coefficient and magnitude of standard errors. Based on these statistical, economic and econometric criteria, the linear form was selected as the best fit. Also, 83.8% variation in the regress and (adoption of rubber technologies) was explained by the regression similarity, the f-value was statistically significant at 5% probability level indicating model fitness.

Conclusion and Recommendations

The study examined enhancing natural rubber production through adoption of improved rubber technologies in Edo Senatorial district of Edo State. Results show that respondents were aware of intercropping, Nig 800 series, Conventional spacing and planting method by holding/dibbling. However, the level of adoption of these improved technologies was high for intercropping (100%), Nig 800 series (92.7%) and conventional spacing of 6.7m x 3.4m (49.6%). It is therefore recommended that, more awareness should be created on the use of improved rubber technologies in the study area by the respondents. Also respondents should be encouraged to take advantage of all the improved rubber technologies in order to boost/increase and enhance production of Rubber in the study area.

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Effect of Intercropping Ginger and Short-Duration Legumes on Yield and Soil Properties in Gwagwalada, FCT, Abuja

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Abstract

Four different short-duration grain legumes (Erect Cowpea White, Erect Cowpea Brown, Groundnut and Soybean) were introduced to a ginger-based system to access their effects on ginger yield and soil properties in the guinea savanna. The results showed that ginger-soybean intercrop had the highest plant height (39.47) and number of leaves (18.20), ginger-brown cowpea had the highest number of tillers (3.83) while ginger-soybean intercrop had the highest ginger yield (1.7t/ha).

Introduction

Ginger, scientifically known as *Zingiber officinale* Roscoe, belongs to the Zingiberaceae family and is a very important plant with several medicinal, nutritional and ethno-medical values and is used extensively worldwide as a spice, flavouring agent and herbal remedy. (Grzanna *et al*, 2005).

Legumes play a wide role in contributing to food security, income generation, and maintenance of environment for millions of small scale farmers in sub-Saharan Africa (Tarawali *et al.*, 2002).

Apart from being a major source of dietary protein and oil for the people of guinea savanna, legumes are known to biologically fix atmospheric Nitrogen (N) in symbiosis with Rhizobium bacteria. The fixed N can at least partly reduce the N requirement of the main field crop in rotation. Thus it becomes an affordable source of N for resource-poor farmers in Nigeria (Nwaogu and Echendu, 2006). In most farming systems in Nigeria, legumes are usually intercropped with cereals and other field crops to improve land productivity (Gbaraneh *et al.*, 2004). This practice is believed to provide the farmer with several options for returns from land and labour and often increases efficiency with which scarce resources are used. It also reduces dependence upon a single crop that is susceptible to environmental and economic fluctuations (Elemo *et al*., 1990; Katung *et al*., 2000). The objectives of the study are:

1. To determine the effect of legume intercrops on ginger yield.
2. To determine the effect of legume intercrops on soil properties

Materials and Methods

The research was conducted at the Teaching and Research farm of the Faculty of Agriculture, University of Abuja, (Latitude 9°4N and Longitude 7°29 E) during the 2018 cropping season. Abuja is located in the southern guinea savannah ecological zone of Nigeria. The experiment was laid out in a Randomized Complete Block Design(RCBD) with five treatments made up of Erect brown cowpea (*Vigna unguiculata*), Erect white cowpea (*Vigna unguiculata*), Soybean (*Glycine max*), Groundnut (*Arachis hypogea*) and Control. The experiment had three replications and plot size for each replicate was 2x2(4m²) with 5 plots in each replicate with an inter-rep distance of 1m and inter-plot distance of 0.5m. The experimental soil was also analyzed for physical and chemical properties. Data collected were plant height, number of leaves, number of tillers and rhizome yield and all the data collected were subjected to Analysis of Variance (ANOVA) using the Genstat statistical package and the treatment means were separated using Duncan's Multiple Range Test (DMRT) as described by Duncan (1955)

Results and Discussion

Table 1 showed the Pre-planting soil analysis. It showed that the textural class of the experimental site is Silt loam with a particle distribution of Sand 35.0%, Silt 40.0% and Clay 25.0%, the p^H 5.45, Total N 0.52g/kg, Available P mg/kg 6.50, K 0.41 C mol/kg, Organic Carbon 0.60 g/kg, Mg 2.20 C mol/kg, Na 0.12 C mol/kg, Ca 2.30 C mol/kg. Teferra *et al* (2015) in their study on Ginger Production, Post-Harvest handling, Processing and Marketing opined that ginger prefers sandy loam soils because they are loose, well drained and offer minimum resistance to rhizome development.

Table 1: Pre-planting Soil Analysis

Soil Properties	Values
pH	5.45
Total Nitrogen (g/kg)	0.52
Available Phosphorous (mg/kg)	6.50

Potassium (C mol/kg)	0.41
Organic Carbon (g/kg)	0.60
Magnesium (C mol/kg)	2.20
Na (C mol/kg)	0.12
Calcium (C mol/kg)	2.30
Texture (Sandy loam)%	Sand 35.0
	Silt 40.0
	Clay 25.0

Table 2 showed height per plant of ginger as influenced by legume crops. There was no significant difference at 2 and 4 months after planting but at 6 months after planting there was significant difference. Ginger-soybean intercrop recorded the highest plant height value (39.47cm) while ginger stands intercropped with groundnut (*Arachis hypogea*) had the lowest value of plant height (33.80cm), (P<0.05). This agrees with the findings of Bechem *et al* (2018) in their report on The Effects of Intercropping and Plant Densities on Growth and Yield of Maize (*Zea mays* L.) and Soybean (*Glycine max*) in the Humid Forest Zone of Mount Cameroon where they opined that soybean intercrop resulted in higher plant height values

Table 2: Effect of Legume Crops on Ginger

	Height per Plant (cm)		
Treatment	**2 MAP**	**4 MAP**	**6 MAP**
White Cowpea	21.57	30.10	38.40
Brown Cowpea	23.73	32.03	39.43
Groundnut	23.50	28.27	33.80
Soybean	24.63	32.03	39.47
Control	23.17	34.27	34.17
LSD	**5.96**	**7.96**	**10.26**

LSD = Least Significant Difference, MAP = Months after Planting

The result of number of leaves per plant is presented in Table 3. There was no significant difference at 2 and 4 months after planting respectively but there was significant difference at 6 months after planting with ginger-soybean intercrop recording the highest value (18.20) while Ginger stands grown in mixture with groundnut (*Arachis hypogea*) had the lowest value of number of leaves per plant (13.10) ($P<0.05$). This agrees with the findings of Bechem *et al* (2018) in their report on The Effects of Intercropping and Plant Densities on Growth and Yield of Maize (*Zea mays* L.) and Soybean (*Glycine max*) in the Humid Forest Zone of Mount Cameroon where they opined that soybean intercrop influenced faster growth of the intercropped plants and so resulted in higher number of leaves

Table 3: Effect of Legume Crops on Ginger

Number of Leaves Per Stand

Treatment	**2 MAP**	**4 MAP**	**6 MAP**	**Mean**
White Cowpea	8.00	11.87	15.70	11.86
Brown Cowpea	8.37	11.10	15.53	11.67
Groundnut	7.80	10.27	13.10	10.39
Soybean	7.77	13.43	18.20	13.13
Control	9.10	14.03	11.37	11.17
LSD	**2.44**	**3.23**	**5.750**	

LSD = Least Significant Difference, MAP = Months after Planting

The result of number of tillers per stand of Ginger as affected by Legume crops and Poultry Manure is presented in Table .4. Tillering as affected by the treatments was significant at both 2 and 6 months only. Ginger stands intercropped with brown cowpea (*Vigna unguiculata*) had the highest number of tillers per stand (3.83) at 6 MAP while those in control plots had the lowest number of tillers (1.60), (P<0.05). This agrees with the observations of Nwaogu and Muogbo (2015) in their study on Effect of Ginger-Legume Cropping System on Ginger where they observed that ginger-legume intercrop gave higher responses in terms of tiller formation.

Table 4: Effect of Legume Crops on Tiller Production of Ginger

Number of Tillers/Stand

Treatment	**2 MAP**	**4 MAP**	**6 MAP**
White Cowpea	1.33	2.03	2.67
Brown Cowpea	2.33	3.20	3.83
Groundnut	1.33	2.23	2.67
Soybean	2.00	2.17	2.17
Control	1.67	1.60	1.60
LSD	**1.09**	**1.90**	**1.72**

LSD = Least Significant Difference, MAP = Months after Planting

The result of rhizome yield is presented in Table 5. There was significant difference with ginger-soybean intercrop recording the highest yield (1.7t/ha) while plots treated with cowpea (*Vigna unguiculata)* recorded the lowest value (0.6t/ha), ($P<0.05$). This agrees with the findings of Bechem *et al* (2018) in their report on The Effects of Intercropping and Plant Densities on Growth and Yield of Maize (*Zea mays* L.) and Soybean (*Glycine max*) in the Humid Forest Zone of Mount Cameroon where they opined that soybean intercrop resulted in higher yield of intercropped plants.

Table 5: Effect of Legume Crops on Rhizome Yield

Treatment	Rhizome Yield t/ha
White Cowpea	0.60
Brown Cowpea	0.60
Groundnut	1
Soybean	1.7
Control	1.3
LSD	**1.2**

The result for Post-Harvest Soil Analysis is presented in Table 6. It showed that there was a reduction in soil p^H in the legume intercrops, there was on the other hand an increase in total soil N with ginger-soybean intercrop recording the highest total N (0.60). There was an increase in soil P with plots treated with ginger-soybean intercrop recording the highest (6.60). There was also an increase in soil K with ginger-soybean intercrop recording the highest (0.48), there was also increase in soil Na with control plots recording the highest (0.90), there was furthermore increase in soil Ca with ginger-soybean intercrop recording the highest (2.36), increase in soil Mg with ginger-soybean intercrop recording the highest (2.29) and increase in soil Organic Carbon (O.C) with ginger-groundnut intercrop recording the highest (0.68). This agrees with the findings of Jean *et al* (2018) in their research work on Effect of Intercropping Maize and Soybean on Soil Fertility where they reported that Soybean had effects on enriching the soil by improving its fertility.

Table 6: Post-harvest Soil Analysis

Treatment	pH	Total Nitrogen (g/kg)	Avail. Phosphorus (mg/kg)	Potassium (Cmol/kg)	Na/Calcium (C mol/kg)	Magnesium (C mol/kg)	O.C (g/kg)	Zinc (mg/kg)
White Cowpea	5.39	0.54	6.52	0.45	0.18/2.34	2.26	0.65	0.277c
Brown Cowpea	5.40	0.53	6.53	0.46	0.18/2.33	2.27	0.66	0.363b
Groundnut	5.41	0.47	6.59	0.45	0.16/2.35	2.28	0.68	0.463a
Soybean	5.40	0.60	6.60	0.48	0.20/2.36	2.29	0.67	0.317bc
Control	5.43	0.48	6.42	0.37	0.90/2.20	1.80	0.43	0.253c

Conclusion

From the study, it is recommended that ginger-soybean intercrop should be adopted for the cultivation of Ginger in the study area.

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EFFECTS OF INDOLE BUTYRIC ACID (IBA) ON THE GROWTH OF *Bambusa vulgaris* Schrad ex Wandl STEM CUTTINGS

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ABSTRACT

Bambusa vulgaris (bamboo) plays a significant role in linking climate change mitigation to sustainable economic development in the world. Therefore, the study examined the response of *Bambusa vulgaris* stem cuttings at different concentrations of Indole butyric acid (IBA) in order to solve the difficulties in propagating bamboo to meet the ever increasing demand of bamboo utilization in Nigeria. The cuttings of *Bambusa vulgaris* were collected from a mother plant into two nodes cuttings by the use of secateur. All prepared cuttings were treated with IBA at different concentration levels while the control was not treated with IBA. It was planted directly in a plastic pots containing sterilized river sand and all were replicated three times in a propagator. The experiment was laid out in completely randomized design, and the following parameters such as leaf production, leaf area, and culm diameter. Readings were taken in every 2 weeks interval for a period of 12 weeks. The data were subjected to analysis of variance. The result obtained revealed that the treatment with 150 mol of Indole butyric acid had the best response in leaf production with a value of 9 leaves while leaf area had broader surface area with a value of 18.20 cm^2, culm diameter had an increment of 1.84 cm. The treatment with 100mol of Indole butyric acid had the highest increment in culm diameter with a value of 1.90cm, while leaf production produced 2 leaves and the leaf area had a surface area value of 3.23cm^2. One hundred and fifty (150) mol of Indole butyric acid had the best performance in leaf production and leaf area. While 100 mol of Indole butyric acid had the highest increment in culm diameter. The research recommends that IBA at 150 mol and 100 mol be utilized effective bamboo cultivation.

Keywords; Bambusa *vulgaris*, stem cuttings, concentration, bamboo, culm diameter

Introduction

Forests in Nigeria are diminishing in size and quality due to extensive activities of human influence. It was estimated that about 230km of the country's forest estimates are lost annually (Wong, 1995). There has been progressive decline in the areas of reserved forest because of desert encroachment due to indiscriminate and uncontrolled felling of trees (Keay, 2000). Hence, *Bambusa vulgaris* (bamboo) contributes a wide variety of uses such as reliability of degraded forest land, afforestation, biomass generation, carbon sequestration, erosion prevention and water shad protection(Bystriakova *et al.,* 2004). The culms of bamboos have variety of usages. They can be used as materials for house constructions, daily sundry goods, agricultural and fisheries tools, crafting materials (Jamaludin and Latif, 1993). It can also be used for fencing and construction, especially of small temporary shelters, including flooring, roof tiles, panelling and walls made with culms or split stems. The culms is used to make many parts of boats, including masts, rudders, outriggers, boating, wind-breakers, flutes, distillation pipes and commonly used as raw material for paper pulp (Leakey, 2010). Young shoots are important as food materials as well (Rout, 1996; Bystriakova *et al.,* 2004; Solomon, 1994). Indole butyric acid (IBA) is among the common chemical used to promote the formation of roots in plant and is helpful with especially plant species as well as bamboo. IBA is plant hormones in the auxins family and is an ingredient in many commercial horticultural plant rooting products. IBA is used to initiate root formation invitro in a procedure called micro propagation (Strivastava, 2002). Therefore, this study was carried out to examine the stem cutting growth performance of *Bambusa vulgaris* with different concentration level of Indole butyric acid.

Materials and Methods

Experimental Site

The study was carried out at Horticultural Nursery, Federal College of Forestry, Jericho hill, Ibadan, Oyo state. It is located in Ibadan North West Local Government Area of Oyo State. The institute lies between latitude 7^{o}26$^{'}$W and longitude 3^{o}54$^{'}$ E of the greenwish meridian. The climate condition of the area is tropically dominated by rainfall pattern ranging from 1300mm-1500mm, the average temperature is about 28^{o}C and the area experiences two different seasons which are dry and raining seasons (Forestry Research Institute of Nigeria, 2011).

Method

Sharp cutlass and secateurs were used in the cutting of very juvenile *Bambusa vulgaris* into two nodes cuttings from the base section of the branches of the specie. Care was observed not to injure any portion of the cuttings, especially the dormant buds. All prepared cuttings were treated in Indole butyric acid (IBA) hormones diluted with distilled water and prepared at 50mol, 100mol and 150mol level of concentration with 10 cuttings for each level, using “quick dip” method, respectively. The cuttings were planted directly in a plastic pots containing sterilized river sand in propagator because most plant cutting will have no root system of their own. Each of the treatments contains 10 cuttings including the control treatment planted without IBA hormone was replicated three times making an aggregate of 30 cuttings for each treatment. All pots were labelled corresponding to each treatment inside the propagator. Watering with 25cl of water on daily basis with use of a bottle and was monitored every day. Data collection started three weeks after the planting of the cuttings, and readings were taken in 2weeks interval for a period of 12weeks. Parameters assessed were the number of leaf, culm diameter, and leaf area.

Experimental Layout

T_4	T_3	T_2
T_2	T_1	T_4
T_3	T_4	T_1
T_3	T_2	T_1

T1= 50mol of diluted IBA hormone + sterilized river sand

T2= 100mol of diluted IBA hormone + sterilized river sand

T3= 150mol of diluted IBA hormone + sterilized river sand

T4= Control (only river sand)

Experimental Design

The experimental design was carried out using completely randomized design (CRD).

Mathematical model of design used.

$Y_{ij}= \mu+ t_i +e_{ij}$...1

Where Y_{ij} means overall observation, μ = grand mean, t_i = treatment effect, e_{ij} = error teams

Data Analysis

The cuttings data were obtained and subjected to analysis of variance and means were separated with the used of least significant difference.

Results and Discussion

Number of leaf

Table 1 shows the result of number of leaves indicating that *Bambusa vulgaris* treated with 150mol of IBA produced the highest numbers of leaves with value of 9 leaves followed by 50 mol of IBA value of 4 leaves while *Bambusa vulgaris* treated without IBA gave least performance in numbers of leaf with value of 1 leaf because the stem cuttings which are likely to die from dehydration, if proper condition are not met (Strivastava, 2002).

Table 1: Parameters Assessed on the Growth of *Bambusa vulgaris* Stem Cuttings.

Treatment	Number of Leaf	Leaf area (cm^2)	Culm diameter (cm)
T_1	4^a	10.17^a	1.20^a
T_2	2^a	3.23^{ab}	1.90^b
T_3	9^b	18.20^a	1.84^{ab}
T_4	1^a	1.27^b	1.53^a

Leaf Area (cm^2)

Table 1 shows the result of leaf area indicating that *Bambusa vulgaris* treated with 150mol of IBA had the broader leaf area with value of 18.20 cm^2 followed by 50 mol of IBA with value of 10.17cm^2 and 100 mol of IBA with value of 3.23 cm^2 while *Bambusa vulgaris* treated without IBA gave least performance in leaf area with value of 1.27 cm^2 due to the low number of leaf production.

Culm diameter (cm)

Table 1 revealed that culm diameter treated with 150 mol of IBA had the highest increment in culm diameter with value of 1.90 cm, followed by 50 mol of IBA with value of 1.84 cm and treatment without IBA gave value of 1.50 cm while *Bambusa vulgaris* treated with 100 mol of IBA gave least performance in culm diameter with value of 1.20 cm.

Table 2: Analysis of Variance for Number of Leaves for *Bambusa vulgaris*

SV	SS	DF	MS	F	Sig.
Treatment	224.12	3	74.708	10.762	0.00
Error	138.833	20	6.942		
Total	362.958	23			

Note: The mean difference is significant at the 0.05 level.

Table 2 shows the analysis of variance for number of leaves for *bambusa vulgaris* that there is significant difference among the treatments at 0.05 probability level. Which implies that the treatment employed gave significant effect on leaf production of *Bambusa vulgaris* because of the low error values which leads to significant of the data.

Table 3: Analysis of Variance for Leaf Area of *Bambusa vulgaris*

SV	S	DF	MS	F	Sig.
Treatment	1059.633	3	353.211	9.296	0.00
Error	759.900	20	37.995		

Total	1819.533	23

Note: The mean difference is significant at the 0.05 level.

Table 3 shows the analysis of variance for leaf area of *bambusa vulgaris* that there is significant difference among the treatments at 0.05 which implies that the treatment employed gave significant effect on leaf area of *Bambusa vulgaris*. The result of the ANOVA is a true representation of the field data because the error value was low which leads to non-significant of the leaf area of *Bambusa vulgaris*.

Table 4: Analysis of Variance for Culm Diameter of *Bambusa vulgaris*

SV	S	DF	MS	F	Sig.
Treatment	1.868	3	0.623	2.331	0.00
Error	0.000	20	0.000		
Total	1.868	23			

Note: The mean difference is significant at the 0.05 level.

Table 4 shows the analysis of variance for culm diameter of *Bambusa vulgaris* that there is significant difference among the treatments at 0.05 which implies that the treatment employed gave significant effect on culm diameter of *Bambusa vulgaris* because of the very low values of error which leads to highly significant of the culm diameter of *bambusa vulgaris*.

Conclusion

The study shows that Indole butyric acid (IBA) hormone contributes to effective propagation of *Bambusa vulgaris* stem cuttings and revealed that the plant requires IBA Hormone for fast growth. However, IBA at 150mol concentration has the best performance and can be used to improve the growth of the species and is recommended for effective bamboo cultivation.

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EFFECT OF POULTRY MANURE, AGROSORB AND WATERING REGIME ON THE GROWTH OF *Treculia africana* (Decne) SEEDLINGS

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Abstract
The study investigated the effect of poultry manure, agrosorb and watering regime on the growth of *Treculia africana* seedlings for a period of eight (8) weeks. Four (4) different levels of poultry manure, two (2) different levels of watering regimes daily and agrosorb at two different levels (0g and 3g) were applied. The experiment was laid in 4x2x2 factorial in a complete randomized design. Sixteen treatments were used for the study and each treatment was replicated four times. Measurements of heights stem diameter and number of leaves carried out at weekly interval for eight (8) weeks. The result showed that combination of poultry manure, agrosorb (3g) and watering regime (twice daily) had the best performance in terms of stem height (11.23cm), stem diameter (1.16mm) and leaf count (22.00**).** There was a significant difference among the treatment in terms of leaf count, girth and stem height as the week increases. It is recommended that combination of poultry manure, agrosorb (3g) and watering twice daily should be applied for optimum growth of *Treculia africana* seedlings at the nursery stage.

Keywords: *Treculia africana*, Seedlings, Manure, Growth, Soil, Water

Introduction
The major available forest species in Nigeria shows that edible forest fruit trees have wide spread distribution throughout the forest zones of Nigeria (Addina, 2000). An example of such species is *T. africana.* It is an indigenous tree species in Nigeria. It survives in other countries such as Ghana, Asia, and Mexico and it belongs to the family of Moraceae (Akinyeye 1980). *T. africana* contributes a reasonable amount to Nigeria economy (Keay *et al.*, 1964). In Nigeria, the use of organic fertilizers such as poultry manure, cow dung, soil amendments and agrosorb in plantation is quite a recent development (Oke and Kadeba, 2000; Alabi 2005). Water is the principal constituent of protoplasm in photosynthesis and the vehicle of every physiochemical process by which life is maintained (Aluko, 2003). Water is highly essential for the maintenance of cell turgidity which is necessary for cell enlargement. Agrosorb as a water retainer, when incorporated into the

soil, absorbs and retains large quantity of water and nutrients (Aluko, 2003; Okafor, 1991). Agrosorb absorbed water and nutrients thereby allowing the plants to have water and nutrients available at will as a function of absorption release cycle (Jal, 2004). Agrosorb is a super absorbent polymer which is specifically designed to improve the capability of soil and other growing media to retain water and plant nutrient (Mahanwar, 2004; Nwoboshi, 1982; Okafor, 1981). Thus there is need to provide a water additive that will supply water needed by plant which will reduce the frequency of water supply and energy wasted.

Materials and Methods

The experimental site was located beside the Audio virtual within the premises of Federal College of Forestry, Ibadan. The climate of the area is tropically dominated by rainfall pattern between 1300mm-1500mm (Mahanwar, 2004). The average temperature is about 36^{o} C and relative humidity is about 80-85%.

Method of Experiment

Sixty four (64) polythene pots of uniform size were filled with top soil and transplanting of the seedlings was done three (3) weeks after sowing. The poultry manure and agrosorb were mixed with top soil (3kg) two weeks before transplanting. Four (4) different levels of poultry manure e.g. 0 kg of poultry manure , 0.5kg of poultry manure, 1 kg of poultry manure, 1.5 kg of poultry manure, two (2) levels of agrosorb (0g and 3g) and two (2) levels of watering regimes e.g. watering once and twice daily with a 50mls container. The parameters assessed were plant height (cm), stem diameter (mm), number of leaves.

Data Analysis

The experimental design for the experiment was Completely Randomized Design (CRD). The data were subjected to Analysis of Variance (ANOVA).

Results and Discussion

Table 1 shows that treatment twelve (T_{12}) had the highest mean height value of 11.23 followed by treatment Sixteen (T_{16}) with mean height value of 10.32cm while treatment one (Ti) has the least mean height value of 6.47cm. This can be attributed to the buffering effect of agrosorb on the availability of fertilizer in the soil.

Table 1: Mean Values of stem height (cm) of *T. africana*

Treatment	Week2	Week4	Week6	Week8	Total	Mean
1	5.95	6.48	6.65	6.81	25.89	6.47

2	7.70	8.80	9.73	9.48	35.11	8.80
3	6.78	7.10	7.41	7.66	28.92	7.23
4	9.00	10.00	10.65	11.21	40.86	10.22
5	6.80	7.21	7.50	7.79	29.3	7.30
6	8.40	9.13	9.59	9.95	37.07	9.27
7	6.63	6.85	7.11	7.86	28.45	7.11
8	6.73	7.04	7.41	7.60	28.77	7.19
9	7.70	8.08	8.44	8.75	32.97	8.24
10	9.10	10.23	10.76	11.10	41.19	10.29
11	6.80	7.18	7.50	7.79	29.27	7.32
12	9.05	11.15	11.95	12.78	44.92	11.23
13	8.60	9.28	9.75	10.2	37.83	9.46
14	8.60	9.35	9.75	10.2	37.92	9.48
15	8.60	9.35	9.75	10.20	37.83	9.46
16	9.10	10.25	10.78	11.15	41.28	10.32

Table 2 shows that treatment twelve (T_{12}) had the highest mean girth value of 1.16mm, followed by treatment one (T_1) with the mean value of 1.11mm while treatment seven (T_7) had the least mean value of 0.65mm. This result confirms and agreed with Schonoh, (1983) in his study on fertilization of *Eucalyptus sp.* in plantation establishment that when fertilizer is correctly applied, it increases the tree crops production. There was a significant different at 5% (0.05) among the treatment as the week increased.

Table 2: Mean Values for stem diameter of *T. africana*

Treatment	Week2	Week4	Week6	Week8	Total	Mean
1	0.77	1.06	1.26	1.36	4.44	1.11
2	0.61	0.65	0.69	0.73	2.68	0.67
3	0.72	0.74	0.50	0.54	3.12	0.75
4	0.61	0.65	0.69	0.73	2.65	0.67
5	0.61	0.65	0.69	0.73	2.68	0.67
6	0.61	0.66	0.70	0.74	2.71	0.68
7	0.59	0.63	0.67	0.70	2.59	0.65
8	0.61	0.65	0.69	0.73	2.68	0.67
9	0.72	0.76	0.80	0.84	3.12	0.78
10	0.61	0.65	0.69	0.73	2.68	0.67
11	0.71	0.75	0.79	0.83	3.08	0.77

12	0.72	0.99	1.16	1.29	4.16	1.04
13	60.58	0.65	0.69	0.73	2.65	0.66
14	0.74	0.86	1.31	1.16	3.77	0.94
15	0.63	0.67	0.71	0.75	2.76	0.69
16	0.72	0.99	1.16	1.29	4.16	1.04

Table 3 revealed that treatment twelve (T_{12}) had the highest mean value of 22.00 number of leaves while treatment one (T_1) which is the control had the least mean value of 14.00 number of leaves. There was a significant difference at 5% (0.05) among the treatment as the week increased at $p< 0.01$.

Table 3: Mean values for leaf count of *T. africana*

Treatment	Week2	Week4	Week6	Week8	Total	Mean
1	8.00	12.00	16.00	20.00	56.00	14.00
2	12.00	16.00	20.00	24.00	72.00	18.00
3	12.00	16.00	20.00	24.00	72.00	18.00
4	12.00	16.00	20.00	24.00	72.00	18.00
5	12.00	16.00	20.00	24.00	72.00	18.00
6	12.00	16.00	20.00	24.00	72.00	18.00
7	12.00	16.00	20.00	24.00	72.00	18.00
8	12.00	16.00	20.00	24.00	72.00	18.00
9	12.00	16.00	20.00	24.00	72.00	18.00
10	12.00	16.00	20.00	24.00	72.00	18.00
11	12.00	16.00	20.00	24.00	72.00	18.00
12	12.00	14.00	18.00	20.00	24.00	22.00
13	16.00	14.00	18.00	20.00	64.00	16.00
14	12.00	16.00	20.00	24.00	72.00	18.00
15	16.00	18.00	22.00	26.00	82.00	21.00
16	16.00	18.00	22.00	26.00	82.00	21.00

1.09

Conclusion

This study has shown that poultry manure and agrosorb contribute to effective development of *T. africana* seedlings. The result showed that combination of poultry manure (1kg/ha), 3g of a agrosorb and watering twice daily gave the best performance in terms of stem height, stem diameter and leaf count. The best performance in height is T_{12} (11.23cm) while the least performance is T_1 (6.27cm). T_{12} produced the highest amount of leaf count (22.00) while T_1 have the least performance (14.00). The best performance in terms of girth is also T_{12} (1.16mm) while T_7 have the least performance (0.65)

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Performance of Vegetable Amaranth (*Amaranthus cruentus*) as Influenced by Time and Rate of Poultry Manure Application in Semi-Arid Environment

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Abstract

This study was carried out to evaluate the performance of Amaranth (*Amaranthus cruentus*) as influenced by time and rate of poultry manure application. The treatments made of four level (0, 5, 10, and 15t ha^{-1}) of poultry manure and three different times (2weeks before transplanting, at transplanting and 2 weeks after transplanting) of poultry manure application. All treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications. Time of poultry manure application was significant ($P<0.05$) on number of leaves, plant height, total dry matter and fresh shoot yield of amaranth. Poultry application at two week before transplanting of amaranth was found to be appropriate for amaranth production in the study area. Application of poultry manure significantly ($P<0.05$) increased number of leaves, plant height, total dry matter and fresh shoot yield of amaranth. Soil fertilization at 15 t ha^{-1} of poultry manure seems to be suitable for growth and yield of amaranth in the study. Application of 15t poultry manure ha^{-1} produced significantly higher amaranth fresh shoot yield (8296.3 kg ha^{-1}) than fresh shoot yields of 758, 4950.6 and 6365.4 kg ha^{-1} obtained for application of 0, 5 and 10t poultry manure ha^{-1}, respectively. Application of 5, 10 and 15 t ha^{-1} of poultry manure produced 553.1, 739.8 and 994.5% increases in amaranth fresh shoot yield when compared with no poultry manure application, respectively Application of 15 t poultry manure ha^{-1} at two weeks before transplanting produced the highest yield (12296.2 kg ha^{-1}).

Key words: Poultry manure, time, transplanting, amaranth, semi-arid environment

Introduction

Amaranth (*Amaranthus cruentus*) is one of the most popular leafy vegetables in Nigeria. It is a well grown crop across Nigeria. It is can be eaten boiled as green salad, prepared as a soup or stew and used to garnish other food. Amaranth plays a very important role in human diet as a good source of proteins, vitamins, minerals, sugar, fibre and water required for healthy body growth and substance (Bailey, 1992). Soil infertility has been one of the challenges confronting the crop production in savanna zone of Nigeria because of its inherent low soil fertility of savanna soils (Singh, 1987). Hence, for profitable crop production, input of fertilizers either as organic or inorganic becomes so imperative. Using of mineral fertilizers is a common denominator in our farming communities but these fertilizers are often not applied in the required quantities in a bit to manage the fertilizers because of their exorbitant prices, consequently, low crop yields. Therefore, there is a need to use organic manures like poultry manure, which is organic matter generator, can serve conveniently as worthy alternative to chemical fertilizer.

Poultry manure is a renewable source of plant nutrients and environmentally friendly to boost production of amaranth which is a very important crop in the human nutrition and a quick source of income to many farmers especially because of its fast growth and short life span for quick harvest to supplement farmers' earnings. Poultry manure is known to generate organic matter which has been referred to as the life wire of soil and store house of chemical nutrients (Okoli and Nweke, 2015). Poultry manure is an excellent soil amendment that makes available nutrients for growing crops and also improves soil quality when applied judiciously, because of its high organic matter content plus available nutrients for plant growth (Oyedeji *et al*., 2014). High content of organic matter in organic fertilizers makes them to gradually release their embedded soil nutrients, increase the population of soil microbes and enhance soil quality (Adesoji, 2015). It was further stated that this causes the soil to be safe and healthy, and sustains soil fertility and productivity. Time of application of organic manure is a very important factor in crop production because it facilitates efficient use of the manure by synchronizing mineralized nutrients supply with demand of the crop for increased crop growth and yield. When organic manures are applied properly to soil, they can be essential resources for production of crops (Ajari, 2003). Therefore, this study was designed to assess the influence of time and rate of poultry manure application on growth and yield of vegetable amaranth (*Amaranthus cruentus*).

Materials and Methods

The study was carried out in the dry season of 2018/2019 at the Research and Teaching Farm of Federal University Dutsin-Ma (Longitude 7°27'18''E and Latitude 12°17'39''N) with altitude of 500m in Sudan ecological zone of Nigeria. The soil of the experimental site was loamy sand. The treatments made of three different times of poultry manure application (T_1= 2weeks before transplanting, T_2= at transplanting and T_3= 2weeks after transplanting) and four levels of poultry manure (0, 5, 10 and 15 t ha^{-1}). The treatments were arranged in a randomized complete block design with various factorial combinations and replicated three times. The gross plot size was 3m x 3m (9m^2) and net plot of 4.5m^2.

The nursery bed was prepared by repeated tilling to maintain a good seed bed for seed germination. Poultry manure was incorporated on the seed bed, watered and allowed for two days before the amaranth seeds were sown by broadcasting. The experimental field was harrowed and consequently watered by flooding method. It was harrowed to give fine tilths and made into raised beds of 3m x 3m in basin for irrigation. The different rates of poultry manure (0, 5, 10 and l5t ha^{-1}) were applied at different times (T_1=2weeks before transplanting, T_2= at transplanting and T_3=2weeks after transplanting) accordingly by broadcasting in the respective plots and mixed with the soil at two weeks before transplanting using hoe. Seedlings were transplanted at two weeks after planting at a spacing of 50cm x 20cm. The field was irrigated every four days using basin method. Weeds were controlled using hoe at 2WAT.

Samplings on number of leaves per plant, plant height per plant and total dry matter per plant of amaranth were taken at 2 and 4 weeks after transplanting (WAT) while fresh shoot yield (kg/ha) of amaranth was obtained at harvest. Data collected from the observations were subjected to statistical analysis of variance (ANOVA) as described by Gomez and Gomez (1984) using SAS package version 9.0 of statistical analysis (SAS institute, 2002). The differences among treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955). Effects were considered statistically significant at 5% level of probability.

Results

Application of poultry manure at 2 weeks before transplanting produced significantly ($P<0.05$) higher number of leaves at both 2 and 4WAT than application of poultry manure at transplanting and 2 weeks after transplanting (Table1). Application of 15 t poultry manure ha^{-1} performed significantly better on number of leaves at 2 and 4WAT than application of 10 and 5 t poultry manure ha^{-1} that were at par on number of leaves of amaranth but produced higher number of leaves than no poultry manure plots (Table 1). Interaction between time and rate of poultry manure application was significant (P<0.05) on number of leaves of amaranth at both 2 and 4WAT (Table 1). Time of application of poultry manure was significant (P<0.05) on plant height at 2 and 4 WAT (Table 1) where application of poultry manure at 2 weeks before transplanting produced significantly (P<0.05) taller amaranth plants than application of poultry manure at transplanting and 2 weeks after transplanting which gave the shortest plants. The plants that received 15 t poultry manure ha^{-1} were the tallest amaranth and significantly (P<0.05) different from the rest rates of the poultry manure while plants without poultry manure produced the shortest amaranth (Table 1). Interaction between time and rate of poultry manure application was significant (P<0.05) on plant height of amaranth at both 2 and 4WAT (Table 1). Time of application of poultry manure was significant (P<0.05) on total dry matter at 2 and 4 WAT (Table 1) where application of poultry manure at 2 weeks before transplanting produced significantly (P<0.05) larger total dry matter than application of poultry manure at transplanting and 2 weeks after transplanting. The smallest total dry matter was produced at 2 weeks after transplanting (Table 2). Increasing poultry manure from 0t ha^{-1} to 15t ha^{-1} significantly increased total dry matter of amaranth and application of 15 t poultry manure ha^{-1} produced the largest total dry matter while amaranth plants without poultry manure produced the smallest total dry matter. Interaction between time and rate of poultry manure application was significant (P<0.05) on total dry matter of amaranth at both 2 and 4WAT (Table 2)

Application of poultry manure at 2 weeks before transplanting significantly (P<0.05) produced higher fresh shoot yield per hectare of amaranth (7624 kg ha^{-1}) than application of poultry manure at transplanting (4588.9 kg ha^{-1}) and 2 weeks after transplanting at harvest (3064.8 kg ha^{-1}) (Table 2). Application of 15t ha^{-1} of poultry manure significantly (P<0.05) produced higher fresh shoot yield per hectare of amaranth (8296.3 kg ha^{-1}) than application of 10 t ha^{-1} (6365.4 kg ha^{-1}) and 5t ha^{-1} (4950.6 kg ha^{-1}) of poultry manure while plots that received 5t ha^{-1} of poultry manure produced less fresh shoot yield per hectare than plot that received 10t ha^{-1} of poultry manure treatment, but produced higher yield than plot with no poultry manure treatment (758 kg ha^{-1}). Application of 5, 10 and 15 t ha^{-1} of poultry manure produced 553.1, 739.8 and 994.5% increases in amaranth fresh shoot yield when compared with no poultry manure application, respectively. Interaction between time and rate of poultry manure application was significant (P<0.05) on fresh shoot yield of amaranth at harvest (Table 3). The highest fresh shoot yield was produced when 15 t ha^{-1} was applied at two weeks before transplanting which was significantly different from other combinations of poultry manure rate and time of application on amaranth fresh shoot yield (Table 3).

Table 1: Influence of nitrogen and poultry manure on number of leaves per plant and plant height (cm) per plant of amaranth at 2 and 4 WAT.

Treatment	No. of leaves plant^{-1}		Plant height plant^{-1}	
	2WAT	4WAT	2WAT	4WAT
Time of Application (T)				
T_1: 2 weeks before transplanting	16.4^{a}	48.3^{a}	24.4^{a}	51.1^{a}
T_2: At transplanting	12.4^{b}	37.6^{b}	16.8^{b}	39.7^{b}
T_3: 2 weeks after transplanting	10.7^{c}	26.6^{c}	12.2^{c}	31.7^{c}
SE±	0.44	1.71	0.54	0.49
Poultry Manure (P) t ha^{-1}				
0	10.6^{c}	16.6^{c}	13.1^{d}	20.3^{d}
5	13.0^{b}	39.5^{b}	16.0^{c}	41.1^{c}
10	13.8^{b}	44.2^{b}	18.7^{b}	48.3^{b}
15	15.3^{a}	49.9^{a}	23.4^{a}	53.6^{a}
SE±	0.51	1.97	0.62	0.57
Interaction				
P x T	*	*	**	**

*: Significant at 5% level of probability. SE±: Standard Error. Means followed by the same superscript(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

Table 2: Influence of time and rate of poultry manure application on total dry matter (g) at 2 and 4 WATand fresh shoot yield (kg ha^{-1}) of amaranth.

Treatment	**Total dry matter plant^{-1}(g)**		**Fresh shoot yield (kg ha^{-1})**
	2WAT	4WAT	
Time of Application (T)			
T_1: 2 weeks before transplanting	2.3^a	10.5^a	7624.0^a
T_2: At transplanting	1.3^b	9.1^b	4588.9^b
T_3: 2 weeks after transplanting	0.4^c	6.8^c	3064.8^c
SE±	0.10	0.20	335.60
Poultry Manure (P) t ha^{-1}			
0	0.5^d	4.5^d	758.0^d
5	1.2^c	8.9^c	4950.6^c
10	1.7^b	10.1^b	6365.4^b
15	2.1^a	11.7^a	8296.3^a
SE±	0.11	0.23	387.52
Interaction			
P x T	**	**	*

*: Significant at 5% level of probability. SE±: Standard Error. Means followed by the same superscript(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

Table 3: Interaction between rate and time of poultry manure application on fresh shoot yield of amaranth at harvest

	Time of Poultry Application		
	T_1	T_2	T_3
Poultry Manure t ha^{-1}			
0	237.0^{h}	1370.4^{gh}	666.7^{h}
5	7740.7^{c}	4244.4^{ef}	2866.7^{fg}
10	10222.2^{b}	5481.5^{de}	3392.6^{ef}
15	12296.2^{a}	7259.2^{dc}	5333.3^{de}
SE±	671.21		

Means followed by the same superscript(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

Discussion

The mark increases observed on number of leaves per plant, plant height per plant, total dry matter per plant and fresh shoot yield as influenced by time of poultry application could be attributed to the important role time played in the decomposition and mineralization of the applied poultry manure before the release of the mineralized nutrients for the growth and consequently, yield of the amaranth. Better performance observed on the measured parameters of amaranth at application of poultry manure at two weeks before transplanting could have been that the time enhanced better supply of the mineralized nutrients for better growth of the crop than the other time regimes. Abdulmaliq *et al*.(2015) reported that okra growth was positively influenced after application of poultry manure at two weeks before planting which was linked to the rate of decomposition of the poultry manure applied at two weeks before planting that caused nutrients to be available for the growing okra when needed most. It has been reported by Ntia *et al*. (2017) that in order to maximize the economic and fertilizer benefit of organic manures, manure application should be matched with the nutrient needs of the crops. Higher fresh shoot yield observed at application of poultry manure at two weeks before transplanting could be that application of poultry manure at two weeks before transplanting was adequate for decomposition and mineralization of the poultry manure to release its embedded nutrients for increased growth of the amaranth and consequently, yield increase. Ntia *et al*. (2017) reported that poultry manure improved the growth and pod yield of okra when applied early prior to planting which was attributed the fact that a time frame is needed for mineralization and release of nutrients from the poultry manure.

Significant increases observed on number of leaves, plant height, total dry matter and fresh shoot yield of amaranth could be attributed to increase in organic matter caused by the decomposition and mineralization of the applied poultry manure. Similarly, Okoli and Nweke (2015) working on poultry manure rates on amaranth observed that the increase in all the amaranth parameters studied could be attributed to the capacity of poultry manure to improve soil organic matter which is the reservoir of plant nutrients, energies the soil organism activities, which help to release the chemical nutrients needed by the crop; these might have invariably contributed to the increase of the parameters studied. It has been reported also that poultry manure is an essential type of organic manure that enhances soil fertility and structure, hence causing nutrient availability for crop nutrition (Mario *et al*., 1989). The improvement observed on amaranth growth after application of poultry manure could be to the fact that organic manure generally improves the whole soil physical, chemical and biological properties and this empowers the soil microbial activities, which assist in the plant nutrient release and the healthy growth of crop plants (Okoli and Nweke, 2015). The positive responses observed on number of leaves, plant height and total dry matter could have been responsible for the significant fresh shoot yield of amaranth. Application of 15t poultry manure ha^{-1} poultry gave the highest performance on growth and fresh shoot yield of amaranth. Other researchers have also reported that poultry manure produced significant increases on yield of amaranth (Law-Ogbomo and Ajayi, 2009; Barau, *et al*., 2018; Adedeji, *et al*., 2019). The highest fresh shoot yield was produced when 15 t ha^{-1} was applied at two weeks before transplanting which could have been that application of poultry manure at the rate of 15 t ha^{-1} at two weeks before transplanting was that the time was suitable for synchronizing mineralized nutrients supply with the need of the crop for increased fresh shoot yield of amaranth.

Conclusion

From the results obtained from this study, it can be concluded that application of poultry manure at two weeks before transplanting produced better performance over other time regimes studied on number of leaves, plant height, total dry matter and fresh shoot yield of amaranth. Poultry manure applied at the rate of 15 t ha^{-1} gave significant influence on number of leaves, plant height, total dry matter and fresh shoot yield of amaranth. Thus, application of 15 t ha^{-1} of poultry manure seems to be best rate for vegetable amaranth production in the study area.

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Influence of induced mutagenesis on storage root formation in the M_1V_1 and M_2V_2 generations of sweet potato (*Ipomoea batatas* (L.) Lam)

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Abstract

Field experiments were conducted in 2015 (M_1V_1) and 2016 (M_2V_2) in Umudike, South-eastern Nigeria with the aim of establishing the influence of sodium azide (SA) and colchicine (COL) induced mutagenesis on percentage storage root formation of four varieties of sweet potato (Butter milk, TIS87/0087, UMUSPO/3 and UMUSPO/1) in the M_1V_1 and M_2V_2 generations. Vine cuttings obtained were soaked in sodium azide (SA) and colchicine (COL) mutagens at various concentrations: 0%, 0.03%, 0.05% and 0.07%, for 2 hours. The experiment was laid out using a split-plot arrangement fitted into a Randomized Complete Block Design and replicated three times. SA and COL 0.07% attained 100% lethality in TIS87/0087 and UMUSPO/3 as those that sprouted did not survive till the 4th week. Significant differences ($P \leq 0.05$) in percentage storage root formation were observed for mutagen concentration, variety and interaction in the M_1V_1 and M_2V_2 generations. For the sodium azide treatments, percentage storage root formation reduced as the mutagen concentration increased; while for the colchicine treatments, COL 0.00% tubered more than the other concentrations in the M_1V_1 generation as shown by the mean values recorded. In the M_2V_2 generation though no significant difference was observed between SA 0.00%, SA 0.03%, and SA 0.05% among the sodium azide treatments; there was a decrease in percentage storage root formation among the colchicine treatments as the concentration increased.

***Key Words*: Colchicine, Sodium azide, Sweet potato**

Introduction

Sweet potato is the only species that produces tuberous roots out of the about 500 other species of the genus *Ipomoea* (Afuape *et al*., 2014). Among the root and tuber crops cultivated in the world, sweet potato ranks second in position after cassava (Ray and Ravi, 2005). Its storage roots, leaves and tender vines all have economic and dietary values (Antiaobong and Bassey, 2009).

Sodium azide and colchicine have proved their worth as mutagens in generating genetic variability (Rajib and Jagatpati, 2011). Sodium azide (NAN_3) has been one of the most powerful mutagens in crop plants (Fahad and Salim, 2009) and is perhaps the least hazardous and the most efficient mutagen as its yields of mutations are achievable at moderate sterility rates (Asad *et al*., 2014). Colchicine, on the other hand, is a chromosome doubling agent (Rajib and Jagatpati, 2011) and also a mutagenic agent (Bragal, 1955).

Self-and-cross-incompatibility restricts the use of genetic resources in clonally propagated crops such as sweet potato. And as such, it is very hard to breed new varieties and improve varieties through cross breeding (Martin, 1965) in such crops. Also, conventional methods are limited in the improvement of sweet potato as they are able to induce many mutations at once since sweet potato is a polyploid and has many chromosomes (Ji-Min *et al*., 2011). To tackle this limitation, induced mutagenesis has proven a potent tool in the improvement of sweet potato varieties (Ji-Min *et al*., 2011).

The aim of this study was to establish the influence of sodium azide (SA) and colchicine (COL) induced mutagenesis on percentage storage root formation of four varieties of sweet potato (Butter milk, TIS87/0087, UMUSPO/3 and UMUSPO/1) in the M_1V_1 and M_2V_2 generations.

Materials and Methods

Field experiment was conducted at the National Root Crops Research Institute (NRCRI) Experimental Farm, Umudike in 2015 (M_1V_1) and at the Eastern Farm, Michael Okpara University of Agriculture, Umudike (MOUAU) in 2016 (M_2V_2).

Uniform vine cuttings (30cm long) each of four (4) cultivars of sweet potato: UMUSPO/1, UMUSPO/3, Butter Milk, and TIS87/0087 popularly grown in the Southeastern part of Nigeria, were obtained from the National Root Crops Research Institute (NRCRI) Umudike, Abia state. Vine cuttings selected at random for each treatment from the best performed M_1V_1 generation plants were used to establish the M_2V_2 generation including the control. M_1V_1 and M_2V_2 were the first and second mutative vegetation respectively.

The vine cuttings were soaked in distilled water for 8 hours. The water was decanted and vines dried in a shade for 6 hours. Fresh solutions of sodium azide and colchicine were prepared in four different concentrations: 0 %, 0.03 %, 0.05 % and 0.07 %. These cuttings were now soaked in these concentrations for 2 hours at room temperature and periodically agitated. Finally, they were rinsed with running tap water for 1 hour to wash out the chemical residues before taking them to the field. The vine cuttings with 0% treatments were used as control.

The experiment was laid out using a split-plot arrangement fitted into a Randomized Complete Block Design and replicated three times. The sweet potato variety was the main plot and the sub-plot was the chemical treatments. The spacing between and within the rows were 1.0 m and 0.3 m respectively. In M_1V_1 population, each plot contained 30 plants. A total of 5040 vine cuttings harvested from M_1V_1 generation were used to establish M_2V_2 population. The site of the experiment was cleared, ploughed, harrowed and ridged. Fertilizer (NPK 15:15:15) was applied at the rate of 400kg/ha at 4 WAP by ring placement method preceding manual weeding and roguing (Ehisianya *et al*., 2012).

The storage roots were harvested at 16 WAP (Ezulike *et al*., 2001). Percentage storage root formation was obtained by counting the number of plants that tubered expressed in percentage of the stand count at harvest.

All data collected were subjected to statistical analyses of variance (ANOVA) using the Genstat Discovery 3rd Edition (Genstat, 2007). Separation of treatment means was done using Fisher's least significant difference (LSD) as described by Obi (1986). Independent analysis was done for data collected in M_1V_1 generation and for that collected in M_2V_2 population.

Results

Table (1) showed the effect of SA and COL mutagens on percentage storage root formation of four varieties of sweet potato in the M_1V_1 generation. For the SA treatments, percentage storage root formation reduced as the mutagen concentration increased; while for the COL treatments, COL 0.00% tubered more than the other concentrations as shown by the mean values recorded. In the M_2V_2 generation, result in Table (2) showed that while there was no significant difference between SA 0.00% (100.00%), SA 0.03% (99.70%) and SA 0.05% (99.26%) among the SA treatments; there was a decrease in percentage storage root formation among the COL treatments as the concentration increased. Analysis of variance showed significant difference ($P \leq 0.05$) for mutagen concentration, variety and interaction for percentage storage root formation in M_1V_1 and M_2V_2 generations (Tables 1 and 2). The Coefficient of variability was 6.60% in M_1V_1 and 2.60% in M_2V_2 generation.

Table 1: Effect of sodium azide (SA) and colchicine (COL) mutagens on percentage storage root formation of sweet potato in the M_1V_1 generation

Mutagen Conc. (%)	Variety				
	Butter Milk	TIS87/0087	UMUSPO/3	UMUSPO/1	Mean
SA 0.00	**97.10**	**100.00**	**100.00**	**100.00**	**99.27**
SA 0.03	53.33	94.58	100.00	80.25	82.04
SA 0.05	44.44	94.44	40.91	54.04	58.46
SA 0.07	33.33	0.00	0.00	44.44	19.44
Mean	57.05	72.26	60.23	69.68	64.80
COL 0.00	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
COL 0.03	100.00	91.11	91.67	98.33	95.28
COL 0.05	100.00	100.00	96.97	100.00	99.24
COL 0.07	100.00	0.00	0.00	100.00	50.00
Mean	100.00	72.78	72.16	99.58	86.13
Grand mean	78.53	72.52	66.19	84.63	75.47

LSD for mutagen conc. = 4.07

LSD for variety = 5.52

LSD for interaction = 8.89

CV (%) =6.60

Table 2: Effect of sodium azide (SA) and colchicine (COL) mutagens on percentage storage root formation of sweet potato in the M_2V_2 generation

Mutagen Conc. (%)	Variety				
	Butter Milk	TIS87/0087	UMUSPO/3	UMUSPO/1	Mean
SA 0.00	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
SA 0.03	100.00	98.81	100.00	100.00	99.70
SA 0.05	98.89	98.16	100.00	100.00	99.26
SA 0.07	98.85	0.00	0.00	100.00	49.71
Mean	99.44	74.24	75.00	100.00	87.17
COL 0.00	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
COL 0.03	100.00	95.08	98.18	100.00	98.32
COL 0.05	93.23	82.24	83.33	100.00	89.70
COL 0.07	83.03	0.00	0.00	91.50	43.63
Mean	94.07	69.33	70.38	97.88	82.91
Grand mean	96.75	71.79	72.69	98.94	85.04

LSD for mutagen conc. = 1.78

LSD for variety = 1.24

LSD for interaction = 3.47

CV (%) =2.60

Discussion

Percentage storage root formation reduced as the mutagen concentration increased among the sodium azide treatments; while for the colchicine treatments, the mean values showed that COL 0.00% tubered more than the other concentrations in the M_1V_1 generation. Asare and Akama

(2014) reported a reduction in storage root formation only at the highest concentration of mutagens in sweet potato. They however concluded that even though the variety induced had low performance for storage root formation in the first generation, the next generation might perform better because of the genetic variability that has been created through mutation induction (Asare and Akama, 2014). Based on the result of this study, though no significant difference was observed between SA 0.00%, SA 0.03%, and SA 0.05% among the sodium azide treatments in the M_2V_2 generation; there was a decrease in percentage storage root formation among the colchicine treatments as the concentration increased contrary to the conclusion of Asare and Akama (2014).

Conclusion

The purpose of this study was to establish the influence of sodium azide (SA) and colchicine (COL) induced mutagenesis on percentage storage root formation of sweet potato in the M_1V_1 and M_2V_2 generations. The results demonstrated that sodium azide and colchicine chemical mutagens had more negative influence on percentage storage root formation in the M_1V_1 than in the M_2V_2 generation. The result in this investigation also suggested that different varieties of sweet potato used in the study responded differently to different mutagenic treatments at specific concentrations for percentage storage root formation. It may therefore be pertinent to compare the effects of different mutagens on growth and yield parameters of different varieties of a crop to arrive at a valid conclusion for that particular crop.

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Effects of organic manure and NPK fertilizer on the yield and performance of sweet potato varieties (*Ipomoea batata*s(L)Lam in Nyanya, FCT, Abuja

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Abstract

In Nigeria, one of the major problems confronting agriculture is poor soil fertility replenishment strategy that could allow sustainable crop production. A field trial was conducted at National Root Crops Research Institute Nyanya Out-Station with the aim of studying the Effects of organic manure and NPK fertilizer on the performance and yield of sweet potato varieties (*Ipomoea batatas* (L)Lam). The Research was conducted during the 2019 farming season. The experiment comprises of six treatments of sole and combined inorganic fertilizer (N.P.K 15:15:15) and organic (Poultry manure) fertilizer as follows: Control (0kg/ha),400kg ha-^{1}NPK,3t/ha-^{1}poultry manure (PM),200kgha-^{1}NPK+1.5t/ha-^{1}PM,300kg/ha-^{1}NPK+0.75t/ha-^{1}PM,100kg/ha-^{1}NPK+2.25t/ha-^{1}NPK+2.25t/ha-^{1}PM.Two varieties of sweet potato (butter milk and umuspo 1) were used. It was a factorial experiment and laid out in a randomized complete block design, with three replications. Results indicates that vine length increased as the week's progresses after planting. At 4 weeks after planting, control gave the least(50.27cm), longest vine(90.08cm) was obtained with application of 100kg ha-^{1}NPK+2.25 t ha-^{1} PM. However, number of tuber increased from control (20.17) and peaked at 200kg ha-^{1}+1.5t ha-^{1}PM. It is therefore recommended that with application of 200kg ha-^{1} NPK+1.5 t ha-^{1}poultry manure should be adopted for the cultivation of sweet potato in the study area.

Keywords: Poultry manure, Sweet Potato, NPK

Introduction

Sweet potato (*Ipomoea batatas)* is a warm season root crop widely grown in the tropic. According to udo *et al*. *(*2005), the largest producer of sweet potato outside the tropics is Japan. However, China and United States of America also produce substantial quantities. Sweet potato is ranked the third most important root crops after cassava and yam. The root tubers are used as food for man and livestock in many countries of the world, it also serves as raw materials for the manufacture of starch, glucose and alcohol. The leaves are used as vegetables in some communities in Nigeria. Plant nutrients are essential for the production of quality crop. Plant nutrients are vital components of sustainable Agriculture; increase in crop relies on the type of fertilizer and manure used to supplement essential nutrients for plant growth. Intensive use of chemical fertilizers was advocated for crop production in the tropics in order to alleviate these nutrient deficiencies (Anonymous, 2000). The yield of sweet potato like other crop is influenced by climatic, biological and soil factors (Udo *et al*., 2005; NRCRI, 2008). Among the soil factors fertility is the most important for sweet potato production. Use of organic manure is a traditional method of boosting soil fertility although the use of inorganic fertilizer like NPK is becoming increasingly important. Therefore, the objective of this study was to determine the effect of organic and inorganic fertilizer combination on the performance of sweet potato

Materials and Methods

The study was carried out at National Root Crops Research Institute Nyanya-Out Station, Abuja (Latitude 9.06°733°E and Longitude 7.62°318°N) during the 2019 cropping season. Abuja is located in the southern guinea savanna ecological zone of Nigeria. The gross plot is 41x 8 (328 m^2). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The plot size for each replicate was 2x2 (4 m^2) with 12 plots in each with a distance of 1m between the replicates and 1m between the treatments. The experiment comprises six (6) treatments which is made up of control (0kg/ha), 400kg ha^{-1}, 3tha^{-1}poultry manure (PM), 200kg ha^{-1}NPK+1.5tha^{-1}(PM), 300kg ha^{-1}NPK+0.75tha^{-1}(PM), and 100kg ha^{-1}NPK+2.25tha^{-1}(PM).

Data collected were vine length, number of tubers, and number of damage tubers which were subjected to analysis of variance using SAS (2008). Means were separated using Student-Newman Keuls Test at $p<0.05$.

Results and Discussion

Table 1 shows the result of physical and chemical properties of the experimental site. Results shows that the pH is 6.8 which is at neutral level. The result also showed that textural class of the soil is sandy loam. The available phosphorus of the soil analyzed has a value of 7.31 mgkg^{-1},which indicates that the available Phosphorous was low which signifies that the soil will show substantial response to applied phosphorous fertilizer for sweet potato production. The organic carbon is low with a value of 8.13 gkg^{-1} this may be as a result of poor vegetation, continuous cropping and subsequent bush burning which are characteristics of savanna soil. Therefore, maintenance of a satisfactory organic matter status in this soil is essential, Onyekwere and Ezenwa (2009) reported that mineralization of most of the nitrogen and half of the phosphorous in the soils, if the potato field were unfertilized. The total nitrogen is 0.78 which is low this may be due to continuous use of land over the years and could be as a result of the organic carbon content of the soils (Onyekwere and Ezenwa, 2009).The exchangeable calcium of the soil was moderate with a mean value of 0.9 cmolkg-1.Soils of the study area had mean value above 4cmolkg-^{1} regarded as lower limit for fertile soils (Onyekwere *et al.*,2001).Also, the exchangeable magnesium content of the soils studied was moderate with a mean value of 0.54cmol kg-^{1},the soils are well furnished with exchangeable magnesium, exchangeable sodium content of the soil was high with a value of 1.55cmol kg-^{1}.The soils had exchangeable sodium above 0.2cmol kg-^{1} considered as the critical value needed in soils(Onyekwere, *et al.*, 2018)

The result in table 2 shows the effect of fertilizer and sweet potato variety on the performance of sweet potato vine length. Results indicate that vine length increased with increase in the number of weeks of observation after planting. At 4 weeks after planting, control gave the least (50.03 cm) while the longest vines (90.08 cm) were obtained with 100kg ha-^{1} NPK+2.25 t ha-^{1} pm. This value was significantly higher($p<0.05$) than the vine length obtained with the control and 3t ha-^{1} poultry manure but was however not significantly different from the rest treatments. At 6 weeks after planting, the vine lengths did not differ significantly, the values however ranged from 87.72cm at the control site to 136.89 at 100kg ha-^{1} NPK+2.25t ha-^{1} poultry manure. The results obtained at week 8 after planting were statically similar to those obtained at 6 weeks after planting. Significant differences were obtained at 10 weeks after planting($p<0.05$) where control produced the shortest (629.83cm) vines. However, the application of 400kg ha-^{1}NPK,200kg ha-^{1} NPK+1.5t ha-^{1}poultry manure(pm),300kg ha-^{1} NPK+0.75t ha-^{1} poultry manure and 100kg ha-^{1}NPK+2.25t ha-^{1}poultry manure were significantly different from one another in the length of vines. This could be due to high nitrogen uptake (Owudike, 2010), while the shortest vine lengths were observed in the control at 4, 6, 8, and 10 WAP. This result is in line with the findings of Ebregt *et al*.,2004 and Nodolo *et al.*,2007 who reported that survival of sweet potato vine is more related to the conditions of the Agro-ecological zones and that the most common cause of planting material failing to take off is drought. A significant difference was also observed in vine length between both varieties at 4, 6, 8, and 10 WAP. Butter milk variety consistently recorded longer vine lengths compared to Umuspo1.There was no significant difference(P>0.05) in the interaction effects across treatments and sweet potato varieties on vine length.

Table 3 shows the effect of fertilizers and variety on sweet potato yield and other yield attributes of sweet potato. Results indicates that no significant differences were observed in the number of tubers and number of damaged tubers.Lowest numbers of tubers(20.17) were observed in control while highest(35.27) was recorded where 200kg ha-^{1}+1. 5 t ha-^{1} poultry manure was applied. According to Yeng *et al* (2012) the integrated application of poultry manure and inorganic fertilizer increase growth and yield of sweet potato. Santhi and Selvakumari (2000) were of the view that the addition of organic manure sources to chemical fertilizer could increase the yield of crops through improving soil productivity and higher fertilizer efficiency. For the number of damaged tubers,300kg ha-^{1} NPK+0.75t ha-^{1} poultry manure had the least (2.17) while the highest (3.50) was obtained with 200kg ha-^{1} NPK+1.5t ha-^{1} poultry manure. Tuber yield ranged from 3.16 t ha-^{1} at the control site to 6.18 t ha-^{1} at 200kg ha-^{1} NPK+1.5t ha-^{1} poultry manure. There were no significant differences among the treatments in damaged tubers. However, the results obtained from all the treatments in the number of tubers were not statistically different from one another. The varieties did not show any significance differences in the number of tubers and number of damaged tubers. However, the tuber yield (5.85) was obtained with butter milk which was significantly higher than that of umuspo 1 variety.

Table 1: Physical and chemical properties of soil of the experimental site

Parameters	Value
Particle size distribution (g kg^{-1})	
Sandy	662
Silt	225
Clay	113
Textural class	Sandy loam
Chemical properties	

pH (1:2.5) soil water ratio	6.8
$CaCl_2$	6
Organic Carbon (g kg^{-1})	8.13
Total N (g kg^{-1})	0.78
Available P (mg $kg-^{1}$)	7.31
Exchangeable bases	
Ca^{2+} (cmol kg^{-1}))	0.9
Mg^{2+} (cmol kg^{-1})	0.54
K^{+} ($cmolkg^{-1}$)	0.58
Na^{+}	1.55
Exchangeable acid (cmol kg^{-1})	0.14

Table 2: Effect of Organic and Inorganic Fertilizer Combination on Sweet Potato vine length

	Vine length (cm)			
	Weeks after planting			
Treatment (T)	4	6	8	10
Control	50.03b	87.72a	276.67a	629.83c
400 kg ha^{-1} NPK	58.57ab	95.05a	341.15a	798.84ab
3 t ha^{-1} PM	50.27b	108.82a	291.13a	698.67bc

200 kg ha^{-1} NPK + 1.5 t ha^{-1} PM	66.30ab	124.42a	361.23a	911.67a
300 kg ha^{-1} NPK + 0.75 t ha^{-1} PM	74.03ab	128.27a	359.70a	871.17a
100 kg ha^{-1} NPK + 2.25 t ha^{-1} PM	90.08a	136.89a	391.97a	877.83a
SE±	9.04	21.44	84.09	101.14
Variety (V)				
Butter milk	88.23a	147.49a	173.32b	1006.00a
Umuspo1	41.54b	77.92b	495.63a	590.00b
SE±	5.24	8.66	21.26	33.47
Interaction				
TxV	NS	NS	NS	NS

Means with the same letter(s) in a column are not significantly different at 5% level of probability using SNK.

NS: Not significant

NS=Not Significant, PM=Poultry Manure

Table 3: Effect of Organic and Inorganic Fertilizer Combination on number of tubers, damaged tubers and yield of Sweet Potato tubers

Treatment (T)	Number of tubers	Damaged tubers	Tuber yield (Kg/ha)

Control	20.17a	3.33a		3.16b
400 kg ha^{-1} NPK	29.67a	2.50a		5.42ab
3 t ha^{-1} PM	34.17a	3. 33a		5.41ab
200 kg ha^{-1} NPK + 1.5 t ha^{-1} PM	35.27a	3.50a		6.18a
300 kg ha^{-1} NPK + 0.75 t ha^{-1} PM	25.33a	2.17a		5.72a
100 kg ha^{-1} NPK + 2.25 t ha^{-1} PM	29.33a	3.00a		5.96a
SE±	2.89	0.48		0.40
Variety (V)				
Butter milk	29.50a	3.22a		5.85a
Umuspo1	28.61a	2.72a		4.76b
SE±	2.21	0.28		0.4
Interaction				
TxV	NS	NS	NS	NS

Means with the same letter(s) in a column are not significantly different at 5% level of probability using SNK.

NS=Not Significant, PM=Poultry Manure

CONCLUSION

The result from this study shows that combined application of organic (poultry manure) and inorganic fertilizer performed better than sole application. The application of 200 kg t ha-¹ of NPK + 1.5 t ha-¹ poultry manure gave the best yield of 6.18 t/ ha while butter milk performed better than umuspo l. Therefore, the application of 200 kg t ha-¹ NPK + 1.5 t ha-¹ of poultry and cultivation of butter milk are recommended for sustainable sweet potato cultivation in the study area.

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Evaluation of three contrasting organic materials on soil chemical properties and maize dry matter yields

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Abstract

A study was conducted at the greenhouse in the Department of Soil Science Chukwuemeka Odumegwu Ojukwu University, to evaluate the effect of vermicompost, abattoir wastes and spent grain on soil properties and maize dry matter yield the experiment comprised of four treatments and three replications. The treatments were 2kg soil (control), 2kg of soil + 216g of vermicompost, 2kg of soil + 216g of abattoir waste and 2kg of soil + 216g of spent grain. The result finding showed that the organic materials significantly ($P < 0.05$) increased the plant height, leaf area, number of leaves per plant and maize dry matter yield. The untreated pots showed the least performance in the study. After harvest, the growth yield of maize showed a high rate of yield in abattoir waste pot, while the control pots recorded the least yield. The organic materials enhanced the pH of the studied soil and increased the availability of P, N, OC, Ca, Mg, K and Na. Based on the result of the study however, AB and SP performed competitively better than the other treatments in growth and yield of maize. Hence, they are recommended in greenhouse production of crops.

Keywords: Abattoir, spent grain, soil nutrients, vermicompost

Introduction

Soil is a living entity that offer support to plants, a reservoir of water and chemical nutrients. Hence, it influences greatly agricultural productivity, water flow and quality and nutrient recycling. Thus, soil is the basic requirement for agricultural crop production, but regrettably soils especially the south-eastern soils of Nigeria faces one form of degradation or the other that affects agricultural production in the area the resultant effect being poor crop production at the end of every cropping season. Another contending problem is the exponential increase in human population and decrease in land availability for cultivation and agricultural activities. In a bid to increase crop production and yield in the area have led to indiscriminate use of chemical fertilizers and pesticides which in turn has resulted into environmental pollution and ecological disturbances by destroying both soil and crop beneficial organisms. Thus, modern day agriculture through seminars and conferences is emphasizing on organic agriculture and de-emphasizing the use of mineral fertilizers because organic materials have been noted to supply all the nutrients required by plants, improves soil productivity, environmental health and agricultural sustainability. Hence, vermicompost, abattoir waste and spent grain as an organic material can enhance soil physical, chemical and biological properties that will impart positively on crop production, maintenance of ecosystem, regulate water flow and soil nutrient recycling and environmental health through its influence on global climate. The essence of this study therefore is to evaluate three contrasting organic materials on soil chemical properties and maize dry matter yield.

Materials and methods

The greenhouse experiment was conducted at the Faculty of Agriculture, Chukwuemeka Odumegwu Ojukwu University Igbariam Campus. The area falls within the derived savannah zone of Nigeria and is located at latitude 06N and 45E and longitude 06N and 40E. The soil sample for the experiment was collected by scrapping away 0-5cm of the surface soil from the Faculty of Agriculture farm land and then 15-20cm deep was collected at five different locations in a plastic container. After the collection of the soil, stones and hard clods where removed in order to ensure fine tilt before measuring out the soil. 2kg soil samples were weighed into 12 plastic pots of dimension 18.7 X 17.0cm and were thoroughly mixed differently with 216g each of vermicompost, spent grain and abattoir waste. The plastic pots were perforated at the base and plugged with cotton wool to avoid excessive drainage. The experiment was a CRD design with 4 treatments replicated 3 times. The treatments were;

Abattoir + subsoil (AB)

Spent grain + subsoil (SP)

Vermicompost + subsoil (VC)

Subsoil (CO).

The amendment mixtures were watered and left for 7days before the test crop maize was planted. This was to give time for the transformation and further decomposition of the mixture. Two seeds of maize were planted per pot and ten days after germination, supply was made for those that did not germinate. The experiment was laid out in a greenhouse constructed with white tarpaulin and wire gauze. This was to avoid external water in form of rainfall to interfere and to moderate the temperature. 75cl of water was added every 2 days for the rest of period of the experiment. The plant height, leaf area and number of leaves per plant were taken at 4, 8 and 10 weeks respectively. After 10 weeks, the plants were carefully uprooted from the pot and the soil particles were washed away. The roots were cut off from the shoots. Both the roots and the shoots were oven-dried for 24hrs for the dry matter yield. At the end of the study, soil samples were collected from each pot and the samples together with prior soil samples were sieved with 2mm sieve and were subjected to chemical analysis as out lined in Black (1965). All the data collected were subjected to analysis of variance and treatment means were separated by least significant difference at 5% alpha level.

Results

The result of the chemical analysis of the soil used for the study presented in Table 1 indicated low to moderate value in the parameters tested. The pH of the soil showed that the soil used for the study is acidic. Hence it is expected that the soil will benefit from organic material treatment.

Table 1 Chemical properties of soil sample before experiment

Parameter	value
pHH_2O	5.58
Avail. P	11mgkg^{-1}
N	0.042%
OC	0.53%
OM	0.91%
Ca	3.60cmolkg^{-1}
Mg	1.60cmolkg^{-1}
K	0.179cmolkg^{-1}

Na	0.165cmolkg^{-1}
EA	1.28cmolkg^{-1}
ECEC	6.82cmolkg^{-1}

Effect of three contrasting organic materials on the growth and dry matter yield of maize

The growth and dry matter yield of maize result presented in Table 2 showed significant ($P < 0.05$) difference among the treatments in all the parameters assessed except for number of leaves result at 10 weeks after planting (WAP). The 4 WAP result showed a result variation of CO > VC > SP > AB for plant height. The value recorded for leaf area was highest (27.33cm^2) in SP and the lowest value 12.08cm^2 obtained from CO. The number of leaves recorded in CO at 4WAP was the least (3.83) compared to the values obtained from the other treatments. The result of the 8WAP shows that VC > SP > AB > CO for plant height result. The highest leaf area value (189.51cm^2) was recorded in VC and the least value of 94.47cm^2 was obtained from CO. The number of leaves recorded show that CO has the least (4.5) while VC has the highest (7.17). The result of 10WAP shows that VC > AB > SP > CO for plant height and VC > SP > AB > CO for leaf area the number of leaves result at 10 WAP indicated that AB and SP recorded similar value and least value (4.5) obtained from CO. The fresh and dry matter yield of maize in Table 2b indicated significant difference among the treatments except for root dry matter result. Similar results were observed in AB and SP in fresh root matter and AB, VC and CO in dry root matter.

Table 2a Effect of three contrasting wastes on the growth dry matter yield of Maize

Treatment	4WAP			8WAP			10WAP		
	Plant height cm	Leaf area cm^2	No of leaves	Plant height cm	Leaf area cm^2	No of leaves	Plant height cm	Leaf area cm^2	No of leaves
AB	9.0	19.58	4.0	22.57	175.36	7	22.57	175.36	7.0
SP	11.08	27.33	4.33	21.99	187.78	7	21.98	187.78	7.0
VC	11.37	14.96	6.33	26.62	189.510	7.17	26.62	189.59	7.17
CO	12.08	12.08	3.83	15.27	94.47	4.5	15.27	94.47	4.5

LSD P< 0.05	1.50	2.80	1.89	3.05	16.89	NS	3.0	16.80	NS

AB=Abattoir Effluent; SP=Spent Grain; VC=Vermicompost CO=Control Soil; WAP =Weeks after planting.

Table 2b: Effect of three contrasting wastes on the fresh and dry matter yield

Treatment	Fresh matter weight		Dry matter weight	
	Shoot gkg^{-1}	Root gkg^{-1}	Shoot gkg^{-1}	Root gkg^{-1}
AB	56.0	10.33	23	4.34
SP	70.00	10.33	28.33	3.67
VC	49.66	7.67	20.66	4.34
CO	19.33	4.33	7.34	4.34
LSD P<0.05	4.76	2.32	2.75	NS

AB =Abattoir Effluent; SP = Spent Grain; VC =Vermicompost CO = Control Soil.

Effect of three contrasting organic materials on soil properties

The result in Table 3 showed that the pH value had the highest mean value (7.48) in pot AB of which is alkaline while SP and VC showed moderately acidic. The recorded values for P, OC, Ca and Mg showed significant differences among the treatments. The least value of P was obtained from CO, while SP and VC recorded statistically similar result. Also, AB and VC recorded the same value for N. The value obtained for OC and Ca showed a result sequence of AB > VC > SP > CO. The result of Mg indicates that AB recorded the highest value (3.07$cmolkg^{-1}$) relative to the other treatments while SP and VC recorded the same value 2.53$cmolkg^{-1}$ for Mg. The recorded values for K, Na and EA showed non-significant difference among the treatments. The value obtained for Na showed that VC and CO recorded the same value 0.2 $cmolkg^{-1}$.

Table 3 **Effect of three contrasting organic materials on soil properties**

Treatment	pH	P mgkg-	N	OC	Ca cmolkg-	Mg	K	Na	EA cmolkg-

	H_2O	1	%	%	1	cmolkg^{-1}	cmolkg^{-1}	cmolkg^{-1}	1
AB	7.48	23.3	0.08	1.73	5.87	3.07	0.11	0.15	0.41
SP	5.87	19.03	0.10	0.97	4.8	2.53	0.12	0.25	0.88
VC	5.74	19.97	0.08	1.03	5.33	2.53	0.10	0.21	0.99
CO	6.25	16.77	0.05	0.54	2.53	1.33	0.09	0.21	0.44
LSD $P < 0.05$	NS	2.09	NS	0.40	2.02	1.05	NS	NS	NS

AB =Abattoir Effluent; SP=Spent Grain; VC=Vermicompost CO=Control Soil.

Discussion

The observed increase in the soil nutrients tested following the application of the organic materials confirms their high nutrient content. This in turn resulted in higher output of maize dry matter recorded in the study. It also attested to the findings that the studied soil is deficient in these nutrients. The positive response of soil nutrient contents to vermicompost, abattoir waste and spent grain recorded in this study agreed with the previous studies of Neboh *et al*. (2013), Nsoanya and Nweke (2015) and Nweke, (2017, 2018). The observed increase in the soil pH following the organic materials application can be attributed to calcium ions released into the soil solution during the microbial breakdown of the organic matter. The organic matter components of vermicompost, abattoir waste and spent grain decomposed and nutrients were released to the soil for the use of the maize plants. Similarly, Nweke, (2018) reported that application of vermicompost favourably affects plant growth and yield and that plant growth promoting hormones are present in vermicompost (Nagavellema *et al*. 2004).

Conclusion

The findings of the study have shown that the organic materials used for the study improved soil properties tested and maize dry matter yield. These wastes when collected and applied to crops in a rational manner is a valuable resource capable of replacing the purchasing of mineral fertilizers that is not always there. The organic materials studied are environmentally safe, cheap and affordable. Poor resource farmers should use them in their crop production activities.

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Effect of N-Fertilizer Placement on Nutrient Use Efficiency of Irrigated Rice (*Oryza Sativa* L.) Variety at Talata Mafara, Sudan Savanna of Nigeria

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Abstract

High loss of nitrogen (N) and low N-use efficiency is usually caused by inappropriate fertilizer placement particularly in irrigated rice fields. A field experiment was therefore conducted to investigate the effect of fertilizer N (prilled urea-PU) and briquettes-urea supergranule (USG) on rice yield and its nutrient use efficiencies at the research Farm of the Institute for Agricultural Research, Talata Mafara under irrigation. The treatment combinations included two granular forms of N as Urea Super Granule (USG) and Prilled Urea (PU) at different rates [0, 45.1, 72.2, 117.3 kg N ha^{-1} with three varieties of rice (FARO 55, FARO 57 and FARO 52) as the test crops. The experimental design was Randomized Complete Block Design (RCBD) and replicated thrice. Application of USG at 45.1 kg N ha^{-1} had the highest (37.33%) Agronomy Efficiency (AE) and (48.20%) Nitrogen Utilization Efficiency (NUE) while the least (13.79%) and (16.36%) were recorded by PU applied at 72.2 kg N ha^{-1} respectively. The varieties evaluated also exhibited significant differences where FARO 52 had significantly highest (36.28%) AE and (40.39%) NUE, while FARO 55 recorded the least (5.17%) and (8.06%) respectively. In conclusion, results of the study show that application of USG can increase yield and nutrient use efficiency of rice crop compared to conventional PU.

Keywords: urea super granular (USG); conventional prilled urea (PU); rice varieties; nutrient use efficiencies;

Introduction

Rice (*Oryza sativa L.)* is the main food crop of an estimated 40% of the world's population (Liu *et al*., 2013). Annually, about 5 million metric tons of rice is consumed in Nigeria and over 80% is imported costing the country a humongous amount of money (Onu *et al.,* 2015). Local production is low and efforts to increase production are hindered by high input costs.

The nature and magnitude of N loss largely depends on the sources and methods of N fertilizer application. Another major constraint to rice production in dry land savanna is lack of appropriate improved varieties where the commonly grown varieties are late-maturing and usually low in yield. Hence, to minimize the losses of nitrogen, slow release of nitrogenous fertilizer such as urea super granules (USG) had been advocated with deep placement (IFDC, 2007). Therefore, the present study was designed to determine the effect of variety and N fertilizer placement rates on nutrients use efficiency of rice (*Oryza sativa* L.) at Talata Mafara under irrigation.

Materials and Methods

Field trial was conducted during the 2013 under irrigation at the Irrigation Research Station, Institute for Agricultural Research (IAR), Talata Mafara (12.6219^0–12.6223^0N, 006.0252^0-006.0255^0E and 305 m above the sea level).The treatments consisted of two factors. Factor one was the rice varieties ($V_{1} =$ FARO 55 (NERICA 1), V_2= FARO 57 (TOX 4004) and V_3= FARO 52 (WITA 4), while factor two consisted of USG at 45.08 kgNha^{-1} (N_1), 72.22 kgNha^{-1} (N_2); and 117.30 kgNha^{-1} (N_3); and PU at 45.08 kgNha^{-1} (N_4), 72.22 kg N ha^{-1} (N_5) and 117.30 kgNha^{-1} (N_6); The Prilled Urea (PU) were applied in two equal halves (at 2 weeks after transplanting and at panicle initiation). A control, unfertilized plot (N_0) was also included. The experiments were laid down as a randomized complete block design (RCBD) in a factorial arrangement and replicated three times.

Rice seedlings raised from the nurseries for three weeks were transplanted at 2 seedlings per hill and at a spacing of 0.2 m × 0.2 m to give a total population of 500, 000 plants ha^{-1}. Each plot received basal application of 50 kg P_20_5 ha^{-1} and 40 kg K_2O during land preparation. These fertilizer rates were based on the recommendations of FMARD (2012). Each capsule of USG (1.8 g, 2.7 g) and addition of (1.8 + 2.7) = 4.5 g size) was inserted between four hills of rice one week after transplanting (1WAT). The Prilled urea (PU) was applied in two equal halves (at 1 week after transplanting and at panicle initiation) by broadcasting. At harvest, the crop was partitioned into straw and grain for the determination of N concentration, uptake of N fertilizer recovery and nutrient use efficiencies as presented in Table 1. All data collected were subjected to analysis of variance (ANOVA) using the mixed model procedure of SAS (Littell *et al*., 1996). Differences between treatment means were compared using Duncan Multiple Range Test (DMRT).

Results and Discussion

Agronomic Efficiency (AE)

The effect of N-management and rice varieties on agronomic efficiency is presented in Table 2. Application of USG at 45.1 kg N ha^{-1} had the highest (37.33%) AE while the least (13.79%) was recorded by GU applied at 72.2 kg N ha^{-1}. Varieties evaluated also exhibited significant variation in AE where FARO 52 had significantly highest (36.28%), while FARO 55 recorded the least (5.17%).

Agro Physiological Efficiency (APE)

The effect of N-management and rice varieties on agro physiological efficiency is presented in Table 2. The results showed no significant different among the treatments evaluated.

Nitrogen Utilization Efficiency (NUE)

The effect of N-management on nitrogen utilization efficiency of rice varieties is presented in Table 3. Results showed that application of USG at 45.1 kg N ha^{-1} had significantly the highest (48.20%) nitrogen utilization efficiency while the least (16.36%) was recorded by PU at 72.2 kg N ha^{-1}. The varieties evaluated also exhibited significant differences in NUE, where FARO 52 had significantly the highest (40.39%) values, while FARO 55 recorded the least (8.06%).

Generally, results obtained from this research work showed that Agronomic Efficiency (AE) and Nitrogen Utilization Efficiency (NUE) increased with decreasing N levels for both USG and PU and this agrees with the findings of Haefele *et al*. (2008) that AE reduce with increasing N levels. On the average, USG at 45.1 kg Nha^{-1} gave the highest AE and NUE which were significantly higher than the other N rates including PU at 45.1 kg Nha^{-1}. The decreasing use efficiency of N with increasing levels as observed in the studied area is attributed to loss of N to the environment which usually takes place when high concentrations of soluble N forms are present in the soil solution in excess compared to the amount that plants can take up (Fageria and Baligar, 2005). Moreover, the high nutrients use efficiencies (AE and NUE) recorded by FARO 52 throughout the study might have been as result of its ability to absorb higher amount of N than FARO 57 and FARO 55; thereby leading to greater yield performance and hence high NUE. This agrees with the report that rice genotypes differ significantly in N uptake and utilization efficiency (Fageria *et al.*, 2010).

From the results of this study, it can be concluded that application of USG at 117.3 kg N ha^{-1}, gave the highest paddy yield. However, nutrient use efficiencies (AE, APE and NUE) were higher at lower rate of USG (45.1 kg N ha^{-1}). Paddy yields were better and the nitrogen utilization efficiency (NUE) more efficient with FARO 52 using USG as compared to FARO 57 and FARO 55.

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Table 1: Formulae for Calculating Nitrogen Use Efficiencies

S/N	Use Efficiency	Formula
1.	Agronomic Efficiency (AE)	$\frac{Gy_f - Gy_u}{N_a}$ = kg/kg
2.	Physiological Efficiency (PE)	$\frac{Y_f - Y_u}{N_f - N_u}$ = kg/kg
3.	Agro Physiological Efficiency (APE)	$\frac{Gy_f - Gy_u}{N_f - N_u}$ = kg/kg
4.	Apparent Recovery Efficiency (ARE)	$\frac{N_f - N_u}{N_a}$ X 100
5.	Nitrogen Utilization Efficiency (NUE)	PE X ARE = kg/kg

Source: Fageria *et al.*, 2010

Where: Gy_f = grain yield of the fertilized plot (kg), Y_f = total biological yield (grain plus straw) of the fertilized plot (kg), Y_u = total biological yield of the unfertilized plot (kg), N_f = nutrient accumulation of the fertilized plot (kg), N_u = nutrient accumulation of the unfertilized plot (kg), Gy_u = grain yield of the unfertilized plot (kg), N_a = quantity of N applied (kg)

Treatment Grain yield (t/ha) AE APE NUE

Means followed by the same letter(s) within the same column and treatment group are not significantly different at 5% level of probability using DMRT. NS = not significant. USG = Urea Super Granules, GU = Granular Urea.

Table 2: Influence of N-Fertilizer placement, Rates and Rice Variety on Grain yield, Agronomic Efficiency (AE), Agro Physiological Efficiency (APE) and Nitrogen Utilization Efficiency (NUE) at Talata Mafara

Nitrogen (N) kg ha^{-1}				
Control	2.08c	-	-	-
USG at 45.1	3.77ab	37.33a	78.35	48.20a
USG at 72.2	3.97ab	26.17ab	161.03	35.43ab
USG at 117.3	4.19a	17.97abc	32.53	19.90bc
GU at 45.1	3.42ab	29.59ab	32.12	35.74ab
GU at 72.2	3.08b	13.79c	102.48	16.36c
GU at 117.3	4.17a	18.50abc	52.45	24.62b
S.E ±	0.289	6.262	51.40	6.940
Variety (V)				
FARO 55	2.09c	5.17c	94.39	8.06b
FARO 57	3.16b	25.07b	49.03	33.62a
FARO 52	4.78a	36.28a	45.26	40.39a
S.E ±	0.178	3.835	31.476	4.250
Interaction				
N x V	*	NS	NS	NS

Antimicrobial Activity of *Turmeric* (*Curcuma longa*) leaf extracts against some pathogenic Microorganisms

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Abstract

This study was carried out due to rapid development of microbial resistance against chemotherapeutic agents (mostly antibiotics), and high in prices of the orthodox medicines, the antimicrobial effect of curcuma longa extracts against selected drug-resistant microorganisms will help to reduce the overdependence on orthodox or synthetic drugs, and it is highly effective, safe, cheap, and readily available. Turmeric leaf was evaluated for antimicrobial activity against gram negative (Escherichia coli) and gram positive (Staphylococcus aureus) microorganisms. Ethanolic and aqueous extracts of curcuma longa were assayed for antimicrobial activity using the agar dilution method, the bioactive components of the extracts were determined using standard techniques and the inhibitory activities of the extracts were compared to gentamicin, ciprofloxacin. The extract on the test organisms ranges from 50 mg/mL – 3.12 mg/mL. The sensitivity test showed that the organisms were susceptible to curcuma longa leave extracts. The phytochemical analysis shows the presence of metabolites such as alkaloids, tannins, saponins, flavonoids, anthocyanin and steroids. Hereafter, the leaves of curcuma longa have antibacterial effects and hence can be used to treat the ailments caused by those organisms at a particular dosage. This work has help in discovering bioactive natural product that may serve as leads in the development of new pharmaceuticals research activities, but there is a need for further research on its toxicity level, synergistic or antagonistic interaction with other medicinal plants.

Keywords: Antibacterial activity, curcuma longa, microorganisms, plant extract, phytochemicals, zone of inhibition.

Introduction

Antibiotic resistance among bacterial strains is a serious situation. Despite the extensive use of antibiotics, infectious diseases continue to be a leading cause of morbidity and mortality worldwide (Dye, 2015). Research on medicinal plants is essential to promote the proper use of herbal medicine to determine their potential as a source for the new drugs (Gajalakshmi *et al*., 2012). There is need for scientific research interest in natural antimicrobial compounds available from plant sources (Davie, 2010). The use of natural antimicrobial plant extracts and phyto-products is gaining attention due to their availability, cost-effectiveness, proven nature of specificity, biodegradability, low toxicity, and minimum residual toxicity in the ecosystem (Ogbo and Oyibo, 2008). Turmeric (*Curcuma longa*) is a perennial herb which belongs to family Zingiberaceae. It is a therapeutic plant, moderately tall with underground rhizomes. Rhizomes are mostly ovate, pyriform, oblong and often short-branched (Singh and Jain, 2012). It is well notorious for its unique medicinal properties. Turmeric is for treating diabetic wounds, cough, anorexia, biliary disorders and hepatic disorders, heals wound, stimulant and sedative in the food industries, as a coloring agent as well as an additive to impart flavor in curries (Ahmad *et al*., 2010). Hence, the aim of this study is to evaluate the antimicrobial activity of *curcuma longa* leaf extract against selected pathogenic bacteria, and to determine the bioactive components in turmeric (*curcuma longa*) leave.

Materials and methods

This experimental study was performed in central laboratory of National Root Crops Research Institute Umudike, Nigeria (longitude 07^0 33$^'$E, latitude 05^0 29$^'$N and altitude 122 M). Umudike is in the low-land humid tropics of south eastern Nigeria.

Plant material collection

Turmeric (*Curcuma longa*) leaves were collected from experimental field of National Root Crop Research Institute Umudike, Abia State.

Isolation of Organisms

The different organisms used were isolated from agricultural soil, characterized and identified in Microbiology Laboratory, Michael Okpara University of Agriculture Umudike, Abia State.

Identification of bacterial isolates

Identification of the collected Gram-positive and Gram-negative isolates was carried out according to Bergey's Manual of Systematic Bacteriology (1989) and Cheesbrough (1984).

Procedure for preparation of extracts

Turmeric leaves were air-dried for two weeks and later oven-dried for proper drying. Dry plant materials were grinded into powder and placed in clean airtight polythene paper (Gakuya, 2001). About 25g of ground plant material of turmeric leaves sample was taken in a dry 250 mL conical flask, then 100mL of methanol and distilled water respectively, and allowed to macerate overnight at room temperature with shaking every 4hrs for 24 hours for proper solvent to occur. The extracts were filtered using a muslin cloth and then Whatman filter paper. The filtrate was then evaporated to dryness using a water bath at a temperature of 60˚C to remove the solvents used in the extraction. The extract was stored in an airtight bottle until further usage and label properly.

Phytochemical analysis

Phytochemical analysis of the crude powder of the plant was determined after extraction by ethanol, methanol and aqueous solvents. The following phytochemical analysis were carried out; Tannins, test for alkaloids, flavonoid, test for sterols and steroids and test for the carbohydrate.

Preparation of inoculums

Inoculums were standardized to give a density of 10^4 colony-forming units (CFU)/mL. A loopful of the test organism was inoculated into nutrient agar and incubated at 37 °C for 24 hrs. After the incubation, the colony of the organisms was taken and each was inoculated into 7 mL of peptone water in a bijou bottle and shook vigorously to obtain homogeneity of the solution. Plates were inoculated within 15 min of standardizing the inoculum, to avoid changes in inoculums density (Abalaka *et al.*, 2012).

Antibacterial activity of plant extract

Preparation of dilutions: The extracts were diluted to a concentration of 250mg/mL using the corresponding extracting solvent. For both the methanol and aqueous extract of *curcuma* longa, the extract concentration was from 50%, 25%, 12.5% and 6.25% and 3.13% with two-fold serial dilutions. Inocula measured up to 1 ml each of the test organisms from the peptone waters in the bijou bottles were introduced on the surface of a sterile Mueller Hinton agar.

Antibacterial assay: It was carried out by agar well diffusion method as described by Das *et al*. (2013). The antimicrobial potentials of the plant extract were tested on the organism using the disc diffusion method. A cork borer was use to cut a filter paper with discs. The discs were labeled with names of different extracts from the plants place in beakers, cover with a foil paper and sterilized in an oven. 24 hour peptone broths of the organism were subculture into nutrient agar plates. The disc previously soaked into the appropriate test extract and dried were place on nutrient agar plates. Control paper disc were also soaked with the extracting solvents only. The pure culture organisms were gram negative (*Escherichia coli*) and gram positive (*Staphylococcus aureus*), it was picked with pipette and introduces it into the plates. A sterile antibiotic disc was carefully placed on different plates containing different isolates using a forceps on the center of each plate, which served as controls. The plates were then incubated aerobically at 37^{o}C for 24-48 hours. The resulting zones of inhibition (mm) were measured in millimeters using calibrated ruler.

Result and Discussion

Phytochemical analysis of the turmeric leaf extract revealed variations in the morphology and biochemical constituents. The phytochemical analysis shows the presence of metabolites such as alkaloids, tannins, saponins, flavonoids, anthocyanin and steroids as been in abundant (Table 1).

Broad spectrum antimicrobial activity against gram-negative bacteria (*Escherichia coli*) revealed that ethanol extract showed the highest zone of inhibition of 15mm at 50mg/mL concentration, whereas aqueous extract was 13.0mm at 50mg/mL concentration , while the orthodox antibiotic (Gentamicin) which serve as control gave 20mm at ethanol and 18mm at aqueous solution. The lowest zone of inhibition recorded was 2mm at 3.12mg/mL concentration for both the extract. The organism is susceptible to the *curcuma longa* extract at all the concentration level (Table 2). Also, antimicrobial activity against gram-positive bacteria (*staphylococcus aureus*) revealed that ethanol extract showed the highest zone of inhibition of 11.0mm at 50mg/mL concentration, whereas aqueous extract was 9.0mm at 50mg/mL concentration, while the orthodox antibiotic (Ciprofloxacin) which serves as control gave 24mm at ethanol and 19mm at aqueous extract. The lowest zone of inhibition recorded was 0.1mm at 3.12mg/mL concentration for ethanol extract and no activity detected at aqueous extract. The organism is also susceptible to the *curcuma longa* extracts (Table 3). From our findings, ethanol extract concentrations exhibited better effects to the organisms compared to aqueous extract, this is because organic solvent dissolves organic compounds quickly resulting in release of larger amount of vigorous antimicrobial constituents, whereas aqueous extracts is due to the anionic constituents such as nitrate, chlorides, sulphates, thiocyanate and several other compounds that are present naturally in plants (Ayoola *et al*., 2008). Plant used have antibacterial potential and are currently been use in traditional medicine for healing purposes and also in the management of infectious diseases. The effectiveness of the *curcuma longa* extracts might be as a result of the phytochemical constituents and the phenolic compounds present in turmeric such as curcuminoids (Chandarana *et al*., 2005). Also, the essential oil, alkaloid, curcumins, turmerol and veleric acid are accountable for antimicrobial activity of turmeric. Components like the tannins, saponins, flavonoids, and terpenes have been reported to exhibit antibacterial activity (Kunle and Egharevba, 2013). Flavonoids are known to possess good antioxidant properties and it has been reported to exhibit some level of antimicrobial activity (Ayoola, *et al*., 2008). In this study, turmeric (*curcuma longa*) extracts showed a considerable varied levels of antibacterial activity by inhibiting the growth of gram positive and gram negative microorganisms such as *Escherichia coli* and *Staphylococcus aureus*.

Table 1 Phytochemical analysis of *curcuma longa* extract

Phytochemicals		**Extracts**	
	Ethanol	Methanol	Aqueous
Alkaloids	+	+	+
Tannins	+	+	+
Steroids	+	+	+
Saponins	+	+	+
Flavonoids	+	+	+
Carbohydrates	+	-	+
Glycosides	-	+	+
Proteins	-	-	+
Phenol	-	-	+
Anthocyanin	+	+	+

Table 2 Antimicrobial activity of *curcuma longa* in ethanol and aqueous extracts on *Escherichia coli*

Organism	Extract Conc. (%)	Zones of inhibition (MM)	
Escherichia coli		Ethanol	Aqueous
	50	15	13
	25	13	11
	12.5	10	8
	6.25	7	7
	3.12	2	2
Control	Gentamicin (GEN)	20	18

Table 3 Antimicrobial activity of *curcuma longa* in ethanol and aqueous extracts on *Staphylococcus aureus*

Organism	Extract Conc. (%)	Zones of inhibition (MM)	
Staphylococcus aureus		Ethanol extract	Aqueous extract
	50	11	9
	25	9	6
	12.5	6	3
	6.25	2	0.28
	3.12	0.1	NAD
Control	Ciprofloxacin (CPR)	24	19

NAD – No activity detected.

Conclusion

Turmeric (*Curcuma longa*) is highly considered as a universal panacea in herbal medicine with varied pharmacological and antimicrobial activities. The overall assessment concludes that turmeric possesses strong antibacterial properties, and showed a narrow spectrum of antibacterial activity by inhibiting the growth of some gram negative (*Escherichia coli*) and gram positive (*staphylococcus aureus*) bacteria. It is expected that *Curcuma longa* may find use as a novel herbal drug in the upcoming future to combat several diseases. Therefore additional evaluations need to be done on *Curcuma longa* in order to explore to its other countless medicinal uses.

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Evaluation of effectiveness of different pre-treatment techniques for breaking seed dormancy in *senna alata* l

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Abstract

The experiment was conducted at the Seed Laboratory Section of Forestry Research Institute of Nigeria (FRIN) on the effects of pre-treatments on seed germination of *Senna alata*. Seeds were subjected to 9 different pre-treatment methods namely; 3 acid treatments, 3 hot water treatments, 3 cold water treatments and a control, given a total of 10 treatment combinations. All the treatments were replicated 3 times using Completely Randomized Design (CRD). Seedling emergence was observed daily for 28 days and number of days to first seedling emergence, interval of days between seedling emergence and percentage germination were assessed. Data were analyzed using analysis of variance (ANOVA) and significant means were separated with Duncan Multiple Range Test at 5% level of probability. Result showed that *Senna alata* seeds subjected to hot water treatment for 60 minutes had the highest percentage germination of 90% with value of 4.75 which was significantly higher than all other treatments and control. The mean numbers of days to first seedling emergence was 3 days and interval between first and last emergence was 7 days. Control had germination percentage of 10%, with value 0.50.The number of days to first seedling emergence was 9 days and there were 14 days between first and last emergences. Soaking the seed in hot water for 90 minutes is recommended because of its effectiveness in enhancing the germination of the species.

Keywords: *Senna alata,* medicinal plants, seed dormancy, pre-treatment, seedling emergence.

Introduction

The candle bush, *Senna alata*, is an important medicinal as well as ornamental flowering plants in the Fabaceae family. It is also known as a candelabra bush, empress candle plant, ringworm tree, or candle tree. It a remarkable species of Senna because of its diverse medicinal usage, commonly known as Raidore in Hausa, Asuwon oyinbo in Yoruba, Omirima in Igbo language (Arbonnier, 2004).Several reports have shown that *S. alata* contain antimicrobial substances (Palanichamy and Nagarajan, 1990; Crockett *et al.*, 1992; Caceres *et al.*, 1993; Ibrahim and Osman, 1995; Khan *et al.*, 2001; Somchit *et al.*, 2003; Timothy *et al.*, 2012; Karthika *et al.*, 2016).

Herbal medicines are used by nearly 75-80% of the world population, especially in developing countries for primary health care because it is cheap and it seems to have lesser side effects (Parekh *et al.*, 2005). Despite the growing use of *S. alata*, there is dearth of information on propagation of the species which pre-treatment is a prerequisite as cultivation and production may depend on it. Diverse ends users often exert pressure on the available stands of these plants with little information on the propagation and attempt on cultivations.

Although, seeds of many tree species germinate readily when subjected to favorable conditions of moisture and temperature (Las, 2000; A1-Menaie *et al.* 2010), many other species possess some degree of seed dormancy. Where dormancy is strong, some forms of seed pretreatment are essential. Without a form of pre-treatment, seed of *S. alata* is difficult to germinate, even in the presence of conditions suitable for germination (Karthika *et al.*, 2016). The Pods contains 50 – 60 black or dark brown flattened seeds which are triangular in shape (Plates 1 and 2). Storage behavior of *S. alata* is orthodox. If kept dry, seeds retain their viability for several years (Ivan, 1999). However, seeds which are not given appropriate pre- treatment may fail to germinate altogether, germination may be slow or germination can take place in an individual seed over a long period of time. Seed pre-treatment is to ensure and enhance uniform germination. Germination of this species can be improved through the use of suitable pre-sowing techniques. This study therefore evaluated the response of *S. alata* seed to different pre-germination treatments in order to determine the most suitable pre- treatment method needed for the production of the species.

Plate 1: Dried fruits of *Senna alata* Plate 2: Seeds of *Senna alata*

Materials and Methods

Seeds of *S. alata* were collected from Omi–Adio in Ibadan, Oyo State Nigeria on longitude 7°39``N, and latitude 3°75``E, where they are abundant in the wild. Seeds were subjected to nine different pre-treatment methods and a control. Each treatment was replicated 3 times with 10 seeds in each replicate as follows:

Soaking in concentrated H_2SO_4 for 3 minutes (T_1)

Soaking in concentrated H_2SO_4 for 6 minutes (T_2)

Soaking in concentrated H_2SO_4 for 9 minutes (T_3)

Soaking in water (100^0C) for 30 minutes (T_4)

Soaking in water (100^0C) for 60 minutes (T_5)

Soaking in water (100^0C) for 90 minutes (T_6)

Soaking in water at room temperature for 6 hours (T_7)

Soaking in water at room temperature for 12 hours (T_8)

Soaking in water at room temperature for 18 hours (T_9)

Direct sowing without any pre-treatment (T_0) was used as control.

The seeds were placed in between Whatman No1 (9cm) filter paper and set inside Copenhagen Germination tank in the Seed Laboratory of Forestry Research Institute of Nigeria. Seeds were observed daily for emergence. Final count was done on the 28th day after sowing. The following parameters were assessed, days to seedling emergence, interval of emergence and percentage germination which was calculated as: No of seeds germinated/No of seed planted×100

Data on germination count were analyzed using analysis of variance (ANOVA) while the means were separated with Duncan Multiple Range Test at 5% level of probability.

Results and Discussion

Germination commenced on the 3rd day after sowing in the acid treatment (T_1-T_3). Seeds treated with H_2SO_4 for 3 minutes had the longest interval between germination (6 days) and also had germination of 40% while seeds treated with H_2SO_4 for 6 and 9 minutes had the shortest interval between germination (4 days) with 10 and 20% germination respectively.

Seedling emergence was observed on 3rd day after sowing on the hot water treatments (T_4-T_6), on treatment four, the interval between first and last germination was 5 days with 55% germination. Treatment 5 extended to the 7th days with 90% germination. The interval between germination on treatment 6 was 5 days and the percentage germination was 35 (Table 1).

For seed soaked in water at room temperature (T_7-T_9), it was observed that number of days to first seedling emergence was 8 days on seeds soaked for 6hours, the interval between first and last germination was 11days with 10%germination.Seed soaked for 12hours showed first germination on 7th day with 10days between germination and also10% germination, while seeds soaked for 18 hours did not germinate at all (Table 1).

The result also showed that germination commenced on the 9th day after sowing in the control experiment and continued for 14 days with 10% at final germination (Table 1).

Follow up test from analysis of variance (ANOVA) showed that soaking seeds of *S. alata* in100^{0}C water for 60 minutes gave the best germination (4.75) .This was significantly higher than all other treatments (Table2). Seed soaked in 100^{0}C water for30 minutes had a mean of 2.75which was not significantly different from those soaked in acid for 3 minutes (2.00)and those soaked in 100^{0}C water for 90 minutes (1.75).All other treatments had means which were not significantly higher from each other at 5% level of probability (Table 2).

Table1: Effect of pre-treatment on seedling emergence of *Senna alata* seeds

Treatments	Number of days to first seedling emergence	Interval between first and last germination (days)	Percentage germination (%)
T_0	9	14	10
T_1	3	6	40
T_2	3	4	10
T_3	3	4	20
T_4	3	5	55
T_5	3	7	90
T_6	3	5	35
T_7	8	11	10
T_8	7	10	10
T_9	-	-	0

Table2: Effect of pre-treatment on germination of *Senna alata* seeds

Treatments	Mean Germination
T_0	0.50^{ab}
T_1	2.00^{cd}
T_2	0.50^{ab}
T_3	1.00^{abc}
T_4	2.75^{d}
T_5	4.75^{e}
T_6	1.75^{bcd}
T_7	0.50^{ab}
T_8	0.05^{ab}
T_9	0.00^{a}

Means with the same alphabet are not significantly different from each other at 5% probability level

Seeds treated with H_2SO_4 had shortest interval between germination. The early emergence observed on acid treatment may be due to the scorching reaction of the acid on the seed coat. This was in line with the findings of Adio *et al.* (2008) on *Afzelia africana* and Ailero (2004) on *Parkia biglobosa*. They reported that acid reduced the thickness of seed coat of the plants and thereby enhanced water absorption. The higher germination percentage observed on hot water treatment may be because hot water has the tendency to soften the seed coat. Asinwa *et al.*, (2008) used hot water treatment to break dormancy of *Canavalia ensiformis* seed. It was also used by Jegede *et al.*, (2011) on seeds of *Diospyrosmes piliformis*. They observed that seed germination responded positively to hot water treatments. This was also corroborated by Adeniji,*et al*., (2017) on seed *of Acaccia auriculiformis* . Seed soaked in water at room temperature all have percentage germination less than 50% and took longer period before first germination, while seeds soaked for 18 hours did not germinate at all. The poor germination observed on cold water treatment may be because water at room temperature was not strong enough to have significant effect on the seed coat.

Results obtained from the follow up test showed that among the pre-sowing treatments used, seed treated with hot water for 60 minutes performed better than other treatments. Seed soaked in water at room temperature took longer period before germination and poor germination was also observed, while seeds soaked for 18 hours did not germinate at all.

Conclusion

Soaking seeds in water (100^0C) for 60 minutes gave a very good germination percentage with early seedling emergence and interval between germination. Soaking the seed of S. *alata* in hot water is recommended due to its cost effectiveness and efficiency.

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SUB-THEME E

FOOD PROCESSING, PRESERVATION, BIOTECHNOLOGY AND TECHNOLOGY

Preservation of African Breadfruit (*Treculia africana*) Among Farm Households in Imo State, Nigeria

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Abstract

This study was undertaken to determine the preservation methods of African Breadfruit (Treculia africana) among farm households in Imo State, Nigeria. Multi-stage sampling procedure involving purposive technique was used to select 97 respondents from 7 communities in the selected local government area. Data were collected through the use of structured questionnaire and analyzed with descriptive statistics. 45.4% of the respondents were between the ages of 40-59 years, 51.5% were females, 76.3% were married, 40.2% of the respondents had secondary education, 67.0% had household size of 1-5 persons with a mean household size of 3 persons and 35.1% had 1-6 years farming experience with a mean of 2.18 years. The perceived preservation methods of African breadfruit (Treculia africana) were preservation by sun drying and storing in air tight container ($\bar{x}$ =2.48) and properly drying/smoking seeds on fire ($\bar{x}$ =2.22). Preservation of African breadfruit is of great economic benefits to man and the environment. There is need for more research work in the use and preservation of African breadfruit to help enlighten the rural people on the potentials of the plant towards improved income and attainment of food security.

Keywords: African breadfruit, preservation, farm, households

Introduction

African breadfruit is an evergreen perennial edible fruit of the tropical and sub-tropical regions (Onyekwelu and Stimm, 2014). It is found growing in the southern part of Nigeria and commonly eaten by the south east people (Amujiri *et al.*, 2018). The African breadfruit trees produce large round compound fruits of which seeds are enclosed in its spongy pulp (Olapade and Umeonuorah, 2014). It contains nutrients ranging from vitamins, minerals, crude proteins, carbohydrate and fats (Uluocha *et al.*, 2016). African breadfruit is considered as a cheap source of nutrients, food and income for the rural households (Osuafor *et al.*, 2018). The fruit can be cooked into porridge, used as soup thickener, fried, roasted and eaten as snack. According to Osuafor *et al*., (2018), African breadfruit leaf decoction is alleged to reduce high blood pressure, relieve asthma, repair enlarged spleen and treat sore throat. African breadfruit like other wildly grown non-timber forest products are constantly overwhelmed by deforestation due to continuous expansion of the urban areas into rural areas (Emodi *et al.*, 2017). These actions have led to premature harvesting and speedy disposal of the crop by farm households to avoid spoilage. Hence, the results of low income earning, discouragement in tree crop cultivation and preservation among farm households.

Neglecting the cultivation and preservation of African breadfruit, not only discourages its production among farm households but has reduced its shelf-life (Uluocha *et al.*, 2016). Considering the economic importance and nutritional benefits of African breadfruit, less has been researched in area of the seed preservation (Osuafor *et al*., 2018). Hence, this study was designed to assess the preservation methods of African breadfruit (*Treculia africana*) among farm households in Imo State. The study therefore sought to identify preservation methods of African breadfruit among farm households in the study area.

Methodology

This study was carried out in Imo State, which is one of the 36 states in Nigeria with 27 local government areas (LGAs) and Owerri as its capital (Okere, 2015). Imo State is delineated into 3 agricultural zones of Owerri, Okigwe and Orlu. It lies on latitude $4^0$45'N and $7^0$15'N north of the equator and on longitude $6^0$50'E and $7^0$25 East of the Greenwich meridian (Imo State gov.ng, 2010). The State has a projected population of 5,408,756 (National Bureau of Statistics [NBS], 2018). The predominant occupation of the people include: farming, hunting, trading with growing of tree crops, roots and tubers, cereals, vegetables and nuts.

All farm households involved in production of African breadfruit (*Treculia africana*) constituted the population for the study. Multi-stage sampling procedure was used in this study. At the first stage, one (Orlu zone) out of the three agricultural zones, was purposively selected because of the high concentration in the number of African breadfruit trees in that zone. At the second stage, Ideato South LGA was purposively selected from Orlu zone due to large number of farm households involved in African breadfruit production. At the third stage, seven (7) town communities (Umueshi, Ntueke, Obioha, Umuezedike, Umuchima, Amanator, and Ogwume) were randomly selected out of the 23 town communities of Ideato South LGA. Finally, fifteen (15) farm households from each of the 7 town communities were selected through snow ball sampling procedure. A total of one hundred and five (105) farm households were used for the study. A structured questionnaire was used to collect data from the farm households, while interview schedules were used to collect data from the illiterate farm households. At the end of the study, 97 farm households who returned their questionnaire copies were eventually used in the analysis that formed the sample size. Data collected from the farm households were presented using descriptive statistics such as frequency, table, percentage and mean score. Data relating to preservation methods of breadfruit, was analyzed using means derived from 3-point Likert type scale with a mid-point of 2.00. In the decision rule, any variable with mean score of 2.00 and above were considered as preservation method in African breadfruit production whereas any variable less than 2.00 were not considered.

Results and Discussion

Entries in Table 1 show that more than half (51.5 %) of the farm households were females while 48.5% were males. The finding may not be unconnected with high female involvement in household work. Both males and females are involved in breadfruit preservation and its use. This is in line with Emodi and Madukwe (2011) who asserted that women are at the center of food consumption activities. In support, Emerole *et al.*, (2013) asserted that dominance of females in African breadfruit production suggests that processing of African breadfruit is time consuming activity that requires expertise, skill and innate physical exertion of carefully selected force of which only females could conveniently participate. 45.5% of the households were in the age range of 40-59 years. The mean age was 26 years. This indicates that the farm households are energetic and to meet their daily energy requirements, energy given food such as African breadfruit is needed. Ugwu and Iwuchukwu, (2013) asserted that at middle age, households may be energetic to undertake task in processing and preservation of African breadfruit. Majority (76.3%) of the farm households were married. This result is in line with the findings of Eme *et al.*, (2013), who reported that high percentage of married people are involved in agricultural production. The Table further reveal that 90% of the farm households were literate and can assess the quality of African breadfruit preservation. Majority (67.0%) of the farm households had household size of 1-5 persons. This implies that greater proportion of the respondents were of household size of 1-5 persons. About (35.1%) of the farm households had 6-10 years of farming experience in African breadfruit production. The mean years of farming experience was 8 years. This is in consonance with Yusuf, (2000) in Ugwu and Iwuchukwu (2013), who asserted that experience is the first determinant of profitability and perfection.

Table 1: Socio-economic characteristics of households in Ideato South LGA

Variables		Frequency (n=97)	Percentage (%)	Mean ($\bar{x}$)
Gender	Male	47	48.5	
	Female	50	51.5	
Age	<20	11	11.3	
	20-39	31	32.0	
	40-59	44	45.4	26 years
	60 and above	11	11.3	
Marital Status	Single	21	21.6	
	Married	74	76.3	
	Divorced	2	2.1	
Educational Status	No formal education	10	10.3	
	Primary education	28	28.9	
	Secondary education	39	40.2	
	Tertiary education	20	20.6	
Household size (persons)	1-5	65	67.0	3 persons
	6-10	31	32.0	
	11 and above	1	1.0	
Farming Experience (years)	1-5	30	30.9	
	6-10	34	35.1	8 years

11-15	19	19.6
16 and 20	14	14.4

Source: Field survey, (2019).

Preservation of African breadfruit among farm households in the study area

Data in Table 2 show that 2 items out of the 4 items were perceived as methods of African breadfruit preservation. These include: African breadfruit is preserved by sun drying and storing in air tight container ($\bar{x}$=2.48), When seeds are well dried/smoked on fire, it will have long shelf life of about 12 months ($\bar{x}$=2.22).The findings were in agreement with Ugwu and Iwuchukwu (2013) who asserted that African breadfruit products are preserved through traditional method of sun drying. Processing and preservation of agricultural products like African breadfruit are done locally by farm households. This implies that it is economical and farm households incur little or no cost in using local methods in crop preservation.

Table 2: Preservation of African breadfruit by farm households in Ideato South LGA

Items	Always	Not always	Not at all	Mean ($\bar{x}$)	Remark
Sun dried and stored in air tight empty container of beverages/bottles	51 (52.6)	42 (43.3)	4 (4.1)	2.48	Agree
Smoking and keeping in mesh basket above cooking fire place	20 (20.6)	45 (46.4)	32 (33.0)	1.88	Disagree
Preservative such as alum is used to wash and brighten the colour	13 (13.4)	63 (64.9)	21 (21.7)	1.92	Disagree
When seeds are well dried/smoked on fire it will have long shelf life of about 12 months	31 (32.0)	56 (57.7)	10 (10.3)	2.22	Agree

Source: Field survey, (2019). **Mean score** ≥ 2.0 is agree

Conclusion

Preservation of African breadfruit is of great economic importance due to its benefits to man and the environment. The study reveals the potential of the nutritional benefits of African breadfruit, which helps to improve the body functions through its numerous nutrients required for a healthy and active life style. There is a need for more research work in the use and preservation of African breadfruit to help enlighten the rural people on the potentials of the plant towards improved income and attainment of food security.

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EVALUATION OF IMPROVED SWEET POTATO BREEDING VARIETIES WITH MARKETABLE ROOT ATTRIBUTES

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ABSTRACT

A trial was conducted at the experimental field of the National Root Crops Research Institute Umudike in the year 2019 to evaluate 12 clones selected from polycross progenies on the bases of number of storage root yield, storage root size, root skin colour and root flesh oxidation. The experiment was laid out in a randomized complete block design with three replications. Two varieties namely TIS87/0087 (a cream fleshed variety) and UMUSPO/4 (an orange fleshed variety) were used as control in the experiment. Each plot had 30 plants planted in 3 rows with 10 plants per row at 1 x 0.3m spacing. Between row spacing was 1.0m while within row spacing was 0.3m. Four node seed vine tips from sweet potato vines were used for planting. The seed vines were planted on the crest of ridges. Supplies of those that failed to sprout were replaced two weeks after planting. Weeding was done until sufficient ground cover to smother the weeds was achieved. Harvesting was done 4 months after planting. Data were recorded on: total number of storage roots, number of large roots, and number of small roots, flesh root colour and Storage root skin. Results obtained indicated that Genotypes with commercial number of storage roots more than the check varieties were selected as variety or varieties for commercial storage root production. The genotypes had storage root size more than 4.0 cm and with no oxidation and were selected for commercial storage root production. They were PYT/19/60, PYT/19/37 and PYT/19/UN.

Keywords: *commercial roots, oxidations, number of storage roots and sweet potato*

INTRODUCTION

Sweet potato is an important staple crop in many regions of Sub-Saharan Africa (Onwueme and Sinha, 1991) and it is grown mainly for the storage roots, which are usually eaten fresh, boiled, fried or roasted. The leaves are used as forage for livestock, or eaten as a vegetable (Agrodok, 2013). Sweet potato comes in varieties with skin and flesh color ranging from white to yellow, orange, and deep purple (Loebenstein *et al*, 2003). Sweet potato is a vegetative propagated crop grown in a 4-6 month cropping cycle, starting each cropping cycle by planting seed vine cuttings. The orange fleshed sweet potato is extremely rich in bioavailable beta-carotene, which the body converts to vitamin A. The storage roots of sweet potato can be processed into different bakery products and the orange and white fleshed colours appeals to consumers. Women in particular make significant profit from selling sweet potato products, and women add value to sweet potato food chains and sweet potato commercial activities brings in income which translates into better household nutrition and improve the family welfare. Sweet potatoknowledge (2012) reported that population increase and high rate of urbanization in many areas in the country have given rise to the need for inexpensive but healthy foods for the urban poor and created concurrent demand for fast food outlets and healthier foods for the growing middle class urban dwellers. The nutrition advantage of sweet potato offers a unique opportunity to promote increased marketing and processing of sweet potato storage roots into flour and baby foods by industrialists, as this will boost export demand and ultimately provide income for sweet potato farmers and marketers (Sorene, 2009).

Sweet potato can substitute for potato in making chips and crisps and serve as a partial substitute (20 - 50%) for wheat flour in bakery products. Sweet potato products are easy marketing campaigns thus increasing demand (Sweet potatoknowlede, 2012). All classes of farmers can grow and invest in fresh root products and seed vine marketing for commercial root production. The objectives of this study was to evaluate the new sweet potato breeding lines for high number of commercial storage root yield, to select varieties with marketable storage root skin and flesh colour attributes that appeal to the eye, to select varieties with none /low flesh root oxidation and storage root size.

MATERIALS AND METHODS

A total of 12 cultivars selected from polycross progenies were laid out in a randomized complete block design with three replications in the experimental field of National Root Crops Research Institute, Umudike, Umuahia Southeastern Nigeria in 2019. Two varieties namely TIS87/0087, (a cream fleshed variety) and UMUSPO/4 (an orange fleshed variety) were used in the experiment. Each plot had 30 plants planted in 3 rows with 10 plants per row 'with spacing of 1 X 0.3m. Four node seed vine tips from sweet potato vines were used for planting. The seed vines were planted on the crest of ridges. Supplies of those that failed to sprout were replaced two weeks after planting. Weeding was done until sufficient ground cover to smother the weeds was achieved. Hand pulling of over grown weeds continued until harvest. While weeding, earthen up was done to seal soil cracks which exposes the storage roots to sweet potato weevil. Harvesting was done 4 months after planting. Data were recorded 'using the following criteria namely: total number of storage roots produced, number of large roots, and number of small roots and Storage root skin and flesh colour. Large storage roots were classified to have a diameter ≥4.0cm while small storage roots were classified to have a diameter ≤ 4.0cm. The storage flesh colour were recorded using sweet potato colour chart while the storage root oxidation was determined immediately after harvest. The storage root was cut into two and the cut surface was exposed to the air for 5 minutes and visually observed for any change in colour. If it turns brown, there was oxidation, it not, no oxidation. Number of storage root measurements were subjected to Analysis of Variance using Genstat Statistical package and mean separation is done based on least significant difference (LSD) at 0.5% level of probability.

RESULTS AND DISCUSSION

The result of the preliminary number of storage root yield of the 12 genotypes are presented in Table 1.

Total number of roots: Number of storage root yield is a function of root yield. The mean total number of storage roots varied significantly ($p<0.01$) from 10 roots//plot (PYT/19/13) to 21 roots/plot (PYT/19/60 and PYT Mabel respectively) with mean of 16.3 roots per plot. Genotypes with more number of storage roots more than the check varieties and above the mean should be selected for commercial storage root production. The higher the number of storage roots per plot, the higher the yield estimation per hectare. The farmer uses number of storage roots produced by the sweet potato plant to evaluate the yield performance of his crop.

Number of large and small storage roots: The emphasis on root yield evaluation is on the large storage root yield since it is of commercial importance. The number of large storage roots ranged between 6.0 and 12. 0. There was a significant difference ($p<0.01$) in the large storage roots of the various varieties. Genotypes with high number of large storage roots is regarded as high yielding since it accumulate large amount of fresh matter in the storage organ. Genotypes with high number of large storage roots more than the test varieties and or more than the grand mean was selected as superior yielding genotype.

The high significant ($P<0.01$) differences in the number of small storage roots indicated that the number varied from 4.0 roots per plot as was produced by PYT/19/13 which represented 40.0% to as high as 13.0 roots per plot which represented 62.0% as was produced by PYT/19/60 with mean of 44.6 roots per plot. Genotypes with high percentage number of small storage roots should not be selected for storage root production (Table 1). Genotypes with high number of small storage roots more than large storage roots per plant is not a selectable trait. High number of small storage roots indicated the plant’s inability to translocate photosynthate to the sink. However, mature small storage roots at harvesting period despite all necessary agronomic inputs is as a result of genetic factors. Immature storage roots at the harvest time of the sweet potato plant and oozes a lot of root latex indicated that the crop requires an extended period to mature and should be regarded as late maturing. Where such is the case and depending on the objective, the genotype(s) should be stepped down/ discarded/kept in the gene bank for any other desirable traits the sweet potato plant may have.

Storage root size, root skin colour, flesh root colour and root oxidation: The storage root size, root skin colour, flesh root colour, and root oxidation are presented in Table 2.

Storage root size: There was wide significant variations in the size of the storage root sizes. The length of the storage roots ranged from 5 to 17 cm with mean of 10cm while the width or diameter ranged from 5 to 10cm with mean of 5.2cm. Storage root size is also a function of yield. (Agrodok, 2013). The sweet potato storage root can go up to any length, but if the diameter is less than 4.0cm, it is of no commercial value and it is not regarded as large root. Sweet potato genotypes producing storage root size of 4.0cm and above has the potential of producing commercial roots. The genotypes presented in Table 1 had storage root diameter above 4.0cm which indicated evidence of large fresh matter accumulation in the storage roots. Storage root yield is a quantitative parameter which depends on many factors such as vine length, plant vigor, efficient water availability, optimum nutrient availability, enhanced solar radiation interception and conversion of solar to chemical energy. Selection of genotype for large size of storage root yield is complex due to genotype interaction with environment (Stathers et al, 2005). Genotypes with large storage root size should be selected for commercial root production since it is a desirable trait.

Root flesh colour: The flesh colour of the sweet potato genotypes were used to differentiate the crop into different varieties such as white/cream fleshed, yellow fleshed, orange fleshed, purple fleshed and so on. The flesh colour intensity of each of the varieties indicated the status of vitamin A contained in that variety. It was observed that orange fleshed genotypes has more beta-carotenoid content than the white/cream fleshed variety (Sweet potatoknowledge, 2012). The following genotypes PYT/19/60 and PYT/19/35 has orange fleshed colour while the genotype PYT/19/13 is a yellow fleshed variety. The sweet potato storage root flesh colour could be used to indicate where each variety will be utilized. The orange fleshed varieties could be used for preparing baby food and infant foods, and for medication in treatment of wounds and building up immunity of patients suffering from HIV. The Yellow fleshed variety could be used as the orange fleshed varieties as well as mixing it with the cream fleshed varieties for making flour and will be put into use for various food formulae.

Storage root skin colour: The Storage root skin colour of the sweet potato plant are of no importance in some locality. Although white/cream skin colour is attractive' and increase the market value of the sweet potato storage roots. For some consumers, white/cream skin colour is an evidence of high dry matter content. However, storage root skin colour of the sweet potato plant cannot be used to differentiate the sweet potato into varieties. Various storage skin colours were observed across the different varieties of white, yellow, orange and cream fleshed varieties observed in the genotypes evaluated.

Oxidation: Browning of the storage root flesh colour when exposed to the air is an undesirable traits that does not appeal to the eye of consumers. Browning is caused by exposure of cut surface of flesh storage root of sweet potato to the air (oxidation). Browning is a negative trait that reduces the market value of sweet potato storage root and may even affect products such as flour prepared from such variety. Genotypes with flesh storage roots that browns during processing should not be selected as variety for commercial root production and food processing (Table 2).

CONCLUSION

Number of storage root is a function of yield in sweet potato. High number of storage roots, big storage root sizes and storage roots with no oxidation (browning) of flesh colour are good marketable attributes required by farmers and marketers for large commercial sweet potato storage root production. Food industrialist, required large storage sweet potato root for processing into flour or fufu and for fresh root marketing since it has large accumulation of starch. Sweet potato genotypes with high number of storage roots more than the check varieties were selected as variety or varieties for commercial storage root production by farmers. Large storage roots are also for commercial root production because of the large size. Genotypes with storage root sizes more than 4.0 cm in diameter and with no oxidation were selected based on these desirable marketable attributes. Genotypes with these superior marketable attributes are for commercial sweet potato root production and for industrial food processors due to large accumulation of starch in the roots. Based on these criteria, the following genotypes were selected: PYT/19/60, PYT/19/37 and PYT/19/UN.

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Table 1: Number of stand at harvest, Total number storage root, Number of large roots, Number of small storage roots,

Genotype name	Total number of storage roots	number of large storage roots	number of small storage roots	% number of small storage roots
PYT/19/056	18.0a	7.0b	11.0a	61.0
PYT /19/60	21.0a	8.0a	13.0a	62.0
PYT/19/40	17.0a	9.0a	8.0b	47.0
PYT /19/82	13.0	8.0a	5.0c	38.0
PYT/19/13	10.0c	6.0	4.0c	40.0
PYT /19/68	12.0b	7.0a	5.0c	42.0
PYT/19/37	16.0b	8.0b	8.0b	50.0
PYT /19/35	18.0a	6.0b	12.0a	67.0
PYT/Mabel	21.0a	11.0a	10.0a	43.0
PYT /19/UN	20.0a	12.0a	8.0b	40.0
UMUSPO/4(check)	19.0a	7.0b	12.0a	63.0

TIS87/0087(check)	11.0c	6.0b	5.0c	45.0
Mean	16.3	7.9	8.4	44.6
Range	10-21	6-12	4-13	=
LSD(0.05)	4.2	2-9	3.0	=
Sig, Level	p<0.01	P<0.01	P<0.01	

Table 2: Storage root size, Storage skin Colour, Storage root flesh colour and Storage flesh root oxidation

	Storage root size				
Genotype name	Length of storage root (cm)	Width of storage (cm)	Root skin colour	Root flesh colour	Root oxidation (within 5mins)
PYT/19/056	16.0	8.0	Pink	Cream	Brown
PYT /19/60	11.0	5.4	Pink	Intermediate orange	None
PYT/19/40	5.0	6.2	Pink	Cream	Brown
PYT /19/82	13.0	5.0	Brown	Cream	Slight
PYT/19/13	13.0	10.0	Pink	Yellow	None
PYT /19/68	8.2	5.0	Cream	Cream	Slight brown
PYT/19/37	12.0	9.0	Pink	Cream	None
PYT /19/35	6.4	5.2	Pink	Deep orange	None
PYT/Mabel	8.0	5.0	Cream	Cream	Brown
PYT /19/UN	17.0	5.3	Pink	Light yellow	None
UMUSPO/4	15.0	6.2	purple	Deep orange	None
TIS87/0087	9.2	6.2	Light purple	Cream	None
Mean	10.0	5.2	=	=	=
Range	5.0-17	5.0-10.0	=	=	=
SED	3.3	2.4	=	=	=
Sig. level	P<0.01	P<0.01	=	=	=

Analysis of the Factors Influencing Household Oil Palm Consumption in Ngor-Okpala Local Government Area of Imo State

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Abstract

The study investigated the factors influencing household oil palm consumption in Ngor-Okpala LGA of Imo State. A random sampling method was used to collect data using a well- structured questionnaire for a sample size of 30 respondents that was used for the analysis. Data were analyzed using descriptive statistics and regression analysis. The result showed that 66.7% of them were married with half of them having a large household size. The high rate of consumption of 83.3% among females shows that they are the highest user of the product both in cooking, making soaps and pomade. The result further show that age was negative and does not add more to the consumption rate. The coefficient of multiple determination of 80.8% variations of the consumption of oil palm was accounted for by the explanatory variables. Household size, sex, transport cost and quantity of oil palm were the major factors influencing household oil palm consumption.

Keywords: Factors, Influencing, Household, Oil Palm, Consumption

Introduction

Oil palm is one of the most productive oil crops and its products (palm oil) ranked high in the list of the world's leading agricultural commodities. Yusof (2007) opined that oil palm gives the highest output value compared to other major oil seeds such as rapeseed, soybeans and sunflower. According to FAOSTAT (2012) the economic importance of the crop to different economies is fingered in its usage and consumption rate. Oil palm is used for various purposes; it is used as cooking oil and shortening and in manufacturing of margarine, non-diary creams and pharmaceutical companies and traditionally used in the manufacture of soaps and detergents and in the production of grease, lubricants and candles for industries. The consumption rate is enormous despite the factors militating against it. Oil world (2009), opined that Nigeria with her self-sufficiency ratio of 89.1%, still needs an annual import supply of 110.7 tons of palm oil to meet her domestic demands. According to report, Nigeria annual oil palm consumption rate increased from 1,042 in 2006/2007 to 1,301(000'MT) in 2009/10 (World Bank, 2009), 1410(000'MT) in 2014 with a slight decline of 1320(000'MT) in 2015, 1240(000'MT) in 2016, 1290(000'MT) in 2017 and marginal increase of 1340(000'MT) in 2018 (World Bank, 2019). This has been a topic of great concern to policy makers on the factors that influences this despite the fact that Nigeria that used to be the leading oil palm producer is now lagging behind as the rate of oil palm consumption increases. Consumption is the supply or provision of goods and services by household for their economic well-being.The consumption of these goods and services by household is dependent on income, price and availability of goods in the market. The consumption of oil palm and other food products is significant and pertinent in assessing household consumption rate. The accelerator coefficient is based on the fact that the demand for capital goods is derived from the demand for consumer goods produced by the farming households. As household demand for consumer goods, which include oil palm and its products, income increases and capital goods are purchased (Jhingan, 2010).The consumption of these goods and services (oil palm) is measured by determining the amount of income that is adequate to purchase them, according to David (2004). This is of the premise that families and individuals derive material well-being from the actual consumption of goods. Dickinson, Hobbs & Bailey, (2003) opined that consumption expenditure on food such as oil palm accounts for a relatively large share of household income in developing countries. The consumption expenditure on food is a reflection of the socio -economic and demographic disposition of households. This is in accordance with Gheblawi&Sherif (2007) on the factors affecting expenditure on rice, fish, and meat in the UAE which indicated that income and household size are important factors affecting the amount of money spent on the three examined food groups. Ghany, Silver &Gehlken, 2002; Gould, 2002; Kirkpatrick &Tarasuk, 2003; Ricciuto, Tarasuk&Yatchew (2006) opined that there is a positive relationship between income and expenditures on food. The study then tends to analyze the factors influencing household oil palm consumption in NgorOkpala LGA of Imo State. The findings will be relevant to individuals for conscious usage, industries, researchers, agencies and government for policy formulation and implementations to understanding the factors that influence food consumption expenditure using oil palm as a case study.

Methodology

The study was carried out in Imerienwe autonomous community which is one of the largest communities located in NgorOkpala Local Government Area in Imo State. A simple random sampling technique was adopted for this study. Primary data were collected using a set of structured questionnaire administered to 50 respondents in the study area but a valid number of 30 were retrieved and used for the analysis. Information collected were on their socio-economic characteristics such as sex, age, marital status, educational level, household size, cost of transportation, distance and monthly income to ascertain the factors influencing the cost/ consumption of oil palm used. Descriptive statistics such as percentages and frequency distribution were used to analyze the socio economic characteristics of the respondents while the ordinary least square method was used to determine the factors influencing household oil palm consumption expenditure.

The formula is implicitly stated as:

Y = f (X1, X2, n…………….,e) ……………………………………….(1)

Where:

n= any number

Y= cost of palm oil used per month (in ₦)

X1= Age of respondent (in years)

X2= Marital status of respondent (Married = 1; Single = 0)

X3= Educational level of respondent (No)

X4= Sex of respondent (Male = 1; Female = 0)

X5= Household size (No)

X6= Total monthly household income (₦)

X7= total quantity of palm oil in liter

X8=Distance in kilometer

X9= Cost of transportation(₦)

e = error term

Explicitly as

Semi log:

$\ln Y = Z_0 + Z_1X_1 + Z_2X_2 + Z_3X_3 + Z_4X_4 + Z_5 X_5 + Z_6X_6 + Z_7X_7 + Z_8X_8 + Z_9X_9 + e$........................(1)

..

Where: Y, X_1, X_2, X_3, X_4 X_5, X_6X_7,X_8,X_9, are as defined as above, Z_o= constant / intercept, Z_1 – Z_9 = regression coefficients and e = error term.

Factors influencing household oil palm consumption were fitted into three functional forms of linear, semilog and Cob-Douglas forms. The lead equation was generated from the model with the best fit base on the highest co-efficient of multiple determination and F-statistics, the model with the highest number of significant explanatory variables and the model with the highest number of consistent a priory expectation base on the signs of the explanatory variables

Results and Discussions

Table 1: Socio-economic characteristics of the oil palm consumption

Variables	Frequency	Percentages
Age (yrs)		
20-40	5	16.7
41-60	15	50
≥ 60	10	33.3
Total	30	100
Sex		
Male	5	16.7
Female	25	83.3
Total	30	100

Marital status		
Single	5	16.7
Married	20	66.7
Widowed	4	13.3
Divorced	1	3.3
Total	30	100
Educational level		
Non formal	3	10
Primary	5	16.7
Secondary	15	50
Tertiary	7	23.3
Total	30	100
Household size		
1-5	15	50
6-10	10	33.3
≥ 10	5	16.7
Total	30	100
Experience		
1-10	5	16.7
11-20	10	33.3
21-30	10	33.3
≥ 30	5	16.7

Total	30	100
Quantity/ liter		
≤ 5	5	16.7
5-10	5	16.7
≥11	20	66.7
Total	30	100
Transport cost(₦)		
5-10	10	33.3
≥11	20	66.7
Total	30	100

Source: FieldSurvey 2019

The age distribution of household oil palm consumption shows that majority of them (50%) falls within the age of 41-60 years which is the middle age while 33.7% of them were above 60 years and 16.7% were less than 41 years. This indicates that the consumption rate is more in the middle aged class which is also the age bracket of Nigerian farmers according to Ekong, (2003) and Ibitoye et al., (2011). The high rate of consumption of 83.3% among females shows that they are the highest usage of the product both in cooking, making soaps and pomade. The result shows that 66.7% of them are married which implies the high rate of consumption within the household which is the same with the number of households indicates that influence of household size on consumption pattern has a disproportionate effect on consumption expenditure according to Guptu, (1986). The educational level shows that 50% of them had only secondary school level which is not well enough to manage and regulate their consumption rate. The experience indicated that 66.6% of them had 11-40 years of experiences implying a long term experience but does not significantly reflect on their consumption. The result shows that 66.7% of them buys and consume more than 11 liters of palm oil at a cost more than ₦11.

Table 2:Factors Influencing Oil Palm Consumption in Ngor- Okpala L.G.A of Imo State

Variables	Semi-log

Constant	0.710(0.011)
X1= Age of respondent (in years)	-5.832(2.159)***
X2= Marital status of respondent (Married = 1; Single = 0)	2.861(1.048)***
X3= Educational level of respondent (No)	5.625E-005(0.009)***
X4= Sex of respondent (Male = 1; Female = 0)	5.758(0.060)***
X5= Household size (No)	3.554E-005(0.000)***
X6= Total monthly household income (₦)	1.875E-006(0.000)**
X7= total quantity of palm oil in liter	4.978(0.023) ***
X8=Distance in kilometer	0.024 (0.954)
X9= Cost of transportation(₦)	-8.987E-006(0.000)***
R^2	0.808
Adj R^2	0.781
F-value	29.784

Source: Field Survey: 2019. .***significant level at 1%, **significant level at 5%, () = *p*-values

Equation formula of the Factors influencing oil palm consumption

$$Y= 0.710--5.832X_1^{xxx}+ 2.861X_2^{xxx}+ 5.625X_3^{xxx} + 5.758X_4^{xxx} + 3.554X_5^{xxx}+ 1.875X_6^{xx} + 4.978X_7^{xxx} + 0.024X_8 -8.987X_9^{xxx}$$

The three functional forms; linear, semi log and Double log were tested. The above equation is the outcome of the best fit from the regression analysis of the three functional forms tested in which the semilog emerged the lead equation. This was as a result of it having the highest coefficient of multiple determination, R^2 of 0.808, that is 80.8% variations of the consumption of oil palm with the Adj R^2 0.781 and F-Stat 29.784 and the greater number of positive and significant explanatory variables. Age showed a negative effect on the consumption indicating a lower rate in oil palm consumption through buying or usage. Other factors such as marital status, educational level, sex, household quantities of oil palm showedpositive and significant effect on oil palm consumption at 1%.. This implies increase in the variable leads to an additional increase in the consumption of oil palm. This is in tandem with the findings of Omafonmwan et al., (2014); Babalola and Isitor, (2014). The total monthly income wassignificantat5% on consumption indicating a direct relationship with oil palm spending while the transportation cost was negative but significantly related the rate of oil palm consumption.

Conclusion

The study focused on the factors influencing oil palm consumption in Ngor-Okpala LGA of Imo State using a sample size of 30 respondents. The result showed that half of them had maximum of secondary education while majority of them were married with high cost of transportation. The likelihood of being married with high household size is major indicator of the consumption rate in the area.

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Appraisal of Consumer's Response to Value Added Selected Non-Timber Forest Products (NTFPs) produced in Forestry Research Institute of Nigeria (FRIN) among Female Respondents in Ibadan North East Local Government Area of Oyo State, Nigeria.

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Forest Products Development and Utilization

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Abstract

Forests are reservoir of products used by households and industries. The products are grouped into two: Timber and Non-Timber Forest Products. This study focused on Non-Timber Forest Products such as Moringa oil extract used in the production of moringa hair kite such as Moringa hair shampoo, Moringa hair conditioner and Moringa hair cream. These products are used mostly by women. .

This study was conducted to examine the appraisal of consumer's response to value added non-timber forest products (NTFP's) in Ibadan North East Local Government, Oyo state, Nigeria. Data were collected with the aids of structured questionnaires which were distributed among sixty–six(66) respondents in the study area using SPSS to analyzed and simple descriptive statistics, frequency and percentage were used. The results showed that all the respondents were female because they were the main user of the products produced from selected NTFPs. It also revealed that majority of the respondents (90.0%) of the NTFPs users heard about FRIN. Few (18.2%) have visited the institution. While 81.8% of the respondents have not visited the FRIN. The study also investigated on level of awareness and how they come across NTFPs, 87.5% of the respondents were aware of NTFPs while few of the respondents were not aware of NTFPs. 81.3% of the respondents were using NTFPs and 54.5% of the respondents were introduced to the products through extension agents, 36.4% were introduced to the products through friends while 6% of the respondents were given as a souvenir. Therefore, institute need to increase awareness of FRIN and NTFPs through Extension agents, print media and mass media as

majority did not know the location of FRIN or heard about NTFPs. Also there is need for improvement on the quality and quantity of Non-Timber Forest Products (NTFPs.)

KEY WORDS: Timber, Non- Timber Forest Products, Moringa hair cream, Moringa Hair Shampoo, and Moringa Hair Conditioners.

Introduction

Forests make available different products used by households and industries (Appiah 2009). These products are classified into timber and non-timber forest products (NTFPs).Non-timber forest products (NTFPs) are items of biological origin other than timber from natural, modified or managed forests. Bamboo, fibres, flosses, flowers, fruits grasses, gum, honey, leaves, medicinal plants, mushrooms, nuts, palms, rattan, resins, seeds, seed oils etc. belong to NTFPs (Shackleton, 2004; Marshall et al.,2003). The term non-timber forest products are used by the Food and Agricultural Organization of the United Nations (FAO) and it encompasses plants and animal products derived from wild-sources and collected on forest lands and or from forest species.Among the NTFPs products are listed leaves, fruits, seeds and seed oils. Moringa oleifera, a non-timber forest tree is extremely useful across the tropical and sub-tropical regions of the world. All parts of this plant (leaves, fruits, seeds, seed oil, bark and roots) are useful. Almost all parts are not only edible, but nutritious (Moyo, B., Masika, P. J., Hugo, A., &Muchenje, V.,2011) . Its leaves, immature pods, seeds and flowers, and oil pressed from mature seeds are utilized in the diet. Moringa seed oil has powerful antioxidant capacity (Lala, Sand Tsaknis, J., 2001). It is part of essential nutrients used in the production of Moringa hair cream, soap, shampoo and hair conditioners. Its outstanding anti-aging properties provide nutrition to our skin and relieve ageing signs (Moyo, B., Masika, P. J., Hugo, A., &Muchenje, V.,2011) The high oleic acid content (70%) aids the skin to retain moisture and strengthens the overall health of skin cells (Mulugetaet al., 2014). Moringa Oil contains four times as much collagen as carrot oil, thus helping to rebuild the skin's collagen fibers, which reduces wrinkling and removes skin blemishes. The oil is rich in healing properties (Mulugeta et al., 2014) such as cleansing the acne-prone skin, reduces the signs (the visibility) of aging, tightens skin and promotes elasticity, making the skin younger and fresh looking, increasing skin radiance along with controlling skin-oil and reducing skin pores (Mulugeta et al., 2014). This work was carried out to evaluate the efficacy and acceptability of Moringa based range of hair care products such as (Moringa hair cream, Moringa shampoo and Moringa hair conditioner) by the users, to identify the benefits and constraints faced by the users and to identify the level of awareness of the products.

Methodology

Study area

This research was conducted in Ibadan North East local government area of Oyo state, Nigeria. A total number of Sixty-six (66) questionnaires were administered to the respondents and were also retrieved. Data obtained were analyzed using statistical package for social science and descriptive statistics such as frequency and percentage were used.

Results and Discussion

Table 1 below revealed that 18.2% of the respondents have visited FRIN exhibition room while 81.8% have not visited FRIN exhibition room. Also 81.3% of the respondents were using NTFPs while 18.8 have not used it.

Table 1: Distribution of the respondents based on visit to FRIN Exhibition and NTFPs user

Visit to FRIN exhibition	**Frequency**	**Percentage**
Yes	12	18.2
No	54	81.8
Total	66	100.0
Uses of NTFPs		
Yes	59	81.3
No	7	18.8
Total	66	100.0

Source: Field Survey, 2020

The results of Table 2 below revealed that 24.2% and 34.8% of the respondents strongly agreed and agreed that sticker need to be improved while 6.1% and 13.6% strongly disagree and disagree that sticker do not need to be improved while 21.2% of the respondents were undecided. Also on packaging material 24.2% and 36.4% of the respondents strongly agreed and agreed that the packaging of the material need to be improved while 6.1% and 7.6% strongly disagreed and disagreed that the packaging of the material do not need to be improved while 27.3% of the respondents were undecided. The respondents above also revealed that quality of the products need to be improved (36.4% and 19.7%) strongly agreed and agreed, also 9.1% and 7.6% strongly disagreed and disagreed that quality of the products do not need to be improved while 27.3% of the respondents were yet to decide if the quality of the products need to be improved. The table also showed that 37.9% and 19.7% strongly agreed and agreed that quantity of the products need to be improved while 15.2% of the respondents strongly disagreed that the quantity of the products need not to be improved, also 10.6% of the respondents disagreed that quantity of the products need not to be improved and 16.7% of the respondents were yet to decide. The result also showed that 25.8% of the respondents strongly agreed that labeling of the products need to be improved, also 27.3% of the respondents agreed that labeling of the product need to be improved while 4.5%, 16.7% and 25.8% of the respondents strongly disagreed, agreed and undecided respectively that the labeling of the products do not need to be improved.

Table 2: Distribution of the respondents based on where NTFPs need to be improved

Product need to be improved	**Frequency**						**Percentage**					
	SA	A	SD	D	U	Total	SA	A	SD	D	U	Total
Sticker	16	23	4	9	14	66	24.2	34.8	6.1	13.6	21.2	100.0
Packaging Material	16	24	4	5	17	66	24.2	36.4	6.1	7.6	25.8	100.0
Quality of the products	24	13	6	5	18	66	36.4	19.7	9.1	7.6	27.3	100.0
Quantity of the products	25	13	10	7	11	66	37.9	19.7	15.2	10.6	16.7	100.0
Labeling	17	18	3	11	17	66	25.8	27.3	4.5	16.7	25.8	100.0

Source: Field Survey, 2020

The result of table 3 below revealed that 63.6% of the respondents strongly agreed that NTFPs were effective on scalp and body, 9.1% of the respondents agreed that the NTFPs were effective on scalp and body, 4.5% of the respondents disagreed that the NTFPs were not effective on scalp and body while 22.7% of the respondent were undecided. This was as a result of respondents has not used it before. The result also revealed that 60.6% of the respondents strongly agreed that NTFPs were highly affordable, 12.1% of the respondents agreed that NTFPs were highly affordable, also 4.5% of the respondents disagreed that NTFPs were not affordable while 22.7% of the respondents were undecided. Also the results revealed that 56.1% of the respondents strongly agreed that NTFPs were available while 13.6% of the respondents agreed that NTFPs were available, 25.8% of the respondents disagreed that NTFPs were available and 4.5% of the respondents were undecided.

Table 3: Distribution of the respondents based on benefit of NTFPs

Benefit of NTFPs	**FREQUENCY**						**PERCENTAGE**					
	SA	A	SD	D	U	Total	SA	A	SD	D	U	Total
Effective on scalp and body	42.0	6.0	3.0	-	15	66	63.6	9.1	4.5	-	22.7	100
Highly affordable	40.0	8.0	3.0	-	15	66	60.6	12.1	4.5	-	22.7	100
Highly available	37.0	9.0	17.0	-	3.0	66	56.1	13.6	25.8	-	4.5	100

Source: Field Survey, 2020

The table 4 below implies that 6.1% of the respondents strongly agreed that NTFPs do not have short period of shelf life, 9.1% of the respondents agreed that NTFPs do not have short period of shelf life, also 16.7% of the respondents strongly disagree that NTFPs have short period of shelf life and 15.2% of the respondents disagreed that NTFPs have short period of shelf life while 53.0% of the respondents were undecided. The table also revealed that 54.5% of the respondents strongly agreed that they were not close to the source (FRIN), also 9.1% of the respondents agreed that they are not close to the source (FRIN) 12.1% of the respondents strongly disagreed that they were closer to the source while 19.7% of the respondents disagreed that they were not close to the source (FRIN) and few of the respondents (4.5%) were yet undecided. The table implies that 65.2% of the respondents strongly agreed that there was no awareness on NTFPs while 13.6% of the respondents agree that there was lesser awareness on NTFPs, also 6.1% of the respondents strongly disagreed that there was stronger awareness for NTFPs while 15.2% of the respondents strongly disagreed that there was stronger awareness for NTFPs. The table implies that 77.3% of the respondents strongly agreed that there was no strong advertisement on NTFPs, 9.1% of the respondents agreed that there was lesser advertisement for NTFPs, also 3.0% of the respondents strongly disagree that there was strong advertisement on NTFPs.

Table 4: Distribution of the respondents based on Constraint of NTFPs

Constraints of NTFPs	**FREQUENCY**						**PERCENTAGE**					
	SA	A	SD	D	U	Total	S A	A	SD	D	U	Total
Short period of shelf life	4.0	6.0	11.0	10.0	35.0	66	6.1	9.1	16.7	15.2	53.0	100
Distance of the exhibition	36.0	6.0	8.0	13.0	3.0	66	54.5	9.1	12.1	19.7	4.5	100
Awareness of NTFPs	43.0	9.0	4.0	10.0	-	66	65.2	13.6	6.1	15.2	-	100
Advertisement	51.0	6.0	2.0	7.0	-	66	77.3	9.1	3.0	10.0	-	100

Source: Field Survey, 2020

Conclusion

In conclusion, majority of the respondents have not visited Forestry Research Institute of Nigeria (FRIN) exhibition room but got to know Moringa products through extension agents. There is need for improvement on the quality, quantity and the packaging of the products in order to meet up the international standard

It is also obvious that those who claimed to be aware of the benefits and uses of NTFPs do not, so there is need to create awareness of the products through the extension agents and media, such as electronics and print media, seminars and workshops and many others because moringa hair products are not yet in circulation in Ibadan North East Local Government and its environ.

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Effect of different storage media on the postharvest preservation and quality of plantain (*Musa AAB*) fruits

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Abstract

The plantain fruit (*Musa*, AAB) is one of the important sources of carbohydrate and mostly consumed by people in most part of the world (Marriott and Lancaster, 1983). However, retaining the postharvest quality and preservation of plantain fruits can be achieved when ripening is delayed and kept in appropriate conditions with different postharvest management practices. The study was conducted to investigate the effect of some specially designed insulating storage media and open shelf storage in delaying the ripening process of freshly harvested plantain fruits and the subsequent effect on quality attributes of stored fruits. Assessment were based on quality traits like color change and proximate composition. Both pre-storage and post- storage observations were made on those traits. Color change was assessed based on the horticultural color chart while proximate analysis was carried out on ripe and unripe plantain fruits. Result showed that wet sawdust in a wooden box is capable of delaying de-greening of stored plantain fruit up to 28 days as compared with plantain fruit placed on the open shelf which could only maintain its greenness for 5 days. There was a progressive reduction in the unit weight of stored plantain fruit as the length of storage increased in all treatments but with more rapid weight loss observed in fruit stored in the open shelf and dry wood shavings. Result from the proximate analysis indicates that as ripening progressed the fruit fat extract and moisture content increased. Pre-storage ash content was higher when compared with the post – storage in all treatment. Protein content was also found higher in post-storage fruit for most of the treatments. A beneficial effect of storage in wet sawdust and wood shavings for delaying of color change and texture was afterward established in this experiment.

Keywords: preservation, de-greening, storage media, Musa AAB, quality and assessment.

Introduction

Plantain (Musa spp. AAB groups) are major starch staple crops of considerable importance in the developing world. They are consumed both as an energy yielding food and as a dessert (Dadzie and Orchard, 1997). In Nigeria plantain are mostly found in the south-western state of Ondo, Ekiti, Osun, Oyo, Ogun and also in Eastern States of Nigeria such as Edo, Delta, Enugu, Abia, Imo and River States, because these parts of the country are rich in loamy soil and have up to 1000-2500mm annual rainfall, with a temperature range of 23°C to 26°C(Fayemi, 1999). Despites the numerous advantages, Plantain as a staple food crop in Nigeria are lost following harvest, due to poor storage facilities, poor or lack of processing technology, among others (Osagie and Eka, 1998).

Usually the fruits are harvested close to or at maturity but unripe in order to transport them to markets in firm, green conditions. They are sometimes fastened to ripening by local traditional methods which includes dark incubation in warm conditions, covering or submerging in wood ash or other plant residue materials and exposure to sunlight for some hours prior to warm incubation. Plantain fruits sealed in poly-ethylene bags were also reported to have remained green for longer than those left on the open self (Ferris. 1998; Baiyeri, 2005).

The quality of the fresh fruits depends on the postharvest handling during harvesting, transportation, and storage, and should be monitored effectively to keep the best quality at harvest period. Due to a rain-fed farming system, lack of storage facilities, limited access to transportation, and risk of high losses, growers in some part of the world are often forced to dispose their produce over a short period of time (Haidar and Demisse, 1999; Workneh*et al.*, 2010) which causes an economic loss of horticultural crops in general and plantain fruits in particular. Therefore, this study examined the effective storage condition that could delay de-greening of stored plantain fruits with appropriate storage media and suitable temperature that could assist in delaying of stored plantain fruits.

Materials and Methods

The experiment was carried out at the Department of Basic Science and General Study, Biology Laboratory of Federal College of Forestry, Jericho Ibadan. Saw dust and wood shavings were gotten locally from a saw-mill industry. Empty wooden boxes of dimensions 0.35m x 0.25m x 0.2m used were constructed locally. Ventilation was provided by creating holes of about 1.5m diameter along sides and tops of the wooden boxes. Sufficient amount of wood shavings and sawdust were put into the various container and wet/moist storage media was also prepared by moistening wood shavings and sawdust to saturation.

The experiment was conducted at basic-science and general studies laboratory, Federal College of Forestry, Jericho, Ibadan, Oyo state and arranged in a completely randomized design (CRD). Physiologically mature green firm freshly harvested french horn plantain was sourced at plantain and banana orchard of National Horticultural Research Institute Ibadan ((NIHORT) and a pre storage treatment was done by placing them in a cool room for 60 minutes in order to remove field heat. The plantains were de-bunched using a sharp knife and divided into 4 portions having 3 fingers of plantains selected without bias. The fingers were weighed and then placed under the different storage media. Thermometers were placed in each medium for temperature readings. A total of 4 storage media was prepared and these includes; plantain fruits placed on dry sawdust in a wooden box (DS/WB) T1, dry wood shavings in a wooden box (DW/WB) T2, wet sawdust in a wooden box (WS/WB) T3, wet wood shavings in a wooden box (WW/WB) T4, Open shelf (control) T5.

Assessment and observation of fruits quality were made every two days, based on horticultural fruit quality chart (Abou Aziz *et al.*, 1976)

Proximate analysis:Plantain fruit were subjected to pre-storage and post-storage analysis for fat content, dry matter, crude protein, ash content, crude fiber, sugar content, moisture content and carbohydrate.

Data obtained from the proximate analysis, weight and temperature readings were subjected to Analysis of Variance (ANOVA) and Least Significant Different (LSD) was used for the separation of mean.

Result and Discussion

TABLE 1: Proximate analysis for unripe plantain (before storage) and ripe plantain (after storage)

Property %	Unripe	T_1 (ripe)	T_2 (ripe)	T_3 (ripe)	T_4 (ripe)	T_5 (ripe)
Crude protein	2.40	0.96	1.00	1.23	1.27	1.02
Crude fibre	0.47	0.33	0.42	0.30	0.31	0.41
Fats	0.35	0.14	0.16	0.14	0.13	0.13
Total ash	0.91	0.56	0.48	0.64	0.64	0.63
Carbohydrate	24.51	20.00	22.00	22.41	23.16	21.66
Dry matter	33.04	25.22	24.62	28.42	24.63	22.61

Sugar	4.41	8.00	9.06	9.03	9.04	9.04
Moisture content	60.00	82.20	83.42	71.20	82.14	85.40

Table 1 above present a summary of the nutritional properties of un-ripe and ripe plantain fruit using different storage media. The crude protein of un-ripe plantain was 2.40 % while the protein content of ripened plantain ranged from 0.96 %(T1) to 1.27 %(T4), which show that there was reduction in crude protein when the fruit get ripened. The moisture content of the ripened fruit varied from 71.20 %(T3) to 85.40 %(T5) which were higher than the un-ripe plantain fruit that contain 66.96% of moisture. There was also an increase in sugar content of ripened plantain fruit which varied from 8.00 %(T1) to 9.06%(T2) which were higher than the un-ripe plantain fruit that contain 4.41% of sugar. The crude fibre of un-ripe plantain fruit was 0.47% while the crude fibre of ripened plantain range from 0.30%(T3) to 0.42%(T2), which shows there was decrease in crude fiber as plantain fruit ripened. The increase in moisture content, crude fibre and sugar content observed as ripening progressed in this study is consistent with earlier report on proximate composition of ripening fruit including plantain (Onwuka and Onwuka, 2005).The ash content, fat, carbohydrate and dry matter varied with little reduction when plantain fruit ripened. This is in support with (Sakyi-Dawson *et al.*,2008) who stated that ash content, fat, carbohydrate and dry matter reduces as plantain and banana fruit get ripened.

TABLE 2: Weight and Temperature variation of Plantain Fruits in Different Storage Media to Ripening

Treatments	Weight (g)	Temperature (^{o} c)
T_1 (DS/WB)	468.50	24.1
T_2 (DW/WB)	494.97	25.0
T_3 (WS/WB)	552.10	22.3
T_4 (WW/WB)	584.38	23.9
T_5 (control)	499.61	25.1
G.M	520.85	24.12

%CV	11.99	3.63
LSD	124.28	0.53

Table 2 above shows that there was no significant difference in the mean temperature of T_2 and T_5 while wet sawdust in wooden box (T_3) had the least temperature recorded from all other treatments. This is in support with (Wills *et al*., 2007) that stated that low temperature delays ripening of fruit and decrease the respiration rate. There was no variation in the weight of T_3 and T_4 storage media. However, T_1, T_2 and T_5 are also not significantly different from each other as well, the whole treatment showed some reduction in weight, this is in accordance with (Ben-Yehoshua*et al*., 1997) which revealed that fruit generally loss weight during storage.

TABLE 3: color assessment on plantain fruits kept in different storage media for 35 days

Treatments	1 (Green)	2(GWTY)	3(MGTY)	4(MYTG)	5 (OTG)	6 (CY)
T_1(DS/WB)	9.3	2.00	16.3	4.0	1.7	1.7
T_2(DW/WB)	9.0	17.3	1.7	3.3	2.7	1.0
T_3(WS/WB)	28.3	3.0	1.0	0.6	1.0	1.0
T_4(WW/WB)	26.6	3.7	2.6	0.0	1.0	1.0
T_5(Control)	5.0	12.0	4.7	3.0	1.7	1.7

Key $_1$- Green, Key $_2$- Green with a trace of yellow, Key $_3$- More green than yellow, Key $_4$- More yellow than green, Key $_5$- Only tips green, Key $_6$- Completely yellow

Key T_1- Dry sawdust in wooden box, T_2- Dry wood shavings in wood box, T_3- Wet sawdust in wooden box, T_4- Wet wood shavings in wooden box and T_5 – Open shelf (control)

Table 3 showed that T_3 (WS/WB) performed best, with a mean value of 28.3 by maintaining it green color for 28 days before any changes occurs, T_4 (WW/WB) also did fairly well, by maintaining its greenness for 27 days with a mean value of 26.6 as compared to T_5 (control) that was placed on the open shelf in the laboratory that lost its green color after the 5th day with a green mean value of 5.0. This confirms earlier report that plantain put in a wooden cabinet for storage remained green for longer period than plantain fruit placed on the open shelf receiving some ventilation (Ferris, 1997, Narayana *et al*., 2004).

Conclusion

The problem of harvest loss is important in the economy and nutrition as well as health. However, the problem can be reduced by increasing field or gross production as well as improving the preservation methods. From the result obtained, it is therefore concluded that wooden cabinet with wet sawdust performed best in preservation of plantain, (*Musa aab*) fruits helps in extending the shelf life value of plantain fruit compare to plantain fruit placed on open shelf. Therefore, it can be recommended that (Wet sawdust in a wooden box (WS/WB) T3 storage media prepared for this experiment can preserve plantain fruit and increase it green life for twenty-eight days at ambient temperature of 23^0c.

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Effect of Metal ion Concentration on Adsorption of Arsenic, Lead and Cadmium from Water Using Agricultural waste

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Abstract

Walnut shell was used as a low cost adsorbent for removal of Pb(II), Cd(II) and As(III) ion from aqueous solution. The effect of initial metal ion concentration was evaluated using batch adsorption method. The result showed a decrease in adsorption of the metal ions with increase in initial metal ion concentration. An equilibrium contact time of 20, 40 and 50 min was achieved As(III), Cd(II) and Pb(II) ion respectively. The adsorption of metal ions followed the order As(III) > Cd(II) >Pb(II). The Langmuir R_L value obtained for all the metals were in range 0.07-0.505 and the Freund Lich n value within 1-10 indicating a favourable adsorption unto walnut shell. The result shows that walnut shell can be used as a low cost adsorbent for removal of Pb(II), Cd(II) and As(III) ions from aqueous solution.

1.0 Introduction

It has been observed that the harmful effect of heavy metals discharged annually into the environment far exceeds the total toxicity of all radioactive and organic waste (Kobya et al. 2005). This is the reason why the discharge of heavy metals into the environment has become a problem of great concern over the last few decades. The contamination of the environment with lead is mainly due to anthropogenic activities which makes the metal the most ubiquitous toxic metal in the environment. Lead is non-biodegradable and it tends to bio accumulate. Lead has the potential to bio accumulate in the food chain causing human health hazard. When present in high concentration it can damage the brain and central nervous system (Barka et al. 2013). Cadmium has been reported to be highly toxic, it is also an enzyme inhibitor and is responsible for kidney tabular impairment, effect calcium metabolism, skeletal calcification and ion regulation. It has been reported to cause diarrhea, severe abdominal pain and liver damages (Barka et al. 2013). Arsenic is known to be a toxic element and arsenic (III) is more toxic than arsenic(v). (Mandal et al, 2013).Long term ingestion of arsenic contaminated drinking water causes lungs, skin, kidney, gastrointestinal diseases, cardiovascular diseases and bone marrow disorder (Mandal et al, 2013).

Treatment process for removal of heavy metals from industrial waste water include precipitate, membrane, filtration, ion exchange, chemical oxidation, electrochemical treatment, evaporation and solvent extraction. These techniques have the disadvantages of high cost, low selectivity, incomplete metal recovery, high energy requirement, difficult to apply and generation of toxic slurries which are difficult to dispose.(Akpomie etal, 2014).

Studies on the treatment of effluent bearing heavy metals have revealed adsorption to be a highly effective technique for the removal of heavy metal from industrial waste water due to its high efficiency, low cost of maintenance and very easy to apply(Kobya et al. 2005)..

This study therefore investigates the effect of metal ion concentration for the removal of toxic elements from water using walnut shell.

2. Materials and Methods

2.1.Materials

2.1.1 Reagents

- Lead(ii)nitrate ($Pb(NO_3)_2$)
- Cadmium(ii)nitrate ($Cd(NO_3)_2$)
- Arsenic trioxide (As_2O_3)
- De-ionized water (H_2O)
- Sodium hydroxide (NaOH)
- Nitric acid (HNO_3)

2.1.2 Apparatus and Equipment

- Plastic bottles
- Measuring cylinder
- Beaker

- Funnels
- Volumetric flask
- Spatula
- Glass rod
- Plastic buckets
- Ph meter
- Chemical balance
- Atomic absorption spectrophotometer (AAS)

2.2.Methods

2.2.1 Adsorbent Preparation

The walnut was washed with de-ionized water and the shell removed. It was sun dried for 7 days and grinded to powdered form. The sample was then passed through a 100um mesh sieve to obtain the prepared walnut shell adsorbent for the adsorption process (Akpomie etal, 2014).

2.3.Adsorption Study

Batch adsorption procedure was applied to determine the effect of initial metal ion concentration.(Akpomie etal, 2014).

2.4.Determination of Effect of Metal Concentration

Solutions of metal ions of concentrations 1000, 800, 600, 400, and 200mg/l were prepared. Constant pH of 6.0 was maintained for all the solutions then 0.1g of prepared walnut shell placed in 100ml plastic bottles and 20ml of each solution was added into the plastic bottle, it was corked, shaked and allowed to stand for 180 minutes at temperature of 300k. The solution were then filtered and taken to the Atomic Absorption Spectrophotometer to check the residual metal concentration (Akpomie etal, 2014).

3. Result and Discussion

TABLE 1: Metal ion concentration parameters for adsorption of Pb(ii) ion unto walnut shell

Concentration (mg/l)	Ce (mg/l)	qe (mg/g)	% Adsorption
200	70.8	25.84	64.60
400	181.6	43.64	54.60
600	291.4	61.72	51.43
800	461.5	67.70	42.31
1000	635.7	72.86	36.43

TABLE 2: Metal ion concentration parameter for adsorption of Cd(ii) ion unto walnut shell

Concentration (mg/l)	Ce (mg/l)	qe (mg/g)	% Adsorption
200	53.8	92.24	73.1
400	142.6	51.48	64.35
600	275.4	64.92	54.1
800	421.6	75.68	47.3
1000	598.4	80.32	40.16

TABLE 3: Metal ion concentration parameter for adsorption of AS(iii) ion unto walnut shell

Concentration	Ce (mg/l)	qe (mg/g)	% Adsorption

(mg/l)			
200	32.4	33.52	83.80
400	96.7	60.66	75.83
600	224.9	75.02	62.52
800	387.4	82.52	51.58
1000	521.3	95.74	47.87

The adsorption of metal ions unto adsorbents can be a function of the initial concentration of the metal ions which makes it an important factor to be determined for an effective sorption. There was a decrease in the percentage removal for Pb(II), Cd(II), As(III) ions with increase in concentration from 200 to 1000 mg/l. A decrease in the percentage adsorption from 64.6 to 34.43%, 73.1 to 40.16% and 83.8 to 47.87% was obtained for Pb(II), Cd(II) and As(III) ions respectively. The metal concentration of 200mg/l was then utilized in this study due to the highest adsorption obtained at this concentration.

4. Conclusion

The experimental factor such as initial metal concentration affected the adsorption of Pb(II), Cd(II) and As(III) ions unto walnut shell. The use of commercially activated carbon for the removal of some toxic elements can be replaced with inexpensive, effective and readily available Agricultural by-product such as walnut shell used in this study since it has a good and favourable adsorption of the three metal ions recorded.

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Studies on the Removal of Toxic Elements From Water Using An Agricultural Waste: The Effect of pH.

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Abstract

This study focuses on the use of walnut shell as a low cost adsorbent for removal of toxic element namely Pd(II), Cd(II), and As(III) ion from aqueous solution. Batch adsorption was used to evaluate the effect of solution pH. The result showed an increase in the adsorption of all metal ions with increase in pH. An equilibrium contact time of 20, 40, and 50 minutes was achieved for As(III), cd(**II**) and Pb(II) ion respectively.

Introduction

Heavy metals such as Cadmium, Lead and Arsenic are released continually from industrial effluent and agricultural activities into receiving water bodies. These metals are toxic and have dangerous health effects on plant, human and aquatic life and also at high concentration, it can lead to death. . Lead has the potential to bio accumulate in the food chain causing human health hazard. when present in high concentration it can damage the brain and central nervous system (Barka et al. 2013). Cadmium has been reported to be highly toxic, it is also an enzyme inhibitor and is responsible for kidney tabular impairment, effect calcium metabolism, skeletal calcification and ion regulation. It has been reported to cause diarrhea, severe abdominal pain and liver damages (Barka et al. 2013). Arsenic is known to be a toxic element and arsenic (III) is more toxic than arsenic(v). long term ingestion of arsenic contaminated drinking water causes lungs, skin, kidney, gastrointestinal diseases, cardiovascular diseases and bone marrow disorder (Mandal et al, 2013).

Activated carbon which is used as an adsorbent for the removal of these toxic elements is expensive making many industries to release these toxic elements to the environment without treatment.

This study investigates the effect of pH on the use of an Agricultural waste (walnut shell) as a low cost adsorbent for the removal of heavy metals from water.

2.1 Materials and Methods

2.1.1 Reagents

- Walnut shell
- Lead(11)nitrate ($Pb(NO_3)_2$)
- Cadmium(ii)nitrate ($Cd(NO_3)_2$)
- Arsenic Trioxide (AS_2O_3)
- De-Ionized Water (H_2O)
- Sodium hydroxide (NaOH)
- Nitric Acid (HNO_3)
- Walman No. 1 filter paper

2.1.2 Apparatus and Equipment

- Plastic bottles
- Measuring cylinder
- Beaker
- Funnels
- Volumetric flask
- Spatula
- Glass rod
- Plastic buckets

- pH Meter
- Chemical balance
- Atomic Absorption Spectrophotometer (AAS)

2.2 Methods

2.2.1 Adsorbent Preparation

The walnut shell was washed with de-ionized water, sundried for 7 days and grinded to powdered form. The sample were then passed through a 1000um mesh sieves to obtain the prepared walnut shell adsorbent to the adsorption process.

2.2.2 Adsorption Study

Batch adsorption procedure was applied to determine the effect of pH.

2.2.3 Determination of the Influence of pH

In order to determine the effect of pH on adsorption of metal ions, the metal solutions of concentration 200mg/L was used and adjusted to different pH value of 2.0, 3.0, 4.0, 5.0, 6.0, 7.0 and 8.0 by the drop wire addition of 0.1m NaOH on 0.1m HNO_3 when required and checked by the help of a pH meter. 0.1g of the walnut shell was placed in 7 different plastic bottles and 20ml of the solution added in each and the plastic bottles were corked, shaked and left for 180min at temperature of 300k. The solution was then filtered into another empty plastic bottle using Watman no 1 filter paper placed in funnel. Then, the filtrate was taken to Atomic Absorption Spectrophotometer (AAS) to determine the concentration of metal ions left in solution (Akpomie et al, 2014).

3.0 Results and Discussion

The initial pH of the solution is one of the most important factors in the adsorption of metal ions unto adsorbents as it affects the surface charge of the adsorbent (Imamoglu et al, 2008). The effect of heavy metals such as Pb(11), Cd(11) and As(111) unto walnut shell is shown in Table 1, 2 and 3. It was observed that an increase in adsorption of all the metal ions with increase in solution pH was obtained. The adsorption of the metals increases steadily up to pH 6.0 after which it became stable with further increase in pH. It should be noted that at higher pH values greater than 6.0, there could be precipitation of the hydroxide forms of the metal ions in solution. Comparing the adsorption of the three metal ions, As(III) recorded the highest adsorption followed by Cd(II) and the least was Pb(II) ions. The differences in the amount adsorbed might be due to differences in the ionic radii of the metals with higher ionic radii (Akpomie et al, 2014). The ionic radii of the metals are as follows As(ii), 0.58A, Cd(II), 0.97A and Pb(II) – 1.20A. This implies As(III) was adsorbed more due to its smaller ionic radii white Pb(II) has the least adsorption due to its larger ionic radii.

Table 1: Effect of pH on the adsorption of Pb(II) ion unto walnut shell

pH	**Ce(mg/L)**	**qe(mg/g)**	**%Removal**
2.0	190.40	1.92	4.8
3.0	171.60	5.68	14.2
4.0	135.80	12.84	32.1
5.0	93.20	21.36	53.4
6.0	70.80	25.84	64.6
7.0	70.30	25.94	64.85
8.0	67.5	26.50	66.25

Table 2: Effect of pH on the adsorption of Cd(II) ion unto walnut shell

pH	Ce(mg/L)	qe(mg/g)	%Removal
2.0	181.30	3.74	9.35
3.0	156.40	8.72	21.80
4.0	117.10	16.58	41.45
5.0	74.60	25.08	62.70
6.0	53.80	29.24	73.10
7.0	52.30	29.24	73.85
8.0	51.40	29.54	74.30

Table 3: Effect of pH on the adsorption of As(III) ion unto walnut shell

pH	Ce(mg/L)	qe(mg/g)	%Removal
2.0	172.80	5.44	13.60
3.0	137.10	12.58	31.45
4.0	103.60	19.28	48.20
5.0	58.70	28.26	70.65
6.0	32.40	33.52	83.80
7.0	32.80	33.44	83.60
8.0	31.60	33.68	84.20

Conclusion

The experimental factor such as pH affected the adsorption of Pb(II), Cd(II), and As(III) onto Walnut Shell. The use of commercially available activated carbon for the removal of heavy metals can be replaced by the utilization of inexpensive effective and readily available agricultural by-products such as walnut shell as adsorbent.

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Investigation of the Proximate Composition of Flours from some selected Yam Cultivars Fortified with *Moringa oleifera* seed meal

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Abstract

Diversification of food use is one of the key solutions in the reduction of postharvest losses of tubers, a staple food in the developing economy. To achieve an increase in varietal uses of food tubers, there is need to screen them for inherent nutrients and bioactive components that could enhance adequate nutrition and wellbeing. The study investigated proximate of yam flours from (*Discorear otundata*, *Discoreaalata*, *Dioscorea cayenensis* and *Discoreabulbifera*) fortified with *Moringaoleifera* seed meal. Results of the proximate composition showed that the protein content of the unfortified yam flours ranged from 3.40-3.73% while the *Moringaoleifera* fortified yam flours had a higher protein content of 4.63-9.10%.The other proximate parameters for both unfortified and fortified yam flours were: moisture content with values of 8.2-9.8 & 9.0-12.1%, crude fibre (0.8-2.4 & 1.0-3.2%), respectively.. This study has shown that *Moringa oleifera* fortification of the flour samples nutritionally improved the yam flours.

Introduction

Yam belongs to *Dioscorea* family; economically it is an important food in many tropical countries where it also has a social and cultural benefit Yam tuber is a staple food in most parts of West Africa, including Nigeria..(Kanu, Ezeocha, & Ogunka, 2018). It is a highly valued crop which forms about 10% of the total roots and tuber produced in the world. *Dioscorea rotundata* Poir (white yam), *Dioscorea cayenensis* Lam (yellow or guinea yam), *Dioscorea alata* L. (Water yam), *Dioscorea bulbifera* L (aerial yam) *Dioscorea dumetorum* (Cluster, or bitter yam), and *D. esculenta* (*Loir*) bark (Chinese yam) are mostly cultivated (Eleazu, Kolawole, & Awa, 2013). They have been researched on, as a good source of essential dietary nutrients and a major contribution to the nutrition of West African; as a source of carbohydrate, minerals and small protein. *Moringa oleifera* belongs to the family of *moringacea*. It is indigenous to India, Africa, Arabia, South America, and Caribbean Islands. Hassan *et al*.,(Fatima Al Gunaid Hassan, 2013) reported that *moringa oleifera* tree is known as a multipurpose plant, it has high protein, vitamins, mineral content. It has been reported that almost, all parts of the *moringa* plant; the root, bark, gum, leaf, immature pods, flower, and seed contain some bioactive compounds that, has been utilized for different industrial, medicinal and food purposes(Isitua, 2015; Radha, 2015). Abiodun *et al.,* (Abiodun, Adegbite, & Omolola, 2012) reported that yam flour is low in protein, fibre content, and the incorporation of soybean and cereals into yam flour enhanced the nutritional content. In a similar study by Egbedike *et al.,* (Egbedike, 2016) reported that the incorporation of rice bran to yam flour improved the nutritional content of the product. *Moringa oleifera* is used as a low -cost supplement enhancer in the poorest countries around the world (Fatima Al Gunaid Hassan, 2013). Therefore the aim of this research work is the estimation of the proximate and phytochemical composition of flours of four yam cultivars fortified with *moringa oleifera* seed Meal.

Experiment/Methodology

The four varieties of yam tubers *(Dioscorea alata, Dioscorea bulbifera, Dioscorea cayenensis* and *Dioscorea rotundata*) were procured from Wuruku Market, while *Moringa oleifera* seeds were collected from a local settlement in Umudike, Ikwuano Local Government Area of Abia State. The yam flour was produced according to the method described by Udensi *et al.*,(. Udensi, 2008) *moringa* seeds were deffated .

Proximate Analysis

Proximate composition was determined by Association of Official Analytical Chemist (AOAC., 2012)

Result and discusion

The protein content of the samples ranged from 3.40 (DRC) to 30.39 (MRGA). The unfortified samples are poor in protein content which is in conformity with the findings of (Ojinnaka, 2017). The inclusion of *moringa* seed meal at both 5 and 10% gave a significant increase in the protein content of the fortified samples. The increase is as a result of the high protein content of *moringa* seed meal. Sengev *et al*.,(Sengev, Abu, & Gernah, 2013) reported that *moringa* leaf powder is high in protein content and it substitution effect brought about increase in protein content (Sengev et al., 2013). Ayo *et al*., (J. A. Ayo1, 2018) reported an increase of protein content of acha- *moringa* flour as the *moring*a inclusion increases at 5, 10, 15 and 20%. The fat content ranged from 1.30-5.85%. *Moringa* seed meal recorded the highest fat content. The inclusion of *moringa* seed meal increased the values significantly. This can be supported by the work of Karim *et al.*, (O. R. Karim, Kayode, Oyeyinka, & Oyeyinka, 2013) that the fat of yam and *moringa* leave blend increased with an increased level of *moringa* leave powder at 2.5, 5.0, 7,5 and 10%. In this study, the increase was observed, as the level of *moringa* seed meal appreciates. This can be attributed to the high fat, the content of *moringa* seed meal as evidenced by the result. The fat content is within an acceptable limit which cannot support oxidative deterioration which will encourage spoilage and rancidification (A. K. Arise1, 2014). Similarly, the crude fiber content increased significantly with the addition of *moringa* seed meal at 5% and 10%. The crude fiber content is comparable with that of yam and *moringa* leave blend (1.1% and 2.2%) of Karim *et al*., (O. R. Karim *et al*., 2013) . The values are not so high such that it will prevent the consumption of other important nutrients. Food which is high in crude fiber prevents the consumption of other nutrients. The consumption of the food formulation with this blend will digest easily and will prevent colon cancer which is one of the functions of a diet rich in crude fiber (O. Karim, Kayode, Oyeyinka, & Oyeyinka, 2015). The result of the ash content showed an appreciable significant increase of the samples with *moringa* seed meal at 5% and higher at 10% inclusion. The ash contents of the unfortified *(Dioscorea*) samples were found to be 1.40-2.20%. Supplementation with 5% and 10% *moring*a seed meal significantly increased to (1.77-2.47) and (2.30-3.00) respectively. High ash content of the *moringa* seed meal (MGRA) has been greatly responsible for the repeated increase of the yam/ *moringa* seed meal blend. The moisture content of this study ranged from 6.90-12.10%, the supplementation of the yam flour with *moringa* seed meal caused an increase in the moisture content. This is contrary to the observation made by Arise *et al*., (A. K. Arise1, 2014) where the addition of *moringa* leaves powder resulted in a reduction of moisture. The moisture contents as observed in this study are low and within the acceptable limit, that will prevent the proliferation of microbial growth. Carbohydrate content of the yam *moringa* blends decreased from 84.80(DRC) to 70.90% (DB90M10) with increase in the level of *moringa* seed meal substitution, with all the control samples (100% *Dioscorea*) being statistically higher (84.80—80.45%) the decrease might be as a result of a low carbohydrate content of *moringa* seed meal (47.21%) and it dilution effect (Sengev *et al*., 2013). Similar decrease trends were observed in study conducted on plantain and *moringa oleifera* leaf powder blend at different level of substitution Karim *et al*., (O. Karim *et al*., 2015).

Table1; Proximate composition of yam/ *moringa* seed meal blends

Mean ± SD with different super script across the columns are significance difference at

Samples	Protein	Crude fiber	Crude fat	Ash	Moisture	Cho
DRC	3.40±0.1j	0.80±0.00	1.30±0.10	1.40±0.10	8.30±0.10	84.80±0.45
DAC	4.40±0.21hi	1.00±0.00	1.70±0.10	1.60±0.10	8.20±0.00	83.47±0.35
DCC	4.03±0.1hi	2.40±0.00	2.75±0.05	1.80±0.00	8.20±0.00	80.45±0.34
DBC	3.73±1.33hi	1.50±0.00	1.90±0.00	2.20±0.00	9.80±0.00	80.75±0.58
MRGA	30..39±0.35a	5.25±0.45	5.85±0.15	4.40±0.00	6.90±0.00	47.21±0.40
DR95M5	4.63±0.35g	1.00±0.00	2.20±0.00	1.77±0.58	10.60±0.00	79.80±0.45
DR90M10	5.60±0.10ef	1.52±0.67	2.80±0.10	2.30±0.10	10.33±0.15	77.45±1.50
DA95M5	5.30±0.10f	1.25±0.50	2.30±0.10	2.00±0.00	12.10±0.10	77.05±0.25
DA90M10	6.20±0.00e	1.40±0.00	2.80±0.00	2.47±0.57	11.60±0.00	75.53±0.25
DC95M5	8.40±0.00c	3.05±0.50	3.40±0.20	2.20±0.00	9.30±0.10	73.65±0.57
DC90M10	9.30±0.00b	3.20±0.00	4.20±0.00	2.70±0.10	9.00±0.00	71.60±4.40
DB95M5	7.20±0.20d	2.55±0.05	2.50±0.10	2.47±0.05	10.80±0.00	74.48±0.30
DB90M10	9.10±0.30b	2.80±0.10	3.60±0.00	3.00±0.00	10.60±0.00	70.90±0.25

($p \geq 0.05$).

Key: DRC (*D. rotundata* control*)*, DAC (*D. alata* control), DCC (*D. cayenensis* control) and DBC (*D. bulbifera* control) their fortified samples(DR95M5,DR90M10,DA95M5, DA90M10,DC95M5, DC90M10, DB95M5 and DB90M10) have 95% and 90% *Dioscore*a, *moringa* seed Meal at 5 %and 10and MRGA is moringa seed meal.

Conclusion

This study has shown that the inclusion of *moringa* seed meal at 5 and 10% inclusion possesses diverse and unique characteristics worth exploiting. The proximate parameters tasted were significantly appreciated, however the carbohydrate decreased with the addition of *moringa* seed meal.

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Effect of processing on the anti-nutritional composition of cassava roots and dried chips

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Abstract

Evaluation of anti-nutritional composition analysis of three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368) shows that the fresh pulp had saponins ranging from (0.51-69 mg/100g), tannins (1.17-1.28 mg/100g), cyanide(18.58-21.77 mg/kg), oxalate (1.73-1.93 mg/100g), phytate (1.17-1.22 mg/100g), alkaloids (0.47-0.64 mg/100g), trypsin inhibitor (3.89-4.78 mg/100g), phenol (0.31-0.48 mg/100g) while the dried chips had saponins ranging from (0.25-0.32 mg/100g), tannins (0.49-0.59 mg/100g), cyanide (6.78-7.70 mg/kg), oxalate (0.67-0.81 mg/100g), phytate (0.37-0.54 mg/100g), alkaloids (0.24-0.31 mg/100g), trypsin inhibitor (2.28-3.47 mg/100g), phenol (0.18-0.24 mg/100g). The fresh peels had saponins ranging from (0.74-0.84 mg/100g), tannins (1.24-1.56 mg/100g), cyanide (22.49-23.64 mg/kg), oxalate (2.37-2.76 mg/100g), phytate (1.24-1.53 mg/100g), alkaloids (0.78-0.84 mg/100g), trypsin inhibitor (4.80-5.54 mg/100g), phenol (0.51-0.64 mg/100g) while the dried peels had saponins ranging from (0.29-0.39 mg/100g), tannins (0.74-0.86 mg/100g), cyanide (8.56-9.53 mg/kg), oxalate (1.24-1.44 mg/100g), phytate (0.59-0.77 mg/100g), alkaloids (0.28-0.42 mg/100g), trypsin inhibitor (3.67-4.74 mg/100g), phenol (0.25-0.32 mg/100g). Hydrogen Cyanide content, trypsin Inhibitors, phytic acids, tannins, oxalates, saponins, alkaloids and phenol content of the samples were determined using the alkaline picrate method by (Sarkiyayi and Agar, 2010), (Anbuselvi and Balarumugan, 2014), (Ismaila *et al*., 2018), (Akaninyene *et al*., 2016), (Marta *et al*., 2017), (AOAC, 2010), (Okwu and Morah, 2007) and (Pasko*et al*., 2008) respectively. The results showed that [soaking + sun drying] and [sun drying] methods have led to the significant loss ($p<0.05$) of anti-nutrients in the dried chips and the dried peels across the varieties which has helped to render the dried chips and the dried peels safe for human consumption and for the production of livestock feeds. Significant variation ($p<0.05$) in anti-nutritional composition exist between the fresh pulp and the dried chips, fresh peels and the dried peels across the varieties.

***Keywords*: Cassava, anti-nutritional, fresh pulp, dried chips, fresh peels, and dried peels.**

Introduction

Cassava (*Manihot esculenta* Crantz) is a woody shrub of the Euphorbiaceae family grown for its tuberous roots (Lebot, 2009). It is a cheap and reliable source of food in the developing countries**.** It is naturally drought resistant and resilient to climatic changes. Cassava root contains anti-nutrients and toxic substances that interfere with the digestibility and the uptake of some nutrients (FAO/WHO., 1991). Nevertheless, depending on the amount consumed, these substances can also bring benefit to humans. Some common anti-nutritional factors found in cassava root include the cyanide, phytate, tannins, oxalates, saponins, trypsin inhibitors etc. Cyanide is the most toxic factor restricting the consumption of cassava root. There are two main classes of cassava: the sweet varieties and the bitter varieties. The bitter varieties has cyanide level higher than the FAO/WHO recommendations, which is <10mg cyanide equivalent/kg DM, to prevent acute toxicity in humans. Consumption of 50 to 100 mg of cyanide has been associated with acute poisoning and has been reported to be lethal in adults (Okafor, 2004). The consumption of lower cyanide amounts is not lethal but long-term intake could cause severe health problems such as tropical neuropathy, glucose intolerance, and goiter and cretinism when combined with low iodine intake (Delange *et al.,* 1994). Several processing methods have been adopted for reducing the high level of cyanide content in cassava roots such as soaking in water for 24 hours, sun drying, oven drying and even boiling, with the former (soaking in water) tending to bring about fermentation due to the introduction of moisture. Cassava roots can be process into several products for human consumption which include chips, gari, flour, and 'abacha'. Studies have shown that cassava chips can be converted into gari of good chemical and functional quality, though some nutritional composition could be lost during processing (Oluwole et al., 2004). Industrially, dried cassava chips are used as an animal feeds and can also be used to produce other useful cassava based products. During processing of cassava root into dried chips it should be expected that there may be some losses in the nutritive and anti-nutritive quality of the root. Therefore, this research is aimed towards evaluating the effect of processing on the anti-nutritional content of three varieties of cassava roots in other to access the losses made during processing.

Materials and Methods

Three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368) were obtained from the experimental farm of National Root Crops Research Institute, Umudike. The samples were washed and peeled. The pulps as well as the peels for each of the samples were divided into two separate portions such that the fresh pulp and the dried chips on one hand, and the fresh peels and the dried peels on the other were obtained each. The fresh sample (fresh pulp and fresh peels) were cut into smaller sizes, and oven dried at 70 ^{O}C for 4 hours. Each of the samples were ground to its powder form using mortar and pestle and used for the anti-nutritional composition analysis. The dried sample (dried chips and dried peels) were produced by first cutting the pulp into chunks and soaking in water for 24 hours, then cut into smaller sizes and sundried into chips. The peels were directly cut into smaller sizes and sun dried into chips without undergoing steeping. The chips were irregular pieces of about 1.5cm thick and 2-3 cm long and were produced within 2-3 days. The chips were ground and use for the anti-nutritional composition analysis. Data were subjected to analysis of variance using the Statistical Package for Service Solution (SPSS), version 20.0. Results were presented as Mean ± standard deviations. One way analysis of variance (ANOVA) was used for comparison of the means. Differences between means were considered to be significant at $p<0.05$ using the Duncan Multiple Range Test.

CASSAVA ROOTS
⇩
WASHING
⇩
PEELING
⇩
CUT INTO CHUNKS
⇩
SOAKING (24hrs)
⇩
CHOPPING
⇩
SUN DRYING
⇩
DRIED CASSAVA CHIPS

CASSAVA ROOTS
⇩
WASHING
⇩
PEELING
⇩
CHOPPING
⇩
SUN DRYING
⇩
DRIED CASSAVA PEELS

1 (b): Flow chart for production of dried Fig. 1(a): **Flow chart for production of dried cassava chips. Cassava peels.**

Results and Discussion

The anti-nutritional composition of the fresh pulp, dried chips, fresh and dried peels of three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368) are shown in the table1: Also, the anti-nutritional % losses incurred by the dried chips and the dried peels in the samples (TMS 30572, TMS 98/0505 and TMS 01/1368) are shown in figure (2) and (3). The result shows that there is a significant loss ($p<0.05$) of anti-nutritional composition of the dried chips and the dried peels when compared with the fresh pulp and the fresh peels across the varieties. This could be attributed to the effect of processing methods applied in the study. This tends to suggest that [soaking + sun drying] reduces the anti-nutritional composition of the dried chips across the varieties while sun drying only reduces the anti-nutritional composition of the dried peels across the varieties. The percentage anti-nutritional composition loss incurred by the dried chips and the dried peels ranges between 27.4% to 68.4% and 14.4% to 64.1% across the varieties respectively. Significant variation ($p<0.05$) exist in anti-nutritional composition between the fresh pulp and the dried chips, the fresh peels and the dried peels across the varieties.

Table 1: Anti-nutritional composition of the fresh pulp, dried chips, fresh and dried peels of three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368)

Variety	Treatments	Saponins (mg/100 g)	Tannins (mg/100 g)	HCN (mg/kg)	Oxalate (mg/100 g)	Phytate (mg/100 g)	Alkaloids (mg/100 g)	Trypsin Inhibitor (mg/100 g)	Phenol (mg/100 g)
TMS 30572	Fresh Pulp	$0.69^{c}\pm0.01$	$1.28^{c}\pm0.03$	$21.77^{c}\pm0.04$	$1.93^{d}\pm0.01$	$1.18^{c}\pm0.00$	$0.64^{c}\pm0.02$	$4.78^{c}\pm0.03$	$0.48^{c}\pm0.01$
	Dried Chips	$0.32^{h}\pm0.00$	$0.59^{g}\pm0.01$	$7.70^{h}\pm0.14$	$0.81^{h}\pm0.01$	$0.54^{f}\pm0.00$	$0.24^{i}\pm0.01$	$3.47^{g}\pm0.01$	$0.24^{g}\pm0.01$
	Fresh Peels	$0.84^{a}\pm0.02$	$1.56^{a}\pm0.02$	$23.64^{a}\pm0.23$	$2.76^{a}\pm0.04$	$1.53^{a}\pm0.11$	$0.83^{a}\pm0.01$	$5.54^{a}\pm0.08$	$0.64^{a}\pm0.01$
	Dried Peels	$0.39^{f}\pm0.01$	$0.86^{e}\pm0.01$	$9.53^{f}\pm0.11$	$1.44^{f}\pm0.02$	$0.77^{d}\pm0.01$	$0.36^{g}\pm0.00$	$4.74^{c}\pm0.02$	$0.32^{e}\pm0.00$
TMS 98/0505	Fresh Pulp	$0.51^{e}\pm0.01$	$1.17^{d}\pm0.01$	$18.58^{e}\pm0.18$	$1.77^{e}\pm0.04$	$1.17^{c}\pm0.01$	$0.57^{d}\pm0.04$	$4.22^{d}\pm0.05$	$0.31^{ef}\pm0.02$
	Dried Chips	$0.25^{j}\pm0.01$	$0.56^{g}\pm0.00$	$6.78^{j}\pm0.00$	$0.67^{j}\pm0.03$	$0.37^{g}\pm0.02$	$0.27^{i}\pm0.02$	$2.28^{i}\pm0.03$	$0.18^{h}\pm0.01$
	Fresh Peels	$0.74^{b}\pm0.03$	$1.24^{c}\pm0.01$	$22.77^{b}\pm0.04$	$2.37^{c}\pm0.04$	$1.24^{c}\pm0.02$	$0.78^{b}\pm0.00$	$5.15^{b}\pm0.04$	$0.51^{b}\pm0.01$
	Dried Peels	$0.29^{i}\pm0.00$	$0.74^{f}\pm0.00$	$8.58^{g}\pm0.25$	$1.24^{g}\pm0.01$	$0.59^{ef}\pm0.01$	$0.28^{hi}\pm0.01$	$3.67^{f}\pm0.04$	$0.25^{g}\pm0.01$
TMS 01/1368	Fresh Pulp	$0.54^{d}\pm0.00$	$1.17^{d}\pm0.04$	$20.72^{d}\pm0.11$	$1.73^{e}\pm0.01$	$1.22^{c}\pm0.03$	$0.47^{e}\pm0.01$	$3.89^{e}\pm0.04$	$0.39^{d}\pm0.01$
	Dried Chips	$0.28^{i}\pm0.00$	$0.49^{h}\pm0.01$	$7.34^{i}\pm0.08$	$0.73^{i}\pm0.00$	$0.40^{g}\pm0.00$	$0.31^{h}\pm0.01$	$2.77^{h}\pm0.02$	$0.20^{h}\pm0.00$
	Fresh Peels	$0.75^{b}\pm0.01$	$1.47^{b}\pm0.02$	$22.49^{b}\pm0.01$	$2.64^{b}\pm0.02$	$1.32^{b}\pm0.04$	$0.84^{a}\pm0.02$	$4.80^{c}\pm0.00$	$0.53^{b}\pm0.01$

Dried Peels	0.36^{g}±0.01	0.83^{e}±0.01	8.56^{g}±0.20	1.39^{f}±0.01	0.64^{e}±0.01	0.42^{f}±0.00	3.69^{f}±0.13	0.28^{f}±0.00

Values are mean ± SD of duplicate determinations. Mean values with the same superscript within the same column are not significantly different (P > 0.05)

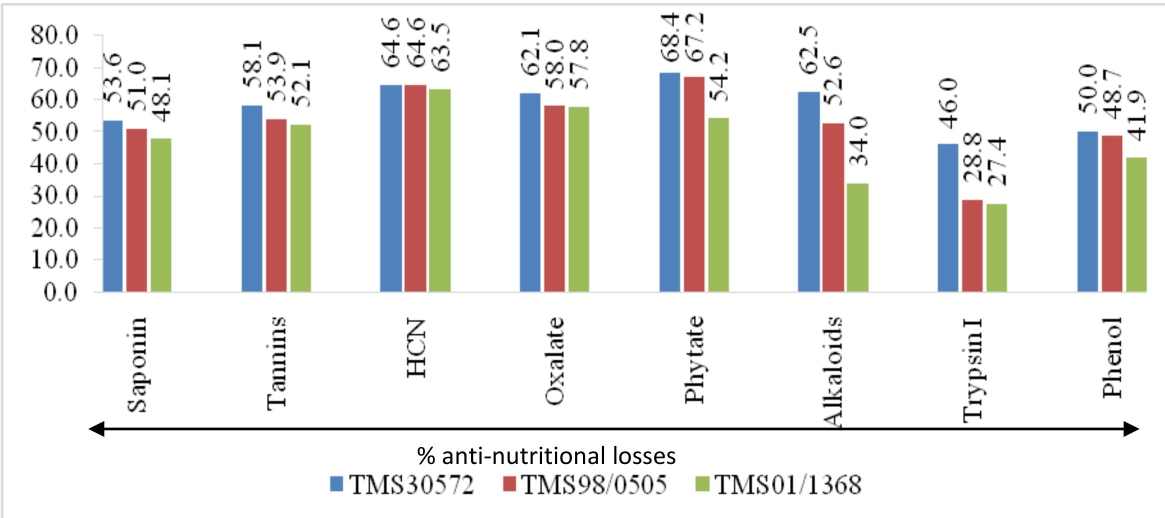

Fig. (2): Anti-nutritional chart presentation of % losses incurred by the dried chips.

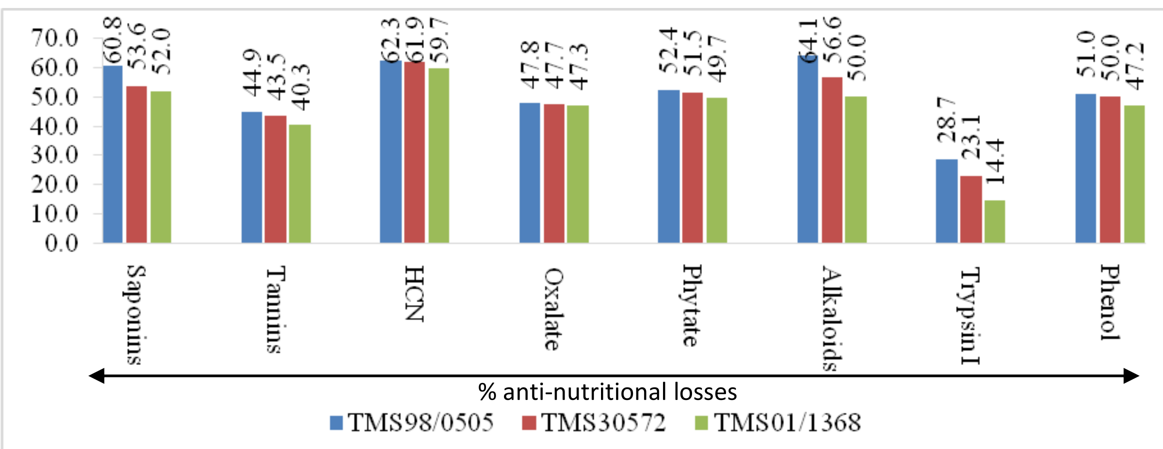

Fig. (3): Anti-nutritional chart presentation of % losses incurred by the dried peels.

Conclusion

- The result shows that [soaking + sun drying] and [sun drying] methods traditionally used for processing fresh cassava roots have been able to reduce the anti-nutritional content of cassava roots in the dried chips and dried peels to the safe levels for human and animal consumption.

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Isolation of microorganisms with amylolytic activity from agro-industrial wastes

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Abstract

Amylases are hydrolytic enzymes that catalyze the breakdown of starch into sugars. Starch degrading microorganisms have found numerous applications in the food, pharmaceutical, textile, detergent and brewing industries. This study was designed to produce amylolytic organisms from agro processing wastes. In this study, bacteria and fungi strains were isolated from thirteen different food processing wastes (date fruit, coconut meat, shea seed, effluent from cassava, cassava peel, cassava tubers, soil from oil palm plantation, yam and potato tubers, starchy medium, parboiled water from noodles and rice). A total number of 19 fungi species and 8 bacteria species were isolated and identified, all isolates had amylolytic activity. *Rhizopus microsporus* from coconut meat waste and *Trichoderma viride* from soil of cassava dumpsite showed the highest zone of clearance of 9.0cm each ($p<0.05$) as confirmed by higher amylase activity of 5.4mM/min/ml and 6mM/min/ml respectively ($p<0.05$). Results revealed high yielding amylolytic organisms; the selection of microorganisms used for the production of alpha amylase depends on their amylolytic activity.

Keywords: Amylase, fungi, bacteria, amylolytic activity.

Introduction

Amylases are class of enzymes that are capable of digesting glycosidic linkages found in starch and glycogen. They are widely distributed in microbial, plant and animal kingdoms (Pandey *et al.*, 2000). They degrade starch and related polymers to yield products characteristic of individual amylolytic enzymes (Dhanya *et al.*, 2009).

Microorganisms are good source of industrially important enzymes. Microbial amylases have almost surpassed synthetic sources in different industries (Pandey *et al.*, 2000). The major advantages of using microorganisms for amylase production is economical bulk production capacity, also microbes can be easily manipulated to obtain enzymes of desired characteristics (Ramesh and Lonsane, 1990). The ubiquitous nature, ease of production and broad spectrum of applications make α-amylase an industrially important enzyme (Leveque *et al.*, 2000). Amylolytic enzymes are widely distributed in bacteria and fungi. Screening and selection of the right organism plays a key role in high yield of desirable enzymes (Jinu, 2017). The isolation and manipulation of pure culture of starch degrading microorganisms from soil and agro waste materials have great importance for various biotechnology industries (Rwarinda *et al.*, 2013). The utilization of agro industrial wastes not only provides alternative substrates but it is also cheap, easily available and helps in solving pollution problems (Priya *et al.*, 2011). Screening of microorganisms with higher amylase activities could therefore facilitate the discovery of novel amylases suitable to biotechnological applications. In this present study, we report the isolation and screening of amylase producing bacteria and fungi from soil and food processing waste.

Materials and Methods

Sample collection: The following samples of agro industrial wastes were collected from their dump sites located at NIFOR main and substations: date fruit, shea seed, coconut meat, soil from oil palm plantation, water pressed from grated cassava, cassava peel, cassava tuber waste and the soil from the dump site of the cassava grinding mill. Waste water from parboiled rice and noodles were obtained from a local fast food eatery, Benin City, Potato (Sweet and Irish) and yam tuber from Uselu market, Benin City. All chemicals, reagents, resins, standard proteins and solvents used in this experiment were of analytical grades .

Isolation of Amylase Producing Microorganisms

Serial dilution was made on the samples collected from different agro wastes sources and was plated on nutrient and potato dextrose agar. The pour plate method (Dezaan cocoa manua,l 2009) was used in the isolation of the microorganisms associated with the samples. One millilitre each of the serially diluted samples was pipetted with the aid of a sterile syringe and then transferred into the corresponding labeled petri dishes. The prepared PDA medium was dispensed into the petri dishes with a glass spreader for fungi isolation. The glass spreader was quickly sterilized by dipping in 95% ethanol and passing it over flame. These were carried out under sterile conditions in a laminar flow chamber. The plates were then incubated at room temperature for 72 hrs. For bacteria, 1 mL of the diluted samples were spread on nutrient agar plates containing 1 % w/v soluble starch and was allowed to incubate at room temperature for 24 hours.

Macroscopic and Microscopic Analyses

Fungi isolates from all the samples were analyzed for morphological and cultural characteristics such as the colony colour, margins, elevation and colony reverse colours.

Biochemical Characterization of Bacterial Isolates

The bacterial cultures were identified using the analytical profile index kit (API 20A system). This was performed according to the method of Murray (1985).

Crude Enzyme Preparations from Bacteria

The bacterial amylase medium contained bacteriological peptone (0.5%), magnesium sulphate (0.1%), potassium chloride (0.02%) and starch (1%) in distilled water, pH 7.0. The medium was mixed, distributed into 40 mL volumes in 100mL Erlenmeyer flasks and sterilized by autoclaving at 121ºC for 15 minutes. A loop full of bacterial culture was added into the amylase production medium. In the extraction of the enzyme from bacteria, the bacterial culture was poured into centrifuge tubes and spun for 20 minutes at 5000 rpm using a refrigerated centrifuge. The supernatant was decanted and used as the crude enzyme extract.

Crude Enzyme Preparations from Fungi

Potato dextrose medium pH 7.0 was used to grow the fungal isolates. The fungi from the culture medium was transferred to 1000 mL of freshly prepared mineral salts medium (2.75g/l of K_2HPO_4, 2.225g/l of KH_2PO_4, 1.0g/l of $(NH_4)2NO_3$, 0.2g/l of $MgCl_2.6H_20$, 0.1g/l of KCl, 0.01g/l of $FeSO_4.6H_2O$ and 0.02g/l of $CaCl_2$) pH 7.0, supplemented with 1% w/v starch (Rehman, 2011). The medium was incubated at 30^oC under sterile condition on a rotary shaker at 200 rpm. Growth of fungi was monitored at 600 nm. Crude enzyme extract was prepared by filtering through a pre-weighed Whatman filter paper No. 1 and the filtrate obtained was centrifuged at 4^oC for 15 minutes at 5000 rpm to separate cells and spores. The supernatant obtained was used as source of the crude extract which was further dialyzed in distilled water for 24 hours to remove residual sugars.

Determination of Alpha Amylase Activity

The alpha amylase activity in the culture filtrates of the different isolated microorganisms were determined by the dinitrosalicyclic acid (DNSA) method (Toye, 2009).

Results and Discussion

Isolation of Amylolytic Fungi: In this study, the fungal species isolated from the various sources were *Geotricum*, *Aspergillus*, *Penicillium*, *Trichoderma*, *Rhizopus* and *Fusarium spp.*(figure 1). Filamentous fungi has been reported to have been widely used for the production of amylases for centuries (Juliana *et al*., 2011). The group *Penicillium* was found to be the most dominant fungi occurring in the wastes. The genera *Aspergillus*, *Penicillium* and *Fusarium* were found to be the most diverse group of fungi isolated from the different amylase sources based on their cultural and microscopic features. Fungi belonging to the genus *Aspergillus* have been employed for the production of alpha amylases (Lemo *et al*., 2019). Few *Penicillium* and *Trichoderma* species have also been reported in recent past as microbial source for producing alpha amylases (Erdal *et al.*, 2010; Abdulaal, 2018).

Isolation of Amylase Producing Bacteria: Five major genera of bacterial species *Corynebacterium*, *Pseudomonas*, *Lactobacillus*, *Micrococcus* and *Bacillus* were isolated from the various samples collected. The genera, *Bacillus* was found to be the most diverse group of bacteria isolated from the different amylase sources. Among bacteria, *Bacillus* species is the most widely used source for the production of amylases (Sundarram and Murthy, 2014)

Amylase Activity of Screened Amylolytic Fungi and Bacteria: Figure 1 shows that all the fungi isolates had amylase activity with the highest activity seen in *Rhizopus sp.* from coconut meat waste followed by *Trichoderma sp.* isolated from soil of cassava dump site. The fungal isolates had higher amylase activity when compared with the

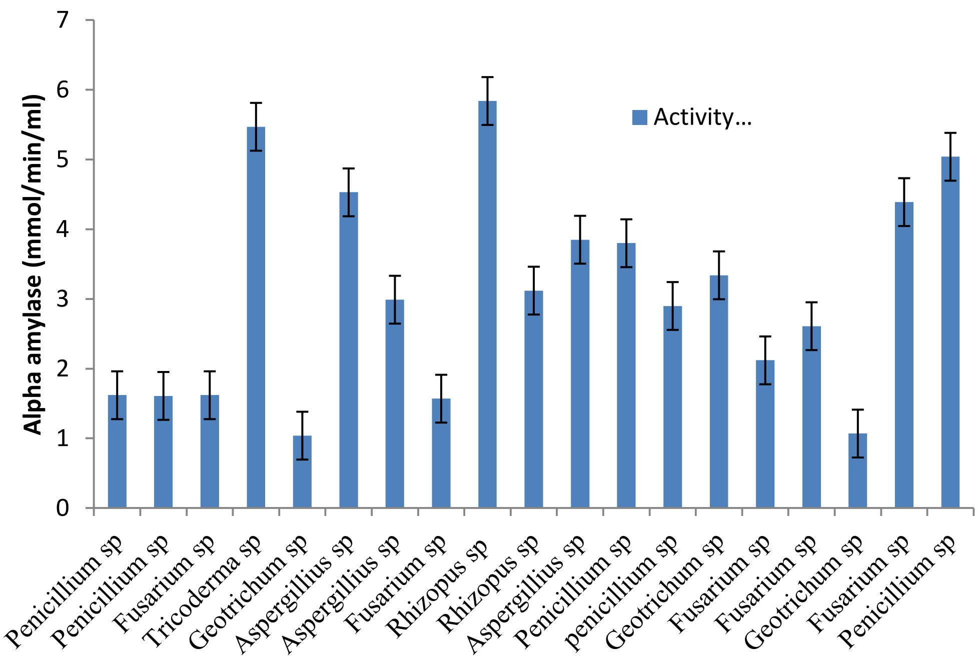

Figure 1. Amylase Activity of Fungi Isolates

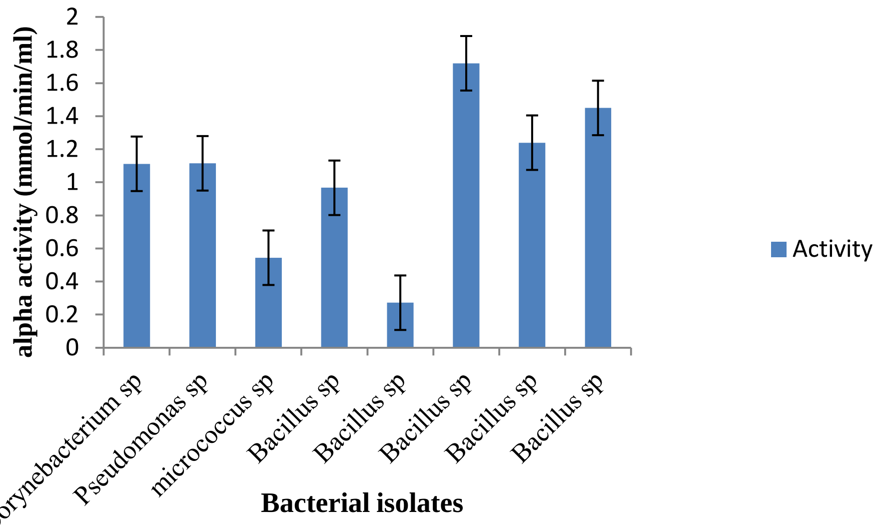

Figure 2. Amylase Activity of Bacteria Isolates

bacterial isolates as observed in figures 1 and 2

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Performance of ginger processors in Abia State, Nigeria

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Abstract

This study was carried out to determine the performance of ginger processors in Abia State Nigeria. A multi-stage sampling procedure was used in selecting one hundred and twenty (120) respondents for the study. A well-structured questionnaire was used in collecting data from the respondents and the data collected were analyzed using simple statistical tools like frequency tables, percentages and cost and return analysis. The result revealed that majorities (82.0%) of ginger processors were females, majority of the respondents are within active working bracket and 96. 67% of the respondents have one form of education or another. The results of the performance of ginger processors show that it is profitable, that every Naira invested in the business the processors made a return of N 1.27. It is therefore recommended that male should be encouraged in the processing of ginger since is profitable and it is source of livelihood. Awareness campaigns should be made to popularize the crop and it benefits.

Keywords: Performance, Ginger, Processors

Introduction

Ginger is grown in Nigeria and the crop is among the principal cash crops in Nigeria. Nigeria is a major producer of the crop and it is an important export commodity of Nigeria (Ojiako *et al.*, 2007). Ginger powder is fast becoming a household kitchen item in Nigeria. In the market, ginger is available in diverse forms; fresh ginger rhizome, powder ginger, and dry ginger rhizome (Brian, 2014). Ten percentage of the ginger product is consumed locally as fresh ginger. The remaining 90% is dried for export and consumed locally Ezeagu (2006). Ezeagu 2006 opined that the 20% of the dried ginger was consumed locally and the remaining 80% exported.

The crop is highly cherished in the international market because of its aroma pungency and high oil and oleoresin content called gingerin.

The crop is an essential spice with real potential for employment creation and income generation. It is a low-volume, high-value tropical crop. Ginger serves as a preservative for its aroma and pungency in the foods and beverages industry. The crop is among the oldest rhizomes widely domesticated with spice. In the Nigerian market, ginger is well-known and it is greatly demanded, though it is quite expensive (Brian, 2014).

Ginger is a seasonal and perishable crop (USAID, 2017). It is an export crop because of its high demand in advanced medical and confectionery industries. Owing to the lack of storage facilities, traders are forced to sell the product immediately after collection from farmers. Similarly, there are limited collection centers at production sites so that there are difficulties in handling the product correctly and also the absence of ginger washing facilities in Nigeria, which has resulted in low price of the crop because of its dirty appearances. The objectives of the study are to determine the socio-economic characteristics and estimate the performance of ginger processors in Abia state, Nigeria

Material and Methods

The study was conducted in Abia states, Nigeria. The study covered one out of the three agricultural zones in Abia state. A multi-stage sampling procedure was used in selecting the respondents for this study. Random and Purposive sampling techniques were used in selecting the study area and the respondents for the study. The ginger processors were randomly sampled and Purposive selection was used in selecting one local Government area and communities. One out of the three agricultural zone was purposively selected, based on their high-level activities on ginger processing. Random sampling technique was employed to select 120 ginger processors. Cross-sectional data were used for this study. Primary data were collected using well-structured questionnaires. The data collected from the ginger respondents were analyzed using descriptive statistics such as percentage, frequencies distributions, mean, marketing margin, and marketing efficiency.

Results and Discussion

The result in Table 1 shows that 18.00% of the ginger processors were males and 82.00% of the processors are females The result shows that the majority of the processors were females. This could be that processing of ginger requires less effort and not tedious for women to engage on.

This is in line with the findings of Ezra *et al*. (2017), who indicated that the domination of women in ginger processing is due to low demands of time and efforts required to work in the enterprise. The result shows that the mean age of ginger processors is 41.50. It was observed that the majority (42.50%) of the ginger processors were wtihin the age bracket of 31-50 years. This implies that ginger processors are within the active working bracket. They are young people who can withstand stress involved in the processing of ginger, and they are matured to take decisions that sustain the business.

The results obtained are in line with the findings of Kantiok (2007), who opined that the majority of the agricultural enterprise actors are in their working age. Also, this is in line with the results of Udoh and Nyienakuma (2008). They opined that agriculturist within the active age groups would be able to withstand stress and put more time in various agricultural operations.

The result in table 1 showed that the majority (67.50%) of ginger processors were married. This result indicates that ginger processing can be used to sustain the basic needs of families involved in the processing. This result agrees with Ojo and Jibowo (2008) that reported that married people being responsible, their views are likely to be respected within the rural communities as they decide on the use of agricultural inputs. The result shows that the majority of the ginger processors (96.67) had one form of formal education or the other. The result shows that the majority of the processors are highly educated. This will enhance the management of ginger processing in the study area. Formal education allows the ginger processors to understand the proper management of resources. This finding agrees with the fact that high literacy level facilitates the adoption of modern technologies and improved practices (Shehu *et al.*, 2013; Offor and Nse-Nelson, 2015). Experience is expected to have a significant positive impact on the managerial ability of the processors. The result in table.1 shows the years of experience the processors had acquired. The mean years of experience for ginger processing is 10.84. This result is an indication that the ginger processors have been in processing over a long period and can be said that there are experienced. This implies that the more experienced the processors, the more committed and confident they have in the business. The finding also shows that the processors are aware of the merits and demerits associated with the processing because of the long years of experience. In this study, the performances of ginger processors were measured using net returns, marketing margin, and marketing efficiency.

The result in Table 2 shows that the average total cost of N 35,464.2 was obtained while processing 60kg of ginger and the average total revenue of N 45027. The net return was N 9562.8. This suggests that the business was profitable and capable of continuing in both the short and long run. The processors had marketing margins of 21.24 %. The marketing efficiency of processors was 26.96%. The result shows that the processors efficient in marketing. The rate of return on investment of N 1.27 was obtained for processors, which means that for every Naira invested in the business the processors made a return of N 1.27.

However, higher margin implies a higher profit (Offor *et al.,* 2017). The results show that the made a profit and Also, the business was able to cover its variable and fixed costs. It would be capable of continuing in the short run (Osarenren and Ojor, 2014).

Conclusion

The study shown the performance of ginger processors in Abia State, Nigeria. The result shows that majority of the ginger processors were females. This could be that processing of ginger requires less effort and not tedious for women to engage on. Which indicated that the domination of women in ginger processing is due to low demands of time and efforts required to work in the enterprise. The results of the performance indicators in Tables 2 shows net return of N9562.8. However, higher margin implies a higher profit. It is therefore recommended that male should be encouraged in the processing of ginger since is profitable and it is source of livelihood. Awareness campaigns should made to popularize the crop and it benefits

The results of the socio-economic characteristics of ginger processors is presented in Table 1.

Table 1: Socio-economic characteristics of ginger processors in Abia State

Variables	Freq	Percentage
Gender		
Male	22	18.00
Female	98	82.00
Total	120	100
Age (years)		
21-30	19	15.83

31-40	51	42.5
41-50	32.	26.17
51-60	11	10.71
61-70	7	5.83
Total	120	100
Mean		41.50
Marital status		
Married	81	67.50
Single	13	10.83
Divorced	12	10.00
Widow	14	11.67
Total	120	100
Education level (years)		
No formal Education	4	3.33
Primary Education	40	33.33
Secondary Education	62	51.66
Tertiary Education	14	11.66
Total	120	100
Experience (Years)		
1-5	18	15.00
6-10	36	30.00
11-15	29	24.17

16-20	22	18.33
21-25	19	15.58
26-30	16	13.33
Total	120	100
Mean		10.84
Total	120	100
Mean		1.38

Source: Field Survey Data, 2019

The result of the Performance of ginger processors is presented in Table 2.

Table 2: Net returns of ginger processors of non-microcredit users (Average quantity per week)

Variables	Quantity (kg)	Unit Cost (N)	Total cost (N)
Variable cost			
The purchase price per kg	60	499.60	29,976
Cost of transportation		15	900
Cost of sorting	60	5.95	357
Cost of processing	60	51.52	3091.2
Total Variable Cost			34304.2
Fixed Cost			
Cost of Rent			450

Depreciation on tools			710
Total Cost			1160
Total variable and Fixed Costs			35,464.2
Selling price per kg of dried ginger	60	750.45	45027
Revenue			45027
Net Return			9562.8
Performance Indicators			
Marketing margin (%)	21.24		
Marketing efficiency (%)	26.96		
Return on Naira investment (N)	1.27		

Source: Field Survey Data, 2019

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Functional Qualities of Bitter Yam (*Dioscorea dumetorum*): A Review

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Abstract

Food security and its safety have led to the continuous quest to improving food and health systems. A large proportion (70%) of the world population still depends on the age-old practice of using traditional medicine because of its minimum side effects along with least cost. Global focus has been on fewer crops in order to mitigate food requirements thereby leading to the neglect of crops like *Dioscorea dumetorum* also known as bitter yam. Research has shown that *D. dumetorum* is rich in phtyo-nutrients and with lots of mineral values; its therapeutic potential has made it a prominent member in the "traditional health care system" to treat several malaises of human being during the early date of civilization. *Dioscorea dumetorum* can be utilized in both food and non-food applications. The present review reveals the importance of *Dioscorea dumetorum* by providing a report on the nutritional and bioactive composition both for improving health and for its industrial uses. In addition, highlights the therapeutic benefits and impact on human health associated with the consumption of yam.

Keywords: Yam, *Dioscorea dumetorum*, bitter yam, Nutritional and mineral values, bioactive compounds, therapeutic potential.

Introduction

Yam *(Dioscorea spp)* is generally classified under the genus Dioscorea, *family* Dioscoreaceae, and order Dioscoreales. They are the most important food crops in West Africa (Bassey, 2017). Yams are the second most important tuber crop in the whole world after cassava, in terms of production (IITA, 2013). They also form an important food source in other tropical countries including East Africa, the Caribbean, South America, India and South East Asia (Bassey, 2017).

Dioscorea dumetorum Pax, belongs to the family *Dioscoreaceae* and genus *Dioscorea* (Ukpabi, 2015). Its origination is in tropical Africa made up of wild and cultivated forms (Ezeocha *et al.*, 2012*)..Dioscorea dumetorum* is also popularly known as African trifoliate yam, three leafed yam, cluster yam and bitter yam for its bitter taste (Degras, 1993; Palaniswami and Peter, 2008; Ukpabi, 2015; Uhuo *et al*., 2020). Morphologically, African trifoliate yam has trifoliate compound leaves (three leaflets) and single heart-shaped leaves. Its slender stem is covered with hairs and spikes. A single plant could produce a cluster of tubers, which is why one of its name is cluster yam with its bitter alkaloid, especially in the uncultivated wild variety (Degras, 1993; Palaniswami and Peter, 2008; Bhattacharjee et *al*., 2011, Ukpabi, 2015). Bitter yam has some characteristics that have made it unpleasant to consumers for consumption in its raw state and this includes itchiness, bitterness, or toxicity (Uhuo *et al.*, 2020).

Dioscorea dumetorum (bitter yam) is rich in phyto-nutrients and phyto-chemical, including proteins and Dioscorin respectively which is the main storage protein of yam, (Medoua *et al*., 2005; Alozie *et al*., 2009) which causes a knock down on humans and mammals (Owuamanam *et al.*, 2013). Overcoming the hard-to-cook defect and the total extraction of the bitter alkaloid will boast its potentialities. Owuamanam *et al. (*2013) and Medoua *et al.* (2005) researchs has shown that the hardening effect of this bitter yam can be slowed down by storing at a low temperature and relative humidity (15°C, 59RH). They are usually detoxified by soaking in a vessel of salt water, in cold or hot fresh water or in a stream. (Owuamanam *et al.*, 2013).

The industrial uses of bitter yam include; bioethanols, which is an alternative source of fuel and sugars using its substrate peels as extract (Banjo *et al.*, 2019). It can also be used to form flour or as starch composition and also to form yam flakes which is another form of post harvest product development using its tubers (Otegbayo *et al.*, 2013; Abiodun and Akinso, 2015; Ukom *et al.*, 2016; Oyeyinka *et al.*, 2018). The present review aims to reveal importance of *Dioscorea dumetorum* (bitter yam) by providing a report on the nutritional and bioactive composition. In addition, highlights the therapeutic benefits and impact on human health associated with the consumption of yam.

Nutritional and Mineral Values of *Dioscorea dumetorum*(bitter yam)

The nutritional values of *Dioscorea dumetorum* (bitter yam) can be influenced or affected by the various agricultural practices carried out through the period of planting (Obidiegwe *et al.*, 2020). Moisture is .a major component of yam and Obidiegwu *et al.*, (2020) gave a range of the proximate composition of *Dioscorea dumetorum* tuber as 64.3-90.2% moisture, 0.19-10.3%

Crude protein, 0.37-3.65% Crude fat, 0.82-5.65% Crude fiber, 2.17-7.79% Ash and 17.0-63.34% Starch. Alozie *et al* (2009) and Ukpabi, 2015 stated that the crude protein of *D. dumetorum* tuber is more stable and has the highest chemical score for cystine and has than that of *D. rotundata*. Amongst the food yam proteins.This is in addition to the bitter yam having the highest protein content (on dry matter basis) amongst the food yams (Degras, 1993). The moisture content of yam tubers is a significant factor to consider in microbial deterioration and maintaining a prolonged shelf life of the produce. Thus, yams with low moisture content have longer shelf life and are more suitable for prolonged storage (Polycarp *et al.*, 2012 and Obidiegwu *et al.*, 2020). An estimate of about 22% and 39% of losses occur in yam occur during storage, which is dependent on the specie with high moisture content, storage environment and season (FAO, 2011), hence leading to the huge economic loss for both farmers and traders. In addition to spoilage caused by high moisture content, it is important to highlight the importance of moisture as it relates to nutritional content of yam. The degree of maturity of yam tuber has a great influence on the physicochemical quality of food (Wireko-Manu *et al.*, 2013).

The dietary fibers found in yam play a huge role in the food digestion in humans as well as animals. Appropriate consumption of yam containing fiber increases water holding capacity, aids in free bowel movement, fecal bulkiness and reduces intestinal transit. It has also been of great importance in physiological effects such as reduction of blood sugar and cholesterol level, trapping of toxic substances and encourages the growth of normal microbial flora in the gut (Obidiegwu *et al.*, 2020). Ash refers to the non-aqueous remains in any food material and which also signifies the total amount of minerals present within the food subjected to any complete oxidation process. However, studies have shown that ash content measurement of any yam starch can be influenced by its processing method especially insufficient starch purification, thus leading to higher values.

Yam tubers are rich in minerals which are of utmost importance for the diet of humans that play vital roles in various metabolic process of the body. These includes Potassium (K), Sodium (Na), Phosphorous (P), Calcium (Ca), Magnesium (Mg), Copper (Cu), Iron (Fe), Manganese (Mn), Zinc (Zn) (Polycarp *et al*., 2012). And among all the minerals Potassium (K) is the most sufficient mineral present in the yam tubers (Baah *et al*., 2009; Polycarp *et al*., 2012; Padhan and Panda, 2020). Adequate Potassium content in the body boasts the iron utilization which is beneficial for controlling hypertension (Padhan *et al*., 2020).

Bioactive Compounds in *Dioscorea dumetorum*

Bioactive compounds are extra nutritional constituents found in small amounts that have the capacity to influence the cellular or physiological activities in humans as well as in animals. They regulate metabolic processes by possessing numerous beneficial health effects such as anti-oxidative, anti-hypertensive, anti-inflammatory and anti-diabetic activities, inhibition of receptor activities, inhibition or induction of enzymes and induction and inhibition of gene expression, thus resulting in the promotion of better health (Obidiegwu *et al.*, 2020). However, it is worth noting that bioactive compounds can also have anti-nutritional properties. Anti-nutritional factors are the naturally occurring chemical compounds synthesized by normal metabolism which reduces the nutrient utilization such as protein digestion and absorption, binding of minerals by the body, interfering with metabolic pathways thus eliciting toxicological effects in humans and animals (Bhandari and Kawabata, 2004). Anti-nutritional factors affect the bioavailability of dietary nutrients especially protein, minerals, and vitamins and reduce the nutritive value of the food (Padhan *et al*., 2018). A wide list of bioactive compounds such as Phenols, flavonoid, alkaloid, tannins, phytates/phytic acid, oxalates and dioscorine have been reported in *Dioscorea dumetorum* by several studies

Therapeutic Potentials of Bitter Yams (*Dioscorea dumetorum)*

Therapeutic potentials refer to those qualities found in bitter yam that help them play positive effective role on the body and its systems. History has it that the use of plant derivatives has proven to be effective in pharmaceutical and phytomedical products (Jahan *et al.,* 2019; Obidiegwu, 2020). Even in this recent century, a large proportion (70%) of world population still depends on the age-old practice of using herbal medicine because of its availability, reduced side effects along with least cost (WHO, 2002; Ikiriza *et al*., 2019). Evidently, Research has shown those yam bioactive compounds and its supplementations play vital roles in the treatment of some diseases (Table 1).

Conclusion and Recommendations

Dioscorea dumetorum also known as bitter yam is of utmost importance in both food and non-food applications. Phenols, flavonoid, alkaloid, tannins, phytates/phytic acid, oxalates and dioscorine are its bioactive compounds that have the capacity to influence the cellular or physiological activities in humans as well as in animals. The hard-to-cook effect can be slowed down by storing at a low temperature and relative humidity (15°C, 59RH). The most common methods the bitter alkaloid toxin can be reduced or removed in bitter yam is by soaking in a vessel of salt water, in cold or hot fresh water or in a stream over time, also by boiling/steaming and /or baking over coals after either cleaning and peeling of the tubers (Medoua *et al*., 2005; Bhandari and Kawabata, 2005; Owuamanam *et al.,* 2013). Its industrial applications cannot be overlooked, as it has played good role in flour making and stiff dough "amala" (Akinoso and Abiodun, 2015), production of bioethanols and sugars. This yam has also shown potentials of being able to treat some diseases as shown in Table 1, but researchers have limited to in-vitro and animal models. There is need to consider its long term effect on humans.

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Table 1. Therapeutic Potentials of Bitter yam (*Dioscorea dumetorum)*

Source of Extract	Biological Properties/Administration	References
Tuber	Treatment of diabetes	Ogbunugafor *et al.*, 2014; Obidiegwu, 2020
Tuber	Control hyperlipidemia, hypercholesterolemia and hyperketonemia	Obidiegwu, 2020
Tuber	Jaundice treatment	Jahan *et al.*, 2019

Assessment of knowledge of Environmental Hygiene Practices among Cassava Processors in Ibarapa Central Local Government Area of Oyo State

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Abstract

The study assessed the environmental hygiene practices among cassava processors in Ibarapa central local government area of Oyo state. A multi--stage Sampling Technique was used to select One Hundred and Ten respondents. Interview Schedule was used to collect data from the respondents. The Data collected was subjected to descriptive statistical analysis such as percentages, frequency count, Mean and Tables while Chi-Square analysis was used to test the stated hypothesis. The study revealed that majority (81%) of the respondents were female with the mean age of 39 years. The respondents identified washing of Cassava tubers (94%), proper washing of machine after use (86%), proper channeling of liquid waste (84%), washing of hand regularly (74%) as the environmental hygiene practices employed. Majority (66%) of the respondents have low level of knowledge of environmental hygiene practices. Improper disposal of cassava peels which causes pollution was the major constraints facing the respondents. Chi-Square analysis revealed that there existed significant relationship between socio-economic characteristics and the level of knowledge on environmental hygiene practices in the study area (X^2=0.000, $p< 0.05$).The Study recommended that both government and non-governmental organizations should put in place a periodical training and retraining of Cassava Processors on the need for good environmental hygiene practices in the study area.

Key words: Assessment, Cassava, Processor, Hygiene, Environment, practices.

Introduction

Cassava *(Manihot esculenta* Crantz) is a root and tuber crop that has been identified as important for food security, especially in Africa and serves as a staple food for over 200 million people in the African continent (CTA, 2005). The production, processing and marketing of cassava provides a major source of income for 450 million people, often women and the poorest, in sub-saharan Africa. Processing by small scale farmers to produce dry, shelf-stable products can be cost effective and provide a means of producing value addition close to the supply source. (Louise, 2015).

Food –borne diseases are recognized as a major human health problem and occurs commonly in both developed and underdeveloped countries particularly in African countries, because of poor food handling and sanitation practices, inadequate food safety laws, weak regulatory systems, lack of financial resources to invest in safer equipment and lack of education for food handlers(Aluko et al 2014). Handling and processing conditions often result in a very poor quality of the products. In addition to the high labour intensity and drudgery, the conditions during processing are generally unsanitary and unwholesome. However, government is paying less attention on activities of small business owners particularly those in agricultural chain and have promoted hazards such as operating in poor local infrastructure, poor food hygiene practices and lack of sanitation (Omeru and Aderoju, 2008).

Cassava as a major staple food in Nigeria produces large volumes of waste that create environmental nuisance in the region, these waste would even be more problematic in future with increased industrial production of cassava products such as starch and cassava flour (Ehiagbonare et al, 2009).Therefore, it is evident that, Cassava processing produces annually big quantity of waste and if they are not properly managed, they can cause a serious pollution to the environment and human life. Disposal of effluents from Cassava processing is becoming an increasing problem and more problem may also arise due to high solid content in the effluents rather than from the cyanogens. As a results of these major threats to the environment by the Cassava processing industry, it is inevitable to critically assess the Cassava Processors' knowledge of environmental hygiene practices in the study area. Consequently, the study identify environmental hygiene practices practice by the respondent in the study. Also, the study examine the sources of knowledge on environmental hygiene practices of the respondents. In addition, the study identify the constraints faced by Cassava processors in the process of processing cassava.

Methodology

The study was carried out in Ibarapa Central Local Government area of Oyo State with its Headquarters at Igboora. The local government consist of two towns: Igboora and Ideere. The rainfall pattern in the area follows a tropical type with an average annual rainfall pattern of 300mm and fairly high temperature. The study area has a population of 116,809 according to (NPC 2016) and land area of408, 424 square metre.

A multi- stage sampling technique was used to obtain 110 Cassava Processors. In the first stage, two towns namely: Igboora and Idere were purposively selected based on large number of cassava processors. Second stage involves selection of Six out of Eleven processing units in Igboora while one out of two processing units was selected in Idere making a total of seven processing units. In the third stage, the lists of the Cassava processors was collected from the Chairman of the Association and a total of One Hundred and Ten Cassava growers was randomly selected which constitute the sample size. Data collected through interview schedule were subjected to both descriptive and inferential statistics.

Results and Discussion

1.0 Selected Socio – economic characteristics of cassava processors

As presented in table 1, the mean age of the respondents was 39 years. This implies that the respondents are in their active age and they have vigour to withstand the stress and energy demanding of the nature of the work). The table also revealed that majority (78.2%) of the respondents had formal education while (21.8%) of the respondents had no formal education. The implication of this is that respondents are relatively educated, which might have positive consequences on their eagerness to adopt environmental hygiene practices in their processing units. Alabi and Oviasogie (2005) asserted that high literacy level is capable of impacting positively on cassava production and processing. Table 1 also shows the mean years of processing experience to be 18 years. This implies that Cassava processors in the study area have acquired a lot of experience and this will proffer them the opportunity to have adequate knowledge on environmental hygiene practices on Cassava processing in the study area.

Table 1: Selected socio- economic characteristics of respondents

Variables	Frequencies	Percentages	Mean
Age			
Below 20	8	7.27	
21-30	21	19.09	
31-40	51	46.36	39 years
41-50	20	18.18	
Above 50	10	9.09	
Marital status			
Married	66	60.0	
Single	44	40.0	
Educational status			
Informal education	24	21.82	
Primary education	61	55.45	
Secondary education	07	6.36	
Tertiary education	18	16.36	
Years of experience in			
Cassava processing			
1-5	33	30.0	
6-10	37	33.6	
11-20 years	40	36.4	18.2years

Source: field survey, 2017

2.0: Cassava processors' knowledge of Environmental hygiene practices

The information in table 2 revealed cassava processors' knowledge of environmental hygiene practices. From the table, the respondents identified the following as the environmental hygiene practices put in place when processing cassava: Washing of peeled cassava tubers (93.6%), Washing and cleaning of processing equipment before and after use (86.4%), washing of hands regularly before and after processing (73.6%), use of clean water to wash cassava peels (69.1%),cutting of finger nails (60.0%) while the following were the least environmental knowledge of hygiene practices revealed by the respondents in the following order: wearing of hand glove during cassava

processing (27.3%), having wounds or infection on the hand during processing (30.9%), Proper channeling of liquid waste(16.4%), and use of decent and clean uniform (44.5%).

Table 2: Distribution of Cassava processors on the basis of knowledge of Environmental hygiene practices

Environmental hygiene practices	**Yes**	**No**
Washing of hands regularly before and after cassava processing should be strictly observed	81(73.6)	29(26.4)
Use of clean water to wash cassava peel is necessary	76(69.1)	34(30.9)
Washing of peeled cassava tubers promote good hygiene	72(93.6)	38(6.5)
Use of decent and clean uniform is part of hygiene practices	49(44.5)	61(55.5)
Cutting of finger nail before processing enhances good hygiene	66(60.0)	44(40.0)
Wearing of hand glove is necessary while carrying out cassava		

processing	30(27.3)	80(72.7)
Having wounds or infection on the hand has nothing to do with good hygiene	34(30.9)	76(69.1)
Washing and cleaning of processing equipment before and after use is part of hygiene practices	95(86.4)	15(13.6)
Proper channeling of liquid waste is part of good hygiene practice	18(16.4)	92(83.6)
Proper disposal of cassava peels can improve hygiene level	58(52.7)	52(47.3)

Source: Field survey, 20017

Note: values in parentheses are in percentages.

3.0 Respondents' level of knowledge of cassava processors on environmental hygiene Practices

Table 3 presented cassava processors level of knowledge of environmental hygiene practices. From the result of analysis, the mean score of the respondents' knowledge was 12.0. This was used to classify the respondents into high and low levels. The respondents whose score falls below the mean score were considered as having low level of knowledge of environmental hygiene practices, while those having mean score and above were considered as having a high level of knowledge. As shown from the table a large number (66%) of the respondents has low level of environmental hygiene practices while 44% of the respondents has high level of environmental hygiene practices in the study area.

Table 3: Respondents' knowledge of environmental hygiene practices

Level of knowledge	Frequency	Percentage
High (mean ≥ 12.0)	48	44.0
Low (mean ≤ 12.0)	62	66.0

3.0 Cassava Processors' sources of information on environmental knowledge of hygiene practices

From table 2, it was revealed that majority(wms=2.1) Public sanitary inspector was ranked as the major source of information on environmental knowledge of hygiene practices in the study, probably due to their nature of work in ensuring the environment is kept tidy. Closely followed by Radio (wms=1.85) and Television (wms=1.28). Other sources of information on environmental knowledge of hygiene practices as ranked by the respondents include: fellow cassava processors (wms=1.0), family (wms=0.75), and Extension agents (wms=0.68) among others. This implies that extension agents who are supposed to disseminate information on the need to keep the respondents processing environment clean have neglected their responsibility.

Table 3: Cassava processors sources of information on environmental knowledge of hygiene practices

			If Yes to what extent					
Sources	Yes	No	Always	Occasionally	Rarely	Never	WMS	Rank
			(3)	(2)	(1)	(0)		
Public Sanitary inspector	90(54.6)	20(45.5)	55(50.0)	33(30.0)	2(1.8)	20(18.2)	2.1	1st
Fellow Processors	40(36.4)	70(63.6)	35(31.8)	3(2.7)	2(1.8)	70(63.6)	1.0	4th
Family	29(26.3)	81(73.7)	25(22.7)	3(2.7)	1(0.9)	81(73.7)	0.75	5th
Extension Agents	33(30.0)	77(70.0)	15(13.6)	12(10.9)	6(5.5)	77(70.0)	0.68	6th
Radio	71(64.6)	39(35.4)	65(59.1)	2(1.8)	5(4.5)	39(35.4)	1.85	2nd
Television	66(60.0)	44(40.0)	30(27.3)	15(13.6)	21(19.1)	44(40.0)	1.28	3rd

Newspaper	10(9.1)	100(90.9)	6(5.5)	4(3.6)	0(0.0)	100(90.9)	0.24	9th
Friends	22(20)	88(80.0)	15(13.6)	4(3.6)	3(2.70)	88(80.0)	0.51	7th
Magazines	16(14.6)	94(85.4)	10(9.2)	5(4.5)	1(0.9)	94(85.4)	0.37	8th

Source: field survey, 2017

Note: figure in parentheses are in percentages

4.0 Constraints to cassava processing

Constraints facing cassava processor was presented in table 4. From the table, it was revealed that inadequate capital (72.0%) was mentioned as the major constraints facing cassava processors in the study area. Others constraints identified by the respondents includes: poor channeling of waste water (68.2%), insufficient water supply (65.5%), inadequate information on environmental hygiene practices (63.6%) inadequate space for disposal of cassava peels (60%) while incessant power supply (40.9%) and inadequate labour supply (18.2%) were identified as the least constraints facing cassava processors in the study area. This implies that the environment where cassava processing is carryout is dirty as there was no provision for the proper channeling of liquid waste and this might pose or threat or expose the health of the processor and the inhabitants to danger. Most of the drinking well around the processing units might have been contaminated. This agrees with the findings of Kolawole et al, (2007) who observed that apart from the high labour intensity and drudgery, the conditions during processing are generally unsanitary and unwholesome.

Table 4: Constraints to cassava processing

Constraints	Yes	No
Insufficient water supply	72(65.5)	38(34.5)
Inadequate capital	79(72.0)	31(28.0)
Inadequate information on environmental		
Hygiene practices	70(63.6)	40(36.4)

Poor channeling of liquid waste	75(68.2)	35(31.8)
Inadequate space for disposal of cassava peels	66(60.0)	44(40.0)
In adequate labour supply	20(18.2)	90(81.8)
Incessant power supply	45(40.9)	65(59.1)

Source: Field survey, 20017

Note: values in parentheses are in percentages

5.0 Chi-square Analysis showing the relationship between socio-economic characteristics of cassava processors and their knowledge of environmental hygiene practices

Table 5 presented the Chi-square analysis showing the relationship between socio-economic characteristics of the respondents and their knowledge on environmental hygiene practices in the study area. From the table, it was revealed that there existed a significant relationship between cassava processors 'environmental knowledge of hygiene practices and years of experience (0.000) and their education (0.001). However, no significant relationship existed between sex (0.747), age (0.008), marital status (0.963).This implies that as the level of education attained and years of processing experience determines their exposure to knowledge of environmental hygiene practices in the study area.

Table 5: Chi-square Analysis showing the relationship between socio-economic characteristics of cassava processors and their knowledge of environmental hygiene practices

Variable	x^2	df	Asymp.sig	Decision
Age	14.118	3	0.008	NS
Sex	0.584	2	0.747	NS
Marital status	0.605	4	0.963	NS
Experience	7.353	1	0.000	S
Education	8.152	1	0.001	S

Significant when p is less than 0.05

Conclusion

Based on the findings of the study, it was revealed that cassava processors has low knowledge of environmental hygiene practices. Also, the major sources of information to cassava processors on environmental hygiene practices was through Radio. However, cassava processors were constrained with inadequate capital, proper channeling of liquid waste, insufficient water supply and inadequate space for disposing cassava peels. The consequences of all these could affect the health status of the cassava processors as well as the inhabitants in the study area.

Recommendation

Considering the findings upon which conclusion was drawn, the following recommendation were proffered:

1. The local government should provide enough space outskirt the town for the cassava processors to carry out their activities so as to reduce soil and air pollution in the town and improve the health condition of the inhabitants.

2. Members of the cassava processing association should be encourage to open account with the Bank of agriculture in their respective areas so that they can have access to loan from the bank to finance their business..

3. Training and retraining programmes by the government and non-government agencies on good environmental hygiene practices will advance cassava processors knowledge of environmental hygiene practices in the study area.

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Agricultural Mechanization: A Pre-Requisite For Food Security In Sub-Saharan Africa

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Abstract

Sub-Saharan Africa is endowed with abundant natural resources for agricultural production. The global food consumption is expected to double by the year 2050 and this calls for an increase in the world food production. The situation is even more challenging for sub---Sahara Africa Where there will be more rapid Population growth (from 770 million in 2005 to between 1.5 and 2 billion in 2050). However, unlike other developing countries in Asia, the level of agricultural Mechanization in Sub---Sahara Africa is still very low and is faced with a number of constraints. It is important for the attention of governments and other institutions to be drawn to these for immediate intervention to be taken. Although there are large tracts of land with varying degrees of agricultural potential in sub-Saharan Africa there the people who would exploit it for agriculture lack access to appropriate technology for production and postharvest practices.

1. Introduction

Agricultural mechanization is an important symbol of agricultural modernization, and agricultural equipment is the carrier of agricultural modernization and thus an important tool used to promote agricultural mechanization (Akande, 2009). Nigeria is one of the countries in the World that is blessed with both human and material resources (UKAID, 2012). In terms of human resources, Nigeria has an estimated population of about 163 million people (NBS, 2012) that are engaged in agricultural and non-agricultural activities. It occupies an estimated land mass of 92.4 million hectare that has tremendous potentials for crop production. Out of the total land mass, the arable land area was 79 million hectare (Federal Ministry of Agriculture and Natural Resources (FMANR, 2010) and out of the 79 million hectares, only about 32 million hectare is usually cultivated (FMANR, 2010) living an excess of about 47 million hectare uncultivated. This implies that land availability is not a major limiting factor in agricultural development but despite the available land and human resources, Nigeria is one of the poorest countries in the world that is battling with food insecurity (Khan, 2000) even when 80 percent (Dauda, Musa and Ahmad, 2012) of her population is said to be engaged in agriculture. To embrace agricultural mechanization, one of the most important agricultural technologies that Nigerian farmers must have access to is tractor and its implements. Although farm mechanization according to Maharjah and Cheltin (2006) encompasses, in its widest sense, hand tools, draught animals and mechanical technologies, tractor is one of the most important mechanical power because it is a major element in farm mechanization (Ishola and Adeoti, 2004). To emphasize the importance of tractor, Dauda, Musa and Ahmad (2012) stated that agricultural mechanization is synonymous with tractorization. It is a critical input for agricultural mechanization and a major indicator for assessing level of agricultural development in any country (NAERLS and NPFS, 2011). Using tractor and its implements for agricultural mechanization have been adopted and its impact on agricultural development has been impressive in many parts of the World.

Since Sub-Sahara Africa farmers have been advised to embrace agricultural mechanization as a way of increasing food production and report by NAERLS and NPFS (2011) indicated that most country in Sub-Sahara Africa including Nigeria had some functional tractors, there is every need to identify the factors limiting small-scale farmers access and use of tractors for farm mechanization for farm mechanization in Africa. This is very important because if tractors are not affordable to farmers or available in public and private offices but not accessible, it makes no meaning to a farmer who needs it for production purposes. Again, it is necessary because documented evidence revealed that tractors were introduced in Nigeria in the 1950's (Dauda et al 2010) implying that this is not a new technology in Sub-Sahara Africa. Since 1950s till date, the level of adoption and diffusion of farm mechanization should be very high enough for the Nigerian farmers to operate mechanized farms.

2. History of Agricultural Mechanization in Sub-Saharan Africa

Agriculture has been the source of man's livelihood since the beginning of time. Although farming using basic tools like the hoe and cutlass was the first step in ancient time in the sub-region, actual records about efforts to promote agricultural mechanization could be traced to the early days of colonization by European masters especially in the early 1900s. On the European settler farms, a combination of hand tool and draught animals were used as sources of power on their farms. Most of these farms were located in Eastern and Southern part of the continent. Although the use of draught animals for various day-today activities dates back to 2000 BC in Ethiopia, using such animals for ploughing purposes was introduced in Ethiopia and other North African countries in the early 1920s. Animal traction is now one of the main sources of power in small holder agriculture in the region, contributing up to 40% of the total power use in some countries such as Botswana (Pawlak et al, 2002).

Tractors were introduced from the 1940s onwards in Ghana and other West African countries. They were first used in commercial, white settlers' farms, but they spread quickly through tractor hire schemes for small farmers, initially promoted by aid agencies, donor countries and tractor manufacturers before the drive was taken up by governments. Government policies which support the use of tractors on the farms were initiated around this period leading to the establishment of various mechanization schemes in the 1960s. After gaining independence, many governments continued to promote the use of tractors in an effort to increase both food and cash crop production in order to ensure self-sufficiency, produce raw material for local industries and increase foreign currency reserve (FAO, 2005; Amponsah et al, 2012). Beyond 1960s, there have been heated debates among experts (mainly economists, sociologists and agricultural engineers) about the negative consequences of mechanization in causing land degradation and displacement of labour.

3. Strategies for Enhancing Sustainable Agricultural Mechanization in Sub Sahara Africa

Engine powered technology (EPT) has helped the developed countries of Europe and America and the fast developing South and South East Asian countries to develop their agriculture such that only a very small percentage of their population is involved in direct food and fibre production. The small percentage has been able to provide enough food for the population with surplus for export, principally, because of the use of machines. Use of appropriate machines has also resulted in the production of abundant raw materials for their numerous agro-based industries which provide employment for a lot of people. Sub-Sahara Africa should emulate this model in preparing for its agricultural industry in the years ahead.

According to Saleh, (2012), in Europe, China, India, etc, their methods of farming are more scientific, therefore more productive. In these countries, mechanization brought about growth in the use of agricultural chemicals (herbicides, insecticides, fungicides and fertilizers) though along with their hazards. They also develop high yielding species that leads to intensive farming on land with sufficient rearing of cattle and poultry. They went further into genetic engineering method for hybridization and embarked on pests control by use of chemicals.

These cannot happen in Sub Sahara Africa until the government begins to realise/resolve the following issues:

- Ensuring internal peace and security of the rural communities from external threats and attacks by destructive persons or group of persons in whatsoever disguise.
- Construction of small dams for electricity and irrigation water provision including the construction of dams across large erosion gullies.
- Declaration of vocational/technical education (that will produce technicians) a top priority and transformation from theoretical education to practical training of its youth, through variety of programmes.
- Encouragement and attraction of foreign based farm machinery manufacturers to establish factories in the state.
- The rural farmers and their communities must be placed at the centres of strategies and policies geared towards agricultural development, and thus economic advancement of the state.
- Promotion of exploitational and management conglomeration or consolidation of land holdings and discouragement of land fragmentation into very small scattered holdings that can make mechanization, irrigation and drainage works difficult.
- Creation of leadership by example by the top hierarchy of government that will re-orientate the workforce from greed and avarice to states manship and awkening of societal development consciousness. This must lead to:

    a. Reduction of corruption to barest minimum.

    b. Abolition of flagrant display of stolen wealth.

    c. Payment of workers as at when due.

    d. Promotion of workers as at when due.

e. Provision of working tools for the workforce.

4. Major Constraints Confronting Agricultural Mechanization in Sub-Sahara Africa

a. Lack of training and technical expertise in farm machinery

Unlike other developing countries like China and India which give much attention to the training of skilled personnel in the area of agricultural machinery, the situation is entirely different in Sub-Saharan Africa. As far back as 1930, the Chinese government, for example, sponsored 30 of her citizens to travel to the United States to be trained in the area of agricultural machinery development and operation. These individuals eventually came back to China to establish various Departments with special focus on the design, development, management and operation of farm machines (Xiang, 2013).

b. Low research and extension in mechanization and development of agricultural machines

Due to inadequate scientific and technical research effort in the area of mechanization, the hand hoe is still regarded as the main tillage and crop production tool and about 80% of farmers rely on it (Sims et. al, 2012). Indeed, the real condition on ground makes it challenging to undertake such projects because of general lack of financial and institutional supports. Individuals who take such paths to innovate and improve upon technology available to farmers are left on their own, making most of them give up pursuing such research directions when faced with difficulties. All over Sub-Saharan Africa, there is very little to talk about in terms of agricultural mechanization technology research and development. And even in areas where there are such breakthroughs, the technology is often not introduced to farmers for use.

c. Unfavorable Government Policies and Interventions

The prices of agricultural machinery have risen sharply in the last 20 years, making it unaffordable for the majority of farmers (Ansu-gyeabour, 2004). Although taxes are removed on the importation of farm machinery in most countries in the sub region, the massive devaluation of the currency and high inflation rates in these countries coupled with unavailability of laws and policies favorable to farmers so they could have easy access to soft loans and be able to purchase farm machines and equipment make it difficult for mechanization programmes to succeed in the sub-region (Candia et. al, 2011).

5. The future prospects for agricultural mechanization in Sub-Sahara Africa

This section aims at enumerating what agricultural engineers expect from themselves, other scientists/professionals, farmers and governments:

• Agricultural engineers have to get involved in the training of the needed manpower or experts in agricultural sciences and engineering including IT to develop and execute a sustainable agricultural production system in Nigeria; be actively involved in funding and promoting Seminars and Workshops for disseminating knowledge in agricultural production technology. The experienced staff with good background in different aspects of engineering and agriculture will be required to manage resources that will improve agricultural production and at the same time be environmentally friendly.

• Agricultural engineers and scientists who are familiar and experienced in the production technology, biotechnology and information and communications technology (ICT) required by agro-industrialists are needed in the area of industrial extension services to provide detailed information on capital investment, type of plant and machinery, source of equipment and materials, skills required for the production of intended goods to be produced.

• To achieve integrated rural development, the various activities involved that have lots of science and engineering content, would require the services and expertise of engineers and scientists. Therefore, there must be co-operation with each other and other stakeholders (including the rural farmers) to make the agricultural programme of Nigeria successful.

• There is no gainsaying the fact that local machinery manufacture is the lasting solution to making agricultural development and the development of local maintenance capability available. Government should enunciate policies that would encourage engineers, technicians, technologists, and fabricators to engage in local manufacture of agricultural machines and implements. And encourage local manufacturers through organization of exhibitions, recognition and awards for useful inventions and manufactured products.

• Agricultural engineers and environmentalists should be ready to embrace the influence of IT in agriculture and the environment which are thought by some as the growing giant consumers of information and communication and electronic technologies.

• Agricultural engineers should exploit the full potentials of information and communication services and applications for the social, cultural and economic benefits of everybody.

6. Conclusion

Unlike experiences in other developing continents such as Asia and Latin America, where scientific and technological inputs has led to improvement, farmers in Africa still depend on rudimentary tools for most farm operations. Presently, about 80% of farmers in Sub-Saharan Africa rely heavily on the use of hand tools to cultivate arable lands and less than 10% employ the use of tractor and other machine services. Most smallholder farmers only manage 0.2-2 hectare per cropping season (FAO, 2005). The hoe is a common hand tool used most for tillage and planting activities which is often inefficient and causes delays and limitation in carrying out important primary operations. The drudgery associated with farming and its eventual low returns makes the business unattractive to the youth causing them to leave rural farming communities to urban centers with only the old and frail men and women in the business. It is therefore obvious that the working force on the farm is decreasing at an alarming rate. This must therefore be a wake-up call for governments and policy makers in Sub- Saharan Africa to put in appropriate agricultural mechanization measures to ensure all-year-round food production.

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Preferences and willingness to pay for renewable energy technologies among microcredit beneficiaries in Abia State, Nigeria

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Abstract

The study examined farmers' preferences and willingness to pay for renewable energy in Bende local Government Area. The study specifically examined the socio-economic characteristics of farmers in the study areas using renewable energy, ascertain farmers' preference/choice and willingness to pay for renewable energy, estimate the factors influencing farmers' preference for renewable energy, determined the influence of socio-economic characteristics on farmers willingness to pay for renewable energy and identified the challenges of renewable energy among farmers. Result shows that majority of the respondents 71.25% perceived the renewable energy technologies to be good, while small proportion 28.75% perceived the technologies not to be good. Solar (60%), fuel from crop (46.25%) and wind (38.75%) were major renewable energy technologies choice demanded by the respondents. The variables relating to sex, age, marital status, household size, availability, education, income are the significant variables influencing renewable energy use choice among farmers**.** While sex, household size, education, income, farm size, perception and marital status are factors influencing consumer's willingness to pay for Solar energy technologies. Government has to enact a variety of incentives, regulations, and programs to encourage the production and use of agriculture-based renewable energy. In addition to these measures, it is recommended to revitalize and modernize indigenous knowledge and technologies of using renewable technologies.

Keywords: Preferences, willingness to pay, renewable energy technologies in Abia State

Introduction

The need for renewable energy to serve as an alternative to fossil fuel is no longer news across the globe. This is not because renewable energy is cheap compared to fossil fuels; rather the negative environmental and health effects fossil fuels have on the general populace may be irreversible (Akinwale, *et al*, 2014). Energy is one of the indispensable factors for continuous development and economic growth (Akinlo, 2009). Yet fossil fuels continue to dominate among all primary energy resources despite expressed support by citizens worldwide for alternative energy sources, such as in Italy (Cicia *et al*., 2012).

Public perceptions of alternative energy policy in Nigeria often reflect an understanding of the trade-offs among primary energy sources. Energy choices facing the individual consumer or society as a whole include not only conventional and alternative primary energy supplies, but also efficiency in energy use and changes in lifestyle (Deitz Yola., 2006).

Renewable types of energy, such as solar, wind and fuels from animal waste or other energy crops, offer many opportunities to reduce fuel costs and increase energy self-sufficiency on the farm. As an added bonus, these energy sources can generate extra income through sales of surplus and offer a more sustainable alternative to energy-intensive corn.

Moreover, the energy intensity of global economies (measured as units of energy per dollar of GDP) has been declining since the middle of the 1970s in most parts of the world reflecting the importance of investments in energy efficiency (Ali, 2012). While energy efficiency measures are generally the fastest and cheapest way to reduce energy-related costs, many farmers are now turning to their land and operations to generate renewable energy.

Thus, when policy makers and the public consider energy futures there must be an understanding that the future will include a mix of conventional energy sources, development and expansion of alternatives. With a little initial investment, energy can be made for free from renewable sources such as the sun, wind, and water.

Methodology

The study was conducted in Abia State, South-eastern Nigeria. It has a land mass of 700 square km. Abia State is bounded on the east by the Cross River and Akwa Ibom Sates, on the north by Ebonyi and Enugu States, on the West by Imo State and on the South by Rivers State Abia State was created out of Imo State on August 27, 1991. (NPC, 2006). The state lies between longitudes $7^o\ 23^1$ and $8^0\ 02^1$ East of Greenwich meridian and latitudes $5^o\ 49^1$ and $6^o\ 12^1$ North of the equator. The population of Abia state is 1,913,917 persons made up of 933,030 males and

971,878 females (NPC, 2006). With estimated annual population growth rate of 2.0 per cent, the present population is about 2,368574 consisting of 1,160,141 males and 1,208,433 females. The annual rainfall ranges from 200-250mm while the temperature ranges from 22^0c to 35^{0-}c. A multi-stage sampling procedure was employed to select the sample size needed for the study. In the first stage Ohafia Agricultural zone was purposively selected. The second stage Bende Local Government Area was selected from the agricultural zone. In the third stage, four (4), autonomous communities each were randomly selected from two main villages of Alayi and Igbere which result to eight (8) autonomous communities. In the fourth stage, 10 farmers were randomly selected from each autonomous community given a total of 80 farmers for the study. Primary data were collected from the various farmers through the use of structured questionnaire.

The empirical logistic model to analyze the farmers preference for solar energy technologies is stated as follows:

$$\mathbf{Log(p_i/1-p_i) = \beta_o+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9+\beta_{10}X_{10}+\varepsilon i}\ldots\ldots 1$$

Where

P_i = the probability for positive influence on preference solar energy technologies.

$1-P_i$ = the odd ratio for negative influence on consumer's preference for solar energy technologies.

β = the logistic coefficient for the independent variables.

X_1 = Gender (male =1, female =2)

X_2 = Age (years)

X_3 = Marital status

X_4 = Household size (numbers)

X_5 = farm size (hectare)

X_6 = Expenditure (Naira)

X_7 = Availability (available=1, otherwise=0)

X_8 = Education (Years)

X_9 = Income (years)

ε_i = error term

The probit model for farmers willingness to pay for solar energy technologies is written as follows:

$$P_i(Y=1/X_1, X_2,\ldots,X_k)=\varphi(Z)=\varphi(\beta_0+\beta_1X_1+\beta_2X_2+\ldots+\ldots+\beta_kX_k) \quad - \quad - \quad - \quad 2$$

Where P_i is the conditional probability of willingness to pay (or participant) for the observation i,i.e, φ is the standard cumulative normal, X_k is the vector of explanatory variables which include

X_1 = Age (years)

X_2 = Gender (male =1, female =2)

X_3 = Marital status

X_4 = Household size (numbers)

X_5 = Educational background (years)

X_6 = Monthly income (naira)

X_7 = Farm size (Hectare)

X_8 = Perception (Good =1, bad =0)

X_{10} = Marital Status (married=1, otherwise=0)

ε_i = error term

Table 1: Distribution of perception of the respondents on the renewable energy technologies

Perception	**Frequency**	**Percentage**
Good	57	71.25
Not Good	23	28.75
Total	**80**	**100.0**

Source: Field Survey, 2019.

The result from Table 1 revealed that majority of the respondents 71.25% perceived the renewable energy technologies to be good, while small proportion 28.75% perceived the technologies not to be good. This is truth because renewable energy and farming are a winning combination, such that renewable energy as wind, solar, and biomass energy can be harvested forever, providing farmers with a long-term source of income (Ali, *et al.*, 2012).

Table 2: Distribution of the respondents based on choice of renewable energy technologies

S/N	Energy type	Frequency	Percent
1.	Solar	48	60
2.	Wind	31	38.75
3.	Fuel from animal	11	13.75
4.	Fuel from crop	37	46.25
5.	Solar photovoltaic	5	6.25
6.	Solar thermal electricity	10	12.5
7.	Ocean energy	-	-
8.	Geothermal heat	19	23.75
9.	Hydropower	-	-

Source: Field Survey, 2019. * Multiple Responses Recorded

Table 2 shows that solar (60%), fuel from crop (46.25%) and wind (38.75%) were major renewable energy technologies choice demanded by the respondents. The choice of solar could be due to ease of usage and its effectiveness. The choice of fuel from crop and wind could be due to their availability. Solar photovoltaic, ocean energy and hydropower choice was low. This low subscription to this source could be due to their unreliability and their arbitrary charges.

Table 3: Distribution of respondent based on Maximum amount of money willing to pay

Amount	Frequency	Percentage
10000-100000	37	24.67

110000-200000	80	53.33
210000-300000	33	22.0
Total	150	100.0

Source: Field survey, 2019

The table shows that majority (45.0%) of the farmers are willing to pay between 110000-200000, while 38.33% lies between 210000- 300000 in a month. Also 22.00% are willing to pay 10000-100000. This has implication for decision, choice of off-farm business enterprise as well as sustainability of the enterprise. Nwibo and Alimba (2013) noted that income level of an individual plays a great role in shaping the type of energy to venture into.

Table 4: Logit estimate of the determinants of renewable energy use choice among farmers

Variable	Coefficient	Standard error	Z-ratio
Intercept	-4.592	-19.042	0.000***
Gender	-0.554	-6.277	0.000***
Age	-0.093	-26.711	0.000***
Marital	-0.130	-3.230	0.001***
Household size	0.066	6.068	0.000***
Farm size	-0.030	-0.741	0.459
Expenditure	-0.078	-1.522	0.128
Availability	0.218	2.504	0.012**
Education	-0.019	-1.728	0.084*
Income	0.000	-3.461	0.001***
Wald chi^2	7846.674***		

Survey, 2019. *** Significant at 1%, ** significant 5%,* significant 10%

The logic model was estimated and presented in Table 4. The X^2 and the Likelihood Ratio value indicate a goodness of fit for the equation. The likely hood ratio chi square was significant at 1% indicating that the data fit the model. The variables relating to sex, age, marital status, household size, availability, education, income are the significant variables influencing renewable energy use choice among farmers**.** Gender was significant at 1% and negatively related to renewable energy use choice among farmers in the area. This implies that gender significantly affect their renewable energy use choice among farmers, Gender refers to social identities attributed to women and men. The age of the farmers (X_2) had a coefficient of -0.093 and Z value of -26.711. The result implies that increase in the farmers' age decreases their renewable energy use choice. Specifically, each additional year to the age of the farmers decrease the probability of their choice of use of renewable energy 0.093. This is in line with study carried out by Nnadi and Akwiwu. (2006a). The coefficient of Marital Status was significant at 1% and negatively related to renewable energy use choice among farmers. This shows that marital status significantly influences the renewable energy use choice among farmers.; This is because increase in members of household added more responsibilities to household heads especially when many of the family member depend totally on the household head. The coefficient of household size was observed to be positive and significant at 1% implying that increase in household size increases farmers' renewable energy use choice. Availability was significant at 10% and positively related to renewable energy use choice among farmers. This implies that farmers will use renewable energy a number of times base on availability of the technology. The coefficient for years of education was significant at 10% and positively related to renewable energy use choice among farmers. This implies that as the educational level increases, renewable energy use choice among farmers also increases. The more educated the farmers is, the more his/her preference for renewable energy use choice. The coefficient of income was significant at 5% and it is positively related to renewable energy use choice among farmers. This implies that a unit increase in income will lead to an increase in renewable energy use choice among farmers in the area.

Table 5: Factors influencing consumer's willingness to pay for Solar energy technologies Source; field

Variable	**Estimate**	**Std. Error**	**Z-statistics**	**Sig**
Age	- 0.0008	0.066	- 1.383	0.167
Gender	- 0.229	0.091	- 2.516**	0.010
Household size	-0.049	0.025	-1.988*	0.054
Education	- 0.003	0.025	- 0.103	0.918
Monthly income	1.354	0.303	4.469***	0.000
Farm size	- 0.844	0.311	-2.714***	0.000
Perception	0.745	0.37	5.440***	0.000
Marital Status	-0.023	0.093	-0.250	0.803
Chi Square	**110.638 ****			

Survey, 2019. *** Significant at 1%, ** significant 5%,* significant 10%

Table 5 presents the result of the Probit estimated model. The chi square and the Likelihood ratio value is 110.638 which indicate a goodness of fit for the equation. The result shows that five independent explanatory variables were significant. The variable include sex, household size, education, income, farm size, perception and marital status. Table 5 shows that the coefficient of sex was significant at 5% level of probability and negatively related to consumer's willingness to pay solar energy technologies. This implies that sex significantly affect the consumer's willingness to pay solar energy technologies. This is in line with the finding of Osuji (2012) whose result also shows a positive relationship between sex and willingness to pay. The coefficient of household size was negative and significant at 10% implying that increase in household size decreases consumer's willingness to pay for solar energy technologies. The coefficient of income was significant at 1% level of probability and positively related to consumer's willingness to pay for solar energy technologies. This meant that as incomes increases, the probability of household's willingness to pay for solar energy technologies increases. The coefficient of the farm size was significant at 1% level of probability and positively related to consumer's willingness to pay for pay solar energy technologies. This implies that the higher the number of bird reared, the higher the better farmers' willingness to pay for solar energy technologies. The coefficient of perception was significant at 1% level of probability and positively related to consumer's willingness to pay for solar pay solar energy technologies. This implies as their perception increase, their willingness to pay for the product also increase.

Conclusion

Based on the finding on willingness to pay for renewable energy technologies among farmers in Abia state, Nigeria, the study therefore concludes that majority of the farmers in the study area are willing to pay for renewable energy technologies. Furthermore, sex, household size, education, income, farm size and perception are determinates of willingness to pay for renewable energy technologies among farmers in Abia state, Nigeria

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Effect of processing on the proximate composition of cassava roots and dried chips

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Abstract

Evaluation of proximate composition analysis of three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368) shows that the fresh pulp had moisture ranging from (26.59-35.28 %), dry matter (64.72-73.41 %), ash (0.95-1.10 %), fat (0.67-0.75 %), protein (3.32-3.45 %), crude fibre (0.91-1.08 %), carbohydrate (58.35-67.44 %) and energy (1078.27-1228.46 kJ/100 g) while the dried chips had moisture ranging from (10.87-12.77 %), dry matter (87.23-89.13 %), ash (1.53-2.08 %), fat (0.68-0.74 %), protein (3.94-4.79 %), crude fibre (1.64-1.83 %), carbohydrate (78.89-80.44 %) and energy (1438.88-1464.89 kJ/100 g). The fresh peels had moisture ranging from (18.77-19.56 %), dry matter (80.44-81.23 %), ash (1.20-1.25 %), fat (0.72-0.82 %), protein (4.84-5.62 %), crude fibre (1.52-1.67 %), carbohydrate (71.14-72.34 %), and energy (1335.26-1347.49 kJ/100 g) while the dried peels had moisture ranging from (10.69-11.32 %), dry matter (88.68-89.31 %), ash (3.31-3.67 %), fat (1.63-1.71 %), protein (6.81-7.87 %), crude fibre (2.54-3.18 %), carbohydrate (73.54-73.89 %), and energy (1433.42-1449.38 kJ/100 g). All the analyses were carried out using standard methods. The result shows that [soaking + sun drying] improves and retains the proximate composition of the dried chips when compared with fresh pulp across the varieties except moisture and fat in TMS 98/0505 which had incurred loss of 4.2% in dried chips while [sun drying] only improves and retains the proximate composition of the dried peels when compared with the fresh peels across the varieties except moisture. Significant variation ($p<0.05$) exist in proximate composition between the fresh pulp and the dried chips, the fresh peels and the dried peels across the varieties.

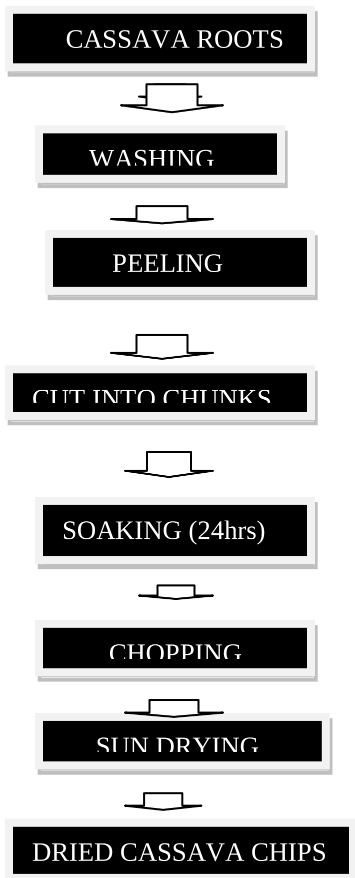
Keywords*:* [soaking + sun drying], proximate composition, fresh pulp, dried chips, fresh peels, and dried peels.

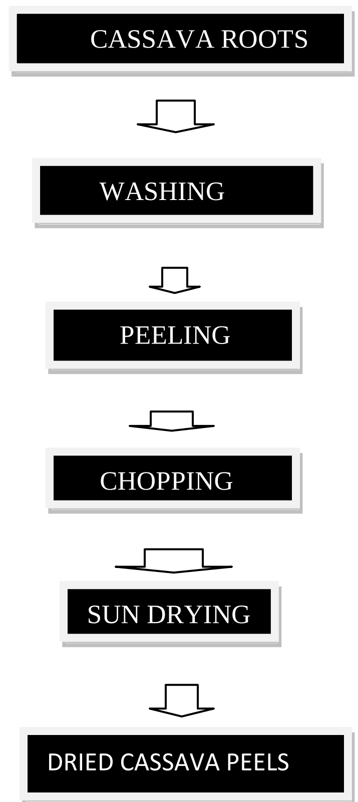
Introduction

Cassava (ManihotesculentaCrantz) has roughly 98 species belonging to the genus Manihot (Monday *et al*., 2017). Cassava serves as a major staple food in the developing countries and is a source of energy (Juanatey, 2018). Cassava root has three distinct layers; the periderm, cortex and pulp. Parboiling, retting, soaking in water and sun drying are the major processing techniques that have been employed to enhance the utilization value of cassava. Cassava roots, unlike any other root crop, have a remarkably short shelf life due to postharvest physiological deterioration. Hence, to prolong the shelf-life of cassava roots, it must be made into dry chips. Dried chips is a shelf stable intermediate product of cassava made from the fresh roots which can be converted to other cassava based products as the need arises (Okaka, 2007). Industrially, dried cassava chips are used as an animal feeds and can also be used to produce other useful products. The peels are the major source of livestock feeds. However, during processing of cassava roots into dried chips it should be expected that the nutritive quality of the root may be affected. Therefore, this research is penciled towards evaluating the effect of processing on the proximate content of three varieties of cassava roots and their dried chips.

Materials and Methods

Three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368) were obtained from the experimental farm of National Root Crops Research Institute, Umudike. The samples were washed and peeled. The pulps as well as the peels for each of the samples were divided into two separate portions such that the fresh pulp and the dried chips on one hand, and the fresh peels and the dried peels on the other were obtained each. The fresh sample (fresh pulp and fresh peels) were cut into smaller sizes, and oven dried at 70 ^{O}C for 4 hours. Each of the samples were ground to its powder form using mortar and pestle and used for the proximate composition analysis. The dried sample (dried chips and dried peels) were produced by first cutting the pulp into chunks and soaking in water for 24 hours, then cut into smaller sizes and sundried into chips. The peels were directly cut into smaller sizes and sun dried into chips without undergoing steeping. The chips were irregular pieces of about 1.5cm thick and 2-3 cm long and were produced within 2-3 days. The chips were ground and use for the proximate composition analysis. Data were subjected to analysis of variance using the Statistical Package for Social Sciences (SPSS), version 20.0. Results were presented as Mean±standard deviations. One way analysis of variance (ANOVA) was used for comparison of the means. Differences between means were considered to be significant at $p<0.05$ using the Duncan Multiple Range Test.





1 (b): Flow chart for production of dried Fig. 1(a): **Flow chart for production of dried cassava chips.** **Cassava peels.**

Results and Discussion

The proximate composition of the fresh pulp, dried chips, fresh and dried peels of the three varieties of cassava roots (TMS 30572, TMS 98/0505 and TMS 01/1368) are shown in table 1. Also, the % gains and losses incurred by the dried chips and the dried peels in the proximate composition of the samples (TMS 30572, TMS 98/0505 and TMS 01/1368) are shown in figure (2) and (3). The result shows that there is a significant increase ($p<0.05$) in the proximate composition of the dried chips and the dried peels when compared with the fresh pulp and the fresh peels across the varieties with the exception of moisture and also fat in TMS 98/0505 which had incurred loss of 4.2% in the dried chips. This could be attributed to the effect of the processing methods applied in the study. This tends to suggest that [soaking + sun drying] improves and retains the proximate composition the dried chips while [sun drying] only improves and retains the proximate composition of the dried peels across the varieties. The moisture loss incurred by the dried chips ranged from 56.6% to 69.2% across the varieties. Also, the moisture loss incurred by the dried peels ranged from 39.7% to 45.3% across the varieties.

Table 1: Proximate composition of the fresh pulp, dried chips, fresh and dried peels of three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368).

Variety	Treatments	MC (%)	DM (%)	ASH (%)	FAT (%)	CP (%)	CF (%)	CHO (%)	E.V (kJ/100 g)
TMS 30572	Fresh Pulp	$35.28^{a}\pm0.74$	$64.72^{i}\pm0.04$	$1.10^{i}\pm0.03$	$0.75^{de}\pm0.01$	$3.45^{i}\pm0.04$	$1.08^{h}\pm0.02$	$58.35^{i}\pm0.84$	$1078.27^{h}\pm13.06$
	Dried Chips	$10.87^{hi}\pm0.04$	$89.13^{ab}\pm0.04$	$2.08^{d}\pm0.02$	$0.74^{de}\pm0.02$	$4.79^{f}\pm0.01$	$1.75^{de}\pm0.04$	$79.78^{b}\pm0.03$	$1464.89^{a}\pm0.06$
	Fresh Peels	$19.56^{d}\pm0.23$	$80.44^{f}\pm0.23$	$1.25^{g}\pm0.01$	$0.82^{c}\pm0.00$	$5.62^{d}\pm0.03$	$1.61^{fg}\pm0.03$	$71.14^{f}\pm0.18$	$1335.26^{e}\pm3.61$
	Dried Peels	$10.69^{i}\pm0.33$	$89.31^{a}\pm0.33$	$3.44^{b}\pm0.02$	$1.63^{b}\pm0.01$	$7.87^{a}\pm0.04$	$2.54^{c}\pm0.08$	$73.84^{d}\pm0.41$	$1449.38^{b}\pm7.17$
TMS 98/0505	Fresh Pulp	$29.42^{b}\pm0.05$	$70.58^{h}\pm0.05$	$1.07^{i}\pm0.03$	$0.71^{ef}\pm0.01$	$3.32^{j}\pm0.03$	$0.91^{i}\pm0.02$	$64.58^{h}\pm0.04$	$1180.57^{g}\pm0.28$
	Dried Chips	$12.77^{f}\pm0.02$	$87.23^{d}\pm0.02$	$1.76^{e}\pm0.00$	$0.68^{fg}\pm0.00$	$4.28^{g}\pm0.04$	$1.64^{f}\pm0.02$	$78.89^{c}\pm0.04$	$1438.88^{c}\pm0.00$
	Fresh Peels	$18.77^{e}\pm0.04$	$81.23^{e}\pm0.04$	$1.20^{h}\pm0.01$	$0.76^{d}\pm0.03$	$5.27^{e}\pm0.01$	$1.67^{ef}\pm0.05$	$72.34^{e}\pm0.03$	$1347.49^{d}\pm0.31$
	Dried Peels	$11.32^{gh}\pm0.03$	$88.68^{bc}\pm0.03$	$3.31^{c}\pm0.01$	$1.71^{a}\pm0.01$	$7.38^{b}\pm0.03$	$2.74^{b}\pm0.00$	$73.54^{d}\pm0.03$	$1438.41^{c}\pm0.18$
TMS 01/1368	Fresh Pulp	$26.59^{c}\pm0.20$	$73.41^{g}\pm0.02$	$0.95^{j}\pm0.01$	$0.67^{g}\pm0.02$	$3.38^{j}\pm0.00$	$0.98^{i}\pm0.08$	$67.44^{g}\pm0.78$	$1228.46^{f}\pm0.54$
	Dried Chips	$11.54^{g}\pm0.08$	$88.46^{c}\pm0.08$	$1.53^{f}\pm0.01$	$0.72^{def}\pm0.00$	$3.94^{h}\pm0.00$	$1.83^{d}\pm0.01$	$80.44^{a}\pm0.11$	$1461.10^{a}\pm1.92$
	Fresh Peels	$19.54^{d}\pm0.06$	$80.46^{f}\pm0.06$	$1.24^{g}\pm0.01$	$0.72^{def}\pm0.03$	$4.84^{f}\pm0.02$	$1.52^{g}\pm0.00$	$72.15^{e}\pm0.78$	$1335.30^{e}\pm0.64$
	Dried peels	$10.79^{hi}\pm0.01$	$89.21^{ab}\pm0.01$	$3.67^{ab}\pm0.03$	$1.67^{b}\pm0.04$	$6.81^{c}\pm0.04$	$3.18^{a}\pm0.00$	$73.89^{d}\pm0.04$	$1433.42^{c}\pm0.01$

MC = Moisture content; DM = Dry matter; CP = Crude protein; CF = Crude fibre; CHO = Carbohydrate; E.V = Energy value.
Values are mean ± SD of duplicate determination. Mean values with the same superscript within the same column are not significantly different ($P > 0.05$).

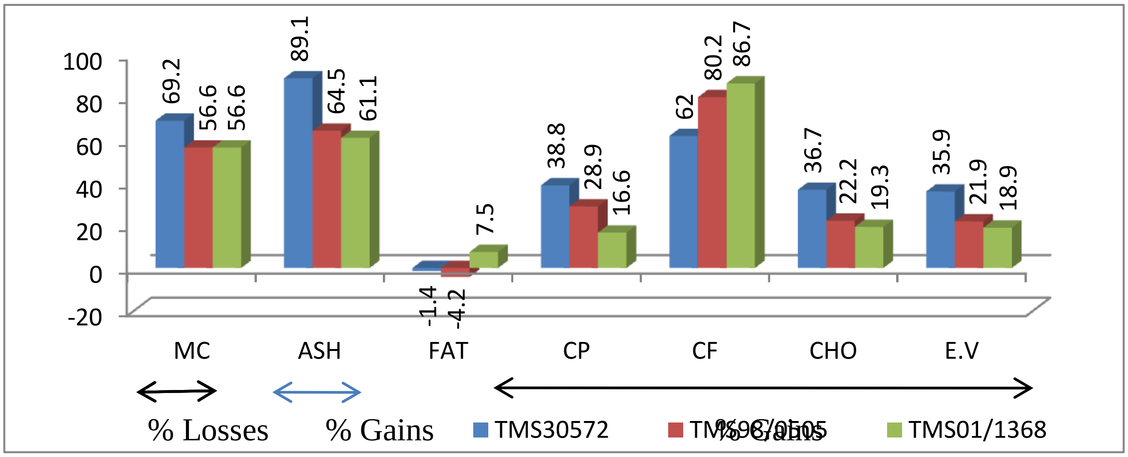


Fig.(2): The proximate chart presentation of % gains and losses incurred by the dried chips

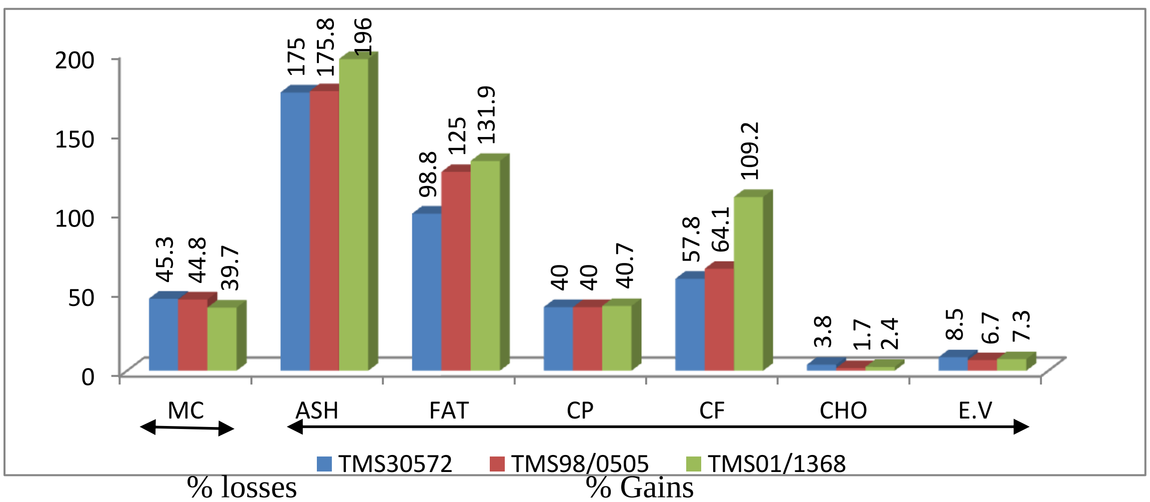


Fig. (3): The proximate chart presentation of % gains and losses incurred by the dried peels

Conclusion

The result shows that [soaking + sun drying] and sun drying methods alone showed the ability to improve and retain the proximate composition of the dried chips and the dried peels when compared with fresh pulp and fresh peels respectively across the varieties except moisture, and fat in TMS 98/0505 which had incurred loss of 4.2% in dried chips.

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SUB-THEME F

GENDER, SOCIOECONOMICS AND AGRICULTURE

Gender Roles on Pro Vitamin A Cassava Commercialization in Anambra State, Nigeria

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Abstract

The study assessed gender roles on pro vitamin A cassava commercialization in Anambra State. Multistage sampling techniques was used for the study. Firstly, two out of the four agriculture zones in Anambra state were purposively selected because of the high level of pro vitamin A production and marketing in the area. The zones are Aguata and Anambra. In the second stage, four communities were randomly selected from each of the agricultural zones, making it a total of eight communities. In the third stage, 15 farmers who produce and sell cassava were randomly selected from each community, making it total of 120 cassava farmers for the study. Data were collected using structured questionnaire. List of pro vitamin A cassava farmers gotten from NRCRI Extension research officers who participated in the dissemination of pro vitamin A cassava served as the sample frame. Data were analyzed using descriptive statistics such as frequency, percentages, mean and represented in tables. Results of the study showed that male farmers had mean age of 35 years while the female farmers had mean age of 33 years, mean of education level was 12 years for both genders, male and female farmers had household mean of five (5) and three (3) persons respectively. Both genders had mean of 4.5km as the distance from their farms to market. The results showed that most of farmers (50.8%) who decide on the sale of vitamin A cassava, who decide on quantity of pro vitamin A cassava to be sold, who decide on borrowing loan to support the business and who decide on the means of transportation were youths. Greater percentage of the farmers (53.3%) who decide on the price of 50kg bags of pro vitamin A cassava and who decide on where to sell pro vitamin A cassava were youths. Also, (48.3%) of the farmers who decide on when to sell pro vitamin A cassava were youths. Result showed that customers prefer to buy pro vitamin A cassava variety because of its colour (80%) which ranked first, gari quality (56.7%) which ranked second and vitamin A content (48.3%) among other reasons. The study therefore concluded that gender plays great roles in pro vitamin

A cassava commercialization in the study area. Youths were actively involved in the decision making on commercialization of pro vitamin A cassava. Therefore, it is recommended that husbands should show interest and be actively involved in pro vitamin A commercialization for high income to be achieved since the results of the study showed low decision from husbands and low monthly income from the male farmers.

Key words: Gender, Roles, Pro vitamin A Cassava and Commercialization

Introduction

Cassava (*Manihot esculenta Crantz*) is a staple food for many people in large parts of Tropical Africa, South America and Asia. Over 700 million people in western and central Africa with an average consumption of approximately 500 calories per day (Ogbuokiri *et al,* 2015). The importance of cassava to resource-poor farmers in Nigeria cannot be overemphasized. Cassava has played and continues to play a remarkable role on the agricultural stage of Nigeria. It can survive droughts, is inexpensive, resistant to pests and easy to grow. Cassava has a special capacity to bridge the gap in food security, poverty alleviation, and environmental protection (Clair and Etukudo 2000).

Pro vitamin A cassava variety is a bio-fortified cassava, according to Onyeneke, *et al.* (2018), it is defined as the enhancement of micronutrient levels of staple crops through biological processes such as plant breeding and genetic engineering. Pro vitamin A cassava has high yields and is resistant to some pest and diseases. The colour of the cassava ranges from deep yellow to light yellow. According to Chavez *et al.,* (2007), Pro vitamin A cassava can provide up to 25% of daily recommended vitamin A intake. To this effect therefore, cassava bio-fortified with vitamin A is an excellent innovation to improve income and health of the populace. Many Nigerians, irrespective of age, sex or geographic location consume less vitamin A than the body needs while women and children remain the most vulnerable (Egesi *et al.*, 2014).

Gender roles refers to the social relationships that have developed between men and women which determine what resources men and women will access jointly or separately, what work men and women perform and for what rewards, what type of knowledge is appropriate for men and women and how and where this knowledge is acquired. It is the socio-cultural differences between males and females as against the biological differences (Sinkaiye, 2005). There is dearth of information on roles gender plays on the commercialization of Pro vitamin A in Anambra State. Hence, the study to assess gender roles on commercialization of Pro vitamin A cassava variety in Anambra State. Specifically, the objectives are to describe the socioeconomic characteristics of the gender, ascertain the gender decision making on the commercialization of pro vitamin A cassava and determine the reasons for why customers prefer to buy pro vitamin A cassava variety.

Methodology

The study was conducted in Anambra State, Nigeria. Multi stage technique was used in selection of pro vitamin A cassava farmers' in the study area. Firstly, two out of the four agriculture zones in Anambra state were purposively selected because of the high level of pro vitamin A production and marketing in the area. The zones are Aguata and Anambra. In the second stage, four communities were selected randomly from each of the two agricultural zones, making it a total of eight communities namely; Omogho, Ajali, Ogboji and Ezira for Aguata zone, Omor, Umumbo, Igbariam and Nando for Anambra state respectively. In the third stage, fifteen cassava farmers were selected randomly from each community in the two zones, bringing it to a total of 120 cassava farmers used for the study. Data were collected using structured questionnaires. List of pro vitamin A cassava farmers gotten from NRCRI Extension research officers who participated in the dissemination of pro vitamin A cassava in the study area served as sample frame. Data were analyzed using descriptive statistics such as frequency, percentages, mean and represented in tables.

Results and Discussion

Socioeconomic characteristic of the farmers

The socioeconomic characteristics of the farmers in pro vitamin A cassava commercialization were presented in table 1. The result showed that male farmers had mean age of 35 years while the female farmers have 33 years mean age. This showed that there were younger female cassava farmers who sell pro vitamin A cassava than their male counterpart in the study area. This implied that both the male and the female farmers were in their active age. The mean of education level was 12 years in both genders, this result showed that they had formal education at secondary level. According to Etwire (2013), formal education is important for impacting literacy and numeracy skills which is necessary for farm planning and budgeting as well as comprehension of good agronomic practices. The result revealed that the males and females had household size of five (5) and three (3) persons respectively, eating and living together under the same roof. This indicated that the farmers had average families size which could serve as source of help in the commercialization of pro vitamin A cassava. Both the male and female farmers in the study area had mean of 4.5km as the distance from their farms to market. This showed that their farms are far to the market place where they sell cassava. The male and female cassava farmers had average marketing experience of 9 years and 9.4 years respectively. Onyegbulam (2016) noted that there is close relationship between marketing and years of experience. This implied that the farmers had long years of marketing which will engage them in pro vitamin A cassava business. The monthly income of male pro vitamin A cassava farmers' showed ₦45,670.83 while the female pro vitamin A cassava farmers' monthly income showed ₦48,500.50. This result indicated that both male and female farmers were still on small scale cassava business.

Table 1: Socioeconomic characteristic of the farmers (n=120)

Variables	Male mean	Female mean
Age (years)	35years	33 years
Education attainment (years)	12 years	12 years
Household size (number)	5 persons	3 persons
Nearest to market (km)	4.5km	4.5km
Marketing experience (years)	9 years	9.4 years
Monthly income (₦)	₦45,670.83	₦48,500.50

Source: Field Survey, 2019

Gender decision making on commercialization of pro vitamin A cassava

The results of table 2 showed that most of farmers (50.8%) who decide on the sale of vitamin A cassava, who decide on quantity of pro vitamin A cassava to be sold, who decide on borrowing loan to support the business and who decide on the means of transportation were youths. Also, greater percentage of the farmers (53.3%) who decide on the price of 50kg bags of pro vitamin A cassava and who decide on where to sell pro vitamin A cassava were youths, respectively. About (48.3%) of the farmers who decide on when to sell pro vitamin A cassava were youths. The results indicated that youths were highly engaged in commercialization of pro vitamin A cassava in the study area.

Table 2: Gender decision making on commercialization of pro vitamin A cassava in Anambra State (n= 120)

Variables	Husbands	Wives	Both husbands and wives	Youths
Who decides on sales of pro vitamin A cassava?	0(0)	55(45.8)	4(3.3)	61(50.8)
Who decides on price of 50kg bag of pro vitamin A cassava in your household?	7(5.8)	8(6.7)	41(34.2)	64(53.3)
Who decides where to sell pro vitamin A cassava?	16(13.3)	0(0)	40(33.3)	64(53.3)
Who decides when to sell (weekly, monthly, quarterly or annually) ?	27(22.5)	6(5.0)	26(21.7)	58(48.3)
Who decides on the quantity of pro vitamin A cassava to be sold?	7(5.8)	0(0)	52(43.3)	61(50.8)
Who decides on taking or borrowing loan to support business?	0(0)	22(18.3)	34(28.3)	61(50.8)
Who decides on means of transportation	0(0)	54(45.0)	5(4.2)	61(50.8)

Source: Field Survey, 2019

Constraints Faced by Genders in the Commercialization of Pro Vitamin A cassava

Results in table 3 revealed that there were many challenges militating against gender commercialization of pro vitamin A cassava in the study area. Top on the list was low financial base (50%) followed by inadequate market stall (45.8%), bulkiness (45%), susceptibility to diseases (45%) poor access road (42.5%) among others were challenges faced by male farmers in pro vitamin A cassava commercialization while the major challenge faced by female farmers in pro vitamin A cassava commercialization was bulkiness constituting the greater percentage (45.8%), followed by low financial base (45%), inadequate market stall (40%), perishability (35%) and low demand (25%) among others. This implied that both male and female farmers faced many challenges in the commercialization of pro vitamin A. This finding is in agreement with the report of Onyegbulam (2019).

Table 3: Constraints Faced by Genders in the Commercialization of Pro Vitamin A cassava (n =120)

	Male		**Female**	
Constraints	***Frequency**	**Percentage**	***Frequency**	**Percentages**
Inadequate market stall	55	45.8	48	40.0
Perishability	41	34.2	42	35.0
Low demand	38	31.6	30	25.0
Low financial base	60	50.0	54	45.0
Bulkiness	54	45.0	55	45.8
Susceptibility to disease	54	45.0	21	17.5
Poor access road	51	42.5	15	12.5

Source: Field Survey, 2019

*Multiple responses recorded

Reason why customers prefer to buy pro vitamin A cassava

Results of table 4 showed the reason why customers prefer to buy pro vitamin A cassava in the study area. The results showed that customers prefer to buy the variety because of its colour (80%) which ranked first. This may be because of the yellowish colour which substitute addition of red palm oil during processing, gari quality (56.7%) ranked second in preference to why customers buy pro vitamin A cassava. Vitamin A content (48.3%) ranked third while *Abacha* quality (45.8%) ranked forth. Other reasons were dry mater content (44.2%) which ranked fifth, fufu quality (31.7 %) ranked sixth and High Quality Cassava Flour (9.2%) ranked seventh. This implied that there are numerous reasons why customers prefer to buy pro vitamin A cassava variety in the study area.

Table 4: Reason why customers prefer to buy pro vitamin A cassava (n= 120)

Reason	*Frequency	Percentages	Rank
Colour	96	80.0	1st
Dry matter content	53	44.2	5th
Gari quality	68	56.7	2nd
Fufu quality	38	31.7	6th
Vitamin A content	58	48.3	3rd
High Quality Cassava Flour	11	9.2	7th
Abacha quality	55	45.8	4th

Source: Field Survey, 2019 *Multiple Responses Recorded

Conclusion

The study therefore concluded that gender plays great roles on pro vitamin A cassava commercialization in the study area. Youths were actively involved in the decision making on commercialization of pro vitamin A cassava. Also, it was revealed that majority of the customers prefer to buy the variety because of its colour, gari quality and vitamin A content among other reasons. Therefore, it is recommended that husbands should show interest and be involved in pro vitamin A commercialization for high income to be achieved since the results of the study showed low decision from husbands and low monthly income from the male farmers.

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EFFECTS OF WOMEN'S CONTRIBUTION TO FARM DECISION MAKING ON LIVELIHOOD OF RURAL WOMEN IN RIVERS STATE, NIGERIA

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ABSTRACT

This study sought to ascertain farm activities undertaken by women; examine areas of decision making where women are involved; investigate perceived effects of women contributions on their livelihood. Data for the study were collected using validated questionnaire from 240 rural women selected through multi-stage sampling techniques. Descriptive statisticssuch as mean, frequency score, percentages were used to analyze data. . The women agreed that areas available in making decision were land (X = 3.50), labour (X = 3.45) and capital (X = 3.21).The women were involved inin decision on marketing time and place (X = 2.6), price regimes (X = 2.5) and use of proceeds (X = 2.5). The women consider their contribution as being capable of having positive effect on their farm size (X = 3.1), increase their self esteem (X = 3.2), renew their zeal and motivation in farming (X = 3.1), increase their income (x = 3.9), among others. A significant relationship (R^2 = 0.691) was found between the socio-economic characteristics of the rural women and their level of contribution to household farm decision-making. According to the result, the rural women in the three zones of Rivers State did not differ in their perceived contributions to household farm decision-making (p= 0.6140).The study recommends among other measures, that stakeholders in agricultural and rural development should lobby for a gender sensitive bill to address the inequality in agricultural resource use.

Keywords: rural women, household farming, farm decision making, rural development, gender

INTRODUCTION

Women are key players in the agricultural sector of most developing countries of the world. However, despite these major roles, men have reportedly continued to dominate farm decision making, even in areas where women are the largest providers of farm labour (Ani, 2004). This could be counter-productive, because there is bound to be conflict when women, as key players, carry out farm tasks without being part of the decision making process, especially when the decisions fail to recognize their other peculiar household responsibilities. Previous efforts at estimating women's role in agriculture tend to concentrate on evaluating their labour contributions. There has been little farm level information regarding their role in decision making, particularly in a male dominated field. Nigeria,likesomeotherdevelopingcountriesisprincipallyanagrariannationwith the greater percentage of her labour force engaged in the agricultural sector of the economy. The agricultural sector plays an important role in Nigeria's economy contributing about 40% of the GDP (Olomola, 2006) and employing 65% of the adult Labour force (Adedipe,Okuneye and Ayinde, 2004).

Agriculture is the principal source of livelihood in Nigeria and the sector employs nearly three quarters of the nation's workforce (Phillip et al, 2008). It consists of all activities geared towards the production of crops (food, cash crops, forest trees) and animals (livestock, poultry, fisheries, etc.) for food and fiber. Food, according to Uwaegbute (2011) is a prerequisite for economic and social development because its nutrients energize the body, promote growth, and protect the body and co-ordinate body activities for optimal growth, development and effective functioning. Fiber, on the other hand, provides the base for primary and secondary processing and reduction in post-harvest losses (Yar'Adua, 2008). It is important to note that the contributions of agriculture to the nation's economic development cannot be separated from the contributions of women, who constitute the major agricultural labour force.

About one- third to half of the total labour contributions to agriculture is made by women (Mollet, 1990). This phenomenon is not only observed in Nigeria or Africa, but across the globe. For instance, in Thailand and India, about eighty-five percent of female workers are in agriculture, and sixty percent in Malaysia (Mollet, 1990). In Africa, women have been found to play active roles in agricultural production, performing about 60-80 percent of all agricultural production activities (Banji&Okunade, 2011). African women do most of the work in the area of plant production, animal production, transportation of crops from farms to the house, processing, storage and marketing (Ayieko, 1986 in Banji and Okunade, 2011). The findings of Nonyelu (1991) reported by Mgbada (2010) revealed that in Africa, women account for 75percent of farm labour, 70percent of them are involved in harvesting, handled 50percent of storage operations, while processing of food was entirely in the hands of women.

Back home in Nigeria, over 70percent of the population lives in rural area, implying that majority of Nigerian women are rural dwellers, and constitute the major food producers Ibe, (2011). According to him, the rural women's contributions to agriculture serve as the base for the production of food and fiber, as well as sources of capital to the small-scale farmers in Nigeria who actually feed the nation. According to Mgbada(2010),55 percent of women provide labour force in subsistence agriculture. The study conducted in Northern, Eastern and Western parts of Nigeria by Adekanye (1981) as reported in Banji and Okunade (2011) revealed that farming was generally second most important economic activity of the rural women, while Yoruba women of South -Western Nigeria engage in food processing and sales of farm commodities, Igbo women of Eastern Nigeria engage in farming activities like oil palm, cassava, and maize products, Hausa/Fulani women of Northern Nigeria specialize in farming and trading which account for a greater productivity from women.

For instance, extension services do not regularly reach women farmers (Walker, 1990). Male farmers often form the primary recipients of training in new technologies and mechanization that allow them to move into cash cropping and that increasingly gives female farmers the sole responsibility for producing subsistence crops or force them out of agriculture entirely (Dauber and Cain, 1987).Formal and informal sources of agricultural credit in Nigeria only provide little facilities to deserving rural women for modern agricultural production. According to Ani (2004) as reported by Danejі*et al*. (2011),poor access to credit facilities, lack of adequate educational training, lack of collateral in getting security for loan result to women's lack of access to capital to acquire necessary inputs for agricultural production. While both men and women are active participants in household farming, the nature and extent of their contributions vary in different context. Gender dynamics also influence access and control over the benefits of production. According to Hovorka (2005), women do not have access and control to land.

In terms of planning for farm families, Saito and Spurling (1992) accused male extension agents and development planners of bias against women as men are often used as references for development policies, programmes and project. Otobe (2014) regrets that much of what the rural women do are not accounted for in the system of national accounts. The poor or total lack of access to basic household production factors like land, capital, labour and management training also point to the inadequate contribution of rural women to household farm decision making. Banji and Okunade (2011) noted that women do not receive equitable opportunities or decision making privileges as men and as a result encounter more difficulty than men in gaining access to land, credit, technical assistance and commercial market outlets.

In most rural contexts, rural women do not have rights to personal lands as they depend on their husbands except where they are able to buy land for themselves (Ani, 2004). Thus, their suggestions with respect to the use of household lands are left to their husbands' discretion. Household labour do not usually reside within the rural women's disposal as the men are often the ones who are in-charge. The family capital is yet another production factor found in the custody of men. According to Youssef (1995), steps taken to make credit available to the poor have mostly favored the men. To help their poor credit access, rural women try to obtain cash through other means, usually through non-farm activities (Banji and Okunade, 2011). Several information and training for improved household farm management are given to men with the assumption that they will transfer to women farmers in their households, which does not hold true in most cases.

Women in riverine areas of Rivers State are involved in fishing, processing and marketing of fish as their major sources of livelihood. They are however, likely to differ from their counterparts in the inland areas. Rural women in the inland areas are often confronted by several forms of social constraints in their effort to contribute in decision regarding what, when, where and how to utilize household farm resources for crop and livestock production, Banji and Okunade (2011) opined that rural women in riverine areas need to be reached with new agricultural information to improve their fishery production. The implication of this is that unlike their counterparts in inland areas, the challenge faced by rural women in Rivers State towards contributing to household farm decision-making may be lack of equal access to agricultural information relative to their male counterparts as opined by Saito and Spurling (1992). According to them, extension services do not regularly reach women farmers due to the culturally imposed bias that favor's men. The above scenario implies how a social milieu can influence the nature and magnitude of women farmers' contributions in household farm decision-making.

OBJECTIVES

1. Ascertain the various farm activities undertaken by the women of the household.
2. Determine the level of women's involvement in household farm decision making

3. Examine perceived constraints of women's contribution to household farm decision making.

METHODOLOGY

The study was carried out in Rivers State, Nigeria. It is located in South –South zone of Nigeria, Itis bordered in the South by the Atlantic Ocean, to the north by Imo, Abia and Anambra States, to the East by Akwa –Ibom state and to the west by Bayelsa and Delta state. (Ministry of Lands And Survey, 2007)It lies between latitude 6^o 45 North and longitude 7^o 23 East and is situated in the southern boundary of the humid zone Meteorological Department, Rivers State Ministry of Lands and Survey, (2007). The mean annual rainfall in the area is 3300mm, lasting from March to November. The mean daily temperature during the wet season is 26^0 C with mean relative humidity of 96 percent.

The population of the study was comprised all rural women farmers in Rivers State. Multi-stage sampling technique was used in selecting respondents for the study. In the first stage, the local government area in the zones was the stratified into rural and urban, The Rural local government areas were purposively sampled as the women under investigation are rural women farmers. The third stage involved random selection of 50 percent of the rural local government area, zone 1=3, zone 2=2 and zone3=2.. The fourth stage was the random sampling of two communities from each of the sampled local government area. The fifth stage involved the random selection of two villages from each community and finally ten rural women farmers from each village to give a sample size of 280 respondents for the study. The sample frame was the list of rural women farmers compiled by the resident extension agents and community leaders in the sampled areas. Primary and secondary data were used for the study. Primary data were collected from rural women with the aid of structured questionnaire.

Descriptive and inferential statistical tools were used to analyze data collected from the study, Frequency table, percentage, mean standard deviation, Ordinary Least Square, multiple regression technique and Analysis of Variance (ANOVA) were used in the analysis. Specifically, frequency table and percentages were used to achieve objectives one and two, while objective three was achieved using mean score analysis.

RESULTS AND DISCUSSIONS

Table 1: Distribution of women by farm activities undertaken in the household

Household farming activities	**Highly undertake**	**Moderately undertaken**	**Not undertaken**	**X**	**SD**	**Remark**
Bush clearing	12	120	108	1.6	0.6	AFA
Bush burning	109	117	13	2.4	0.5	AFA
Stumping	06	81	143	1.4	0.5	N AFA
Ridge making	14	136	90	1.7	0.6	N AFA
Seed selection	101	102	37	2.3	0.6	AFA
Planting	92	114	34	2.3	0.6	AFA
Staking	98	113	30	2.2	0.5	AFA
Weeding	103	78	59	2.2	0.6	AFA
Fertilizer application	94	109	47	2.2	0.6	AFA
Pests and disease control	53	54	123	1.4	0.6	AFA
Transportation of harvested crops	11	123	106	2.2	0.5	AFA
Storage of harvested crops	84	106	50	2.4	0.6	AFA
Processing of produce	104	115	21	2.3	0.4	AFA
Castrating farm animals	02	21	217	1.1	0.5	NAFA
Breeding farm animals	87	104	42	1.9	0.6	NAFA
Marketing	36	181	13	2.0	0.5	AFA
Grand mean				2.0	0.5	AFA

Source: Field survey data, 2016 ($\bar{X}\geq$ 2.0 (AFA), X< 2.0 (NAFA)

AFA =Area of Farm Activity **NAFA** = Not Area of Farm Activity

Table 2: Distribution of women by Level of involvement in household farm decision making

Areas of decision making	**SA**	**A**	**U**	**D**	**SD**	$\bar{X}$	**S.D**	**Remark**
Storage and marking of farm produce	85	43	36	49	27	3.5	0.5	Involved
Purchase and sale of farming implements	81	51	38	60	10	3.5	0.4	Involved
Purchase and sale of farmlands	50	48	46	81	15	3.2	0.5	Involved
Farm credit	75	41	56	59	09	3.2	0.3	Involved
Grand mean						**3.4**	**0.4**	**Not involved**

Source: Field survey data, 2016 $\bar{X}\geq$ 3.0 (areas of decision making $\bar{X}<$ 3.0 (Not areas of decision making)

Table 3: Distribution of women by constraints to women's contribution in household farm decision making

Constraints	SA	A	U	D	SD	X	S.D	Remark
Low/poor education of women	42	39	56	39	64	2.8	0.3	No constraint
Traditional practices/expectations from women								

	96	112	26	04	02	4.2	0.5	Constraint
Weak gender laws	87	94	34	07	08	3.9	0.3	Constraint
Weak extension support	26	24	59	48	83	2.4	0.2	No constraint
Gender sensitive technologies	24	32	26	53	105	2.2	0.5	No constraint
Poor access to credit	91	84	39	13	13	3.9	0.6	Constraint
Social roles and responsibilities in family	42	36	49	73	40	2.9	0.5	No constraint
Overbearing men's dominance	51	37	54	26	72	2.9	0.3	No constraint
Low self esteem	47	52	49	32	60	3.0	0.4	Constraint
Low income of women farmers	99	36	47	29	29	3.6	0.4	Constraint
Grand mean						**3.1**	**0.4**	**Constraint**

Source: Field survey data, 2016

($\bar{X} \geq 3.0$(Constraint) ($\bar{X} < 3.0$ (Not Constraint)

Farm activities undertaken in the household

The result of the distribution of the women by household farm activities is shown in Table 1. Based on 2.0 mean discriminating index for area of farm activity, the result shows that eleven out of seventeen household farm activities investigated in the study were performed by women in the study area. The mean scores ranged from 2.0 to 2.4 while the standard deviation ranged from 0.4 to 0.6.and implied that the women were homogeneous in their rating of the individual activities. Bush burning (X = 2.4; SD = 0.5) and storage of harvested crops (X = 2.4; SD = 0.6) were the most engaged area of farm activity by the women. This is likely because bush burning and storage of harvested crops are less backbreaking farming activities. Seed selection and planting were next on the rating with mean scores of (X = 2.3; SD = 0.6) and (X = 2.3; SD =

0.6), respectively. Going by the view of Umoh, Ikeme and Ekanem (2015) less backbreaking farm activities are often associated with women in family farming, the result of the farm activities which were highly undertaken by the women were therefore anticipated. Other areas of farm activities carried out by the women included: weeding (2.2), staking (2.2), seed selection (2.3), transportation of harvested crops (2.2) and fertilizer application. (2.2). Apart from staking, which could be energy sapping the other listed activities are easier and need smooth and polish touch. These areas of farm activities according to Adegeye and Ayodele (1996) mean so much to household farm business and in complementing women's resources for greater productivity. This therefore explained why they were highly undertaken. On the other hand, bush clearing (X = 1.6), stumping (X = 1.6), ridge making (X = 1.7), castrating of farm animals (X = 1.1) recorded low participation of the women. Adisa and Okunade (2011) explain that the activities receive low patronage from women as they are either regarded as back-breaking tasks or reserved for men and energetic youths. This result also aligns strongly with the findings of Mohammed *et al*. (2009) which reported that women perform less back-breaking farm activities like marketing, planting/sowing. Given that most primary production activities are back-breaking in nature, this finding implies that the absence of energetic men and youths in household farming will decline women productivity through increased labour/production cost. Land includes any natural resources used to generate farm produce. The income that the resource owners earn in return for using these resources constitutes the rent. The effort the people contribute to the production of farm produce is the labour. Capital is the farm machineries, the tools, household members use to produce farm produce for profit purpose. The acumen for successfully utilizing land, labour and capital entails management.

Level of women involvement in household farm decision making

Table 2 shows the result of the distribution of women by area of involvement in decision making. According to the result, the women indicated the following areas of decision making land ($\bar{X}$= 3.5), labour ($\bar{X}$= 3.5), capital ($\bar{X}$= 3.2) and management of household farm resources ($\bar{X}$= 3.2). This result agrees with the findings of Adisa and Okunade (2011) that farm decision are made on the effective use of land, household capital, household labour and knowledge in family farming. Women are often considered as workaholics in farming as they spend greater time towards optimum farm operation Otobe, (2014). According to him, their preoccupation is to ensure that every part of the farm land is cultivated says. Thus, when they are made part of the decision making process they also influence and contribute ideas that ensure that household lands are put into optimal use. Corroborating this, Ironkwe (2009) noted that the outcome of women's intense farm activities include the cultivation of greater expanse of farm land, adequate weed control, reduction in postharvest losses, wide distribution which culminate in increasing the productivity and income of women farmers. With adequate opportunity to influence household labour mobilization women demonstrate capability in making input that lead to increased productivity (ILO, 2012).Women often make wise use of household labour to undertake backbreaking operations like bush clearing, ridge making, staking that often undermine their productivity. In like manner, women contribute ideas that mildly persuade every member of the household to be part of the labour force. In terms of utilizing household farm capital Ugboaja and Obinna, (2009) describe women as prudent financial managers who deploy household capital in the most profitable. They assist in taking decisions that prioritize household needs as well as engender cost effectiveness. Poor management background of many women according to them is part of the price of gender inequality that denies women adequate opportunity and access to entrepreneurial education and training. This situation sets the stage for synergy of efforts and ideas between women and other household members towards efficient use of household resources. The average standard deviation of 0.4 shows that the women were unanimous in their views and hence implies that greater productivity of women involves giving them adequate opportunity to contribute towards decisions regarding what to farm, how to farm, when to farm and where to farm.

Constraints to women's contribution in household farm decision making

The result in Table 3 is the distribution of women by factors constraining their contributions to household farm decision making. Based on 5 points Likert rating scale of agreement with 3.0 discriminating index, 5 out of 10 items listed were perceived as constraints while the other 5 items were not considered as constraints to women's contribution to decision making. The standard deviation ranged from 0.2 to 0.5, implying unanimity in their responses as there was minimal deviation from the mean .The result reveals that traditional practices ($\bar{X}$= 2.8), weak gender laws ($\bar{X}$= 3.9), poor access to credit ($\bar{X}$= 3.9), low self esteem ($\bar{X}$= 3.0) and low income of women farmers ($\bar{X}$= 3.6) were adjudged by the women as constraining conditions to their contributions to household farm decision making, rural are culture bound Nnadi and Amaechi, (2009) and thus the activities of women in such an environment are often stereotype, bereft of creativity and ingenuity. The expectations in such a setting are regimentation and total submission to the dictating culture. Again, in such an environment of total obedience, the saving grace could be the enactment of favorable laws, edicts and decrees but these are either in extinction or where they exist, they are weak. This thus worsens the problems of the women. The poor access to credit could be attributed to the superimposition of men's interest, whims and caprices over and above these women by culture. Also, the issue of collateral could be problematic for credit pronouncement as a woman and her asset are considered her husband's. This is further reinforced by little or no provisions legally for the protection of the women. In this bid, lack of incentive, like subsidy, loan, etc. were identified as limitations to women's exploits in agricultural production (Ifenkwe, 2009; Yusuf, et al 2009). The low esteem is a function of how the women see themselves vis-a–vis how the society see them. With poor cultural projection and protection, weak institutional support and poor governmental security.

CONCLUSION AND RECOMMENDATIONS

The study concludes that rural women of Rivers State do not contribute to household farm decision making. The few areas of the women's contribution are related to their role in the household which is mainly domestic in nature, such as home economics, processing, storage, etc. Women's contributions to household farm decision making are capable of improving their livelihood conditions. The women's contributions are largely constrained by traditional and institutional factors.

Based on the findings of the study, the following recommendations were made:

1. Women should be assisted through the Women in Agriculture (WIA) programme to organize themselves into co-operative groups to enable them pool their meager resources together towards mobilizing means of production like lands, finance, inputs, labour, hitherto denied them by the traditional African value system. Such a platform would provide avenue for periodic thrift contribution, input supply at highly subsidized rate, cheap labour mobilization, cross fertilization of ideas through interpersonal interaction amongst members, among other potentialsthat are capable of increasing their productivity,

2. Federal and States' Ministries of Agriculture, interventionist agencies, human right organizations, research institutes, universities, input suppliers and other stakeholders in agricultural production system should synergize efforts towards lobbying members of the legislative houses for gender sensitive bills that would grant women farmers easy and greater access to agricultural support services, institutions and systems.

3. Educational and leadership empowerment programmes should be mounted for women to enable them develop high self-concept and self-worth by the state Agricultural Development Programmes.

4. Special considerations such as less interest rate, alternatives to landed collateral should be given to women for lending by financial institutions.

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Assessment of Socio-Economic Factors Influencing Non-Timber Forest Products (NTFPS) Among Rural Dwellers In Edo State

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Abstract

This study investigated those factors which influenced the gathering of NTFPs to standard of living of rural dwellers in Edo state Nigeria. This research article explores cases of socio-economic factors influencing NTFPs. Motivational factors, major NTFPs and problems encountered in NTFPs gathering, in the forest. Were all identified in the forest. Data were collected with the aid of structured questionnaire from 347 respondents; however 270 copies of questionnaire were usable giving a response rate of 77.8%. The data were analyzed using descriptive statistics and logit regression model. Finding reveal that, non-timber forest products gathering in Edo State was male dominated (73.3%), more than 80% of the respondents were married men while less than 1% were single. This shows that NTFPs as that of settled minds and that it contributes to household economic stability in one way or the other. Most of the respondents (41.3%) had secondary education, 40.3% had primary education, while 11.7% had no formal education. 82% of them are literates and had one form of education or the other. Also, 71% of the respondents had experience about NTFPs gathering. Major non-timber forest products gathered in the area were Fuel wood (86.7%), vegetables (86.3%) and medicinal plants (58.1%).The result further revealed the motivational factors which influenced NTFPs gathering significantly a crossed the zones were, forest availability (mean=4.40) in Edo North, (mean= 4.28) in Edo Central and Edo South respectively, while in Edo North free access to forest (mean=3.97).The Socio-economic factors influencing NTFPs significantly were married status and years of experience However, the significant relationship for years of experience implies that the more years spent in non-timber forest gathering, the more experiential knowledge gained from participation in non-timber forest products gathering in the study area and rainfall (mean=3.11) was considered a severe constraint by the respondents in the zones. .

INTRODUCTION

Non-timber forest products (NTFPs) are defined as any forest-derived tradable products apart from timber and have been identified as an important way for households in developing countries to adapt to food insecurity situations (Mahassin, 2011 and Mulenga 2011. Non-timber forest products include products such as bark, roots, tubers, leaves, fruits, flowers, seeds, resins, honey, mushrooms, and fuelwood (Sunderland *et al*., 2003). It is estimated that about 60 percent of the population in sub-sahara Africa live and work near forested land (Mulenga, 2011). They rely on

NTFPs in order to satisfy their basic needs such as income, food, medicine, wood, fodder for animals, shade and soil fertilization (Onuche, 2011 and Edeoghon *et al* 2017). As example fuelwood is collected for subsistence and income generation while wild fruits and leaves are also collected because they are the major source of micronutrients for rural households (Sunderland, 2014). Hence NTFPs is important to rural households in developing countries because they contribute to their nutrition and provides income which may be used to buy food for the family (Shaanker, 2004 and Shackleton and Shackleton, 2004). In sub-sahara Africa, fuelwood and charcoal remain the main source of fuel for populations in rural and urban areas (MEAAI, 2010). Array of edible foods that are obtained from trees and shrubs, either growing naturally in the wild or cultivated on farms and around homes (FAO, 1989 and Mahassin, 2006). The standard of living includes factors such as income, quality and availability of employment, class disparity, poverty rate, quality and affordability of housing, hours of work required to purchase necessities, gross domestic product, inflation rate, amount of leisure time every year, affordable (or free) access to quality healthcare, quality and availability of education, life expectancy, incidence of disease, cost of goods and services, infrastructure, national economic growth, economic and political stability, political and religious freedom, environmental quality, climate and safety (HDI, 2016).

METHODOLOGY

Area of Study

The study area was Edo State, south-south Nigeria. The state shares boundary with Delta State in the south, Ondo State on the west and Kogi State in the north. The state has 18 local government areas with Benin City the capital. The state has a population of about 4milion people, (National population commission, 2006) and is made up of three major ethnic groups namely; the Benin, Esan, Afemai and others. The state lies within the geographical coordinate of longitude 06°04'E and 0643'E and latitude 05°44N and 07°34'N. Edo State is endowed with abundant natural resources. The principal mineral resources include; crude oil, natural gas, clay, chalk, marble and limestone. Agriculture is the predominant occupation of people in the state. The climate is tropical with raining and dry season alternating annually. The wet (rain) season which lasts between April and November and the dry hot season between December and March.

Sampling Procedure and Data Analysis

Multi-stage sampling procedure was employed in selecting respondents from the study population. The respondents were drawn from the three (3) agro-ecological zones in the State. The first stage involved Purposive sampling of one Local Government Area (LGA) in each of the agro-ecological zones based on closeness to forest and where respondents had high intensity in gathering of non-timber forest products. This was obtained from the preliminary study. A total of 3 LGAs was sampled for the study.

In the second stageTwo (2) villages were purposively selected from each of the Local Government Areas (LGAs) based on closeness to forest and high intensity of non-timber forest products gatherers. Thus, making a total of six (6) villages in the 3(three) zones.

The final stage involved random selection of 347 respondents out of a total population of 556. Thus, a total of 270 respondents provided usable information for this study. The study made use

of the formular provided by The Lohr (2010) formula to determine the sample size from the study population. This formula is explained below

- The formula is given as
- $\frac{Z_{\propto/2}.S^2}{e^2+(Z_{\propto/2}.S^2)/Ni}$ (Lohr, 2010)
- Where $Z_{\propto/2}$ =1.96
- e=0.05
- S^2= P (1-P)
- P = Population of ith stratum to total population ($\frac{Ni}{Nh}$)
- N_i = Total number of population per ith stratum.
- N_h= Total population.
- Based on the formula, a total of 347 respondents were obtained with response rate of 77.80%.

Analytical techniques

Descriptive statistics such as frequency count, percentages were used to describe the socio-economic characteristics of the respondents.a likert type rating scale was used to ascertain the motivating factors. This was achieved by using a construct of motivating factors for participating in Non-Timber Forest Products gathering using a five scale rating of strongly agree, agree, not sure, disagree, strongly disagree. These were scored in their order as follows; strongly agree Scored 5, agree Scored 4, not sure Scored 3, disagree Scored 2,and strongly disagree, Scored 1. A mean score of 3.0 was obtained as follows (5+4+3+2+1) =15/5=3.0, a value of 3.0 and above implied high motivating factors and below 3 implied low motivating factors.

Testing of hypothesis:

The wald-test component of logit regression was used to test the hypothesis.

Hypothesis one: There is no significant relationship between respondents' socio-economic characteristics and their standard of living. The wald test component of logit regression was used to test this hypothensis one.

Model specification

The implicit form of the model is specified as:

$$\text{Log}\left(\frac{\bar{\lambda}}{1-\bar{\lambda}}\right) = \beta_0 + \beta_1 \text{ x } 1 + \beta_2 x_2 + \ldots \beta_m X_m + u$$

$\bar{\lambda}$ = probability
X = independent variable
Y = Standard of living
X_1= Age
X_2 = Sex
X_3 = Marital status
X4 = Educational qualification
X_5 = House hold size
X_6 = NTFPs gathering experience
X_7 = Membership of Association
X_8 = Extension contact
X_9 = Length of stay in the village
X_{10} = Nature of NTFPs gathering

Motivating factors for participating in Non-Timber Forest Products gathering

The result in Table 5revealed the factors which influenced NTFPs gathering significantly were, forest availability (mean=4.40) in Edo North, (mean= 4.28) in Edo Central and Edo South respectively, while in Edo North free access to forest (mean=3.97).

Socio-economic characteristics of respondents

All socio- economic characteristics measured in influencing respondents' views on standard of living of rural dwellers are summarized in Table 4. As shown in Table 4, there are differences in some of the factors across the three zones selected for the study. Some of the differences are noticeable in respondents around the South zone with modal age between 41-50 and average years of formal education. These differences positively influence respondents' view on NTFPs. Result of Table 4 also shows that respondents' age, education and experience were all significant variables in forest products across the three zones. Furthermore, the respondents' age, marital status and experience implies that there is a strong influence on how far rural people would appreciate the resources in the forest that are non-timber.

Hypothesis 1: Relationship between socio-economic characteristics of the rural dwellers and **standard of living**.

Table 6: shows that years of experience (β = 0.21, $P \leq 0.01$)and marital status (β = 0.41, $P \leq$ 0.05) were significant predictors of living standard. The marital status odd ratio of 0.66, indicate that odd of having a high standard of living was 0.66 times more for the gatherers that were

married relative to gatherers that were not married. The findings show that experience and marital status among the socio-economic characteristics of gatherers in the study area had positive significant effect on their standard of living. However, the significant relationship for years of experience implies that the more years spent in non-timber forest gathering, the more experiential knowledge gained from participation in non-timber forest products gathering in the study area.

CONCLUSION AND RECOMMENDATION

The study concludes that the zones investigated (Edo south, Central and North) had good awareness of the forests and the forest produce which are non-timber in nature. It is essential to know that among the various forest products common in the three zones were fuel-wood, vegetable and giantrat. Thecontribution of NTFPs to food security differs across ecological zones/settings, seasons, income level, etc. Non-timber forest products (NTFPs) also contribute to achieving household income. It has been well-known that a significant number of rural, tribalcommunities to a large extentdepend on forest for their food, nutrition, healthcare needs and their income from NTFPs. They also contribute to the well-being of rural households, particularly the poor, in terms of food security, nutrition, health and subsistence. Augmenting livelihoods of the forest dependent communities requires some focused intervention on NTFPs. Facilities pertaining to storage, grading, processing and value addition through convergence of existing schemes and programs in private and public sectors should be promoted and created. Communities should be empowered with information about the market, policy and products to enable them strategizing and accessing better returns from NTFPs.The study therefore recommends that rural dwellers should form themselves into association because such association will aid in collective soliciting for assistance from governmentand other funding agencies. Also, more awareness should be created by the extension agents on the importance of forest conservation.

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Table 1: Sample frame from the pre survey

ZONE	VILLAGE	MALE	FEMALE	TOTAL
EDO SOUTH	Ekehuan	69	21	90
	Ugbine	72	24	96
EDO CENTRAL	Udowo	45	48	93
	Ugbokhare	82	10	92
EDO NORTH	Iyerekhu	80	15	95
	Ibie Nafe	54	36	90
		402	154	556

Respondents (Total= 556)

Source: Computed from field survey data, 2018

Table 2: Sample Size: Using non-proportionate simple random Sampling Size

ZONE	VILLAGE	MALE	FEMALE	TOTAL

EDO SOUTH	Ekehuan	40	16	56
	Ugbineh	41	18	59
EDO CENTRAL	Udowo	28	35	63
	Ugbokhare	45	7	52
EDO NORTH	Iyerekhu	44	12	56
	Ibie Nafe	32	29	61
		230	117	347

Source: Computed from field survey data, 2018

Table 3: Major NTFPs in the study area

	Edo South, n = 89		**Central, n = 87**		**North, n= 94**		**Pooled , n = 270**	
Variable	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Fuel wood	81	91.0	66	75.9	87	92.6	234	86.7
Palm wine	9	10.1	2	2.3	31	33.0	42	15.6
Oil palm (Fresh fruit bunches)	43	48.3	27	31.0	21	22.3	91	33.7
Medicinal plant	51	57.3	37	42.5	69	73.4	157	58.1
Mushroom	15	16.9	5	5.7	37	39.4	57	21.1
Bitter bush	3	3.4	21	24.1	21	22.3	45	16.7
Rope	14	15.7	3	3.4	36	38.3	53	19.6
Vegetables	68	76.4	73	83.9	92	97.9	233	86.3
Snails	33	37.1	31	35.6	32	34.0	96	35.6
Chewing stick	15	16.9	12	13.8	33	35.1	60	22.2
Bitter-kola	24	27.0	32	36.8	37	39.4	93	34.4
African pears	22	24.7	11	12.6	19	20.2	52	19.3
Pepper fruits	9	10.1	41	47.1	26	27.7	76	28.1
Cherry	23	25.8	57	65.5	25	26.6	105	38.9

Cotton plant	12	13.5	33	37.9	13	13.8	58	21.5
Rubber	8	9.0	9	10.3	27	28.7	44	16.3
Black walnut	29	32.6	21	24.1	45	47.9	95	35.2
Jartropha	12	13.5	17	19.5	32	34.0	61	22.6
Wrapping leave	30	33.7	22	25.3	77	81.9	129	47.8
Scent leaf	19	21.3	5	5.7	12	12.8	36	13.3
Monkey sugarcane	22	24.7	12	13.8	13	13.8	47	17.4
Flying squirrel	3	3.4	4	4.6	21	22.3	28	10.4
Guinea fowl	1	1.1	5	5.7	11	11.7	17	6.3
Fresh water fish	6	6.7	1	1.1	5	5.3	12	4.4
Tortoise	13	14.6	5	5.7	6	6.4	24	8.9
Grass cutter	29	32.6	14	16.1	32	34.0	75	27.8
Land squirrel	17	19.1	21	24.1	23	24.5	61	22.6
Giant rat	48	53.9	51	58.6	56	59.6	155	57.4

Source: Computed from field survey data, 2018

Table 4: Socio-economic characteristics of respondents

	Edo South n = 89		**Central n = 87**		**North n= 94**		**Pooled n = 270**	
Variable	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Sex								
Male	65	73	60	69	73	77.7	198	73.3
Female	24	27	27	31	21	22.3	72	26.7
Age								
<= 30	3	3.4	1	1.1	3	3.2	7	2.6
31- 40	5	5.6	8	9.2	4	4.3	17	6.3
41- 50	44	49.4	37	42.5	33	35.1	114	42.2
51 – 60	29	32.6	28	32.2	41	43.6	98	36.3
61-70	8	9	13	14.9	13	13.8	34	12.6
Mean	49		51		51		50	
Marital Status								
No response	2	2.2			6	6.4	9	3.3
Married	77	86.5	86	98.9	80	85.1	219	81.1
Widowed	8	9	1	1.1	6	6.4	38	14.1

Variable	Edo South n = 89 F	%	Central n = 87 F	%	North n= 94 F	%	Pooled n = 270 F	%
Separated	1	1.1			1	1.1	2	0.7
Single	1	1.1			1	1.1	2	0.7
Household Size								
<= 4	64	71.9	78	89.7	68	72.3	210	77.8
5 – 6	24	27	8	9.2	23	24.5	55	20.4
7-8	1	1.1	1	1.1	3	3.2	5	1.9
Mean	3		3		3		3	
Educational Qualification								
No response	1	1.1	10	11.5	7	7.4	18	6.7
Non-primary	15	16.9	3	3.4	14	14.9	32	11.9
Primary	32	36	42	48.3	34	36.2	108	40.0
Secondary	40	44.9	32	36.8	39	41.5	111	41.1
Tertiary	1	1.1					1	0.4
Major Occupation								
Non-Response	2	2.2	59	67.8	61	64.9	122	45.2
NTFPs gathering	50	56.2	11	12.6	17	18.1	78	28.9
Farming	25	28.1	15	17.2	8	8.5	48	17.8
Trading	4	4.5	1	1.1	6	6.4	11	4.1

Variable	Edo South n = 89 F	%	Central n = 87 F	%	North n= 94 F	%	Pooled n = 270 F	%
Artisanship	1	1.1					1	0.4
Working experience								
<= 10	7	7.9	15	17.2	20	21.3	42	15.6
11 – 20	16	18	7	8	12	12.8	35	13.0
21-30	66	74.2	65	74.7	62	66	193	71.5
Mean	22.1		19.3		19.6		20.3	
Source of credit								
Cooperatives	4	4.5	15	17.2	18	19.2	37	13.7
Personal savings	35	39.3	48	55.2	45	47.9	128	47.4

Family and friend	50	56.2	24	27.6	31	33	105	38.9
Source of labour								
No response	2	2.2	25	28.7	26	27.7	53	19.6
Family labour	24	27	42	48.3	34	36.2	100	37.0
Hired Labour	1	1.1	2	2.2	2	2.2	5	1.9
Self	36	40.4	12	13.8	26	27.7	74	27.4
Mixed	26	29.2	6	6.9	6	6.4	38	14.1
Nature of engagement								
Full Time	53	59.5	58	66.7	55	58.5	166	61.5
Part Time	36	40.5	29	33.3	39	41.5	104	38.5
Membership of Association								
Yes	10	11.2	7	8	2	2.1	19	7.0
Access to ext agent								
Yes	10	11.2	8	9.2	1	1.1	19	7.0
Length of stay								
<= 20	10	11.2	30	34.5	28	29.8	68	25.2
21 – 30	33	37.1	38	43.7	33	35.1	104	38.5
31-40	46	51.7	19	21.8	33	35.1	98	36.3
Mean	32.3		20.7		26.0		26.3	

Table 5: Motivational factors in NTFPs gathering

	Edo South		**Central**		**North**		**Pooled**	
Motivation factor	**Mean**	**std. Dev**	**Mean**	**std. Dev**	**Mean**	**std. Dev**	**Mean**	**std. Dev**
Forest availability	**3.97***	1.93	**4.28***	1.56	**4.40***	1.31	**4.22***	1.62
Family labour availability	2.64	1.10	2.18	1.96	2.72	2.03	2.52	1.04
Free access to forest	2.47	1.49	2.95	1.18	**3.07***	1.39	2.84	1.38
Market availability	2.47	1.54	2.08	1.40	2.61	1.49	2.39	1.49
For leisure	2.06	1.76	2.17	1.73	2.60	1.76	2.28	1.76

Income	2.45	1.95	2.46	1.94	2.59	1.96	2.50	1.94
Wealth/better living	2.58	1.86	2.78	1.67	3.24	1.64	2.88	1.74
Food	2.29	1.85	2.25	1.98	2.40	1.97	2.32	1.93
Personal interest	2.21	1.77	2.38	1.76	2.86	1.79	2.49	1.79
Occupation	2.79	1.85	2.59	1.77	2.70	1.90	2.69	1.84

Source: Computed from field survey data, 2018

Mean≥3.00
Respondents (Total= 556)

Table6: Binary Logistic Regression showing the relationship between socio-economic characteristics of the rural dwellers and standard of living.

Variable	Bβ	S.E.	Wald	Sig.	Odd ratio
Sex	0.30	0.34	0.80	0.37	1.36
Age	0.02	0.02	0.93	0.33	0.99
Marital status	0.41	0.29	2.00*	0.04	0.66
Household size	0.04	0.09	0.17	0.68	1.04
Education	0.16	0.17	0.85	0.36	1.17
Experience	0.21	0.20	**5.25****	0.01	1.01
Nature of NTFPs gathering	-0.38	0.25	2.24	0.13	0.69
Association	0.39	0.39	0.97	0.33	1.47
Ext access	0.50	0.34	2.20	0.14	1.64
Length of stay in the village	-0.01	0.01	1.32	0.25	0.99
Constant	0.43	0.95	0.20	0.66	1.53

Source: Field survey, 2018.
-2 Log likelihood= 0.681; R Square= 0.462; Chi-square= 131
* Significant at 0.05 level of probability
**Significant at 0.01 level of probability

Table 7: Constraints Encountered by NTFPs Gatherers.

	Edo South		Central		North		Pooled	
Constraints	**Mean**	**std.**	**Mean**	**std.**	**Mean**	**std.**	**Mean**	**std.**

		Dev		Dev		Dev		Dev
Rainfall	2.70	2.32	3.38	2.11	3.24	2.09	**3.11***	2.19
credit facilities sales of NTFPs	1.79	2.04	1.71	1.97	1.97	1.98	1.83	1.99
Poor storage facilities	2.14	1.79	2.64	1.78	2.61	1.65	2.46	1.75
Wildlife attack e.g bush dog, fox, lion and so on	2.36	1.98	1.74	1.60	2.09	1.77	2.06	1.80
Seasonality of wildlife	1.96	1.85	2.34	2.03	2.09	1.89	2.13	1.92
Perishability of fruits	1.99	1.93	2.78	1.91	2.65	1.94	2.47	1.95
Bush burning	2.13	1.80	2.59	1.64	2.55	1.74	2.43	1.73
Poor returns to investment	2.07	2.04	1.80	1.89	1.65	1.78	1.84	1.90
Deforestation	2.17	1.87	2.33	1.80	2.38	1.84	2.30	1.84
People's perception	1.62	1.68	1.83	1.70	2.03	1.76	1.83	1.71
Continuous poor harvest	2.44	1.96	2.41	1.67	2.64	1.86	2.50	1.83
It is tiresome	2.08	1.98	2.18	2.20	2.38	1.98	2.22	2.05
Lack of transportation	2.29	1.75	2.14	1.46	2.00	1.50	2.14	1.57
Lack of workforce	2.04	1.91	1.92	1.88	2.19	1.87	2.06	1.88
Law by government restrictions	1.74	1.80	2.33	1.87	2.10	1.87	2.06	1.85
Lack of social amenities e.g. road	2.09	2.04	2.51	1.92	2.64	1.90	2.41	1.96
Forest location	1.92	1.97	2.47	1.89	2.66	1.88	2.36	1.93
Risk and uncertainty	1.99	1.84	2.15	1.96	2.21	1.88	2.12	1.89
Drudgery	2.01	1.77	2.59	1.51	2.44	1.60	2.34	1.64
Lack of loan	2.02	1.94	2.16	1.81	2.04	1.67	2.07	1.80
	1.82	1.61	1.94	1.50	1.89	1.68	1.89	1.60
Activities of herdsmen	1.39	1.74	1.55	1.61	1.73	1.68	1.56	1.68
Lack of market	1.66	1.58	1.82	1.52	1.90	1.64	1.80	1.58
Poor extension contact	1.12	1.59	1.56	1.58	1.68	1.65	1.46	1.62
Distance to forest	1.69	1.68	2.60	1.57	2.57	1.74	2.29	1.71

Source: Field Survey, 2018

$\bar{x} = 3.00$

≥ 3.00 = serious constraint

Effect of Field Trips on Agripreneurship Knowledge and Skills Development among Students in Tertiary Institutions in Nigeria: A Study of Federal College of Agriculture, Ishiagu, Ebonyi State

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Abstract

This study investigated the effects of field trips on agricultural knowledge and entrepreneurship skills of students Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria. Four research questions and three hypotheses were postulated. Experimental design method was adopted and Yamane method was used to obtain a sample size of 200 respondents from a total populaion of 518 for the experimental and control groups. A structured questionnaire was used to administed questions boardening on exposure of students to modern methods of Agriculture, acquisition of Entrepreneurship skills, retention and the utilization of skills learnt after field trips. Data were analysed using descriptive statistics and Chi-square at 0.05 level of significance. The findings of the study revealed the following, that: there was a significant difference in the mean scores between the experimental and control groups (p-value = 0.00, < = 0.05) on the exposure of students to modern methods of Agriculture; acquisition of Agricultural entrepreneurship skills was statistically significant (p = 0.01, < = 0.05) and the difference between the mean score of the groups on retention ability of the students after field trips was also statistically significant. (p-value = 0.00). Hence, the study concluded that field trips broaden and expose participating students to modern methods of agriculture, enhances entrepreneurship skills and contributes to retention and utilization of knowledge and skills learnt during the visits.Therefore, fieldtrip was a contributing factor in increasing agricultural knowledge and entrepreneurship skills among students in tertiary institutions. It was recommended that field trips be funded and implemented *by Government and institutions' managements to enhance students' creativity, innovativeness and prepare them as solution providers for the world of work.*

Keywords: Field Trip, Agripreneurship, Knowledge, Skills

Introduction

Most of the younger generations had never been on a farm and that even less understood that agriculture was where their food came from. Some do not even know that what they eat or wear come from a farm. Agriculture is defined as the cultivation of animals, plants, fungi, and other life forms for food, fibre, biofuel, drugs and other products used to sustain and enhance human life (Agriculture, 2014). This definition is generally accepted by most people without another thought as to the impact those 25 words has on each of us every day (Sigmon, 2014). Hunting and gathering was the only sources of food and substance for man before agriculture. Agriculture provides us with our food to nourish our body, fibre for our clothing, materials for our shelter and raw materials for manufacturing. This important economic, political and life-sustaining system's foundation is and will remain the farm. The goal of agricultural literacy is for agricultural education. There has been a lot of work done concerning the idea of agricultural literacy. Frick, Kahler and Miller defined agricultural knowledge as possessing knowledge and understanding of our food and fibre system that, an individual possessing such knowledge would be able to synthesize, analyze, and communicate basic information about agriculture (Frick, Kahler and Miller 1991). As the global population grows to a projected 9 billion people by 2050, the non-agriculture population has little to no understanding of the complexities involved with sustaining a viable agriculture system (Doerfert, 2011). An agricultural knowledgeable population helps in ensuring that intelligent and informed decisions concerning agricultural policies are made that benefit society (Pope, 1990).

The concept of encouraging young graduates to study and practice agriculture as a profession and as a market-oriented business is what is termed agripreneurship. An agripreneure is someone who acts with ambition beyond that supportable by the resources currently under his or her control, in relentless pursuit of an opportunity by taking calculated risks, and assuming responsibility for his decision and action. Some of the basic qualities of an agripreneur such as: Knowledge of Agriculture, initiative, ambition, focused problem-solving trait, creative thinking, taking and managing risks, flexibility and adaptability, interpersonal abilities, networking and readiness to learn, may not be possible with classroom learning alone, but could be acquired by interacting with experienced entrepreneurs outside the conventional classroom environments.

With these competencies, Agripreneurs will be more able to produce and compete in the new environment and make profits by taking advantage of new market opportunities (Usanga,)..

Tal and Morag (2009) described field trips as students' experiences outside of the classroom at interactive locations designed for educational purposes. Field trips may be planned for the following purposes: 1) to provide firsthand experience, 2) to stimulate interest and motivation in science, 3) to add relevance to learning and interrelationships, 4) to strengthen observation and perception skills, and 5) to promote personal (social) development (Michie, 1998). Field trips are a critical component of standards-based activity and a direct extension of classroom instruction in practice and in real world situations. Examples are: presentation of real object- specimen, models, excursions, field work, projected/non-projected images, print and non-prints, (Awotua-Efebo, 1999). Basically, agricultural field trip is seen as a support for effective teaching and learning, which implies getting the content (message) across in a manner that, will accomplish the desired objectives. Furthermore, agricultural field trips were expected to enhance student learning experiences through interaction with resource persons, agripreneurs and the environment. Such centres were supposed to provide better resources than the school for first hand information, especially as learning outside the classroom aims at ensuring that learners (students) had chances to participate in high quality outdoor learning experiences. It also set out to improve academic achievement, developed skills and interdependent in a widening range of environments and provide the opportunity to acceptable levels of risk taking among the participants (Awotua-Efebo, 1999). The benefits of field trips in knowledge and skill development among students in tertiary institutions cannot be taken for granted as it has motivational effects on students towards accepting and practicing agriculture as a profession. It also has the potential to expose and educate students in practical and real knowledge of what agriculture is. If well designed, results in higher student academic performance in theory and in practice. Above all, the collaboration with Entrepreneurs can result in the improvement in community relationship in the joint task for national development. The following research questions therefore guide the study:

1. What is the effect of field trips on students' agricultural knowledge in tertiary institutions in Nigeria?

2. What is the effect of field trips on acquisition of Entrepreneurship skills of students?

3. What is the effect of field trips on retention of agricultural knowledge and Entrepreneurship skills?

4. What are the constraints to conducting field trips in tertiary institutions in Nigeria?

Objectives of the Study

The main purpose of the study was to ascertain the effect of field trips on acquisition of agricultural knowledge and entrepreneurial skills by students in tertiary institutions in Nigeria.

In specific terms, the study was designed to:

- i) identify the elements of Agripreneurship skills that students learn from farm field trips;
- determine the effect of field trips on agricultural knowledge
- determine the effect of field trip on Agripreneurial skills
- Identify the constraints to farm field trips in tertiary institutions in the study area

Hypotheses

The following hypotheses were postulated to guide the study:

Null hypothesis 1: There is no significant difference between the students that participated in field trips and those who did not participate

Null hypothesis 2: There is no significant difference between the Experimental and Control groups in the acquisition of Entrepreneurship Skills using Field Trip.

Null hypothesis 3: There is no significant between the Experimental and Control groups in Agricultural Knowledge and Entrepreneurship skills retention using the field trips strategy

Statement of the Problem

Field trips is a practical course, which take students away from their classrooms, laboratories and experimental research farms to an entirely new environment for learning, understanding and comparing what they were instructed in their schools with real life situations. Field trips have not been studied or taken seriously in tertiary institutions in Nigeria in recent times, and many aspects of the large-scale utilization of the benefits of this course remain unknown, though it is included in academic curriculum as a mandate for certification of candidates in tertiary institutions.

Methodology

The study adopted the experimental method to determine the effect of field trips on acquisition of agricultural knowledge, entrepreneurial skills and retention by students of Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria. In order to determine the sample size of the study, **Yamane** method of sample size determination was employed to select **200** respondents for the Experimental (Participants) and Control (Non-participants) groups. The sample consisted of students from three academic sessions, (2013 – 2015), who have gone on field trips and those who have not been exposed to field trips. A questionnaire was designed and administered to the students (experimental and control) based on the objectives of the study. Both groups were subjected to pre-test (to determine the effect of the treatment on Agricultural knowledge) Post test (to determine the effect of the treatment on acquisition of Entrepreneurship skills), and delayed post-test (to determine treatment effect on knowledge and skills retention abilities after the field trips). Data collected were analyzed using the mean score statistical method, while the hypotheses were tested and analyzed using *Chi*-square statistical technique. These analyses were presented in tables based on the research questions and a range of mean used to determine its level of acceptance or rejection.

Sample Population (Yamane Formular)

$N = 184 + 172 + 162 =$ **518 Students**

(2013) (2014) (2015)

$$n = \frac{N}{1 + N(e)^2}$$

$$n = \frac{518}{1 + 518(0.05)^2}$$

$$\frac{518}{1 + 518(0.0025000000000000005)}$$

$$\frac{518}{1 + 518(1.2950000000000002)}$$

225.70806100217865

Therefore, the sample size of the study is 200 respondents were **used for the study**

Analysis and Results Presentation

The data collected for the purpose of this study were analyzed based on the research questions and the hypotheses formulated.

Research Question 1: What is the effect of field trips on students' agricultural knowledge in tertiary institutions in Nigeria? The descriptive statistics of mean and standard deviation were used to answer this research question and the summary of the results is presented in Table 1.

Table 1: Means and Standard Deviation of the Experimental (field trip) and Control (Non-participants) groups in Agricultural Knowledge Test (AKT).

Variable	n	Mean	SD	MD

Experimental group	100	51.73	12.68	6.97
Control group	100	44.76	14.43	

Source: Field Study, 2015

Table 4.1 shows Means and Standard Deviation of the Experimental (field trip participants) and Control (non-participants) groups in test on knowledge of Agriculture. Results show that the mean score of the experimental group was 51.73 and a standard deviation of 12.68; while the mean scores for the control group was 44.76 and a standard deviation of 14.43. The mean difference of the experimental and control group was 6.97 in favour of the experimental group. This shows that the experimental group had mean scores more than the control group, meaning that the effect of the treatment had impact on the experimental group.

Table 2: Mean and Standard Deviation of the Experimental (field trip) and Control group (Non-participants) in acquisition of Entrepreneurship skills (EKT)

Variable	n	Mean	SD	MD
Experimental group	100	55.09	14.14	10.33
Control group	100	44.76	14.43	

Source: Field Study, 2015

Table 2 shows that the mean scores of the experimental group was 55.09 and a standard deviation of 14.14; while the means scores for the control group was 44.76 and a standard deviation of 14.43. The means difference of the experimental and control group was 10.33 in favour of the experimental group. This proved that the experimental group had mean scores more than the control group. It implied that the effect of the treatment had impact on the experimental group.

Table 3: Means and Standard Deviation of effect of field trips on retention of agricultural knowledge and Entrepreneurship skills after the trip

Variable	n	Mean	SD	MD
Experimental group (Participants)	100	42.21	12.30	2.01
Control group (Non-participants)	100	40.20	11.29	

Source: Field Study, 2015

Table 3 showed the mean scores of the experimental group was 42.21 with a standard deviation of 12.30; while the mean scores for the control group was 40.20 with a standard deviation of 11.29. The means difference of the experimental and control groups was 2.01 in favour of the experimental group. The implication is that the experimental group had mean scores more than the control group, meaning that the effect of the treatment had impact on the experimental group.

Testing of Research Hypotheses

The inferential statistic t-test was used to test the research hypotheses. The Ho1 was analyzed using t-test statistics.

Null Hypothesis 1: There is no significant difference between the mean scores of the students that participated in field trips and those who did not participate.

Table 4: t-test of Post-test Means Score of the Experimental and Control groups in the acquisition of Agricultural knowledge

Variable	n	Mean	SD	DF	SE	*t-cal*	*t-crit*	p-value	Remarks
Experimental group	100	51.73	12.68	198	1.92	3.63	1.98	0.00	Significant
Control group	100	44.76	1 4.43						

Source: Field Study, 2015

The results in Table 4 shows that the *t- calculated* is 3.63 and the P-value = 0.00 at degree of freedom (df) = 198. Since the P-value = 0.00 < = 0.05, it means that there is a significant difference in the mean scores of the experimental and control groups. The significant difference is in favour of the experimental group exposed to field trip as indicated by the mean scores. With this result the Null hypothesis 1 was therefore rejected.

Null hypothesis 2: There is no significant difference in the mean scores of the Experimental and Control groups in the acquisition of Entrepreneurship Skills using Field Trip.

Table 5: t-test of Post-test Means Score of the Experimental and Control groups in the acquisition of Entrepreneurship Skills

Variable	n	Mean	SD	DF	SE	t-cal	t-crit	P-value	Remarks
Experimental group	100	58.76	13.27	98	2.68	2.76	1.96	0.01	Significant
Experimental group	100	51.10	13.53						

The results in Table 5 shows that the *t- cal* = 2.76 with a P-value = 0.01 and 98 degree of freedom (df). Since the P-value = 0.01 < 0.05, this indicates that there is a significant difference in the mean scores of the experimental and control groups in the acquisition of Entrepreneurship skills of the students. The significant difference is in favour of the experimental (participants) group exposed to field trip as indicated by the mean scores. With this result, the Null hypothesis 2 was therefore rejected.

Null hypothesis 3: There is no significant difference in the mean scores of the Experimental and Control groups in Agricultural Knowledge and Entrepreneurship skills retention with the field trips strategy

Table 6: t-tests of post-posttest means scores of Experimental (field Trip) and Control groups in Agricultural Knowledge and Entrepreneurship skills retention test

Variable	n	Mean	SD	DF	SD	*t-cal*	*t-crit*	p-value	Remarks
Experimental group	100	55.09	14.14	198	2.68	2.86	1.98	0.00	Significant
Control group	100	44.76	14.43						

The results in Table 6 shows that *t- cal* is 2.86 with a *p-value* = 0.00 at degree of freedom (df) = 198. Since the *p* = 0.00 < = 0.05. It means that there is a significant difference in the mean scores of the experimental and the control groups in retention level of the students. The significant difference is in favour of the experimental group in retention level exposed to field trip strategy as indicated by the mean scores. With this result, the Null hypothesis 3 was therefore rejected.

Table 7:Constraints to Field Trips in Tertiary Institutions in Nigeria

Constraints	Frequency	(%)	Ranking
Negligence by School Management and Policy Makers	125	62.5	3rd
Limited funding	162	81.0	1st
Limited available time due to each school systems and academic activities’	159	79.5	2nd
Budget Restraints	118	.59.0	5th
Difficulty controlling student behavior during such trips	120	60.0	4th
Fear of accident and other eventualities/Lack of insurance for participants	115	57.7	6th

***Multiple Response**

Table 7 shows the constraints to Field Trips in tertiary institutions. Limited funding, representing 81% ranked the first, followed by Limited available time due to each school systems and academic activities (79%), Negligence by school management and policy makers ranked 3rd (62.5%), difficulty in controlling student behaviour (60%) ranked 4th, Budget restraints (59%) ranked 5th and fear of accident and other eventualities/ lack of insurance for participants

Summary of Finding

Based on the data analyzed in this study, the following findings were obtained. Table 1 reveals that there is a significant difference between students exposed to field trip experiences and those who were not on the Agricultural concepts and knowledge. P-value = 0.00, < = 0.05, it means that there is a significant difference in the mean scores of the experimental and control groups. With this result the Null hypothesis 1 was therefore rejected. The result of analysis on Table 2 suggested that the difference between the mean achievement of the experimental and control groups in Entrepreneurial skills was statistically significant (P = 0.01, < = 0.05). With this finding, Ho2 was rejected. Table 3 shows that, the result of analysis between the mean achievement of the experimental (field trip participants) and control (non-participants) groups in a retention ability of students after field trips is statistically significant. *p-value* = 0.00, meaning, there is a significant difference in the mean scores of the experimental and the control groups in knowledge and skills retention level of the students. This results in the Null hypothesis 3 being rejected.

Discussions

This study is very significant in because it has been able to demonstrate the usefulness of field trip in the learning of Agriculture and Entrepreneurship, particularly the practical application of agricultural business concept. The most important advantage of field trips is that they provided most realistic means of meeting practitioners and Entrepreneurs in their actual operating environments. This makes topics or concepts and principles taught in Agriculture and Entrepreneurship more vivid and retention better. This Unit presented explanation of results obtained from the hypothesis tested and acknowledged the published works of other authors in the study like Ajaja, (2010), Michie (2001), Fred (2007), Ogbuluijah, (2014) and Ahmad, (2014).

Null Hypothesis 1: There is no significant difference between the mean scores of the students that participated in field trips and those who did not participate. Table 4 proved that there was significant difference between mean score of the experimental and control groups in Agricultural knowledge and concepts. This suggested that the field trip strategy has favoured the experimental groups. This confirmed the findings of David (2006) , Ajaja 73 (2010), Michie (2007), which stated that knowledge gains were found to be significant with the experimental group using field trip teaching strategy more than their counterparts that were strictly taught in the class using lecture method.

Null Hypothesis 2: There is no significant difference in the mean scores of the Experimental and Control groups in the acquisition of Entrepreneurship skills using Field Trip. Table 5 revealed that there was significant difference in the mean scores of the experimental and control groups in the acquisition of Entrepreneurship skills during field trips. The result demonstrated that field trip strategy has more positive effect on the experimental group (participants) than the control group (non-participants). This might be due to:

1) Exposure: Students participating in field trips are more exposed to those concepts that were taught practically. They can see, touch, feel and count objects, phenomena and perceive situations as they are in real life. They also have opportunity to ask questions from the hosts entrepreneurs. The control group (non-participants) might be coming in contact with count objects, phenomena and perceive situations but know very little about them hence the difference in Agricultural knowledge and Entrepreneurial skills achievement. 2) Students in the experimental group may communicate directly to hosts by asking questions were they are skeptical and getting answers much more than those who did not participate. Therefore are able to express themselves better and understand more than their non-participating counterparts. 3) Field trips enhance social interactions, increase student engagement and retention of information, increase student interest and knowledge of topics learned, students become more aware of their own community and world, Field trips help Participants to develop problem-solving and conflict resolution skills and make early friendships, and above all, participants actively develop imagination, dexterity, emotional and physical strength.

Null Hypothesis 3: There is no significant difference between students in the experimental group and control group in retention ability using field trip. It was established in table 6 that there was a significant difference between mean score of the experimental and control group retention ability in Agricultural knowledge and Entrepreneurship skills. This confirmed that field trips strategy gained upper hand than the traditional classroom method in retention ability. This confirmed the study of Mechie (2000), Fred, (2007) and Ahmad, (2014), which their finding recommended that field trip strategy should be adopted as the most effective learning and teaching strategy in science because of it influence on retention.

Therefore, since field trips provide the most realistic means for meeting agricultural concepts and principles in their actual environment of the objects, practitioners and host enterprises, the student should have the ability to recognize, organize and practicalize reality and also act on objects by observing, identifying, classifying and even manipulating the objects or situations in its natural environment. Field trips can stimulate new learning, increased attitude towards science, trigger interest development, and provide many rewards to both the teacher and the students (Scarce, 1997).Therefore, field trip is a strategy that enhanced the teaching and learning or the achievement of students in Agriculture and Entrepreneurship skills development, utilization and sustenance of these knowledge and skills at the tertiary level of education.

Conclusion and Recommendation

Based on the research findings, the following conclusions are made: That the learning experience in which field trips expose students to in Tertiary institutions in Nigeria includes:

1. Field trips broaden and expose participating students to modern methods of farming.

2. It enhances knowledge and skills on entrepreneurship

3. It Improves farm knowledge and produce utilization.

4. It contributes to retention, performance and utilization of knowledge and skills learnt during the visit.

Owing to the fact that that students submit a detailed Field Trip Report and Log Book for assessment and evaluation of their activities after the exercise, the effects of field trips and student performance In Agricultural practice and Entrepreneurship skills make a recall of learned experiences easy. Field trips boost students' practical experiences. It enhances their ability in the management of practical exercises in their farm projects.

Recommendation and Policy Implications

Based on the findings of the study, it is certain that field trips is essential and fundamental to agricultural knowledge acquisition and Entrepreneurship skills development. There is therefore the need to:

1. Establish more opportunities for field trips or educational tours within the current curriculum as the findings revealed that students' creativity and innovativeness were enhanced by these visits;

2. Establish rules, solicit support, proper planning, budgeting and funding can alleviate many of the disadvantages of taking a field trip.

3. Equip school coordinators of Field Trips with skills, knowledge and competencies considered essential for the success of the event. The students should know and understand the plan of work and the cooperating personnel should be a qualified specialist in this occupational area rather than a certified classroom and Laboratory Lecturer/Instructor.

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Socio Economic Characteristics and Level of Biosecurity Practices among Fish Farmers in Obio-Akpor Local Government of Rivers State

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Abstract

The socio-economic characteristics and level of practice of biosecurity measures amongst fish farmers in Obio-Akpor Local Government of Rivers State were assessed. Data was collected randomly from 150 fish farmers by interview and administration of structured questionnaires. Descriptive statistics such as frequency and percentages were used to analyze data collected. Results obtained from the study indicated that fish farming were dominated by males (64.66%) and were mostly (46.00%) within the age bracket of 21-40years. Majority of the respondents (71.43%) were educated up to secondary level with 6-10 years experience in fish farming. Most (53.33%) of the farmers in the study area had been trained in fish farming enterprise and they are not full time farmers (30.66%). From the study area, majority (52.67%) of the farmers were fully aware of the biosecurity strategies in aquaculture production. While, a greater proportion (18.67%) of the farmers engaged in cleaning of their environment as a means of biosecurity practices. There was low level of compliance of biosecurity strategies among the fish farmers, with finance (54.67%) as a major constraint. In conclusion, the study observed that the practice of biosecurity measures was not an important issue among the farmers. It is therefore recommended that financial assistance should be made available to farmers so as to enhance their production capacities and biosecurity compliance. Also, guidelines supported by appropriate legislation are needed to enforce practice and compliance of biosecurity practices in the study area.

Key words: Aquaculture, Fish health, Biosecurity, Socio-economics, Rivers State

Introduction

Aquaculture production in Nigeria have grown in leaps and bounds, giving rise to many farms all over the federation (Akinrotim *et al*., 2018). In recent times, many farmers across the country have witnessed some losses in their farming operations (Adeogun *et al*., 2017). Many factors are responsible for these losses during aquaculture operations. Among these factors, disease is the most serious constraint that causes drop in performance and productivity in farms, which resulted to reduced incomes, and food insecurity (Baruwa *et al.*, 2012). Massive production loss of up to 70% in the hatchery due to diseases have been recorded in developing countries causing many farmers to abandon fish farming and new farmers to become discouraged in aquaculture enterprise (Fagbenro, 2005). Health maintenance in aquaculture production through good hygiene and husbandry practices to manage the impact of these pathogens, is one of the most important aspects of aquaculture development and management. Biosecurity is therefore the key to reduce the risk of diseases entering a farm. Hence, suitable biosecurity measures can prevent emerging health issues and reduce impacts of disease, with the principle of preventing diseases rather than curative response (Arthur *et al*., 2009).

Biosecurity procedures can be described as "cumulative steps taken to keep disease from a farm and to prevent the transmission of disease within an infected farm to other farms." (Baton *et al.*, 2005). Biosecurity is a team effort, a shared responsibility, and an on-going process to be followed at all times. From the breeder to the hatchery, to grow-out operators, biosecurity measures have to be observed, so as to contribute to the success of aquaculture industry in different parts of the world (FAO, 2005;Oladejo, 2010). The purpose of these practices is to prevent the introduction of pathogens and to provide the best living conditions for the health of the cultured fish. Also, FAO/NACA ,(2007) defined biosecurity as "an essential group of tools for the prevention, control, and eradication of infectious disease and the preservation of human, animal, and environmental health. There is less information on the level of compliance of biosecurity measures of fish farms in the study area. Thus necessitating the need for this study. This study therefore assessed the practice of biosecurity amongst fish farmers in Obio/Akpor Local Government Area (LGA), Rivers State, Nigeria, to recommend appropriate measures for improved fish health and prevention of disease outbreak especially in the hatchery.

Materials and Methods

The study was conducted in Obio/Akpor Local Government Area (LGA), Rivers State, Nigeria. Obio/AkporLGA is one of the two LGAs in Port Harcourt metropolis, Rivers State, Nigeria. Obio-Akpor is bounded by Port Harcourt (Local Government Area) to the south, Oyigbo to the east, Ikwerre to the north, and Emohua to the west. It is located between latitudes 4°45'N and4°60'N and longitudes 6°50'E and 8°00'E.Port Harcourt is the administrative capital of Rivers State, in the Niger Delta area of Nigeria. Port Harcourt lies between 4.75°N and 7°E with network of rivers and tributaries (e.g., New Calabar, Orashi, Bonny, Sombrero and Bartholomew Rivers) which provide great opportunity for fish farming (Ibemere and Ezeano, 2014).

Obio/Akpor L.G.A is one of the Agricultural Zones of Agricultural Development Programs of Rivers State. Simple random sampling method was used for the study. The sampling frame was obtained from the Catfish Farmers Association Nigeria, Rivers State Chapter. A total of 150 fish farms were randomly selected from Obio/Akpor LGA. The selected fish farmers were interviewed with the aid of structured questionnaires. The collected data was analyzed using descriptive statistics (such as percentages and frequency tables).

Results and Discussion

The socio-economic characteristics and level of practice of biosecurity measures amongst fish farmers in Obio-Akpor Local Government of Rivers State are presented in Table 1. Results from the study indicated that fish farming in the study area were dominated by males (64.66%) and were mostly (46.00%) within the age bracket of 21-40years. The result of the present study was in line with those reported in other areas of Nigeria (Oladejo, 2010). They reported the age group (21-40 years) and suggested that fish farming required youth that were strong and active because fish farming required adequate attention and a lot of responsibility. In this study area, most of the farmers were males, this played an important role in fish farming and agriculture, in terms of property acquisition (Kudi *et al.*, 2008). It also determined the ability to perform some physical work as it was generally believed that men are more efficient in physical and strenuous activities than women. Majority of the respondents (71.43%) were educated up to secondary level with 6-10 years experience in fish farming. Most (53.33%) of the farmers in the study area had been trained in fish farming enterprise and they are not full time farmers (30.66%). This meant that fish farming is dominated by the educated class, with a lot farming experience, practicing on part time basis and are well trained. This is line with the results of Kudi *et al.* (2008) who observed the same trend in fish farmers from Kaduna State. This is so because fish farming required a lot of technical and scientific knowledge to be successful. From the study area, the majority (52.67%) of the farmers are fully aware of the biosecurity strategies in aquaculture production (Table 2). While most (18.67%) of the farmers engaged in cleaning of their environment as a means of biosecurity practices (Table 3). There was low level of compliance biosecurity strategies among the fish farmers (Table 4), with finance (54.67%) as a major constraint (Table 5). This observation agrees with the findings of Nwabueze and Ofuoku (2020) who observed the same trend among the catfish farmers in Delta State, Nigeria. They reported that issue of biosecurity measures were taken as less importance in the study area.

Table1: Socio-Economic Characteristics of Fish Farmers in Obio-Akpor Local Government of Rivers State

Socio-economic characteristics	Frequency	Percentage (%)
Sex		
Male	97.00	64.66
Female	53.00	35.34
Total	**150.00**	**100.00**
Age		
< 20 years	10.00	6.67
21-40 years	69.00	46.00
41-60years	60.00	40.00
> 60 years	11	7.33
Total	**150.00**	**100.00**
Educational Level		
Primary	14.00	5.71
Secondary	100.00	71.43
Tertiary	36.00	22.86
None	0.00	0.00
Total	**150.00**	**100.00**
Years of Experience		
1 – 5	49.00	50.00
6 -10	36.00	21.43

11 – 15	30.00	14.29
16 – 20	20.00	7.14
>20	15.00	7.14
Total	**150.00**	**100.00**
Received Training in fish farming		
Yes	80	53.33
No	70	46.67
Total	**150.00**	**100.00**
Principal Occupation		
Fish Farmer	23	15.33
Civil Servants	46	30.66
Business (Trader)	31	20.67
Farming (Crop and Livestock)	17	11.33
Self Employed	23	15.34
Work in companies/industries	10	6.67
Total	**150.00**	**100.00**

Table 2: Level of Awareness of Bio-security Strategies of Fish Farmers in Obio-Akpor Local Government of Rivers State

Level of Awareness	Frequency	Percentage (%)
Fully Aware	79	52.67
Partially Aware	54	36.00
Not Aware	17	11.33
Total	**150**	**100**

Table 3: Biosecurity Practices among Fish Farmers in Obio-Akpor Local Government of Rivers State

Biosecurity Practices	Frequency	Percentage (%)
Fenced Farm	27	18.00
Quarantine of new fish	7	4.67
Clean Environment	28	18.67
Restriction of Visitors Access to Ponds	16	10.67
Provision of Footbath	14	9.33
Disinfection of farm tools before use	8	5.33
Diagnosis and Treatment of Disease	10	6.67
Proper discharge of pond water	26	17.33
Analysis of water quality	7	4.67
Workers use of clean personal protective wears (clean coverall and boots)	8	5.33
Total	**150**	**100**

Table 4: Level of Compliance of Bio-security Strategies among Fish Farmers in Obio-Akpor Local Government of Rivers State

Level of Compliance	Frequency	Percentage (%)
High	18	12.00
Moderate	56	37.33
Low	44	29.33
Zero	32	21.34
Total	**150**	**100**

Table 5: Constraints to the Compliance of Bio-security Strategies among Fish Farmers in Obio-Akpor Local Government of Rivers State

Constraints	Frequency	Percentage (%)
Lack of information	17	11.33
Finance	82	54.67
Farmers indifference attitude	18	10.00
Community interference	10	5.55
Government Policy	23	12.77
Total	**150**	**100**

Conclusion

In conclusion, the study observed that the practice of biosecurity measures was not an important issue among the farmers. Based on the findings of this study, it therefore recommended that financial assistance should be made available to farmers so as to enhance their production capacities. Also, Guidelines supported by appropriate legislation is needed to enforce practice and compliance of biosecurity practices in the study area.

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Improving Women Participation in Agricultural Production in Nigeria

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Abstract

The paper reviewed strategies for improving women participation in agricultural production in Nigeria. As evidenced in literature, Women were found to supply large proportion of labour in rural agricultural production, from subsistence to commercial farming. This paper draws on the available empirical evidence to articulate areas and degree of women participation in agriculture. As shown in literature, women comprised of about 43 percent of the agricultural labour force globally. However, this figure masks considerable variation across regions and within countries with respect to age and social class. Specifically, in Nigeria, this figure was estimated to be above 50 percent. Time use surveys, which are more comprehensive but typically not nationally representative, add further insight into the substantial heterogeneity among countries and within countries in women's contribution to agriculture. This paper re-affirms that women make essential contributions to agriculture production in Nigeria. There are challenges such as poor access to finance, input subsidy, and training among others militating factors against their productivity. This paper identifies provision of technologies and access to basic production resources as some of the strategies to increase productivity of women agriculture productivity.

Keywords: women, participation, strategies, agricultural, rural, Nigeria.

Introduction

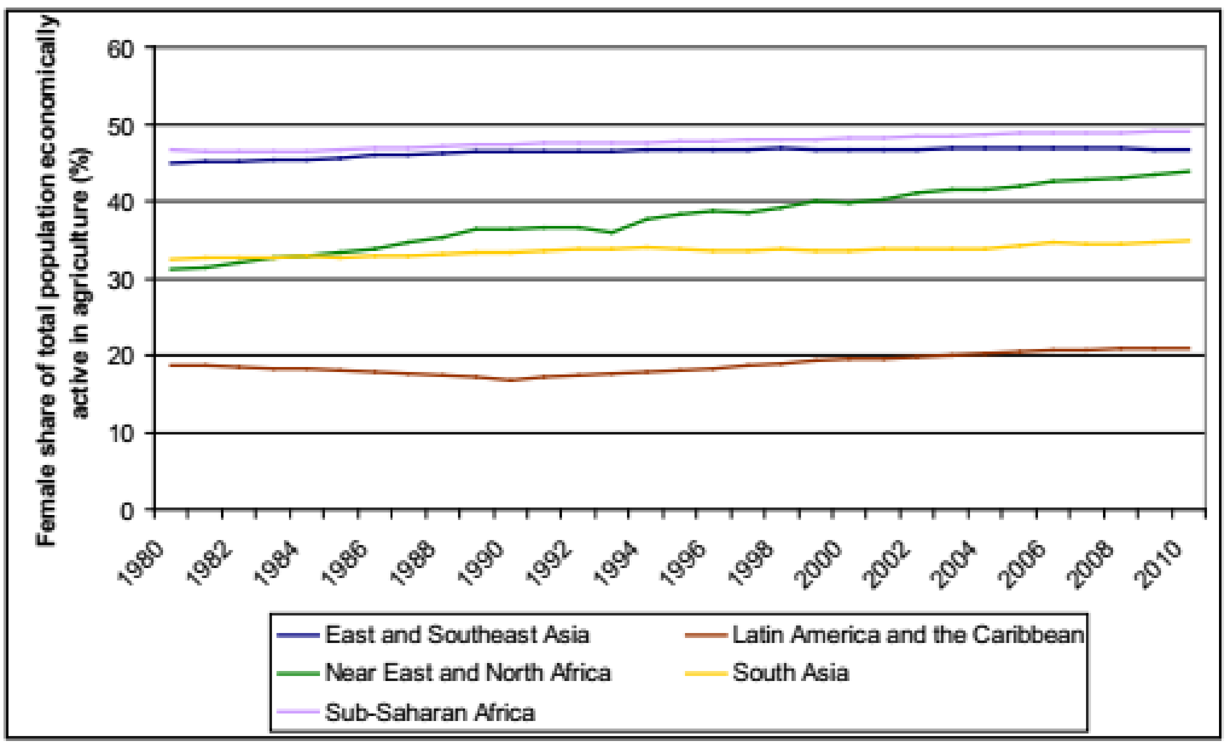
Agriculture plays an important role in most non-industrial economies, as a major contributor to the country's export earnings and as a source of employment and livelihood. Women continue to provide a large proportion of the labour that goes into agriculture. Food and Agricultural Organization's (FAO's) estimates reveal that around two-thirds of the female labour force in developing economies is engaged in agricultural production. They undertake a wide range of activities relating to food production, processing and marketing; and beyond farming, they are involved in land and water management: most often they are collectors of water, firewood and fodder.

In Nigeria, over 60 per cent of families kept poultry with women being the major managers and owners controlling the limited cash income from sales (Dessie and Ogle, 2001). Also, Oji and Ekumankama (2002) reported that 77, 73 and 25 per cent of women were involved in chicken, goat, and sheep production, respectively and their main activities were pen cleaning 89 per cent and feeding 83 per cent. Generally, women are rarely connected with agricultural export crops. Though women constitute a large portion of the farming population, women's possibilities in agriculture are hindered by formal and traditional rules. Hence, this study becomes imperative. Apart from the introduction, the paper is structured into the following sections. In section two, women in the agricultural labour force are discussed, section three elucidates women participation in agriculture in Nigeria, section four centres on women involvement across value chains of agricultural production, section five challenges to women participation in agricultural production in Nigeria was explained while section six identified approaches to increasing the productivity of women in agriculture in Nigeria.

Women in the agricultural labour force

The role that women play and their position in meeting the challenges of agricultural production and development are quite dominant and prominent. According to Bill and Melinda Gates Foundation (2012), women in Sub-Saharan Africa do about 80 per cent of the farm labour. Banji and Okuade (2005) attributed 60 per cent of the farm labour force to women who produce 80 per cent of food and earn 10 per cent of the monetary income but own just 1 per cent of the farm assets. Two types of data can contribute to measuring the contribution of women in the agricultural labour force: statistics on the share of women in the economically active population in agriculture and time use surveys, which document the time spent by men and women in different activities.

Economically active population in agriculture: Data on the economically active population in agriculture are available for many countries, and provide the most comprehensive measure of the participation of women in agriculture. In this measure, an individual is reported as being in the agricultural labour force if he or she reports that agriculture is his or her main economic activity. However, these data may underestimate female participation in agriculture for reasons therefore caution is advised in interpreting changes over time because improvements in data collection may be responsible for some of the observed changes. FAO (2011) reported weighted averages for the share of women that are economically active in agricultural production in 5 major regions of the world. According to these data as represented in figure1, women comprise just over 40 percent of the agricultural labour force in the developing world, a figure that has risen slightly since 1980 and ranges from about 20 percent in the Americas to almost 50 percent in Africa. Even considering these data as lower bounds for the participation of women in the agricultural labour force, they do not support estimates above 60 percent except for a few countries.



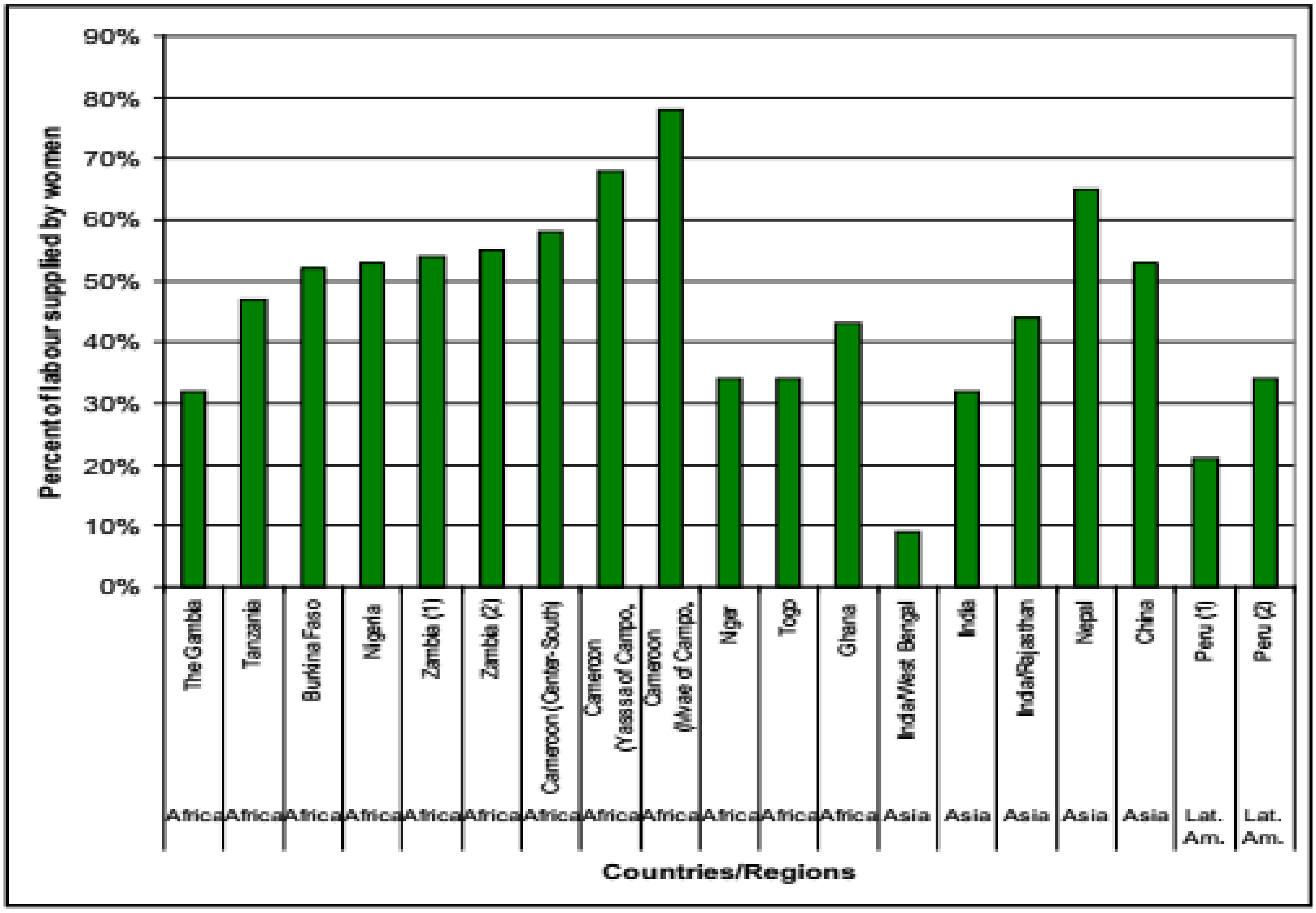
Source. FAOSTAT. Note: The female share of the agricultural labour force is calculated as the total number of women economically active in agriculture divided by the total population economically active in agriculture. Regional averages are weighted by population.

Figure 1 Female share of the agricultural labour force

Women make up almost 50 percent of the agricultural labour force in sub-Saharan Africa, an increase from about 45 percent in 1980. The averages in Africa range from over 40 percent in Southern Africa to over 50 percent in Eastern Africa. These sub-regional averages have remained fairly stable since 1980, with the exception of North Africa, where the female share appears to have risen from 30 percent to almost 45 percent. The sub-regional data for Africa conceal wide differences between countries both in the share of female labour in agriculture and the trend.

The global average is dominated by Asia. Within Asia, the sub-regional averages range from about 35 percent in South Asia to almost 50 percent in East and Southeast Asia. The Asian average is dominated by China, where the female share of the agricultural labour force has increased slightly during the past three decades. The developing countries of the Americas have much lower average female agricultural labour shares than the other developing country regions at just over 20 percent in 2010, slightly higher than in 1980.

***Time spent in agricultural activities**:* Time use surveys attempt to provide a more complete account of time use by men and women than are available from the labour force statistics reported above. Such studies usually are not nationally representative and are not directly comparable because they usually cover small samples, report on different types of activities (that are not always clearly specified) and use different methodologies. Despite these caveats, a summary of the evidence from studies which specify time use by agricultural activity suggests interesting patterns.



Sources and notes: Only the survey for India is nationally representative. Sources (from left to right): The Gambia: von Braun and Webb (1989); Tanzania: Fontana and Natali (2008); Burkina Faso: Saito, Mekonnen and Spurling (1994); Nigeria: Rahji and Falusi (2005); Zambia (1): Saito, Mekonnen and Spurling (1994); Zambia (2): Kumar (1994); Cameroon (Center-South): Leplaideur (1978), cited by Charmes (2006): Cameroon (Yasssa of Campo, Southwest): Charmes (2006) based on Pasquet and Koppert (1993 and 1996); Cameroon (Mvae of Campo, Southwest): Charmes (2006) based on Pasquet and Koppert (1993 and 1996); Niger: Baanante, Thompson and Acheampong (1999); Togo: Baanante, Thompson and Acheampong (1999); Ghana: Baananate, Thompson and Acheampong (1999); India (West Bengal): Jain (1996); India: Singh and Sengupta (2009); India (Rajasthan): Jain (1996); Nepal: Joshi (2000); China: De Brauw et al (2008); Peru (1): Deere (1982); Peru (2): Jacoby (1992)

Figure 2: Proportion of labour in all agricultural activities that is supplied by women

Proportion of labour in all agricultural activities that is supplied by women is represented in figure 2 above. It revealed considerable variation across countries, and sometimes within countries. In Africa, estimates of the time contribution of women to agricultural activities ranges from about 30 percent in The Gambia to a little above 50 percent in Nigeria

Women participation in agriculture in Nigeria

The activities of women in agriculture cannot be over-emphasized. In many countries of the world including Nigeria, women play significant role in making sure that food is available for growing population of the world. In fact, there is an increasing trend towards what has been called the feminization of agriculture. Saito, Mokennem and Spurling in Okoli (2011) noted that there is highly acknowledgement of the role of women in agricultural development. The authors noted that three major events in the post-independent in Nigeria accounted for the notice of women role in farming. These include formal and free education of 1954/1955; the Nigerian civil war which lasted for 28 months and drastically reduced the population of men and Sharp increase in oil price in the mid and late 1970s which resulted to the abandonment of agricultural sector in search of oil jobs created in the oil sectors, which could help to improve their socio-economic status. Women who were now left in agricultural sector as noted by Ogundele (2014) provided about 14-18 hours of productive physical labour in various farming activities. Banji and Okunade (2011) noted that women are found working all the year round producing food crops, while men perform only replanting tasks that occupy small part of the agricultural year. In the observations of Ayioko (1996), African women especially Nigerians play crucial role in production of about 60-80 percent of agricultural products such as engaging in growing food crops, like maize, Sorghum millet and other staple food in the North, Rice yam, cassava and some nuts in the South. Women perform most of the farm operation themselves, even when such heavy work as land clearing or ridge making is involved.

Women involvement across value chains of Agricultural Production

Sahel (2014) categorise women involvement across value chains of agricultural production as follows:

Aggregators & Distributors: These are the first point of contact after food products are harvested. Bulk buying of food products is highly capital intensive, therefore women are restricted from this process due to low access to funding.

Logistics: Women are involved in the sale and transportation of packaging materials used for most crops and processed foods such as maize, *gari* and yam lakes.

Processing: The processing landscape in agricultural value chains is mostly at the informal and small-scale level. At this stage, women handle the bulk of the processing.

Market Access & Trading: Women are less involved in wholesale but rather are more active on the retail side and very visible in open air markets. Women find it harder to enter into the market due to limited education, funds and low social status.

Challenges to women participation in agricultural production in Nigeria

Despite the important roles women play in agriculture in the country, there are challenges still militating against their productivity. Sahel (2014) categories challenges faced by women in Agricultural production into four as:

Access to financing: In Nigeria, women receive less than 10 percent of the credit offered to small-scale farmers. Women are deterred from applying for formal loans because of the complexity of the administrative process, unsuitable loan sizes and credit rates. According to the National Bureau of Statistics, in 2007, some 20,098 men accessed loans compared to 8,550 women.

Access to information and training: Women participation in farmer training is low due to the lack of awareness, society barriers, and transportation facilities. Cultural norms restrict women from accessing Information Communication Technology (ICT).

Access to inputs: Due to poor financing, women are unable to access agricultural inputs such as improved seedlings and fertilizer. Women have indicated that they are unable to use inputs due to high cost in the open market.

Access to land: Women in Nigeria generally own less land due to traditional authority. According to the 2012 'Gender in Nigeria' report by the British Council, women own 4percent of land in the North-East, and just over 10 percent in the South-East and South-South, less than 10 percent of Nigerian women own land. Thus, the lack of land ownership significantly reduces the chances for women's access to financing because of the need for collateral.

Other challenges include

Poor subsidy on agricultural input: Subsidy in agricultural input is imperative. Women were noted to have less access to purchase agricultural resources than men because of their dependent on their husband's fund (Okoli 2011).

Limited access to new practice: The bulk of production comes from the rural small scale women farmers who are many and work consistently to produce food for the populace. If attention is paid to these neglected but active small scale women farmers, food security would be ensured.

Poor means of transportation of produce: Agriculture products need to get to the final consumers. This is done by road, rail etc. But the deplorable state of roads in Nigeria has increased the transport fare and also makes it difficult for farmers to transport their goods hence limited the farmers marketing activities.

Approaches to increasing the productivity of women in agriculture in Nigeria

In an attempt to identify the strategies to increasing the productivity of women in agriculture in rural areas of

Nigeria, it will be necessary to identify their strengths and potentials, on which these strategies will be premised. It is widely acknowledged that women are very hard working with so much done in an average day. Most jobs are done manually. If the domestic work of women farmers could be made lighter and easier through the provision of appropriate technology, much of her energies would be conserved for other productive ventures.

Technologies needed particularly by women in Agriculture

- ***Labour and energy saving technologies:*** Women typically lack technologies to relieve time-consuming agricultural tasks such as weeding, transplanting, and harvesting. Grinding, transport, and water and firewood collection are the main non-agricultural activities where appropriate technologies can reduce the time and energy use of women.

- ***Production Technologies:*** The processing of agricultural produce typically is carried out by women, often providing additional sources of income. However, given the primitive technology used, many agro-processing procedures consume much time and energy Improvements in agro-processing and storage technologies together with better rural infrastructure, market information systems and transport could substantially raise labour productivity and yields.

Access to basic production resources: Access of women to basic production resources such as land, labour and capital for investment must be facilitated and specific efforts must be made to break through the social and intra-household constraints that impede accessibility of these resources.

Market outlets and formation of thrift and credit cooperatives: It is crucial to create market outlets for farm products and off farm products of women, most of which would develop into small scale industries with further expansion.

Conclusion

This paper has been able to establish that women play significant roles in agricultural production in Nigeria. Largely, most of the activities in production, processing and marketing of agriculture products are performed by women, despite certain limiting factors or hindrances to their participation in agricultural production that is basically traditional in nature. These limiting factors include but not limited to poor access to finance, input subsidy, training and climate variability. There is therefore, the need for a multi-dimensional approach to surmounting all the challenges towards unleashing the productive capacity of Nigerian rural women in agricultural production.

Recommendations

It is recommended that women should be given:

- appropriate types of technology to cater for the labour intensive farm activities;
- good financial support;
- more access to farm land through appropriate land reforms; and
- farm inputs and other innovations should be available to women farmers at affordable and subsidized rates as and when needed.

Also, governments should listen to the voice of women through their participation in decision-making processes;

There should not be gender disparity or gender bias in agricultural policies and programmes implementation.

Government should invest more on women education, since development in all spheres of life including agriculture hinges on education of the people particularly women.

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Effects Of Covid-19 Pandemic On Non-Farming Activities Of Rural Women Farmers In Ughelli North Local Government Area, Delta State

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Abstract

The study analyzed the effects of Covid-19 pandemic on non-farming activities of rural women farmers in Ughelli North Local Government Area, Delta State. Specifically, the study described the socio-economic characteristic of rural women farmers; ascertained the livelihood effects of Covid-19 on non-farm activities of rural women; and investigated measures adopted to mitigate the livelihood effects of the pandemic. All women farmers in the area constituted the study population. Data were collected from 210 respondents selected through multistage sampling technique using structured questionnaire, and complimented by personal interview and on-the-spot observation. Data analysis was carried using frequency distribution and percentage count. The result revealed that the mean age of the rural women farmers was 48 years. Majority of the women (81.2%) were married with a mean household size of 8 persons. In terms of literacy, 53.8% of the farmers had primary education as their highest education qualification. The mean farming experience of the women was 27years. The result indicated that 25.0% representing majority of the women indicated that marketing of non-farm commodities was most affected by the pandemic. From the result, 65.2% of the women identified the provision palliatives as the measure taken to mitigate the livelihood effect of the pandemic in the area. The study concludes that covid-19 pandemic affected non-farming activities of rural women which undermined their income earnings, and therefore recommended for more palliatives and government supports to enable the women achieve livelihood resilience.

Keywords: Non-farming activities, rural women farmers, covid-19 pandemic, Ughelli North Local Government.

Introduction

Rural women represent a higher percentage of 206 million population in Nigeria. One of the major problems facing mankind is how to overcome food challenges and to ensure that the shortage of it does not overwhelm them. The importance of food to man cannot be over-emphasized. It is also of note that 70% of the world's population live in the rural area and a large percentage of this population are women, and these women provide 70% of the total staple food in Nigeria (Ozo-Eson, 2002), notwithstanding this huge contribution, women still face lots of challenges which stop them from optimizing this all important role.

The Covid-19 pandemic came in as a joke initially with many people waving it off in all ramifications. This was not different from the people of Ughelli-North local government area. Covid-19 as declared by W.H.O was a pandemic. It is a viral infection that can be contracted from person to person caused by severe acute respiratory syndrome (wikipidia 2020). According to David, (2020) Covid-19 is defined as an illness caused by the novel coronavirus, now called severe acute respiratory syndrome Coronavirus 2(SARS-Cov-2: formerly called 2019 – n Cov) that was first identified amidst an outbreak of respiratory illness cases in Wuhan city, Hubei Province, China. Covid -19 was reported by W.H.O on Dec. 31, 2019 and declared pandemic in March 2020.Maheidra in India for instance, reported that there's been massive consequences to ill health and livelihood feared and the government has imposed a 21 national lockdown to limit virus transmission given the situation that is not different from many other countries including Nigeria and Delta State in particular. Report abound of the challenges of food security, agriculture and safety net policy which have brought both negative and positive effects. Many States in Nigeria including Delta State ordered two-weeks lockdown which was repeated for another two weeks (pointer April 1st), (Ministry of information, Delta State). However, the pandemic disrupted many activities, one of the foremost was agriculture activities. Reports from the rural areas showed that the non-availability of food was as a result of interruption of farming activities such as weeding, harvesting, processing and transportation among others. This resulted in scarcity of food, increase in food price causing consumers to pay more due to demand and loss of harvested food due to lack of transportation to the market. The lockdown/pandemic has hindered economic activities leading to a wide spread loss of employment both in formal and informal sectors. The shutdown caused untold food shortage leading to higher levels of hunger and malnutrition.

The roles women play in agriculture in Nigeria cannot be over emphasized, as bear they bear the primary responsibility of their households' survival (Okwoye, 2007). According to him, in addition to carrying out majority of the farming operations, they engage in multiple livelihood activities to complement their household earnings, provide care giving to their household members, undertake domestic chores like fetching water, gathering fuel wood, going to market, among other activities which are directly or indirectly laden with financial burden. In Delta State, rural women provide approximately 65% of the labour force, and contributed significantly in home keeping, child care and farming. Unfortunately, the advent of the Covid-19 pandemic has taken a toll on non-farming activities as the nation-wide lockdown measures restrained them from engaging in their enterprise and vocational activities like hawking, petty trading, sewing, stocking, food vending, food processing, among other livelihood activities that hitherto served as complementary income sources. Unlike most ventures, farming was not significantly affected by the lockdown as it provided ample time for people to go into agriculture. Hence, this study is designed to understudy how rural women in Delta State were affected by the Covid-19 pandemic.

Aim and objectives of the study

The study broadly analysed effects of non-farming activities of rural women farmers in Ughelli North Local Government Area amidst covid-19 pandemic. The specific objectives include to:

i. describe the socio-economic characteristic of rural women farmers;

ii. ascertain the livelihood effects of Covid-19 on rural women farmers;

iii. investigate measures adopted to mitigate the livelihood effects of the pandemic

Methodology

Study Area

The study was carried out in Ughelli-North LGA of Delta State, which comprises of Afiesere, Odedegho, Ufuoma, Agbara, Owheru, Evwreni, Ogor, Agbaro and Orogun. The mean annual rainfall in the area is 3300mm, lasting from March to November. The mean daily temperature during the wet season is 26^{o}c with mean relative humidity of 24% (Delta State Ministry of lands and survey 2007).Major livelihood activities in the area are trading and farming, while the main crops cultivated in the area are cassava, plantain, yams, water yam, and vegetables. The population of the study was drawn from women farmers in the study area.

Data Collection

Data were collected from 216 respondents selected through multistage sampling technique using structured questionnaire, and complimented by personal interview and on-the-spot observation. In the first stage, all the nine communities in Ughelli-North LGA of Delta State were purposively selected to achieve a representative sample. Secondly, 24 women farmers were purposively selected based on the severity of Covid-19 effects on their nonfarm ventures to give a total sample size of 216. To determine their socioeconomic attributes, the respondents were asked to indicate socioeconomic attributes that apply to them by simply ticking in the list of options provided. To ascertain the livelihood effects of Covid-19 pandemic, the respondents were asked to indicate from a list of options areas affected by the pandemic. Measures adopted to mitigate the livelihood effects of the pandemic were measured by asking the respondents to indicate from a list of options measures taken to mitigate effects of the pandemic amongst rural women farmers.

Result and Discussion

Rural women socio-economic characteristics

Table 1 was the distribution of rural women by socio-economic characteristics. The result revealed that the mean age of the rural women farmers was 48 years expressing them as adults within the productive age according to Ani (2013). Majority of the women (81.2%) were married with a mean household size of 8 persons. This status assisted farmers to reduce cost of labour by leveraging on the economics of scale derived from large household size (Asiabaka, 2012). In terms of literacy, 53.8% of the farmers had primary education as their highest educational qualification. This portrays them as literates capable of reading about measures to prevent the pandemic as well as palliative measures available for farmers in alleviating the effects of the pandemic (Federal Ministry of Agriculture and Rural Development, FMARD, 2016).The mean farming experience of the women was 27years. Experience enables farmers develop sound and rational attitudes and behaviours towards difficult situations like the pandemic (Nwachukwu, 2013). Finally, the average farm size of 1.3 hectares described the farmers as smallholder farmers who might not have the financial disposition to access materials and methods for mitigating the effects of the pandemic.

Table 1: Distribution of rural women by socio-economic characteristics

Variables	frequency	Percentage	Mean
Age (years)			
20 – 29	29	13.6	
30 – 39	76	36.4	48
40 – 49	98	46.5	
50 – 59	3	41.2	
60 – 69	5	52.5	
70 and above	11	5.0	
Marital status			
Married	171	81.2	
Widowed	21	10.2	
Divorced	21	9.8	
Educational Level			
No formal education	39	18.8	
Primary School	113	53.8	
Secondary School	47	22.4	
Tertiary Education	11	5.0	
Household Size Number			
1 - 5	18	8.7	
6 – 10	126	59.9	9
11 – 15	63	30.2	

16 – 20	3	1.2	
Farming experience			
1 – 9	11	5	
10 – 19	63	29.9	
20 – 29	68	32.6	27
30 – 39	50	23.7	
40 – 49	18	8.8	
Farm Size (Hectare)			
0 -1	53	25.0	
1 – 2	126	60.0	1.3
2 – 3	32	15.0	

Source: Field survey data, 2020

Livelihood activities of rural women affected by Covid-19 pandemic

Table 2 is the distribution of rural women by livelihood areas affected by Covid-19 pandemic. The result indicated that 25.0% representing majority of the women indicated that marketing of non-farm commodities was most affected by the pandemic. This was followed by processing (19.5%), harvesting (19.0%) and transportation (18.5%). Notably, while the pandemic subsisted the study area was placed under 24-hour lockdown for days making movement of goods and services difficult. FMARD (2011) considered marketing most challenging factor to non-farm/value added activities as to exposes goods and services to economic losses due to spoilage, accumulated levies and demurrage, payment of toll on unsold goods and services. Similarly, the restriction of movement during the lockdown took a huge toll on harvesting as several farm products hitherto harvested by mobile labour could not be harvested. Ani (2013) noted that due to rural urban migration that has occasioned the exodus of youthful labour force, many rural women farmers have had to rely on mobile labourers from neighbouring towns and communities for their harvesting operations. Thus, the restriction of movement affected harvesting, exacerbating poverty and hunger during the lockdown. Typically, the resulting food scarcity brought untold hardship, ranging from empty shelves of shopping malls and food stores to hike in prices of foods items. Other non-farm activities like transportation and processing did not suffer different fate; while rural women processors could not buy processing feedstuff those who depended on transporters for survival suffered lack throughout the lockdown.

Table 2: Distribution of rural women by affects ofCovid-19 pandemic on non-farm activities

Livelihood activities	Frequency	Percentage
Harvesting	41	19.0
Processing	42	19.5
Transportation	40	18.5
Weeding	39	18.0
Marketing	56	25.0
Total	**216**	**100.0**

Source: Field survey data, 2020

Measures of mitigating the livelihood effects of covid-19 pandemic

Table 3 is the distribution of rural women by measures of mitigating livelihood effects of Covid-19 pandemic. From the result, 65.2% of the women identified the provision of palliatives as the measure taken to mitigate the livelihood effects of the pandemic in the area. This was followed by support from the government (20.9%), while 13.9% indicated security as part of the mitigating intervention. This result aligned with the assertion of Habib and Negedu (2016), that farmers need palliatives in the event of postharvest losses palliatives to enable them achieve resilience in production. The concept of palliatives was publicized among rural women during the lockdown, as government and non-governmental organizations, groups and individuals continued to send palliatives home in form of food donation, free supply of drugs, personal protective equipment, and free healthcare delivery. Thus, rural women were able to restock their food supply, stay healthy by receiving free treatment, and protect themselves against community transmission of pandemic. Most palliatives sent received by rural women came from their wealthy sons and daughters living outside the community. Federal and State governments also sent palliative materials to rural communities, including political office holders who used it as constituency projects. Others came from religious organizations, community development societies, NGOs, among other interventionist groups. The finding on government support was consistent with the views of Mgbada, 2010; Anjorin*et al.*, 2015; Habib *et al.*, 2015, FMARD (2016) who stated that to sustain the gains of agriculture, government must assist farmers during emergency situations like flood, fire outbreak, livestock intrusion and destruction, diseases and pests infestation, health crisis, among other phenomena which may incapacitate farmers from earning. Government support available to farmers in the area include 9% interest loan with 7-year payback period administered by the Central Bank of Nigeria through NIRSAL Microfinance bank. On the issue of security intervention, enforcement of the lockdown to contain the spread of the virus was administered by security agencies.

Table 3: Distribution of rural women by measures of mitigating livelihood effects of covid-19 pandemic

Mitigating intervention	Percentage	Mean
Palliatives	141	65.2
Government support	45	20.9
Security	30	13.9
Total	**216**	**100**

Source: field survey data, 2020

Conclusion and recommendation

The study concludes that the rural women farmers were within their productive age. Majority of the women were married with a mean household size. The farmers had primary education as their highest education qualification with mean farming experience of 27years. Majority of the women indicated that marketing of non-farm commodities were mostly affected by the pandemic. These women identified the provision of palliatives as the measure taken to mitigate the livelihood effect of the pandemic in the area. Covid-19 pandemic affected non-farming activities of rural women which undermined their income generation, Hence, it is recommended that more palliatives and government supports be sustained to enable the women achieve livelihood resilience.

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Perception Of Agricultural Undergraduates To Agriculture Related Entrepreneurship Education Among Selected Tertiary Institutions In Ibadan, Oyo State

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ABSTRACT

This study was based on the perception of Agricultural undergraduates to agriculture related entrepreneurship education among selected tertiary institutions in Ibadan, Oyo State. One hundred and twenty (120) respondents were randomly selected from the tertiary institutions. Data collected were statistically analyzed using inferential and descriptive statistics. Chi-square was used to assess the respondents' socio-economic characteristics and their level of perception on agricultural related entrepreneurship education, while Pearson product moment correlation was used to examine the perception

of students towards agriculture related entrepreneurship education as well as problems associated with agriculture related entrepreneurship education. The result shows that socio-economic characteristics of the respondents had no influence on their perception to agricultural related entrepreneurship education. The Pearson moment correlation shows that there is no significant relation between perceived problems associated with entrepreneurship education ($r = 0.101$, $p=0.270$). Therefore, it is recommended that efforts should be put in place by all concerned stakeholders in educational sector to encourage entrepreneurship education in all tertiary institutions.

INTRODUCTION

Nigeria is a country blessed with so many abundant natural resources, yet larger proportion of its citizen's lives in abject poverty, hunger and starvation with a high rate of unemployment ratio. A high degree of migration from the rural to urban areas for employment opportunities which in turn has made the urban areas over-populated. The agricultural sector is still the dominant provider of employment and it remains crucial to economic growth and development. The issue of entrepreneur education is considered very important for economic growth and for solving the scourge of employment, yet the challenges that affect people's interest in agricultural entrepreneurship as a career include accessing funds, lack of technical support at start up, marketing and inadequate business opportunities. It has been observed that many agricultural undergraduates have refused to show enthusiasm and has regarded agricultural entrepreneurship as a dirty work or its drudgery if done manually.

Agribusiness which has been defined as all business-oriented entities involved in the production, input supply, agro-processing, marketing and distribution of agricultural commodities. GTZ (2001) is arguably the largest source of employment among rural populates in many developing countries (FAO, 2006). As such in the national development agenda agriculture is expected to lead the growth and structural transformation of the economy; providing jobs, ensuring food security and providing the needed raw materials to propel the country's industrialization agenda (George, 2008; MOFA 2007).

Shook and Bratianu (2010) argued that individual forms their attitude based on their beliefs or perception of the likely outcomes. As such the more favourable the possibility is to an individual, the stronger their intention to do the behavior will be, and vice versa. Onubuogu and Esiobu (2014) opined that sustainable development of agribusiness requires the development of entrepreneurial and organizational competency in farmers.

Moreover, the involvement and willingness of agricultural students to participate in agricultural entrepreneurship in Nigeria will help minimize unemployment overdependence on crude oil and white collar jobs; it will also of immense benefit to the individual especially when aimed at self-reliance. These will also be enable the students to remove the wrong impression that those practicing agriculture are poor and illiterate and will enable the upcoming agricultural students to have respect for agricultural profession.

The general objective of the study is to examine perception of agricultural undergraduates to agricultural related entrepreneurship education among selected tertiary institutions in Ibadan, Oyo State.

RESEARCH METHODOLOGY

The study area is located in the south west geographical zone of Nigeria. Oyo state is located at an elevation of 1,219 above sea level and its population amounts to 5,591,589 according to 2016 census. It covers approximately an area of 28,454 square kilometers, the landscape consist of old hard rocks and dome shaped hills, which rise gently from about 500 meters in the southern part, it's coordinates are 8.000 4.00 and 8.000^{0}N and 4.000^{0}E weather condition is equatorial, notably with dry and wet season with relatively high humidity. Average daily temperature ranges between 25^{0}C (77.0^{0}F) and 35^{0}C (95.0F) almost throughout the year. The population of the study was the undergraduate agricultural students of selected tertiary institutions in Ibadan, Oyo State. Target population of this study was the selected undergraduate agricultural students in the tertiary institutions. A multistage sampling technique which also features purposiveness and randomness was used for the study. Ten percentage of the total number of the institutions selected were used, while forty (40) agricultural students were randomly selected in each tertiary institution to give 120 respondents for the study. The data collected were subjected to both descriptive and inferential statastics.

RESULTS AND DISCUSSION

Table 1: Socio-Economic Characteristics of the Respondents

Variable	Frequency	Percentage
Age		
16-25 years	39	32.5
26-30years	49	40.8
31-40years	32	26.7
Total	120	100
SEX		
Male	31	25.8
Female	89	74.2
Total	120	100

Marital Status		
Single	72	60.0
Married	43	35.8
Divorce	5	4.2
Total	120	100

Source: Field Survey, 2017

The age in years of the respondents are grouped to reflect the expected physical strengths of the respondents. The age distribution as shown on table 4.1 shows that 40.8% of the respondents are between the age ranges of 26-30 years, 32.5% were in the age ranged of 16-25 years, while age within range of 31-40 years accounted for 26.7%. This implies that majority of the respondents were young and still possess enough strength vigour and vitality to play their active roles in agriculture related entrepreneur. It was also observed that majority (74.2%) of the respondents were females, while 25.8% of them were males. This is in accordance with the findings of Sani and Sani (2005) who asserted that women's contribution to economic life and share in the labour force continues to rise as they are becoming more involved in small scale enterprises such as agricultural processing and marketing. It can also be deduced shows that majority (60.0%) of the respondents were single, 35.8% were married, while 4.2% were divorced. This implies that majority of the respondents being single are more committed to their future and more focused on their academic study.

Table 2: Perception of Students towards Agricultural Related Entrepreneurship Education

s/n	Statements	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1	I enjoy entrepreneurship education lessons		2(1.7)		43(35.8)	75(62.5)
2	Entrepreneurship education lessons increase my interest in a career in entrepreneur	1(1.8)	2(1.7)	3(2.5)	72(60.0)	42(35.0)

3	Entrepreneurship education prepared me to make innovation and informed decisions about career choice	2(1.7)	10(8.3)	2(1.7)	76(63.3)	30(25.0)
4	Student who finished the course on entrepreneurship are not expected to possess better skills than those without the skill	22(18.3)	19(15.8)	37(30.8)	19(15.8)	23(19.2)
5	The institution encouraged students to pursue entrepreneurship ventures		5(4.2)	2(1.7)	51(42.5)	62(51.7)
6	Student in agriculture generally have low of average achievement motivation level	8(6.7)	10(8.3)	6(5.0)	63(52.5)	33(27.5)
7	Student with no entrepreneurial experience have significantly better achievement motivation than those with entrepreneurial experience	31(25.8)	16(13.3)	24(20.0)	25(20.8)	24(20.0)
8	I consider entrepreneurship a desirable career option	8(6.7)	6(5.0)	13(10.8)	61(50.8)	32(26.7)

It can be deduced from the table that 62.5% of the students strongly disagree that agriculture related entrepreneurship education is enjoyable. This might be due to the reason that majority of the students studying agriculture science of related course did not choose the course as their choice of the course to study. Perhaps it might be desperation for seeking the admission and time factor or cut-off marks at Jambs that made majority of the respondents studying agriculture as a course. Sixty percent of the respondents disagreed that entrepreneurship education lessons increased their interest in a career in agricultural related entrepreneur, This may be due to the fact that youth of nowadays are not ready to engage in tedious of long term investment, but white collar jobs and jobs that bring returns in due time.

It can also be inferred from the table that 50.8% of the respondents disagreed to consider entrepreneurship as a desirable career option this might be due to the orientation of the student and risk involved in entrepreneurship. The table also shows that 23.3% of the respondents strongly disagreed that those students who don't have experience on entrepreneurship have better entrepreneurial career and better work habits.

Table 3: Perceived problems associated with entrepreneurship education

s/n	Problem	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1	Poor access to entrepreneurship information	2(1.7)	10(8.3)	2(1.7)	39(32.5)	67(55.8)
2	Limited availability of farmland	4(3.3)	8(6.7)	2(1.7)	70(58.3)	36(30.0)
3	Poor experience/training in entrepreneurship education	2(1.7)	9(7.5)	9(7.5)	57(47.5)	43(35.8)
4	Poor access to capital	2(1.7)	9(7.5)	2(1.7)	76(63.3)	30(25.0)

Table 3 shows the perceived problems associated with entrepreneurship education. Majority (55.8%) of the respondents strongly disagreed that poor access to entrepreneurship information is a problem of agricultural entrepreneurship education. This may be due to the fact that access to media to seek information enables them to have adequate entrepreneurship information. Nigeria is blessed with fertile land and land is available for agricultural cultivation, thereby 56.3% of the respondents disagree that limited availability of farm land is a problem. Majority (47.5%) of the respondents also disagree that inadequate training in entrepreneurship education is a problem associated with agriculture entrepreneurship education while 50.0% of the disagreed that poor access to capital is a problem. This may be due to the awareness and government intervention through agricultural bank to give agricultural loan to anyone who engages in agricultural business of enterprise.

This implies that agricultural entrepreneurship education is paramount to economy development and youth empowerment.

CONCLUSION

It can be concluded that majority of the respondents were young and still possess enough strength, vigour and vitality to play important and active roles in agriculture related entrepreneurship. However, access to media to seek information enables them to have adequate entrepreneurship information, while some of the perceived problems could pose as a major challenges and negative perception towards agriculture related entrepreneurship education as a future career. Therefore, it is recommended that Governments and all stakeholders in agricultural sectors should intensify efforts to encourage youth involvement in agricultural business, such as providing loans through agricultural Developments Banks, availability of farmland and adequate entrepreneurial training and access to agricultural infrastructures.

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Attitudes and constraints faced by poultry workers in Kwara state, Nigeria.

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Abstract

It has been discovered that in some poultry farms, despite provisions for effective management practices, they are still beset by loss of birds, inputs and an eventual collapse of the farms. This however calls for the determination of the Knowledge, Attitudes and Constraints faced by the workers towards expected effective management of the farm, and this was what this paper sought to address. It adopted a multi-stage random sampling method, and Stage 1 involved the selection of 2 Local Government Areas from each of the Four Agricultural Development Programme (ADP) zones of Kwara State, followed by selection of 3 Poultry farms from each of the selected Local Government Areas. Data was analyzed using frequency, percentage, mean statistics and Pearson Product Moment Correlation (PPMC). In the last stage, a proportionate sampling of 70% of sample population was used to select a total number of 156 poultry workers from all farms selected. Findings revealed that 70.5% of the respondents knew nothing about the poultry work before being employed, and their highest interval of training was monthly (49.4). They have a positive attitude on the need for better motivation and treatment of the workers (4.69 and 4.72 respectively), while their major constraints to effective production were Insufficient training (2.90), Poor motivation (2.72), and little income received (2.57). Fortnight training of the workers is thus recommended and their income should be considered, while some other motivational benefits should be provided to enhance expected performance and profit.

Key words: Poultry worker; Attitude, Constraints

Introduction

The Agricultural sector in Nigeria being the next important economic activity after oil is the largest employer of labour force, employing about 70% of the country's workforce (USDA, 2013; NBS, 2014). It contributed about 40.07% in 2010 and 22% in 2014 of Gross Domestic Product (GDP) (NBS, 2014). The Nigeria's livestock population consists of 3.7 million pigs; 27 million sheep; 16.3 million cattle; 40.8 million goats; and 151 million poultry (Nasiru *et al.*, 2012). Going by this figure however, it is well-established that poultry alone constitutes more than 60% of total livestock population in Nigeria. This indicates the dominance of poultry sub-sector in the livestock industry (Adeyonu *et al*, 2016).

Commercial and rural family poultry are thought to attract private investors, despite the fact that the sector is the most fragile of the livestock component which has high risk. Studies have shown that most poultry farmers find it difficult to maximize profit because of risks and challenges associated with poultry management (Egbe, 2015). In this era of climate change where heat stress poses a severe challenge to the poultry farmers (Liverpool-Tasie, Sanou & Tambou (2019), carelessness on the part of the workers in the poultry farms will plunge the owners of the farms into more losses.

Experiences drawn from different studies have demonstrated that the people having favorable attitude towards a programme reflects a cumulative positive effect in the form of boon reactions. Since management problem however, has been described as one of the major problems associated with poultry production in Nigeria, there should be proper care and attention to the poultry workers' attitudes as this will reveal their inner disposition towards the work, since they are responsible for majority of the activities on the poultry farm. Against this back drop, this study will seek to answer the following questions. What are the attitudes of the poultry workers towards the work? And what are the constraints militating against their effective performance?

Objectives of the Study

The study assessed the attitudes and constraints faced by poultry workers in Kwara, State. specifically:

It determined the attitude of the respondents in poultry farming, and it determined the constraints militating against the respondents' productivity, and later identified the determinants of the constraints faced by the workers.

Methodology: The project was carried out in Kwara State, Nigeria. The sample population involved all the poultry workers in the State. It adopted the multi-stage sampling technique with the first stage involving a purposive selection of two local governments (with the highest poultry activities) from each of the four ADP zones in the study area. The second stage involved a purposive selection of three poultry farms from each of the selected local governments, while the last stage involved the selection of poultry workers using a proportionate sampling of 70% of sample population. 156 respondents were selected, and the Instrument validation was done with a reliability coefficient of 0.831 obtained using a test-retest method implying a reliable instrument. In determining the attitudes of the respondents towards Poultry work, about 10 attitudinal statements were generated which were rated on a 5-point likert-type scale of strongly agreed = 5, agreed = 4, undecided = 3, disagreed = 2, and strongly disagreed = 1. The mean scores were determined, and the bench mark of 3 was calculated. Also, Attitude scores were obtained from the scale with total scores ranging from 15 to 45 scores, so respondents with scores between 15 and 30 were termed negative attitude, while those with scores between 31 and 45 were termed workers with positive attitude. Mean below the bench mark were considered low attitude while those above were considered positive attitude. For the constraints militating against their effective performance, a list of factor affecting their performance was generated on a 3-point scale of not serious = 1, serious = 2, very serious =3 respondents specified their preference, the mean of each factor was determined and the one with the highest frequency was identified. The weighted values were added (i.e. 3+2+1= 6/3=2). Any mean score of less than 2 was regarded as minor constraints, while mean score of greater than 2 was regarded as major constraints respectively. Data was analyzed using frequency, percentage, mean statistics and Pearson Product Moment Correlation (PPMC).

Results and Discussion

Attitude of poultry workers towards the poultry work

Table 2: Attitude of poultry workers towards the poultry work

Attitudinal Statement	Frequency (Percentages)					**Mean**	**Decision**
	SA	**A**	**U**	**D**	**SD**	**(S D)**	
Poultry work requires prior poultry knowledge	31(19.9)	61(39.1)	4(2.6)	50(32.1)	10(6.4)	3.34(1.29)	Positive
Poultry work requires prior poultry experience	16(10.3)	43(27.6)	9(5.8)	65(41.7)	23(14.7)	**2.77**(1.28)	Negative
Higher educational certificate is	0(0.0)	11(7.1)	24(15.4)	46(29.	75(48.	**1.81**(0.9	Negati

necessary in poultry work				5)	1)	4)	ve
Regular training is necessary in poultry work	80(51.3)	74(48.7)	0(0.0)	0(0.0)	0(0.0)	**4.51**(0.50)	Positive
Poultry work ensures professionalism	12(7.7)	141(90.4)	0(0.0)	3(1.9)	0(0.0)	**4.04**(0.39)	Positive
Poultry workers need better motivation	108(69.2)	48(30.8)	0(0.0)	0(0.0)	0(0.0)	**4.69**(0.46)	Positive
Poultry workers needs better treatment	112(71.8)	44(28.2)	0(0.0)	0(0.0)	0(0.0)	**4.72**(4.51)	Positive
Poultry workers should form an association	14(9.0)	98(62.8)	35(22.4)	6(3.8)	3(1.9)	**3.73**(0.76)	Positive
I am thinking of establishing a poultry farm	62(39.7)	91(58.3)	1(0.6)	0(0.0)	2(1.3)	**4.35**(0.63)	Positive
I am happy as a poultry worker	35(22.4)	110(70.5)	5(3.2)	6(3.8)	0(0.0)	**4.12**(0.63)	Positive
I communicate freely with the manager/supervisor	62(39.7)	94(60.3)	0(0.0)	0(0.0)	0(0.0)	**4.40**(0.49)	Positive
Poultry work need better source of information e.g ICT	35(22.4)	71(45.5)	50(32.1)	0(0.0)	0(0.0)	**3.90**(0.74)	Positive
Poultry work exposes one to a lot of risk	43(27.6)	87(55.8)	4(2.6)	22(14.1)	0(0.0)	**3.97**(0.93)	Positive
Poultry work belittles my personality	11(7.1)	31(19.9)	17(10.9)	92(59.0)	5(3.2)	**2.69**(1.05)	Negative
I am doing the work out of circumstance	12(7.7)	12(7.7)	15(9.6)	94(60.3)	23(14.7)	**2.33**(1.07)	Negative

SA= Strongly agree, Agree, U=undecided; D= disagree, Strongly disagree, Freq.= Frequency, SD = Standard deviation

Table 2 above shows the attitudes of the respondents towards the poultry work. However, only four out of the fifteen statements received negative attitudes showing that they believe that poultry work neither requires prior poultry experience (2.77), nor higher educational certificate (1.81). They also believe that neither does the work belittle their personalities (2.69) nor are they doing the work out of circumstance (2.33). This shows that majority of them are confident of the job, and this is a factor towards effective service discharge. However, they believe that the work exposes them to a lot of risk (3.97), this however confirms the work of Narinder *et al* (2011) which revealed that Poultry farming is highly sensitive to diseases. They are also positive on the fact that, as workers, they need better motivation (4.69), and treatment (4.72). This is a good determinant of their zeal to work because if they are not well motivated, they may not bring out the best in them, and this might be among other reasons of poor management in Poultry farms by the workers. Lastly, they believed that Poultry farming ensures professionalism, which means, it is a venture that can stand as a reputable means of income. This also confirms the work of Paul et *al (*2011).

Constraint to poultry workers' performance

Table 3: Constraint to poultry workers' performance

Perceived constraints	Very serious	Serious	Not serious	Mean(S.D)	Mean rating
Insufficient Training	141(90.4)	14(9.0)	1(0.6)	**2.90**(0.325)	1
Poor motivation	113(72.4)	42(26.9)	1(0.6)	**2.72**(0.466)	2
Little income received	104(66.7)	37(23.7)	15(9.6)	**2.57**(0.663)	3
Wide comm. gap	76(48.7)	63(40.4)	17(10.9)	**2.38**(0.675)	4
Insufficient inputs	58(37.2)	90(57.7)	8(5.1)	**2.32**(0.568)	5
Inconsistent Farm Admin Policies	48(30.8)	105(67.3)	3(1.9)	**2.29**(0.495)	6
Poor farm organization	46(29.5)	98(62.8)	12(7.7)	**2.22**(0.571)	7
Old and outdated equip.	16(10.3)	73(46.8)	67(42.9)	**1.67**(0.654)	8

Poor Extension serv.	24(15.4)	27(17.3)	105(67.3)	**1.48**(0.749)	9
Low-level education	17(10.9)	27(17.3)	112(71.8)	**1.39**(0.678)	10

Table 3 above shows the perceived constraints that contribute to poultry workers non effective performance. The severest of their constraints was lack of adequate training (2.90), and it is ranked first. This is evident in their intervals of training which they claimed was monthly. This is followed by the poor motivation of workers (2.72), and little income received as salaries and allowances (2.57), which were assumed to be major causes of poultry collapse. Wide communication gap (2.38) was ranked fourth, while not severe constraints are low-level of education (1.39), lack of extension support (1.48) and old and outdated equipment used (1.67).

Table 4: Pearson Product Moment Correlation results of the relationship between selected socioeconomic characteristics of respondents and constraints to the performance of poultry workers

Variables	Pearson (r-value)	Significance(p-value)	Decision
Age	0.169^{*}	0.035	Significant
Sex	-0.019	0.811	Not significant
Marital status	0.039	0.625	Not significant
Religion	0.060	0.458	Not significant
Education	-0.232^{**}	0.004	Significant
Household size	0.064	0.424	Not significant
Experience	0.051	0.526	Not significant
Number of birds raised	-0.144	0.073	Not significant
Monthly Income	0.143	0.074	Not significant

Membership	0.014	0.867	Not significant

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Results presented in table showed that age at $p \leq 0.05$ was positively related to the constraints faced by the poultry workers. This implies that as age of respondents' increases, the more constraints that will affect the poultry workers' effectiveness in delivering his/her duties. This is noted by Iheke (2010) who revealed that the risk bearing abilities and innovativeness of a farmer, his mental capacity to cope with the daily challenges and demands of farm production activities and his ability to do manual work decrease with advancing age.

Also, the level of education at $p \leq 0.05$ has inverse relationship with constraints to the poultry workers' performance. This implies that as level of education of respondents' increases, the less the constraints that will be faced by the poultry workers' effectiveness in delivering his/her duties. Education has been described as being pivotal to unlocking the entrepreneurial abilities of farmers and enhancing their ability to understand and evaluate new production techniques (Iheke, 2010; Nwaru *et al.,* 2011).

Conclusion

The poultry workers are very positive on the need for better motivation and treatment of the Poultry workers (4.69) and (4.72) respectively, and that the work exposed them to a lot of risk (3.97). But, they have a negative attitude on whether the work belittles their personalities (2.69), or were they doing the job out of circumstance (2.33). The severest of the constraints is a lack of adequate training (2.90), and it is ranked first. This is followed by the poor motivation of workers (2.72), and little income received (2.57) which are assumed to be major causes of poultry collapse. Wide communication gap (2.38) is ranked fourth' and not severe constraints are low-level of education (1.39), lack of extension support (1.48) and old and outdated equipment used (1.67). Also, the age of the workers has a significant relationship with their constraints to effective management practices; meaning that, the older they are, the more they are constrained to effectively discharge their duties, while Education has an inverse relationship with their constraints to effective production. This implies that the more they are educated, the less the constraints.

Recommendations

Fortnight training of the workers is recommended, since majority of them knew nothing about the poultry work, and the monthly training that they are conversant with is not yielding much. The workers need to be better motivated so that they can be made to bring out their best. This can be done by increasing their income and giving them some motivational benefits. Lastly, education should be among the criteria for employing the workers, as this reduces the constraints faced by them, and certain ages should not be employed so as not to expose the farm to mismanagement stemming from old age of the workers.

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An investigation of the utilization of improved rubber technologies among farm settlers in Edo and Delta states of Nigeria

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Abstract

The study was designed to investigate utilization of improved rubber technologies among farm settlers in Edo and Delta States. A total of 150 respondents were randomly selected from the three farm settlements. Analytical tools used included percentages and frequency. The results indicated that rubber farmers are old and majority of the improved rubber technologies were not utilized. It was recommended that Rubber farmers should be encouraged to make use of all the improved rubber technologies to achieve the desired result of boosting rubber production in the region thereby improving their livelihood. Extension activities should be encouraged through funding by Government and nongovernmental organizations to effectively disseminate production information to farmers. Information should be given priority attention since these will promote the level of utilization of improved rubber technologies in the study area.

Keywords: Investigation, utilization, Improved Rubber, technologies and farm settlers

Introduction

Planted rubber is grown between longitudes 150N and 100S where the climax vegetation is humid with temperatures ranging from 23 to 450C and a well- distributed rainfall of 1800mm to 2000 mm on a well- drained soil (Aigbekaen et al. 2000). Production statistics show that Nigeria has a total of 247,100 hectares of land under rubber cultivation. Of this figure, small-scale farmers own 200,100 hectares while the remaining 47,000 hectares are owned by estates (Aigbekaen et al. 2000; Delabarre and Serier 2000). Improvements have been made in the breeding of high- yielding clones of rubber by the Rubber Research Institute of Nigeria as RRIN adapted (exotic) clones and RRIN developed clones having a latex yield of 900 to 1600 kg per hectare per year of dry rubber and 2000 to 3500 kg per hectare per year respectively (Omokhafe and Nasiru 2004). Many researchers are of the view that the non adoption of improved farm practices by farmers is one of the major reasons for low productivity in agriculture, and natural rubber production is not an exception. In spite of the problems of the decline in natural rubber production, research in rubber has evolved improved technologies that may stem the decline in rubber production (Ugwa and Abubakar 2006). It is against this background that the study was conducted on investigation of the utilization of improved rubber technologies by farm settlers in Edo State and Delta states of Nigeria..

Objectives: the objectives of the study are as follows:

i. analyze the socio-economic characteristics of rubber farmers in the study area;

ii. ascertain the level of utilization of improved rubber technologies;

iii. determine sources of information available to the farmers.

Materials and Methods

The Study Area

The study was conducted in Iguoriakhi farm settlement in Edo State, Mbiri and Utagba-uno farm settlements in Delta State.

Sample Size Selection and analysis

The population of this study consisted of all rubber farmers in three farm settlements namely, Iguoriakhi (Edo State), Mbiri and Utagba–uno (Delta State) who were purposively selected based on their involvement in rubber farming, a simple random sampling technique was used to select 40, 58 and 52 respondents from Iguoriakhi, Mbiri and Utagba-uno farm settlements respectively with use of structure questionnaire. The total sample sizes were 150 respondents. One hundred and thirty (130) questionnaires were accurately filled and returned. The Iguoriakhi, Mbiri and Utagba-uno farm settlements composed of 125, 182 and 162 farm families respectively (Begho et al. 2000 in Otene, et al., 2010).

Results and Discussion

Socio-economic Characteristics of Rubber Farmers

Table 1 revealed that majority of the respondents (85.38%) who were actively involved in rubber farming were within the age brackets of 51-70 years implying that the farmers are old. This result agrees with the views of Abolagba et al. (2003) who noted that rubber farmers consisted mainly of the aged category. The preponderance of older people in rubber farming profession means that adoption of innovation may be difficult. All the rubber farmers (100%) were male and majority of them (93.78%) were married. Land allocation in the farm settlements tends to favour men due to the culture of the people (Swanker, 1998). Farm size distribution of respondents revealed that rubber production is predominantly at very small scale. This is because respondents cultivated between 1 and 8 hectares, is within the average of small-scale production. Adoption of an innovation may be affected by small hectares and might be a disincentive in the acquisition of credit facilities from commercial banks. Majority of the respondents (89.23%) had family size ranging from 5 and above. The large family size could be a valuable source of labour for rubber production and other agricultural activities.

Table1: Socio-economic characteristics of rubber farmers (N=130)

Socio-economic characteristics	Percentage
Age (Years)	
21 - 30	3.85
31 – 40	3.46
41 – 50	3.46
51 – 60	56.15
61 – 70	29.23
> 70	3.85
Sex	
Male	100.00
Female	0.00

Marital Status	
Married	93.85
Single	4.62
Widower	1.52
Farm Size (ha)	
1 – 2	79.23
3 – 5	15.38
5 – 6	3.08
7 – 8	2.31
Family Size (persons)	
1 – 2	5.38
3 – 4	5.38
5 – 6	16.92
7 – 8	31.54
9 and above	40.77
Experience (years)	
2 – 4	3.85
5 – 15	42.30
16 – 25	28.46
26 – 35	22.31
36 - 45	3.08
Education	

Primary school	75.38
Secondary School	17.69
NCE	6.15
University	0.77

Many (50.77%) of the respondents had 16-35 years of experiences in rubber farming while 42.30% had between five to fifteen year of experience in rubber farming and only 3.85% had two to four years of experience in rubber farming. This result revealed that rubber farmers in the study areas had long years of experience in rubber production.. Respondents were all educated and acquired first school-leaving certificate.. This finding is agrees with the work of (van den Ban and Hawkins 1996) who reported that there is positive correlation between education and adoption of innovation, and that, an educated mind is able to accept positive change.

Utilization Level of Improved Rubber technologies

From the table 2 all (100.00%) of the respondents were aware of improved rubber management practices. About 58.46% of the respondents utilized the improved rubber technologies. This is not a surprise as farmers in the study area were educated, thereby, made utilization of the improved practices easier for them. Majority of the respondents (93.08%) used budded stumps as their sources of planting material. This is in agreement with Schroth et al. (2004) who reported that a basic component of any crop production enterprise is the planting material. Most (88.46) of the respondents practiced intercropping by planting rubber and pineapple, cassava, pepper, okra, coca-yam, and maize. Multiple cropping in the vast interior of young rubber plantation holds the key to attracting small holders to rubber farming due to its long gestation period. This agrees with the views of Esekhade et al. (1996) who noted that intercropping rubber with arable crops has been found to be economically viable, in that the farmers obtain revenue from the sales of the crops while waiting for the maturity of the trees before the commencement of tapping. About 40.7% of the respondents practice recommended land spacing. Esekhade et al. (1996) are of the view that recommended land spacing which gives about 450 plants per hectare help in the introduction of intercropping with arable crops before canopy closure ensures effective utilization of the avenue. Majority did not practice cleaning of latex cup before tapping because they are not involved in latex production but coagulant production.

Table 2: Utilization level of improved rubber technologies by the respondents

Utilization of improved rubber technologies	*Percentage
Awareness	
Aware of the improved management practices	100
Level of Utilization	
1.Use of budded stumps	93.08
2.Intercropping	88.46
3.Recommended land spacing (450 plant/ha)	40.77
4.Fertilizer application (N P K 15,15,15;Urea)	24.62
5.Use of trained tappers	31.54
6.Cleaning 0f latex cups before tapping	
7.Cleaning 0f latex coagulating pans before tapping	
8.Use of raised platform/cemented Surfaces	20.78
9.Clearing of plantation before commencement of tapping	42.31
10.Use of chemical e.g. pesticide	15.39
11.Use of ammonia to preserve rubber latex	5.38
12.Thinning	41.51
13.Supplying	36.92
14.Use of fire trace	38.46
Types of Clones Planted	

NIG 800	26.15
RRIM 600	10.77
GT1	61.54
PB5/63	0.77
RRIM 628	0.77

Sources of Information on Rubber Production

Table 3 indicated that majority (70.00%) of the respondents obtain information from cooperative societies and about 45.38% obtain their information from family/friends while 35- 38 % of the respondents obtain their information from RRIN extension agents. This may be as a result of the respondents having strong cooperative societies so it was easier for extension agents to pass information to the group. Majority (69.23%) of the respondents were visited one to two times last season, 20.77% were visited three to four times last season and 10.00% were visited five times and above. This further explain why majority (60.00%) of the respondents indicated that extension agents in the study areas were inadequate. This agrees with the view of Ogundele (2016) who reported that for adequacy of extension workers, there should be an average of 500 farmers to one-extension personnel, but there are instances where the ratio of extension workers to farmers is 1:10,000.

Table 3: Distribution of respondents based on information sources on rubber production

Items	*Percentage
Sources of information	
Radio and Print Media	0-77
Family/Friends	45.38
RRIN Extension Agents	35.38
TCU/ADP	16.15

Cooperative societies	70.00
Michelin Agents	5.38
Extension Contact	
Had contact with extension agents	89.21
Did not have contact with extension agents	10.79
Number of Times Visited by Extension Agents last season	
1 – 2	69.23
3 – 4	20.77
5 and above	10.00
Adequacy of Extension Agents	
They are adequate	40.00
They are not adequate	60.00

Conclusion and Recommendations

The results of a descriptive statistics indicated that rubber farmers are old and majority of the improved rubber technologies were utilized. It was recommended that Rubber farmers should be encouraged to make use of all the improved rubber technologies to achieve the desired result of boosting rubber production in the region thereby improving their livelihood. Extension activities should be encouraged through funding by Government and nongovernmental organizations to effectively disseminate production information to farmers. Information should be given priority attention since these will promote the level of utilization of improved rubber technologies in the study area

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WOMEN EMPOWERMENT FOR POVERTY REDUCTION: CASE OF SOKOTO SKILL ACQUISITION PROGRAMME IN SOKOTO STATE, NIGERIA

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ABSTRACT

The study was carried out to evaluate the role of Sokoto Skill Acquisition Programme in poverty alleviation among women in Sokoto metropolis. Random sampling was used to select 80 respondents from the study area and data collection was through the administration of structured questionnaire. Data were analysed using simple descriptive statistics and t-test. The result revealed that 38.0% of the respondents fell in age class interval of 21-30 years, most were married and had no western education (58.8% and 56.3% respectively). The most common areas they received training were knitting and tailoring. Using income level before and after joining the program, there was a positive effect of the program on the beneficiaries. Inadequate machines for training and exceeded period of training time were the major constraints of the respondents. The study therefore recommends that adequate machines for training should be made available to the respondents and there should be timely graduation of trainees.

Keywords: skill acquisition, women, machines, trainees, poverty alleviation.

INTRODUCTION

Women are responsible for ensuring food security for their families in many developing countries particularly in sub-Saharan Africa (Pesticide Action Network, Asia and Pacific, PAN AP 2005). Women play significant if not dominant role in food production, economic access to available food and nutrition security necessary to achieve food security in developing countries (Quisumbing *et al*. 1995). They have important role as producers of food, managers of natural resources, income earners and caretakers of household's food and security. Women empowerment has become one of the key priorities for sustainable development around the world (Akhter and Cheng, 2020). Even in developed countries, this factor is also being considered, as women in developed countries experience several types of discrimination in different ways. For developing countries, gender inequality has been established as one of the most vital obstacles to progress. Indeed, women empowerment has been reflected as a significant indicator of the sustainability of women's success and well-being (Kulkarni, 2011). In most nations, there is still discrimination against women, who are still considered only for domestic work at home, and this has impacted on the assumption that women are not allowed to work outside their homes (Nadim and Nurlukman, 2017). Not to mention many other cases of discrimination for women who limit them to develop their potential. Generally, women are more involved in informal work compared to men, women receive lower payments, social threats and challenges, lack of a good working environment, and limitations in making opinions on decisions (Nadim and Nurlukman, 2017). Social and religious cultures consider women to be 'physically weaker' than men and hence women are limited to joining economic activities outside of their homes.

The conception of women's empowerment is used to understand what is needed to change the condition of women who still experience discrimination and poor problems. In developing countries, there are many reasons for the helplessness of women. This control is exhibited by men over women, men over men, and by social, economic and political class dominant over those who are less powerful. The term "women empowerment" has become popular in land development since the 1980s. It is acknowledged that women's empowerment is needed in relation to sustainable economic growth and poverty reduction (Chowdhary, 2009). After becoming empowered, women are able to contribute to sustainable growth (Lyons *et al*., 2001). Economic empowerment has become a vital implement for decreasing poverty and increasing the economic progress of women, as well as their output and effectiveness, by promoting their ability to attain rights and well-being (Islam *et al*., 2015).

Empowerment approach, when properly implemented helps in raising the consciousness awareness which helps in closing the wide gaps in development process between men and women with a view to increasing their level of participation and benefit in development activities. It is with this in mind that the Sokoto State Government of Nigeria initiated a ministry specially for women-The Ministry of Women affair was aimed to improve the standard of living for women in the State. The duties of this ministry include all activities that concern women in the state to overcome problems faced by women and their children and the household in general.

In view of the foregoing, the study evaluated how the Ministry of Women Affairs in Sokoto State has improved the quality of life of women.

The broad objective of the study is to evaluate the role of Sokoto Skill Acquisition Program toward poverty reduction among women in Sokoto metropolis and the specific objectives are to:

1. Examine the socio-economic characteristics of the respondents,
2. Determine the type of assistance women received from the Ministry,
3. Determine the income difference before and after benefiting from the Ministry, and
4. Determine the factors affecting women participation in skill acquisition centre in Sokoto metropolis.

Hypothesis of the study

Ho: There is no significant difference in the income level of women before and after joining the program.

MATERIALS AND METHOD

Sokoto State is located in the Sudan savannah zone in the north western part of Nigeria, between longitudes 4°8'E and 6o54'E and latitude 12°0'N and 13°56'N (Mamman *et al.*, 2000). The total land area is about 32,000 square kilometers; the population of the state is estimated to be 3,696,999 million people (NPC, 2006). Sokoto women development center is where the skill acquisition program is located. A list of the trainees was collected from the official in the centre. Simple random sampling procedure was used to select 80 respondents from the list.

The data for the study were collected through primary data source by the use of structured questionnaire administered to the respondents. Data for the study were analyzed with the use of descriptive statistics such as table, frequency count, percentage and T-test was used to test the formulated hypothesis.

RESULTS AND DISCUSSION

Socio economic characteristics of respondents

Table 1 shows that 38.8% of the respondents fell between age group 21-30 years, 23.7% were in age group 31-40 years and 10.1% were above 50 years of age. This indicates that majority of the respondents were in their prime age time. The implication of this is that the respondents are still productive and active, hence their ability to participate more in income earning activities (e.g Sokoto Skills Acquisition Programme).

Marital status may determine or influence personal expenditure because of the added responsibility associated with family life. As seen in Table 1 majority (58.8%) of the respondents were married, 15.0 were single, another 15.0% were widowers while 11.3% were divorced. This could have either positive or negative implication for food security. On the positive side, the husbands of the married respondents supply the basis food for the family leaving the women to supplement and chose the type of food quality and quantity, thus ensuring more food security for the household. On the other hand, married individuals may have added responsibility associated with family life especially if the husband do not help much (Shuaibu *et al*., 2013).

Education is an important factor in improving the living status of an individual. Table 1 reveals the highest educational qualification of the respondents. It could be seen that 56.3% attended qur'anic school, 26.3% secondary school and 17.5% attended tertiary schools. This indicates that majority of the respondents had low level of western education. This result could have negative influence on innovation adoption and food security. Past studies (Ajayi, 2006 and Abdullah *et al*., 2014) stated that increasing women's education is a key ingredient for women's empowerment which would invariably affect household food security.

Table 1: Distribution of socio-economic characteristics of respondents (n = 80)

Characteristics	Frequency	Percentage
Age		
<20	11	13.7
21-30	31	38.8
31-40	19	23.7
41-50	11	13.7

>50	8	10.1
Marital status		
Married	47	58.8
Single	12	15.0
Divorced	9	11.3
Widow	12	15.0
Level of education		
Qur'anic alone	45	56.3
Secondary	21	26.3
Tertiary	14	17.5
Housed size		
<3	34	42.5
4-7	38	47.5
>7	8	10.0
S		

Household size as stated by David *et al*. (2009) is the total number of individuals who live within a household and fed from the same pot. In Table 1, 47.5% of the respondents have family size of 4-7, 42.4% less than 3 and only 10.0% in greater than 7. This shows that majority of the respondents have relatively small household when this is compared to what is usually obtained in a typical Hausa/community in the Northern Nigeria. The findings concur that of Jamilu *et al.* (2014) and means that the study area is characterized by large households which is not unexpected in that part of the country where many polygamous homes exist.

Training received

Training is capacity building and a process which enable women to realize their potential and build self-confidence. It is a process which frees people from the fear of wants and exploitation. Table 2 reveals that 46.3% of the respondents had training in knitting, 35.0% in tailoring and

8.8% in soap and Vaseline making. Other training received were: spice making; combination of juice preparation and spice making; tailoring, soap and Vaseline making; and knitting and spice making (each 2.5%). This indicates that trainees do receive trainings that are relevant and manageable to them as they can easily carry out these activities in their homes. This is necessary when considering the fact that women's time is usually constrained by their extremely heavy burden of providing food, water and cooking fuel for the family and child-care. Lyons *et al*. (2001) stated that after becoming empowered, women are able to contribute to sustainable growth. It has been recognized that economic empowerment has become a vital implement for decreasing poverty and increasing the economic progress of women, as well as their output and effectiveness, by promoting their ability to attain rights and well-being (Islam *et al*., 2015).

Distribution of respondents by training received (n = 80)

Types of training	Frequency	Percentage
Knitting	37	46.3
Tailoring	28	35.0
Soap and Vaseline making	7	8.8
Spice making	2	2.5
Tailoring and soap and Vaseline making	2	2.5
Knitting and spice making	2	2.5
Juice preparation and spice making	2	2.5

Assistance received by respondents

In Table 3, 55.0% of the respondents indicated to have received allowance in addition to the training received. This could be due to the fact that they had completed the training while 45% did not. This could be supported by the statement of one of the officials of skill acquisition centre who stated that allowances are usually given after completion of training. Table 3 also shows that 86.4% of the 44 respondents that received allowances were given between N5,500 - N10,000. Table 3 also showed that 45.0% of the respondents had received equipment while 55.0% did not. This could be because some of them prefer money to equipment. Table 3 also shows that 39.0% received knitting machine 55.5% sewing machine and 5.5% set of repair stools. This could be because trainees are usually given equipment based on what they were trained on and usually women prepare simple income generating activity which they can manage at home as they carry on other household activities.

Table 3: Distribution of assistance received by the respondents (n= 80)

Characteristics	**Frequency**	**Percentage**
Received allowances		
Yes	34	55.0
No	36	45.0
Amount (N)		
0-5,000	2	4.6
5,500-10,000	38	86.4
10,500-15,000	4	9.0
Received equipment		
Yes	36	45.0
No	44	55.0
Types of equipment		
Sawing machine	20	55.5
Knitting machine	14	39.0
Set of repairing tools	2	5.5

Hypothesis testing

Table 4 shows a mean income of N1779.39/week for the respondents before joining the program and N3324.39/week after joining the program. A mean difference of N1545.00 (t-value = 6.64, p

< 0.01) was obtained. This indicates that Sokoto skill acquisition centre had a positive impact on the poverty status of women beneficiaries in Sokoto metropolis.

Table 4: Income Difference before and after joining Program

Income earned	Means	Std. Dev.	Mean. Diff	T-value	Significance
Before	1,779.39	1848.48	1545.00	6.63	0.00
After	3324.39	1859.23			

Constraints faced by women in the training

Constraints are the problems the respondents encounter during the program. Table 5 shows that 81.3% of the respondents reported inadequate start-up capital as a challenge, 67.5% of them complained of faulty training machines, 23.8% exceeded period of training while 5.0% of the respondents' experience both. This may be due to constant used of equipment without services, improper maintenance and lack of good handling by the trainers and trainees. The finding is a common characteristic of most enterprises that are ran by women especially when compared to their male counterpart. Studies (Ibrahim *et al*., 2010; Sani and Danwanka, 2011; Kelvin-Iloafu *et al*., 2019) confirm this finding in separate studies.

Table 5: Distribution of constraints faced by women in the training (n = 80)

Problems encountered	Frequency*	Percentage
None	3	3.8
Faulty training machine	54	67.5
Inadequate start-up capital	65	81.3
***Multiple response allowed**	19	23.8
Exceeded period of training		
Both of above	4	5.0

Conclusion and Recommendation

From the finding of the study, it could be concluded that Sokoto Skill Acquisition Program had a beneficial effect on the income of women in the study area. Based on the results of the study, more programs of this kind should be established to improve the living standard of women. Also, given the obvious benefits of the program, more women should be encouraged to join.

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Socio Economics of Fish Marketing in Ibeju Lekki Local Government Area of Lagos State, Nigeria

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Abstract

The study analyzed the socioeconomics of fish marketing in Ibeju Lekki Local government area of Lagos state. A total of eighty structured questionnaires were administered on the fish marketers in the study area who were fish marketers. A random sampling technique was used in the selection of the respondents. Sample size comprised eighty fish marketers. Primary Data were collected using structured questionnaire administered through personal interview of the fish marketers. Data collected were analyzed using both descriptive and chi square statistics. Results revealed that fish marketing in the area is dominated by males (60%). Majority (71.25%) were married. 21.25% of them were within 28-33years of age. 63.75% of them attempted secondary school. The data also shows that trading (fish marketing) is the main occupation of the people (66.25%)..The constraints faced by the fish marketers include; lack of storage facilities, lack of electricity, distance to market, lack of basic infrastructure among others. The chi-square result shows that there is significant difference in the socio-economic returns in the study area at x = 6.05 It was therefore recommended that fish marketers should call for Government assistance in the area of electricity supply to enable them keep unsold fish till the next day as well as reduce spoilage and unprofitable sales.

Key words: Fish, marketers, socioeconomics, Ibeju Lekki.

Introduction

Fish is an important source of good quality protein required in human diets. It has the highest level of easily metabolisable protein, fats, vitamins, calcium, iron and essential amino acids when compared to other sources of animal protein such as poultry and beef. (Amao, et.al 2009)

Fish is important to the ever-increasing world population, especially in most parts of Africa, as it is the major source of cheap high quality animal by the Nigerian government has been identified as a key constraint (Chidiogo2011). protein, contributing about 50 to 60 percent of the fish intake of the population especially in rural communities (Ayoola 2010, Adekoya and Miller 2004). The total demand for fish and fish products is higher in Nigeria than many other West African countries (Adekoya and Miller 2004). Despite the fact that the country has the potential to lead the continent in fisheries and aquaculture, some 800,000 metric tons, which is more than 2/3 of domestic consumption of fish (accounting for about US $48.8m in 2002 alone and almost US $0.5bn annually thereafter) are annually imported to augment domestic supply, yet domestic demand is still not met (Awoyemi and Ajiboye 2011). Despite the abundance of human and natural resources, Nigeria depends largely on importation to meet its fish consumption needs. Fish is one of the most diverse groups of animals known to man with more than 20,500 species. (Amao et al, 2006). In fact, to many Nigerians in the coastal areas, creeks and rivers, fish is protein which is essential for healthy human growth. The shortfall has resulted in a low animal per capital consumption rate of 7.5kg against the 13kg recommended by the food and agriculture organization (Ayinla, 2003). The total demand for fish and fish products is higher in Nigeria than many other West African countries (Adekoya and Miller 2004). Despite the fact that the country has the potential to lead the continent in fisheries and aquaculture, some 800,000 metric tons, which is more than 2/3 of domestic consumption of fish (accounting for about US $48.8m in 2002 alone and almost US $0.5bn annually thereafter) are annually imported to augment domestic supply, yet domestic demand is still not met (Awoyemi and Ajiboye 2011). Research has shown that there is continuous increase in the number of people involved in fish marketing because of growing population of the country (Akinrotimi et al., 2008). There are many challenges on marketing of goods and services in the country, especially agricultural products like fish. There have been arguments that agricultural marketing is inefficient resulting in high rate of food spoilage, poverty and unaffordable food prices by consumers. However, not many studies have empirically evaluated the validity of these hypotheses in fish marketing. Therefore, the socio-economic of fish marketing evaluates the structure, conduct and performance of fish marketing system as indicators of the overall efficiency of the system. The objectives of the study include to describe the socio-economic characteristics of fish marketing among rural women in the study area. To compare the different species of fish marketed and to describe the constraints affecting the fish marketers.

Methodology

This study was carried out in Igbolomi, Ilagbo and Idata community area of Ibeju Lekki Local Government Area of Lagos state, Nigeria. Lagos state is located in the southwest geopolitical zone of Nigeria. This study was carried out in Eti-Osa and Ibeju-Lekki Local Government Areas of Lagos State, Nigeria. Lagos State is located in the southwest geopolitical zone of Nigeria. Lagos State is arguably the most economically important state of the country, the nation's largest urban area. According to the (NPC, 2006) national population census, the total population of Ibeju lekki is 177793 consisting of 60729 males and 57064 females. A random sampling technique was used to select four (4) communities (Idata, Folu, Idagbo and Igbolomi) out of ten (10) communities in the study area. Twenty (20) questionnaire was administered to twenty (20) respondents in each of the four (4) selected communities to make total of eighty (80) respondent. The data collected was analyzed based on the specific objectives of the study. Objectives I was analyzed using the descriptive statistics while objective II was analyzed using the chi-square analysis.

Results and Discussion

Table 1: Socioeconomic Distribution of the respondents

Variable	Frequency	Percentage
Gender		
Male	48	60
Female	32	40
Total	80	100
Age		
16 – 21	4	5
22 – 27	12	15
28---33	17	21.25

34----39	12	15
40---45	20	25
46 and above	15	18.75
Total	80	100
Marital Status		
Single	18	22.5
Married	57	71.25
Widows	05	6.25
Total	80	100
Educational level		
No Formal Education	05	6.25
Primary	16	20
Secondary	51	63.75
Tertiary	08	10
Total	80	100
Main Occupation		
Civil Servant	03	3.75
Trader	53	66.25
Private Sector	24	30
Total	80	100

Source: field survey, 2019.

The data collected shows that fish marketing business is majored by male gender where 60% of the 80 respondents used for the research are male, while 40% are female. This shows that fish marketers in Ibeju - Lekki are mostly male with very few female engaged in fish marketing. The data collected also shows that most of the fish marketers are married people with 71.25% of the respondents married, 22.5% of the fish marketers are single. While 6.25% of the fish marketers in the study area widowed. The result presented in Table 1 shows the age distribution of fish marketers in the study area. The result shows that people involved in fish marketing in Ibeju Lekki Local Government Area of Lagos State are mostly mature people within the age of 40-45 years(25%), followed by youth which are struggling and aging 28-33 years (21.25%) followed by those above the age of 46 years(18.75%) .Young adults within the age of 34-39 years were(15%), followed by younger youths of age 22-27 years(15%) and ordinary school boys and girls that helped their parents within the age range of 16-21 years(5%). The data collected shows that most of the fish marketers are married people with 71.25% of the respondents married, 22.5% of the fish marketers are single. While 6.25% of the fish marketers in the study area widowed. The data collected also shows that the greater people involved in fish marketing in the study area are people who have obtained secondary education (63%). The result above also shows that 20% of the people involved in fish marketing in the study area obtained primary education. 10% of have obtained tertiary education. While 6.25% of fish marketers in the study area have no formal education. The data collected shows that 66.25% of the respondents are traders, 30% of respondents are working in the private sector as well as engaging in fish marketing as another source of income. While 3.75% of fish the respondents are civil servants and engage in fish marketing as a secondary source of income.

Table 2: Distribution of Respondents According to Constraints

CONSTRAINTS	FREQUENCY	PERCENTAGE (%)
Lack of market information	2	1.43
Barriers to entry in the market	1	0.71
Distance to market	62	44.29
Lack of sales	21	15
Weather	24	17.14
Bad road	27	19.29

Others	3	2.14
Total	80	100

Source: Field survey 2019.

Information collected from the survey reveals that 44% of the respondents identified distance to market as a market challenge. This is due to absent of good Market in the study area where fish can be sold. 19.29% of the respondents identified bad roads as a market challenge. Thus causing high cost of transportation, delay of fish getting to the market, loss of customers, fish spoilage if not sold on time, it will lead to loss on the fish marketer. 17.14% of respondents identified weather as a market challenge they are faced with. 15% of the respondents identified lack of sale of fish as a market challenge they face. This is because most of their customers come from a far location to buy their fishes and most of the time, the bad road discourages them and long distance to market coupled with traffic, which affects transportation cost and has an effect on the cost of fish. 2.14% of respondents in the study area identified other market challenges they are faced with which was not indicated in the questionnaire such as; lack of capital, higher demand of labors, exploitation by intermediaries etc. As a result, the perishable fishes get damage and they are forced to sell the fishes at a cheaper rate. 1.43% of the respondents identified lack of market information as a challenges of fish marketing in the study area. While 0.71% of the respondents identified barrier to entry as challenges of fish marketing in the study area.

Table 3. Distributions of Respondents according to fish marketed

Location/fish marketed	Catfish	Tilapia	Titus
Igbolomi	12	05	03
Idata	10	06	03
Folu	09	07	04
Ilagbo	14	05	02
Total	45	23	12

Source: Survey Data 2019.

Chi-square for Table 3.1

Preference	F_o	Ft	$F_o - Ft$	$(F_o - F_t)^2$	$\frac{F_o - F_t}{Ft}$
Catfish	45	26.7	18.3	334.89	12.54
Tilapia	23	26.7	-3.7	13.69	0,51
Titus	12	26.7	-14.7	216.09	8.09
Total	**80**		**0**	564.67	21.14

Decision rule: f. calculated is greater than f. tabulated. Therefore, Ho is rejected and HA is accepted .

Conclusion

The results obtained have shown that fish marketing is a well-known enterprise among men and women folk in the study area and it is a profitable venture.. Therefore, fish marketing if well supported will boost the potential of rural men and women in the area.. It will also boost supply of food fish and improve the economic welfare of their families and also contribute to the economic growth of the country.

Recommendation.

Government should provide the basic infrastructure that will ease fish marketing activities in the study area such as good roads, portable water, health care services and electricity. Also, government should provide storage and processing facilities to preserve fish. This is because fish marketers sell their products even when they are not supposed to sell them due to lack of storage and processing devices in the study area just to avoid loss. This will go a long way to further increase the economic returns from fish marketing in the study area.

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Gender differential in economic and scale efficiency in broiler production in the Federal Capital Territory (FCT), Abuja, Nigeria

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Abstract

This study examined gender differential in economic and scale efficiency in broiler production in FCT, Abuja using data collected from 60 each of male and female respondents with the aid of structured questionnaire using a multistage sampling technique. Data envelopment analysis (DEA) was used to analyse the data. Result of the analysis revealed a mean technical efficiency of 0.80 and 0.90 under the constant returns to scale for male and female farmers respectively and 0.88 and 0.92 under the variable returns to scale for male and female farmers respectively. The mean allocative efficiency were 0.91 and 0.89 for male and female respectively, and a mean economic efficiency of 0.73 and 0.80 for male and female respectively while the mean scale efficiency was 0.91 and 0.98 for male and female respectively. The differences in mean TE under CRS and EE between male and female are significant while TE under VRS and AE are not. These efficiency results showed a high level of inefficiency and considerable room for improvement in broiler production. Further analysis of the returns to scale revealed that 85%, 8.33% and 6.67 of the male operated under the increasing, constant and decreasing returns to scale respectively while 50%, 13.33% and 36.67% of the female operated under the IRS, CRS and DRS respectively. Education and experience are the major factors affecting economic efficiency of broiler farmers. We recommend education of farmers through extension training as a way bridging the differences in efficiency of the farmers.

Introduction

The Nigerian poultry industry is very important in the livestock sub-sector. The industry is estimated at ₦80 billion ($600million) and is comprised of approximately 165 million birds, which produced 650,000MT of eggs and 290,000MT of poultry meat in 2013(SAHEL, 2015). Broiler production is an important enterprise in the poultry subsector in Nigeria because it has incredible potentials for expanding protein supply because of the fast growth rates and productivity of the animal (Omolayo, 2018). Men and women play different roles and face different constraints as well as opportunities in agricultural production system. However, the situation in developing countries including Nigeria is characterized by gender blindness, deafness and dumbness in the formulation and implementation of most development policies and strategies. Therefore, analysis of gender differentiated economic efficiency is essential for planning and policy formulation if efficient and sustainable food production that provides food security is to be achieved. Previous studies on gender and agricultural productivity or efficiency focused primarily on crops (see Alderman et al., 1995; Timothy, 2000; Oladebo and Fajuyigbe, 2007; Adeleke et al., 2008; Peterman et al., 2010;Oseni et al.,2015; Ali et al.,2015; among others).These studies reported mixed results on efficiency of plots managed by male-headed households and female-headed households. However, empirical studies that examined differences in productivity or efficiency on broiler farms managed by male-headed households and female-headed households are relatively scare. It against this study gaps that this study is carried out. Findings from this study would be useful in formulating policies that will address gender gaps in agricultural production efficiency.

Materials and Methods

This study was conducted in the Federal Capital Territory (FCT), Abuja, Nigeria which is located on Lat. 9.0579 and Long.7.4951. The population of the area as at 2016 is estimated at 6 million persons. There are six area councils in FCT, namely; Abaji, Abuja Municipal, Bwari, Gwagwalada, Kuje and Kwali Area councils..

Respondents for this study were selected using a multistage sampling technique. In the first stage, three (3) Area Councils (Abaji, Kuje and Bwari) were purposively selected based on their involvement in poultry production. In the second stage 2 council wards were randomly selected from each local council giving a total of six (6) council wards. In the third stage 20 poultry farmers (comprising of 10 male and 10 female farmers) were randomly selected from each council wards thus giving a total of 120 respondents (made up of 60 male and 60 female farmers). Structured questionnaire were used to obtain data from the respondents in addition to personal interview for those with low educational background. The data collected was for one production cycle in 2019.

Estimates of economic and scale efficiency of broiler farmers were obtained using Data Envelopment Analysis (DEA). DEA as developed by Charnes *et al*. (1978) is a non-parametric, deterministic procedure for evaluating the frontier and employs the best-practice frontier (Bates et.al., 1996). The technical efficiency (TE) score of a given farmer n is obtained by solving the following input-oriented linear programming (LP) problem:

$$TE_n = \min \theta_n \quad (1)$$

Subject to:

$$\sum_{i=1}^{1} \lambda_i x_{ij} - \theta_n x_{nj} \leq 0 \quad (2)$$

$$\sum_{i=1}^{1} \lambda_i y_{ik} - y_{nk} \geq 0 \quad (3)$$

$$\sum_{i}^{1} \lambda_i = 1 \quad (4)$$

$$\lambda_i \geq 0 \quad (5)$$

Where:

i = one to I farmer; j = one to J inputs; k = one to K outputs; x_{ij} = the amount of input j used by farmer i; ; x_{nj}= amount of input j used by farmer n; y_{ik} = amount of output k produced by farmer i ; y_{nk} = amount of output k produced by farmer n ; λ_i = non-negative weights for I firms; θ_n= a scalar $\leq$ 1 that defines the TE of farmer n. If θ_n= 1 , it means the farmer is technically efficient and if the value is less than one , it means a technically inefficient farmer with the level of technical inefficiency equal to 1 - TE_n (Coelli,1995).

Economic efficiency (EE) also known as cost efficiency is the ratio of the minimum feasible costs and the actually observed costs for a decision-making unit (Farrell, 1957).The EE score for a given farmer n is obtained by solving the following input-oriented DEA model to obtain the minimum cost:

$$MC_n = min\lambda_i x_{nj}^* \sum_{j=1}^{J} p_{nj}\, x_{nj}^* \quad (6)$$

Subject to:

$$\sum_{i=1}^{j} \lambda_i \, x_{ij} - x_{nj}^* \leq 0 \qquad (7)$$

$$\sum_{i=1}^{I} \lambda_i \, y_{ik} - y_{nk} \geq 0 \qquad (8)$$

$$\sum_{i=1}^{I} \lambda_i = 1 \qquad (9)$$

$$\lambda_i \geq 0 \qquad (10)$$

Where:

MC_n= the minimum total cost for farmer n; p_{nj} = the price for input j for farmer n ; x_{nj}^*= the cost minimizing level of input j for farmer n given its input price and output levels; all other variables are as previously defined. The economic efficiency for each farmer n can then be estimated using Eq. (11).

$$EE_n = \frac{\sum_{j=1}^{J} P_{nj} x_{nj}^*}{\sum_{j=1}^{J} P_{nj} x_{nj}} \qquad (11)$$

Where:

The numerator is the minimum total cost obtained for farmer n based on eqs. (6) to (10) and the denominator is the actual total cost observed for farmer n. When EE_n =1, the firm is economically efficient and EE_n < 1 means the firm is economically inefficient.

EE for each firm can also be estimated as a product of technical efficiency and allocative efficiency, expressed as:

$$EE_n = TE_n \text{ X } AE_n \qquad (12)$$

The allocative efficiency (AE) score for farmer n can be estimated given both TE and EE for the farmer as follows:

$$AE_n = \frac{EE_n}{TE_n} \qquad (13)$$

Where:

EE_n = economic efficiency calculated for farmer n using Eq. (11) and TE_n = technical efficiency calculated for farmer n using Eqs. (1) to (5). When the value of AE_n = 1, the farmer is allocatively efficient and an AE_n < 1 means it is allocatively inefficient.

The scale efficiency (SE_n) for a farmer n is estimated as follows:

$$SE_n = \frac{TE_{CRS_n}}{TE_{VRS_n}} \quad (14)$$

Where:

TE_{CRS_n} = technical efficiency of a farmer n under constant returns to scale and TE_{VRS_n}= technical efficiency under variable returns to scale. When SE_n = 1, it means the firm is operating at an optimal scale and when SE_n < 1, the firm is scale inefficient. The computer program DEAP version 2.1 developed by Coelli (1996) was used to estimate technical, allocative, cost and scale efficiency of broiler farmer

Factors affecting EE of broiler farmers were examined using ordinary least squares regression. The use Tobit regression has been criticized for producing inconsistent estimates and contextually inappropriate since the TE scores are fractions and not generated by censoring procedure (Banker and Natarajan, 2008. The OLS is expressed as: $Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$……………………… (15). Where:

Y = EE scores; α = constant; $\beta_1 \ldots\ldots \beta_4$ = parameters to be estimated; X_1 = sex (dummy) ; X_3 = education (years of formal education) X_3= household size (number) ; X_4 = farming experience(years) ; ε = error term.

Results and Discussion

The summary statistics of the technical, allocative economic and scale efficiency of broiler farmers are presented in Table 1.As shown in Table 1, the mean TE under the CRS are 0.80 and 0.90 for male and female broiler farmers respectively while the mean TE under the VRS are 0.88 and 0.92 for male and female farmers respectively. Only 5 (8.33%) farmers achieved full technical efficiency under the CRS for both male and female farmers respectively while 12 (20%) and 11 (18.33%) farmers achieved full technical efficiency under the VRS for male and female farmers respectively. This means that an inefficient male and female farmers can still increase their TE by 20% and 10% respectively under CRS and 12% and 8% respectively under the VRS. The differences in TE between male and female farmers under the CRS are statistically significant while that of VRS is not. The mean AE are 0.91 and 0.89 for male and female broiler farmers respectively. Only one farmer (1.67%) achieved full AE for male and female farmers respectively. This means that some broiler farmers are not using inputs in a cost-minimizing level given the prices of inputs they face and that on average cost may be reduced by 9% and 11% for male and female farmers respectively to attain the level of the best allocative efficient farmer. The mean EE are 0.73 and 0.80 for male and female farmers respectively. Again, only one farmer (1.67%) achieved full EE for male and female farmers respectively. The differences in mean EE between male and female is also significant. This implies that some farmers are economically inefficient and that cost of broiler production can be reduced on average by 27% and 20% respectively for male and female farmers to attain the same level of output. The mean SE are 0.91 and 0.98 for male and female farmers respectively. About 8.33% and 13.33% achieved full SE for male and female broiler farmers respectively. Thus TE can be improved by 9% and 2% respectively for male and female farmers by adapting the scale of their farms.

Table 1: Summary of Technical, Allocative and Economic Efficiency Indexes of Broiler Farmers

Class	TECRS		TEVRS		Alloc. Eff.		Eco. Eff.		Scale Eff.	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1	5	5	12	11	1	1	1	1	5	8
0.9 - 0.999	26	42	27	38	48	41	11	19	39	46
0.8 - 0.899	10	2	7	1	7	13	22	22	6	6
0.7 - 0.799	1	1	3	1	2	2	5	4	5	0
0.6 - 0.699	3	6	8	7	1	1	1	4	1	0
0.5 - 0.599	9	3	2	2	1	0	12	7	4	0
0.4 -	4	1	1	0	0	1	3	2	0	0

0.499										
0.3 - 0.399	2	0	0	0	0	1	5	1	0	0
Total	60	60	60	60	60	60	60	60	60	60
Mean	0.80	0.90	0.88	0.92	0.91	0.89	0.73	0.80	0.91	0.98
Min	0.39	0.47	0.43	0.5	0.56	0.37	0.37	0.31	0.55	0.85
Max	1	1	1	1	1	1	1	1	1	1

Source: Field Survey 2019 and DEAP 2.1

Analysis of the returns to scale of broiler farmers as presented in Table 2 showed that about 85% and 50% of male and female farmers respectively operate at an IRS (sub-optimal scale). This means that most of the farmers sampled are too small and therefore would benefit from an increase in scale. The number of firms operating at CRS (optimal size) are 8.33% and 13.33% for male and female respectively while about 6.67% and 36.67% operate at DRS (i.e. operating above optimal size).for male and female farmers respectively.

Table 2: Returns to scale of broiler farmers

	Male		**Female**	
Class of Scale Eff.*	**Freq.**	**Perc.**	**Freq.**	**Perc.**
IRS	51	85	30	50
CRS	5	8.33	8	13.33
DRS	4	6.67	22	36.67

Total	60	100	60	100

* CRS: Constant Returns to Scale; IRS: Increasing Returns to Scale; DRS: Decreasing Returns to Scale

Source :Computed from DEAP 2.1

OLS estimates of factors affecting EE of broiler farmers are presented in Table 3. From Table 3, education and experience are the significant factors affecting EE of the farmers while sex and household size are not significant.

Table 3: OLS Estimates of Factors Affecting Economic Efficiency of Broiler Farmers

Variable	**Coeff.**	**Std. Error**	**T-Stat.**	**Prob.**
Constant	0.874	0.142	6.168	0.000***
Sex	.072	.053	1.343	0.182
Education	-0.013	0.006	-2.256	0.026**
Household Size	0.002	0.014	0.16	0.873
Experience	0.023	0.01	2.233	0.027**
Model				
R^2	0.091			
Adj. R^2	0.06			
F (4 , 115)	2.892			
Prob. > F	0.025			
No. of Observ.	120			

Source: SPSS 20 ; ***P < 0.01 **P < 0.05

Conclusion

This study used DEA to estimate TE, AE SE and EE scores and OLS to examine factors affecting EE of broiler farmers. The result of the analysis revealed that female farmers have higher TE, AE, SE and EE scores compared to their male counterparts and the differences in TE under CRS and EE scores between the male and female farmers are significant while the differences in TE under VRS and AE are not. These efficiency scores also showed high level of inefficiency and a considerable room for improvement. Education and experience are the significant factors affecting economic efficiency of broiler farmers in the study area. Education of farmers through extension services is seen as a major way of bridging the differences observed in their efficiency.

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The role of women in forestry and agriculture: the gender issues

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ABSTRACT

The roles of women in forest management are enormous, they therefore create outstanding growth and development to agricultural and forestry industry and profession due to their various involvements cutting across crop production, horticulture, natural resources management and conservation strategies. Women's contribution varies across regions, socio-cultural and agro-production systems. Though the proportion of women workers in agriculture and forestry has declined, yet they constitute a significant workforce in agriculture due to gender differences as men are perceived to be the pivotal force in forestry activities. On the other hand, the persisting gender gap in access to and control of resources remains an important concern which has not only kept women in a vicious circle of low productivity but also has thrown up questions about inclusive and sustainable growth of the sector. However, this paper has reviewed the various roles of women in agriculture and forestry with diversing gender issues including recommendable strategies of combating these gender related issues.

INTRODUCTION

The relevance and roles of women in agriculture and forestry cannot be over-emphasized, however in agriculture and forestry, their roles take different dimensions such as farming, conservers and environmental conservation (Basavaraj and Suresh, 2018). Research has proven that women play an essential role in forest conservation, however depending on the context, they fulfill specific tasks inside forest-dependent communities and have a special relationship with the forest. In a world dominated by patriarchal societies and cultures, forest destruction caused by "development" projects such as industrial tree plantations, mining and oil extraction have severe and differentiated impacts on women, even more serious than those affecting men, disempowering and impoverishing women, women have little influence on forest conservation and management; while forest-dependent communities most often only have customary and no legal land rights, often the role of women is still a secondary one in the struggles for recognition of these rights, and therefore deserves more attention and support (Rajwana *et al.*, 2015).

It is also important to state categorically that the roles and status of women in agriculture and rural areas vary widely by region, age, ethnicity and social class and are changing rapidly in some parts of the world (Mrunalini and Snehalatha, 2010).

ROLES OF WOMEN IN FOREST MANAGEMENT

Forests often represent an important source of employment for women, especially in rural areas, from nurseries to plantations, and from logging to wood processing, women make up a notable proportion of the labour force in forest industries throughout the world (World Bank, FAO and IFAD, 2009).

The Global Forest Resources Assessment (2010) reports that the forestry sector worldwide employed approximately 11 million people in 2005; however, sex disaggregated data on the number of women employed by the sector are not available on a comprehensive basis (FAO, 2010). Evidence from developing countries suggests that women are often employed in menial jobs in sawmills, plantation nurseries and logging camps (World Bank, FAO and IFAD, 2009). Studies conducted by FAO in Africa and Europe indicate that women do not hold senior or policy-making positions in the sector (World Bank, FAO and IFAD, 2009). Rather, they are primarily employed in administrative and support roles, with professional women foresters tending to have specialist roles (like research) or first-line junior management positions (FAO, 2006).

The role of women in forestry has to change from one of wage-earning labourers to that of project holders, they should have the independence to manage the project and the harvest should be the reward for their toil; when they work as labourers, they do not have an attachment to the trees as their role is only that of hired labour for different operations in the plantation (FAO, 2002). Women should be made to feel that they own the trees, or at least usage rights, and that the income is theirs to keep.

Women contribute to both the formal and informal forestry sectors in many significant ways. They play roles in agroforestry, watershed management:

a) agroforestry,
b) watershed management,
c) tree improvement,
d) forest protection
e) conservation (FAO, 2002).

Sustainable agriculture which deals with sustainable exploitation of renewable natural resources including annual and perennial cropping, agro-forestry and livestock as well as the conservation measures needed for long-term maintenance of resources need women involvement (Deb, 1994). Even in the larger scenario of rapid exploitation of natural resources women have inadvertently been contributing to the sustenance by her traditionally assigned role, domestication of crops is widely believed to have begun by women. Seeds are the source of food and are valued for their quality to maintain genetic continuity. From time immemorial, it has been a woman's domain to sort seed at home by observation and through experience (UNEP, 2008). In doing so, the methods of seed storage were always practiced by women. The search for medicinal seeds and plant material for her family, fruit seeds for kitchen gardens and ornamentals to quench her aesthetic needs have all contributed, indirectly, for preservation of seeds and the biodiversity that we are endowed with (Agarwal, 2010).

Conservation and re-vegetation of forest resources: The livelihood of rural communities has been inter-dependent on forest resources traditionally, since the benefits derived from forests by men and women are different, the impact of their activities on forests and the impact of deforestation on their lives differ; forest-related activities of women such as harvesting food, fodder, fuelwood and non-wood products are less destructive than that of men which usually involve felling trees for timber. Unlike men who have a greater propensity to migrate when forest resources are depleted in a locality, women continue to stay and depend on the same degraded resources. Hence women suffer more when forest resources around them are destroyed (FAO, 2002).

Many women have highly specialized knowledge of trees and forests in terms of biological diversity, sustainable management and use for various purposes, and conservation practices, they are aware of the food and medicinal values of forest products, which are particularly important during food crises (FAO, 2002).

Women make specific contributions to forestry and agroforestry value chains, these are important for their incomes, and in turn for the well-being and food security of their households; however, women's roles in value chains tend to be poorly supported by policy-makers and extension services (Agarwal, 2010). The perpetual lack of gender disaggregated data hampers the development of policy interventions to address the issue.

Conclusion

With regard to productive labour in developing countries, women constitute an important segment of the work-force in forest and forest-related activities: they work in tree nurseries, plantations, harvesting, processing, sale of wood and others. What differentiates men and women above all is the fact that much of women's work "remains unrecognized and unvalued. This has an impact on the status of women in society, their opportunities in public life and the gender-blindness of development policy. Women's work is greatly undervalued in economic terms".

It is evident from this review that womens' role in agriculture and forestry are limited and constrained with a range of interrelated cultural, social, economic and institutional reasons in their access to and control over forest resources, and in the economic opportunities available to them. Therefore, closing the gender gap in agriculture and foresry would produce significant gains for society by increasing agricultural productivity, reducing poverty and hunger and promoting economic growth.

Recommendations

In the bid of solving various related gender issues hindering the full performances and roles of women in agriculture and forestry, I recommend the following:

1) Establishment of policies and practices empowering women in the forest sector yield significant benefits to food security and nutrition and the sustainable management of forests.

2) Facilitating women's participation in forest user groups, improving their access to modern sources of energy, and

3) Enhancing their access to processing techniques and markets have been found to make a major difference in the livelihoods of forest dependent people and their societies.

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Strategies to reduce gender inequality among cassava farmers in Imo state

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Abstract

This study investigated the likelihood of different strategies to reduce gender inequality in influence, access to opportunities and benefits among cassava producing and processing farmers in Imo State. Purposive and multi-stage random sampling techniques were used in the selection of 240 respondents comprising of 120 males and 120 females involved in this study. Instrument for data collection was a structured and pre-tested questionnaire. Data were collected using a 5 point Likert rating scale where 5 = Strongly Agree, 4 = Agree, 3 = Undecided, 2 = Disagree and 1 = Strongly disagree with 3 ({5+4+3+2+1}/5) as the threshold. Strategies with mean scores above the threshold were adjudged effective in reducing gender inequality amongst respondents. Results obtained show that all the nine strategies were rated above the threshold (critical mean cut off score of 3.0) thus suggesting that if they are applied, they will bring about gender equality in cassava production and processing. These strategies include, open forum for dialogue between men and women, public enlightenment through Radio and TV, enlightenment through town criers, enlightenment through print media, training of VEAs, greater enfranchisement of women and youths in leadership and policy making, fostering policy changes that increase women's land ownership, strengthening women's and youth's access to financial services and enhancing education of the girl child. Highest mean score (4.73 from male and 4.77 from female respondents) posted by enhancing education of the girl child suggests that it is likely to be the most effective; while enlightenment through town criers will be the least effective with mean scores of 3.90 and 3.83 from male and female respondents respectively. Girl child education should be further strengthened in order to reduce gender inequality.

Keywords: Cassava farmers, Production, Processing, Gender, inequality, Strategies

Introduction

Cassava production and processing are prime agro-activities in cassava growing areas of Nigeria and especially in Imo State. It has now been widely recognized that the fight against gender bias in agriculture is crucial to sustaining economic growth and ensuring food security. This is particularly germane in countries where the vast majority of the populations earn their incomes from agriculture-based activities (Mukasa and Salami, 2016). Gender equity in access to resources, goods, services and decision-making in rural areas - has been formulated in response to evidence that gender inequality exacerbates food insecurity, malnutrition and poverty (FAO, 2017).

Gender transformative approaches seek to address and eventually change gender norms, roles and imbalances of power when inequities are large and can easily be combined with agricultural extension. They raise awareness of gender roles and relations between women and men; foster – at a local pace (CGIAR 2012). Kürschner *et al*. (2000) and Bishop-Sambrook and Wonani (2008) reported two transformative programmes namely Gender Oriented Participatory Extension Approach (GPEA) and Household Approach respectively applying strategies to create greater gender equality of influence, opportunity and benefit. Through GPEA extension staff were trained to raise gender awareness among staff and target groups while household approach initiated a joint learning process amongst family members is a non-confrontational and effective way addressing gender issues with aims of bringing about changes in gender relations "from within" the household, rather than from outside the household. Through the GPEA and household approach, women were empowered to make their own decisions in ways that did not create conflicts in their relationships. In addition, they became used to active participation, could move around more freely, were allowed to keep their own income and were more involved in decision-making (Klos, 2000; Kürschner *et al*. 2000). These changes had also led to an increase of responsibilities and burden for women while bringing at the same time new freedoms.

Kaitano and Adrienne (2009) reported that respondents across different regions of Malawi gave some suggestions of changes that would create greater gender equality and wider access to opportunities and benefits from cassava production, processing and marketing. Key changes suggested hinge on community gender awareness and sensitization, challenging cultural norms and practices.

This study was undertaken to investigate the likelihood of different strategies to reduce gender inequality in influence, opportunities and benefits among cassava producing and processing communities in Imo State

Methodology

The study was carried out in Imo State in the South East of Nigeria. A purposive and multi-stage sampling technique was used in the selection of 240 respondents consisting of 120 males and 120 females who produced and processed cassava. Primary data for the study were obtained mainly using semi-structured questionnaire administered on cassava producers and processors.

Data on the likelihood of the following strategies to reduce gender inequality in influence, opportunities and benefits among cassava farmers (females and males), were collected using a 5 point Likert rating scale where 5 = Strongly Agree, 4 = Agree, 3 = Undecided, 2 = Disagree and 1 = Strongly disagree with 3 ({5+4+3+2+1}/5) as the threshold. These assessed strategies included open forum for dialogue between men and women, public enlightenment through Radio and TV, enlightenment through town criers, enlightenment through print media, training of VEAs, greater enfranchisement of women and youths in leadership and policy making, fostering policy changes that increase women's land ownership, strengthening women's and youth's access to financial services and enhancing education of the girl child. Mean values above the 3.0 threshold indicated that the strategy will be effective in reducing gender inequality.

Results and discussion

The Likert analysis of responses by female and male respondents on the likelihood of the assessed strategies to reduce gender inequality in influence, opportunity and benefit among cassava producing and processing farmers in the study area are presented in Tables 1 and 2 respectively. The overall mean of 4.36 amongst both males and females was above the threshold of 3.0 and points to the likelihood of these strategies in achieving the desired objectives. However, on individual basis, all nine strategies assessed amongst the male and female respondents had mean score values above the critical mean cut off score of 3.0 thus suggesting that if they are applied, they will bring about gender equality in cassava production and processing. Enhancing education of the girl child posted the highest mean score values of 4.77 from female and 4.73 from male respondents thus suggesting that is likely to be the most effective. According to Okoye *et al* (2004), education has the capacity to influence people to accept new technology and change their attitude to the desired technology. Girl child education will enhance the awareness, understanding, acceptance, utilization of new technologies by females thereby improving their income, livelihood, influence, opportunities and other benefits. Conversely, enlightenment through town criers posted the least mean scores of 3.83 and 3.90 from female and male respondents respectively suggesting that it will be the least effective of the strategies. The least effectiveness of town crying is likely because the act is dipped in culture and town criers are mostly men who may not be favourably disposed to disseminate information that will transform the gender statuesque. Kaitano and Adrienne (2009) reported open dialogue between men and women at household and village levels was effective in reducing gender inequality in Malawi. The above strategies are consistent with the suggestion by Ferguson and Moosa, (2011) that support for the sensitization and mobilization of women farmers is vital for ensuring gender equality and women's rights in agriculture

Table 1: Distribution of female respondents on strategies for gender equality of influence

Strategies	Female						
	SD (1)	**D (2)**	**U (3)**	**A (4)**	**SA (5)**	**Total**	**Mean Score**
Open forum for Dialogue between men and women	4(4)	11(22)	2(6)	32(128)	71(355)	515	**4.29**
Public enlightenment through Radio and TV	0(0)	2(4)	3(9)	44(176)	71(355)	544	**4.53**
Enlightenment through town criers	4(4)	21(42)	18(54)	25(100)	52(260)	460	**3.83**
Enlightenment through print media	2(2)	9(18)	8(24)	38(152)	63(315)	511	**4.26**
Training of VEAs	0(0)	8(16)	10(30)	35(140)	67(335)	521	**4.34**
Greater enfranchisement of women and youths in leadership and policy making	2(2)	11(22)	3(9)	29(116)	75(375)	524	**4.37**
Fostering policy changes that increase women's land ownership	3(3)	16(32)	2(6)	20(80)	79(395)	516	**4.30**
Strengthening women's and youth's access to financial services	0(0)	8(16)	1(3)	29(116)	82(410)	545	**4.54**
Enhancing education of the girl child	0(0)	1(2)	0(0)	25(100)	94(470)	572	**4.77**
Overall Mean							**4.36**

Source: Field Survey, 2017; Cut-off score = 3.0, > 3.0 = Yes (Effective); < 3.0 = No. (Non Effective); Figures in and outside parenthesis are the Likert scale values and frequencies respectively. Strongly agree (SA) 5, Agree (A)4, Undecided (U)3, Disagree (D)2, Strongly disagree (SD)1.

Table 2: Distribution of male respondents on strategies for gender equality of influence

Strategies	**Male**						
	SD (1)	D (2)	U (3)	A (4)	SA (5)	Total	**Mean Score**
Open forum for Dialogue between men and women	5(5)	10(20)	1(3)	38(152)	66(330)	510	**4.25**
Public enlightenement through Radio and TV	0(0)	2(4)	5(15)	42(168)	71(355)	542	**4.52**
Enlightenment through town criers	7(7)	17(34)	12(36)	29(116)	55(275)	468	**3.90**
Enlightenment through print media	1(1)	11(22)	10(30)	34(136)	64(320)	509	**4.24**
Training of VEAs	0(0)	9(18)	9(27)	38(152)	64(320)	517	**4.31**
Greater enfranchisement of women and youths in leadership and policy making	1(1)	6(12)	9(27)	24(96)	80(400)	536	**4.47**
Fostering policy changes that increase women's land ownership	2(2)	16(32)	5(15)	24(96)	73(365)	510	**4.25**
Strengthening women's and youth's access to financial services	0(0)	3(6)	3(9)	37(148)	77(385)	548	**4.57**
Enhancing education of the girl child	1(1)	1(2)	1(3)	24(96)	93(465)	567	**4.73**
Overall Mean							**4.36**

Source: Field Survey, 2017; Cut-off score = 3.0, > 3.0 = Yes (Effective); < 3.0 = No. (Non Effective); Figures in and outside parenthesis are the Likert scale values and frequencies respectively. Strongly agree (SA) 5, Agree (A)4, Undecided (U)3, Disagree (D)2, Strongly disagree (SD)1

Conclusion and recommendation

Results obtained from this study suggests that all strategies assessed for reducing gender inequality in influence, opportunities and benefits amongst the male and female in the study area will be effective if applied. Enhancing education of the girl child is likely to be the most effective hence girl child education should be further strengthened and encouraged in order to reduce gender inequality

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Differences Between Male and Female Participation in Cassava Production and Processing in Imo State

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Abstract

This study analysed male and female participation in cassava production and processing in Imo State in South Eastern Nigeria in order to generate gender disaggregated data that will guide policy formulation and implementation aimed at improving cassava production and processing in the state. Purposive and multi-stage random sampling techniques were used in the selection of 240 respondents comprising of 120 males and 120 females involved in this study. Instrument for data collection was a structured and pre-tested questionnaire. A 5-point Likert scale with 3.00 ({5+4+3+2+1}/5) as the threshold was used to estimate level of participation. Differences between males and females in the level of participation in cassava production and processing was determined by a Z-test. Results obtained show that mean values of the participation of females and males in cassava production were 2.390 and 2.406 with a difference of -0.016. The Z-value (-0.1697) for this difference was not significant indicating that there was no difference between male and female participation in cassava production in the study area. However, when it comes to processing, the mean values of the participation of females and males were 4.242 and 3.369 with a difference of 0.873. The Z-value (-17.425***) for this difference was significant at 1.0% indicating that females participated more than their male counterparts. It is therefore recommended that men should be incentivized to improve their participation in cassava processing.

Keywords: Cassava Production, Cassava Processing, Gender, Z-test

Introduction

In Imo State, cassava is one the food crops that are cultivated and consumed widely. In rural household, there is division of labour according to gender and age. Gender refers to socially constructed role differences between men and women usually for the purpose of allocating powers, duties, status, responsibilities and roles in any given social milieu or context (USAID, 2005). Such gender relations exist in agricultural production and processing where men and women have different roles, priorities, opportunities and constraints. Men and women perform different functions and roles in cassava production and processing. These roles vary widely and are in many instances determined by culture and tradition (Ironkwe and Asumugha, 2007).

Lack of gender consideration has often led to failure of different popular projects in the past (Chukwu and Nwaiwu, 2012). There is also lack of disaggregated data on gender which could help in understanding gender differences in cassava production and processing. In addition, there are poor planning, monitoring and evaluating development programmes targeted at different gender to increase productivity due to scarcity of necessary gender specific data (Ukeje, 2004; Ironkwe and Asumugha, 2007). Ukeje (2004) reported that the major constraint to effective recognition of women's participation, actual roles and responsibilities in agriculture is the scarcity of gender disaggregated data for purposes of planning and policy making. This paucity of empirical disaggregated data on gender necessitated this study on the differences between male and female participation in cassava production and processing in order to generate gender disaggregated data that will guide policy formulation and implementation aimed at improving cassava production and processing Imo state Nigeria.

Methodology

The study was carried out in Imo State in the South East of Nigeria. A purposive and multi-stage sampling technique was used in the selection of 240 respondents consisting of 120 males and 120 females who produced and processed cassava. Primary data for the study were obtained mainly using semi-structured questionnaire administered on cassava producers and processors. Data gathered included socio-economic characteristics of respondents like age, education, occupation, marital status, household size, farm size, distance from farm to market, quantity of roots produced, quantity of roots processed, distance from house to processing centre, farming/processing experience, income from cassava business, membership of cooperative societies, types of cassava products produced and gender. A 5-point Likert scale with 3.00 ({5+4+3+2+1}/5) as the threshold was used to estimate level of participation. The five point Likert scoring was used as follows: (5 = Strongly Agree, 4 = Agree, 3 = Undecided, 2 = Disagree and 1 = Strongly disagree). The model was specified as follows:

Thus mean participation score X_bar = ∑fn/N

X_bar = Mean score, ∑ = Summation sign, F = Frequency or number of respondent who responded positively, n = Nominal likert score, N = number of respondents

Respondents with mean value of 3.00 and above indicate that they participated while values less than 3.00 indicate non participation.

Differences between males and females in the level of participation in cassava production and processing was determined by a Z-test. The model of which was specified as follows:

$Z = (P_1 - P_2) / SE$

Where p_1 is the level of male participation, p_2 is the level of female participation, and SE is the standard error of the sampling distribution. Breaking further the equation we have:

$$Z = \frac{\text{X1\_bar} - \text{X2\_bar}}{\sqrt{\frac{\sigma 1}{n1} + \frac{\sigma 2}{n2}}}$$

Where

X_1= Mean level of participation in cassava production and processing for males

X_2= Mean level of participation in cassava production and processing for females

σ_1= Standard error for level of participation in cassava production and processing for males

σ_2= Standard error for level of participation in cassava production and processing for females

n_1 = Number of males

n_2 = Number of females

Results and discussion

Difference in participation levels of male and female farmers/processors

The result of the Z-test for the difference in participation levels of male and female farmers in cassava production in Imo State is presented in Table 1. The mean values of the participation of females and males were 2.390 and 2.406 with a difference of -0.017. The Z-value (-0.1697) for this difference was not significant. There was therefore no difference between male and female participation in cassava production in the study area. This might be because of the level of profit in cassava root and stem production. This finding is in agreement with IBC, (2018) and in disagreement with Ironkwe *et al. (*2008) and Ezeibe *et al*., (2015)

Table 1: Z-test of effect of gender on participation of respondents in cassava production

Variable	Observation	Mean	Standard Error	Standard Deviation
Female	120	2.390	0.069	0.752
Male	120	2.406	0.070	0.769
Combined	240	2.398	0.049	0.759
Difference		-0.017	0.098	
Z = -0.1697				
degrees of freedom = 238				
Pr = 0.4327				

Source: STATA 13

Difference in participation levels of male and female in cassava processing

The result of the Z-test for the difference in participation levels of male and females in cassava processing is presented in Table 2. The mean values of the participation of females and males were 4.242 and 3.369 with a difference of 0.873. The Z-value (-17.425***) for this difference was significant at 1.0%. This implies that in the study area, females participated in cassava processing more than their male counterparts. This finding is in agreement with those of many other authors (Ironkwe *et al*, 2008; Ogunleye *et al*, 2008; Ezeibe *et al.*, 2015, Aminu *et al*, 2017). Women are the bedrock of cassava processing hence this finding is in conformity with a priori expectation.

Table 2: Z-test of effect of gender on participation of respondents in cassava processing

Variable	Observation	Mean	Standard Error	Standard Deviation
Female	240	4.242	0.042	0.657
Male	240	3.369	0.027	0.414
Combined	480	3.805	0.032	0.701

Difference	0.873	0.050

*Z = -17.425****

degrees of freedom = 478

*Source: STATA 13, *** Significant at 1.0%*

Conclusion and recommendation

This study indicated that there was no difference between male and female participation in cassava production in the study area. However, when it comes to processing, females participated more than their male counterparts. It is therefore recommended that men should be incentivized to participate in cassava processing.

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Turmeric Production as a Frontier in Women Empowerment and Sustainability in Nigeria.

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Abstract

This study reviewed the role of women in agricultural practices and their contributions to rural and economic growth. Across developing countries, women make up of 43% of the agricultural labour force, participating in all aspect of rural life by raising animals and major crops like cassava, maize, cocoyam etc. The need for women to participate in the production practices of minor and underutilized crop species like turmeric (*Curcurma longa*) is further emphasized in this review. Turmeric is a perennial herb that can be grown according to the best agronomical and organic practices aimed at preserving their natural characteristics and properties. The curcumin content of turmeric has anti-inflammatory, anti-mutagen, anti-cancer agents and other medicinal values. National Root Crops Research Institute Umudike has established the awareness of this “Wonder Crop” to the rural communities, with the result most of the farmers come to the institute for the purchase of turmeric rhizomes, in recent times the demand became higher than the production at N800 per kg. Consequently, local women are encouraged to embark on turmeric production following the agronomic practices, and the sales made from their output can improve their livelihood and go further to alleviate poverty.

Keyword: Turmeric, Production, Women, Empowerment.

Introduction

Agriculture can be an important engine of growth and poverty reduction. But the sector is underperforming in many countries because women who are often a crucial resource in agriculture and rural economy face constraints that reduce their productivity. Effort by national governments and the international community to achieve their goals for agricultural development economic growth and food security will be strengthened and accelerated if they build on contributions that women make and take steps to alleviate these constraints.(Ammon,1991)

If we are going to end hunger in our life time, we need to empower women. Across developing countries, they make up 43 percent of the agricultural labour force in Nigeria, (Kashish, 2005) .

Many of our women are small holder farmers and from paid employment for trade and marketing, women participate in all aspect of rural life. They raise animals and major crops like cassava, cocoyam, maize etc. Historically, agricultural production in African societies has been characterized by gender in equality. Roles and responsibilities between men and women are either based on sex or gender. This explains the gender based division of labour in African societies in which men and women are made to perform different specific task (Nwosu, 2010; NOUN, 2008). Minor crops or important underutilized crops like turmeric can be part of women agricultural produce. Turmeric is a perennial herb and the part utilized for its products is the brightly coloured rhizomes. It contains curcumin which is the active ingredient and the determinant of the health properties of turmeric. Turmeric is used in textile industries and culinary purpose.(Balakrishan,2007)

The aim of this review is to highlight the potentials of women in agriculture and to introduce the turmeric production as a priority in women empowerment.

Women in agriculture

The opportunity existing in the Nigeria agricultural sector is considerably particular for women. Women are the backbone of the development of rural and national economies. They comprise 43% of the world's agricultural labour force, which rises to 70% in some countries. In Africa, 80% of the agricultural production comes from small farmers, who are mostly rural women. In 2015, Nigeria Government launched its global hunger and food security initiative "Green Alternative"(Akpabio,2008). At the heart of Green Alternatives strategy there is an understanding that women play a vital role in advancing agricultural development and food security, helping to reduce poverty and promote global stability. Through the initiative, women farmers are provided with training and opportunities to adopt new agricultural technologies in order to increase their productivity, reduce un paid work and improve families' nutritional status (Kashish, 2015).The work done by Jayshree, *et al* (2019) stated the key role of farm women in turmeric cropping system in Marathwada region was found in planting rhizomes, removing weeds, cutting and sorting turmeric roots as well as cleaning activities

Crop Production

Agricultural sector remains the bedrock of development of the nation in spite of the superiority of the oil sector in its contribution to the economy. The important of agriculture to economic rejuvenation of the country cannot be over looked.(Okonjo,1991) Agriculture with emphasis on crop production has been playing a tremendous role in the socio-economic development of the nation. It contributes to the provision of food for our ever growing population, provides the greatest avenue for employment; ensures forex earnings from plantain crops such as cocoa, coffee, rubber, cashew e.t.c and medicinal crops like turmeric provides raw materials for domestic industries income for those involved in the profession and the provision of markets for industrial goods (Adikwu, 2017).

Turmeric Production

Turmeric is a rhizomatous perennial plant of the ginger family Zingibercea. It is a native of South East India and needs temperature of 20-30˚C and a considerate amount of annual rainfall to thrive. Turmeric is grown to the best agronomic and organic practices aim at preserving their natural characteristics and properties (Grubinger, 2004).

Turmeric comprises of three types of rhizomes, mother rhizome, secondary rhizome and primary rhizome. Mother rhizome are the most suitable planting materials. Turmeric plants are planted on flat beds with plant spacing of 30cm x 35 cm , the beds are mulched immediately after planting. The work done by Obasi *et al*., (2017) revealed that turmeric can be intercropped by cover crop species like melon and cowpea (Akidiani) as live mulching materials. Turmeric field should be fertilized 2 weeks after planting at the rate of 60kg N, 13kg P and 25 kg K/ha (Onwubiko, *et al.*, 2007). Agronomic practices like weeding are done 4 and 8weeks after planting (WAP). Harvesting is done 4-5 Months after planting, they are stored in a cool dry place. Processing into floor can be done thus;

Harvesting ⟶ washing ⟶ boiling ⟶ Drying ⟶ Grinding ⟶ Sieving ⟶ Packaging.

Health Benefit

Turmeric whose active ingredients is curcumin has a natural antiseptic and anti-bacterial agent useful for disinfecting cuts and burns, preventing prostate cancer and reducing the risk of child hook leukemia while acting as a natural detoxifier (Brown, 2015). Modern in vitro studies revealed that turmeric contains potent anti-oxidants, anti-inflammatory, anti-mutagenic, antimicrobial and anticancer agents (Titalk *et al*., 2004). In addition to this, it is used to relieve menstrual and arthritic pains for arthritis. Dosage of 60-80g of turmeric 3 times daily have been recommended (Blumnethal *et al*., 2000).

Economic benefits of turmeric and gender sustainability

Women are key contributors to economies as producers of food, managers of natural resources care takers of children and elderly. Turmeric production should be tailored into economic sustainability and women empowerment. This will be achieved by training the rural women on the value chain production and sensitization on labour management, prolific harvest and marketing links, to optimize the potentials of turmeric . The work done by Akinpelu *et al*., (2008) revealed that harvesting of turmeric has the highest value distribution of contribution to labour inputs of N22, 600.00.They further stated that a return of N466, 696.30 was recorded. Net farm income (NFI) was 326,918.90.In their conclusion the evaluated the percentage return per naira as N233.90 which implies that for every N1.00 invested about N2.33 will be generated from the production of turmeric. Obasi *et a l* ,(2017) also stated in their work done on 2014 and 2015 that Turmeric production without mulch (0 mulch) gave a net return of 470,000 and 160,000 in naira yield per hecter. While the grass mulched Turmeric (GMT) yield in tonnes per hecter of 11.8 and 6.50 gave net returns of 550,000 and 150,000 naira . In this regards turmeric can be a source of revenue for rural farmers especially women. In conclusion, women are therefore encouraged to embark on turmeric production because this will go a long way to improve their livelihood and alleviate poverty.

Table 1: Distribution of labour inputs for production of 1 ha of turmeric

Items	Number of persons	Percentage (%)
Planting	17	7.0
Herbicides application	16	6.80
Supplementary hand weeding (2ce)	76	1.70
Fertilizer application	9	32.34
Harvesting	113	48.00

(Source: Field data 2006 and 2007; Akinpelu *et al*., 2008).

Table 2: Proximate Components of Turmeric Rhizome as Affected by Turmeric Intercrop

Cropping system	% MC	% DM	% CP	% CF	% OL	% ASH	%CHO	% CU
Cowpea/turmeric	81.3	17.5	6.32	3.25	2.91	2.03	2.60	16.5
Egusimelon/turmeric	82.3	18.3	5.30	4.02	3.211	1.90	3.13	14.3
OFSP/turmeric	81.4	16.4	6.53	3.8	3.06	2.30	4.31	12.2

Source: Obasi *et al.*, 2017; (Ph.D work).

Note: MC = Moisture content, DM = Dry Matter, CP, Crude Protein, OL =Oleoresin,

ASH = Ashing, CHO = Carbohydrate and CU = Curcumin

OFSP. Orange Flesh Sweet Potato

Table 3. Gross Monetary And Net Return of Turmeric Production in 2014 and 2015

	Yield in tonnes/ha		Total variable cost (TVC) (N)		Gross return(N)		Net returns (N)	
Sole	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
0mulch	8.52	6.13	10,000	12,000	40,000	480,000	470,000	160,000
GMT	11.8	6.50	30,000	32,000	5,5000	72,0000	550,000	150,000

Source: Obasi *et al* 2017(Ph.D work)

GMT=Grassed mulched turmeric

0 mulch=No mulch

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Benefits of Gurara Dam on Rural Livelihood of Crop Farmers in Kachia Local Government Area of Kaduna State

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Abstract

Benefits of Gurara dam on rural livelihood in Kachia Local Government Area of Kaduna state were investigated. The objectives of the study were to describe the socio-economic status of famers, highlight the yield of crops from irrigation and identify problems encountered by farmers from their use of gurara dam. Data was collected from the respondents through the use of well-structured questionnaire and analyzed using descriptive statistics. Purposive sampling technique was used to select three (3) districts (Katari North, Katari South and Mai Ido) out of the twelve (12) districts in Kachia LGA. From the three (3) districts, three (3) villages each which are immediate villages where the use of the gurara dam is prominent were selected. The Nine (9) villages selected are Kada, Kushegudu, Kuchi, Popori, Korigida, Ido, Kori-Daji, Katari, and Katambi. Ten (10) farmers from each of the nine (9) villages selected add up to the Ninety (90) respondents interviewed for the study. Findings from the study show that majority (85.56%) were male while the least (14.44%) were females. The result also revealed that majority (38.89%) were between the age brackets of 31-40 years while the least (4.44%) were those above 50 years. Majority (81.11%) are married while the least (5.56%) are widow. On the level of education attained by farmers in the villages, majority (33.33%) had primary school leaving certificate and the least (16.67%) attained the tertiary institution status. Majority (50.00%) of the households had between 6-10 individuals while the least (3.33%) were with individuals above twenty (20). Crops cultivated under irrigation by farmers in the villages include cabbage, carrot, banana, pine apple, wheat and maize. The highest (12, 916kg/ha) yield was obtained in the cultivation of pine-apple while the least (715.08kg/ha) yield was obtained in the cultivation of maize. Among the problems encountered by farmers from their use of the dam include; disease outbreak, flooding, lack of proper water channel from the dam and ecological degradation. Majority (52.22%) witnessed the outbreak of disease on their farms while the least (7.78%) perceive ecological degradation as a problem arising from the use of the dam. Conclusively, the benefits derived from the use of the Gurara dam impacted on the socio-economic status of the farmers in the study area culminating in improved yield and substantial earnings.

Keywords: Gurara, Dam, Villages, Irrigation, Yield

Introduction

Dams are large socio-economic investments built to fulfill purposes such as domestic and industrial water supply, energy production, irrigation and flood control. A dam is one of the artificial methods that represent one of the methods of developing water resources by man and the best strategy for averting the effects of perennial drought in the dry lands of the world (Maigari, 2002). A dam is described as man-made structure built across a river to bring water, power, flood control, recreation, economic possibilities and many other advantages to people. Hussain *et al.*, (2003) in his study highlighted one of the benefits of irrigation through dams and found that the availability of irrigation water had strong effect on poverty reduction and improving welfare of the rural areas. It was observed that crop intensification, land productivity, value of production per hectare and level of crop diversification were on higher side in irrigated areas as compare to rain-fed areas (Hussain *et al*. 2003). He further discovered that higher household income due to higher cropping intensity, higher crop and labour productivity and higher employment in irrigated setting as compare to the rain-fed settings (Hussain and Hanjra 2004). Dams provide water supply and increase means of support through irrigation, boosting agricultural development (Yuskel, 2009, Dalil *et al*., 2015). Irrigation alleviates both permanent and temporary poverty as it is productivity enhancing, growth promoting and poverty reducing. Nwa (2003) defined irrigation as method whereby artificial or natural ground water is manipulated for the benefit of the crop. When irrigation water is properly applied, it gives better yield than natural water supply. Yahaya (2002) defined irrigation as the application of water to the soil for the purpose of supply of moisture essential for plant growth. Owusu, *et al.*, (2011) found that irrigation water availability had positively affected the socio-economic conditions of the people in which net farm income after irrigation showed significant increase.

Food consumption will continue to increase in response to global population growth and thus crop production through agricultural practices will be linked to modern agriculture. Moreover, it should be noted that in recent decades the world food consumption per capita has increased. This impacts economic growth, individual wealth, and water consumption (WWAP 2012). Of the additional amount of the food, some will be produced in irrigated areas that will require 11% more water than the current volume, most likely coming from storage reservoirs (World

Commission on Dams 2000). Dams therefore have been used for various purposes among which is irrigation (Berga *et al.*, 2006).

Materials and Methods

The study was conducted in Kachia Local Government Area (LGA) of Kaduna State located on latitude 9^0 52 'N and longitude of 7^0 57 'E. This area has a population of about 244, 270 people (NPC, 2006), with an annual rainfall of about 1392 – 1797mm per annum occupying a land area of about 4, 632km^3. Gurara dam is located in Kachia LGA of Kaduna state. The dam is built on the Gurara river near Abuja; the capital of Nigeria. The dam has capacity of 880 million m^3 with a surface area of 64 square kilometers and an average depth of 53m. Purposive sampling technique was used to select three (3) districts (Katari North, Katari South and Mai Ido) out of the twelve (12) districts in Kachia LGA. From the three (3) districts, three (3) villages each which are immediate villages where the use of the gurara dam is prominent were selected. The Nine (9) villages selected are Kada, Kushegudu, Kuchi, Popori, Korigida, Ido, Kori-Daji, Katari, and Katambi. Ten (10) farmers from each of the nine (9) villages selected add up to the Ninety (90) respondents interviewed for the study.

Results and Discussion

Table 1: Socio – Economic Status of Farmers in the Study Area

Gender	**Frequency**	**Percentage**
Male	77	85.56
Female	13	14.44
Age		
10 – 20	10	11.11
21 – 30	26	28.89
31 - 40	35	38.89
41 – 50	15	16.67
Above 50	4	4.44

Marital Status		
Single	12	13.33
Married	73	81.11
Widow	5	5.56
Educational Level		
Primary	30	33.33
Secondary	20	22.22
Tertiary	15	16.67
No Formal Education	25	27.78
Household Size		
1 – 5	25	27.78
6 – 10	45	50.00
11- 15	10	11.11
16- 20	7	7.78
Above 20	3	3.33
Total	**90**	**100.00**

Source: Field Study

Table 1 above shows the socio-economic status of farmers in villages in Kachia LGA benefiting from the utilization of gurara dam. The result shows that majority (85.56%) were male while the least (14.44%) were females. The result also revealed that majority (38.89%) were between the age brackets of 31-40 years while the least (4.44%) were those above 50 years. This finding affirm with that of different authors (Loibooki *et al*., 2002; Gandiwa 2011, Lindsey *et al*., 2011, Friant *et al*., 2015 and Akinsorotan 2017) that young adults engage in economic activities since they are physically stronger than older people. The results also revealed the marital status of the farmers in the villages utilizing the gurara dam. In this aspect majority (81.11%) are married while the least (5.56%) are widow. The result further shows the level of education attained by farmers in the villages with majority (33.33%) having primary school leaving certificate and the least (16.67%) attaining the tertiary institution status. The result shows the number of individuals inhabiting the villages by households. This reveals that majority (50.00%) of the households had between 6-10 individuals while the least (3.33%) were with individuals above twenty (20).

Table 2: Yield from Irrigation through Gurara Dam in the Study Area

Crop	Yield (kg/ha)
Cabbage	7432.48
Carrot	4443.48
Banana	8903.00
Pineapple	12916.00
Wheat	972.22
Maize	715.08
Total	**35382.26**

Source: Field Study

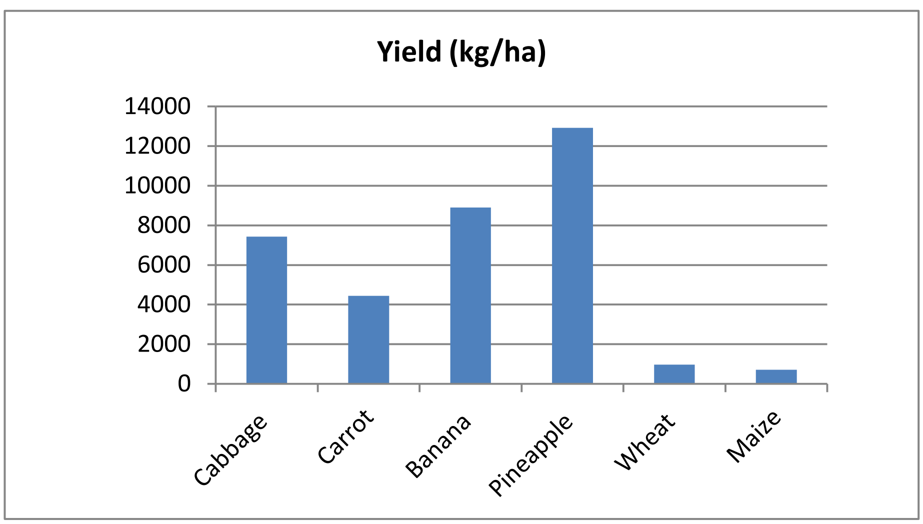

Figure 1: Yield From Irrigation Through Gurara Dam in the Study Area

Table 2 above and Figure 1 shows the yield from farms irrigated through the dam by famers in kachia LGA. The calculated yield is the sum total of yield obtained from the villages sampled in the three districts purposively selected for the study. Crops cultivated under irrigation include cabbage, carrot, banana, pine apple, wheat and maize. The yields were calculated in kilogram per hectare. The highest (12, 916kg/ha) yield was obtained in the cultivation of pine-apple while the least (715.08kg/ha) yield was obtained in the cultivation of maize. This finding affirms the submission by Kirchherr *et al.*, (2016) that dams frequently serve several primary purposes among which is irrigation. It is also in line with the report of Duflo and Pande (2007) that dams' social impacts reach downstream populations via benefits from irrigation. Richter *et al.*, (2010) estimated that 472 million people downstream have been impacted by dam construction.

Table 3: Problems Encountered during the Use of Gurara Dam by Farmers in the Study Area

Problem	Frequency	Percentage	Ranking
Disease outbreak	47	52.22	1st
Flooding	23	25.56	2nd
Lack of proper water channel from the dam	13	14.44	3rd
Ecological Degradation	7	7.78	4th
Total	**90**	**100**	

Source: Field Study

Table 3 above shows the problem encountered by farmers in the villages during the use of gurara dam for their farming activities. Among the problems encountered include; disease outbreak, flooding, lack of proper water channel from the dam and ecological degradation. Majority (52.22%) witnessed the outbreak of disease on their farms while the least (7.78%) perceive ecological degradation as a problem arising from the use of the dam. This finding aligns with the fact established by Schulz and Adams (2019) that dams impact negatively on certain factors among which is ecological degradation.

Conclusion and Recommendation

The advent of dams has brought into fore the utilization of irrigation as a means of improving high yield of almost every crop. Dam construction has made crop revenues increase significantly thereby impacting on the socio-economic status of farmers in households surrounding the dam. Financial returns to farmers provided them the opportunity of alleviating their poverty. Based on findings from the study, it is recommended that small dams should be constructed so as to make the overall impact of dams highly significant on agricultural improvement. The water channel should be lined so that water losses can be reduced so that farmers do not face water shortages.

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Influence of risk management practices on poverty status of cassava farmers by gender in Abia State, Nigeria

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Abstract

The study investigated the influence of risk management practices (RMP) on poverty status of cassava farmers by gender in Abia State, Nigeria. The specific objectives were to identify risk management practices used by male and female cassava farmers; and estimate the influence of risk management on poverty status of cassava farmers. A sample size of 160 cassava farmers were used which comprises 80 males and 80 females cassava farmers. Primary data used for this study were collected with a structured questionnaire. Data were analysed using frequency, percentages, and Tobit regression model. The poverty index (MPCE) mean per capita expenditure as proposed by Foster Greer and Thorbeck model 1984 was used to determine the level of poverty status of male and female cassava farmers. The result on risk management practices reveal that 78% and 74% of male and female cassava farmers respectively, practiced mixed farming.75% and 84% used agrochemicals, while 86% and 81% of male and female farmers used disease resistant cassava varieties The result for Tobit regression shows that RMP adoption, age, education, household size, credit facilities, farming experience, farm size, annual nonfarm income, farm output, and cooperative membership were the significant factors that influenced poverty status of cassava farmers. Therefore, credit facilities should be made available to farmers, to enable them to access the best risk management practices needed and other technological inputs to increase their productivity level.

Keywords: Risk management practice, Poverty status, Cassava farmers, Gender, Abia State

Introduction

Risk in agricultural production is pervasive and complex. Farmers confront a variety of yields, unstable output, input prices and radical changes in production technology as inherent in their farming operations. These affect the fluctuation in farm profitability from season to season and from one year to another Hardaker, Huirne, Anderson, and Lien, (200)

Gender issue refer to the widely shared expectations and norms within a society about appropriate male and female behaviour, characteristics, and roles. It is a social and cultural construct that differentiates women from men and defines the ways in which women and men interact. Men and women play important roles in cassava production and its value chain. Nigeria is the largest producer of cassava in the world (Ogbe and Olojede, 2003). Cassava is a very important staple food consumed in different forms by millions of Nigerians. Cassava is important, not just as a food crop but even more so as major source of cash income for producing households. As a cash crop, cassava generates cash income for the largest number of households, in comparison with other staples, contributing positively to poverty alleviation (Philips *et al*, 2004).

World Bank (2007) in a report, identified poverty as the condition of life so limited by high rate of illiteracy and unemployment, short life expectancy, high incidence of malnutrition, outbreak of disease in infants and adults as well as high rate of mortality. Poverty prevents the realization of the very potentials of a human. Poverty in Nigeria is rising with almost 100 million people living on less than $1 a day (World Bank, 2007). The percentage of Nigerians living in absolute poverty - those who can afford only the bare essentials of food, shelter and clothing - rose to 60.9% in 2010, compared with 54.7% in 2004 (Subair, 2012). These scenario, and the many risk in agriculture, has a debilitating effect on cassava farmers in Nigeria.

Fundamentally, agriculture is prone to risk. This is evidenced by the fluctuations in the prices of farm output and input, drought, floods, pest and disease infestations, poor health condition of the farming households, loss of soil fertility and soil conservation to mention but a few. As a result of this, there is variations in the level of farm income (Okunmadewa, 2003). More so, the various risk management practices and their influence on poverty have been highlighted in the past by previous studies (Salimonu *et al*, 2009). However, there is inadequate empirical information as regards to risk management practices along gender line and their implication on poverty status of cassava farmers in Abia State. Against this backdrop, this study aimed at filling this knowledge gap.

Materials and Method

The study was carried out in Abia State, Nigeria. Multi-stage sampling procedure was used for the study. Umuahia and Ohafia agricultural zones were purposive selected from the three agricultural zones in the state because of the level of agricultural activities carried out in those zones. Two LGAs were randomly selected from each of the agricultural zones selected namely Ikwuano, Umuahia North, Ohafia and Isikwuato LGAs giving a total of four LGAs. Two communities were randomly selected from each of the four LGAs selected giving a total of eight communities. Two villages were randomly selected from each of the communities selected earlier giving a total of sixteen villages. Cassava farmers in each of the villages selected form the sampling frame. Ten cassava farmers were randomly selected from each of the villages selected. Note, selection of the cassava farmers at the village level was gender sensitive. In each village, 5 male and 5 female cassava farmers were randomly selected giving a total of 160 comprising (80 males and 80 females). Primary data used for this study were analysed using both descriptive and inferential statistics such frequency, percentages and Tobit regression model.

The Tobit regression model was specified in an implicit form as follows:

$PI_i = \beta 0 + \beta_1 INC + \beta_2 FS + \beta_3 EDU + \beta_4 FEXP + \beta_5 AGE + \beta_6 HHS + \beta_7 CREDIT + \beta_8 MAC + \beta_{9OUTPUT} + \beta_{10} RMP + \beta 11 NEV + e_i$ 1

Where.

$\beta 0$ = Constant

PI_i= Poverty status of i^{th} cassava farmer (Left censored at zero);

β_{1} - $\beta 11$ Intercept

INC =Annual income (Naira)

FS =Farm size (ha);

EDU = Educational status of the respondents (years of schooling)

FEXP =Farming experience (years);

AGE = Age of cassava farmer (years);

HHS= Household size (count of individual living in the same household and feeding from same pots

QTY = Quantity of Cassava Output (naira)

CREDIT= Volume of credit used (naira)

MAC = Membership of agricultural cooperative society (membership = 1, otherwise = 0).

RMP = Index of risk management practices (no of RMP used)

NEV = Extension contacts (number of extension visits)

ei =Stochastic error term

The model for poverty status was implicitly stated as follows:

$$PCHE = \frac{THME}{HS} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$MPCE = \frac{TPCE}{HS} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Three mutually exclusive classes that were obtained from the MPCE are:

(i) A core poverty line equivalent to one third (1/3) of MPCE.

(ii) The moderate poverty line equivalent to two third (2/3) of the MPCE.

(iii) The non-poor (those that are above the poverty line).

Where,

PCHE = Per capita Household expenditure.

THME =Total Household Monthly expenditure.

HS = Household size.

MPCE = Mean per capita expenditure.

TPCE = Total per capita expenditure for all household

Result and Discussion

Risk Management Practices Used By Male and Female Cassava Farmers

The risk management practices employed by male and female cassava farmers were highlighted in Table 1. The result in Table 1. Shows that 86% and 75% of male and female cassava farmers had off farm investment as a measure to manage their risk. 81% and 53% of male and female farmers practiced soil conservation, about 81% and 75% of male and female farmers respectively, used agrochemicals. The use of fertilizer is seen as a way of improving crop yield in order to reduce loss of farm revenue associated with low crop output. This method could be seen as a loss reduction technique (Okereke, 2012). Also, 81% and 75% of both farmers borrowed loan in order to manage their farms, while 81% and 63% of male and female farmers planted disease resistant cassava varieties to reduce risk so as to improve crops productivity. The result is presented in Table 1.

Table 1: Risk management practices adopted in cassava production according to gender

Risk management Practices (RMP)	Male Farmer		Female Farmer	
	Freq.	%	Freq.	%
Planting of improved disease resistant cassava stem	70	81	65	63
mixed cropping	50	63	60	75
Mixed farming (crop and animal production)	62	78	59	74
Off-farm investment/employment	65	86	50	75
Sharecropping arrangement	30	38	15	19
Increase in farm size and farming in different locations against crop failure	55	69	50	63
Use of agrochemicals	60	75	67	84

Borrowing of loan/credit from banks/financial institutions	65	81	60	75
irrigation practice	20	25	10	13
Practice of soil conservation and improvement techniques	65	81	42	53
Farm protection (fencing)	60	75	60	63

Source: Field survey, 2017

***Multiple responses**

Influence of Risk Management on Poverty Status of Male and Female Cassava Farmers

The results of the Tobit regression models employed to estimate the influence of the level of adoption of risk management practices on the poverty status of male and female cassava farmers in the study area is presented in Table 2.The result in Table 2 shows that the model gave a Pseudo R-squares value of 0.692 and 0.713 for male and female cassava farmers, respectively. Suggesting that at 69.2% and 71.3% variations in poverty status of the male and female cassava farmers respectively were explained by variations in the specified explanatory variables. The model has a likelihood ratio chi-square of -47.947 and -49.324 all significant at 1% level, giving the model an acceptable fit.

The result shows that at 5% level of significance, the level of adoption of risk management practices of both the male and female cassava farmers in the study area had positive and significant influence on poverty status of the farmers. This implies that the probability of a farmers being poor decreases with the adoption of risk management practices by the farmers. This is attributable to the ability of the farmers to reduce farm losses, thus leading to increased productivity. The result with respect to level of adoption of risk management practices is consistent with *a priori* expectation and with the work of Pingpoh *et al*., (2007).Thus, economic policies for the poverty status of male and female cassava farmers in the study area should be skewed more towards encouraging them to adopt more risk management practices.

The study shows that at 1% level of significance, the coefficient of age of the male cassava farmers had negative and significant influence on poverty status of the farmers. This implies that the probability of a farmers being poor increases with age of the male cassava farmer. This is attributable to the ability of the male farmers to do manual work, suggesting that as the ability to do manual work decreases poverty increases. This will lead to lower productivity and increase the probability of the male cassava farmers being poor. The result with respect to age is consistent with *a priori* expectation and with the work of Asogwa *et al,* (2012).

The coefficient of membership of cooperative societies was significant and exhibited a positive relationship with female cassava farmers' poverty status at 1% level, an indication that the intensity of poverty was lower among female cassava farmers who were member of any cooperative society or any farmers' association than in those who are no-members of any cooperative society or any farmers' association. Membership to a cooperative society allows such a member to have access to better farming information and credit as well as to enjoy economies of scale. The use of better farming information and adequate credit necessitated by membership of cooperative society will lead to increased income Simonyan *et al,* (2012).

The coefficients of educational status of the male and female cassava farmers was significant at 5% level and had negative relationship with the poverty status of the farmers. This implies that increase in educational status of these famers increase their poverty level. This result is consistent with a priori expectation and with the work of (Iheke and Nwaru, (2014); that several studies have revealed that the incidence of poverty is higher among people with little or no education. Increase in farmers' education will enable them to adopt technologies and strategies that will aid them in handling daily farming challenges and to be able to set realistic cost and time targets, allocate and utilized resources efficiently and identify production risks of (Iheke and Nwaru, (2014).

The coefficient of access to credit by male cassava farmers in the study area had significant and positive relationship with poverty status at 10% for the male respondents. This implies that access to credit enhances the probability of male cassava farmers to live above the poverty line. The result with respect to access to credit obtained is consistent with *a priori* expectation and with the work of Kalu (2013), whose study shows that farmers who had access to credit are able to acquire more productive resources thereby enhancing their income-generating capability and overall household welfare.

Table 4: Influence of the level of risk management practices on poverty status of cassava farmers by gender

	Male Cassava Farmers			Female Cassava Farmers		
Variables	**Coefficient**	**SEM**	**t-value**	**Coefficient**	**SEM**	**t-value**
Constant	1.309	0.289	4.529***	1.314	0.271	4.849***
Level of use of RMP	0.547	0.239	2.289**	0.723	0.326	2.218**
Age of farmers	-1.046	0.352	-2.972***	-0.791	0.592	-1.336
Educational status	-0.575	0.276	-2.083**	-0.804	0.386	-2.083**
Household size	-0.507	0.28	-1.811*	-0.514	0.276	-1.862*
Quantity of cassava output	0.333	0.743	0.448	0.721	0.282	2.557**
Access to credit	0.737	0.392	1.880*	0.574	0.566	1.014
Farming experience	0.661	0.323	2.046**	0.211	0.095	2.221**
Farm size	0.301	0.14	2.150**	0.589	0.112	5.259***
Cooperative membership	0.809	0.857	0.944	0.144	0.052	2.769***
No. of extension contact	0.289	0.186	1.554	0.297	0.223	1.332
Annual Non-farm income	0.023	0.0 13	1.769*	0.862	0.816	1.056
LR Chi- square	47.947***			49.324***		
Pseudo R^2	0.692			0.713		
Number of Obs	80			80		
Log likelihood	-49.990			-51.010		

Source: Field survey, 2017. ***, **, * = significant at 1, 5, and 10% respectively.

SEM = Standard Error of Mean

Conclusion and Recommendations

The findings suggest that majority of male cassava farmers used more risk management practices and were good managers of risk practices. That is to say, they adopt more risk management practices, have more access to both technological input, capital and land acquisition thereby enhancing their productivity levels. The result of the Tobit regression model shows that the level of use of RMP, farming experience, output, access to credit, cooperative membership, farm size and non-farm income were significant at different levels. This implies that as these variables increase, the incidence of poverty decrease in different units in male and female cassava farmers. Age, level of education and household size had an inverse relationship with poverty in the study area.

In the light of the forgoing conclusion, it is recommended that given the dominance of male cassava farmers in the adoption of risk management practices in the study area, women should adopt more risk management technologies so as to reduce risk of crop failure and boast crop production. Credit facilities should be provided to the farmers to enable them increase their level of production.

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Analysis of Livelihood Status of Irish Potato Farmers and its Determinants in Barikin-Ladi LGA of Plateau State, Nigeria

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Abstract

Livelihood implies adequate and sustainable access to income and resources to meet basic household needs such as access to food, portable water, health facilities, educational opportunities, housing, time for community participation and social integration. It is derived from a range of on-farm and off-farm activities. The study analyzed the livelihood status of Irish potato farmers and its determinant. A multi-stage sampling was adopted for the study to interview 120 respondents from 8 communities in Barikin Ladi LGA. The Household Livelihood Security Assessment (HLSA) framework and ordered logit regression were used to achieve the objectives of the study. Results showed that majority of Irish potato farmers (85%) had a medium livelihood status ranging between livelihood scale of 0.34-0.66. Household size, years in education and non-farm income were found to positive influence the livelihood status of Irish potato farmers by 1.164, 0.819 and 1.00 units respectively. Other variables tested were also found to influence livelihood status positively however, they are not significant. The study therefore concludes that majority of Irish potato farmers live within a reasonable livelihood status and thus can provide their family's basic requirements. Some of the recommendations proffered include the need for coaching farmers on principles of group formation and dynamics and also government formulation and enforcement of policies that will ensure prices of inputs are controlled and regulated.

Keywords: Irish Potato, Plateau, Livelihood, Household Livelihood Security Assessment

Introduction

Nigeria with a population of over one hundred and forty million people is the Africa's most populous nation and agriculture is the predominant activity (Daniel, 2013). Agriculture is traditionally the mainstay of many developing countries, Nigeria inclusive as it plays multiple roles in the development of the economy. Agricultural sector was the major source of national income, foreign exchange, employment and contribute to the gross domestic product (GDP) and it employs about 70% of the rural working population (Joshua and Teli, 2010).

Irish potato (*solanum tuberosum L.*) belongs to the solanaceae family. It is a native of western hemisphere and is believed to have originated somewhere between Mexico and Chile, possibly in Andes highlands of Bolivia and Peru. It later spread to other places like England and Ireland. The planting stock has been received from Ireland, hence the name Irish potato. Irish was introduced into Nigeria in the later part of the 19th century and early 20th century by the Europeans notably the tin miners in the Jos plateau (Okonkwo *et al*., 1995). Irish potato is grown for food as well as a commercial crop. It is a major source of income among rural farmers in many African countries.

Irish potato is by far the most fruitful and efficient tuber crop in the world in terms of tuber yields and days to maturity. The crop matures in about 60 to 90 days as compared 9 to 12 months for yam and cassava, respectively (NRCRI, 2005). Kudi, (2011), maintain that the Irish potato gives the highest yield per unit area among roots and tuber crops in Nigeria and that brings more income to farmers and hence improved livelihood.

Livelihood according to Frankenberger (1998) is 'adequate and sustainable access to income and resources to meet basic needs (including adequate access to food, potable water, health facilities, educational opportunities, housing, time for community participation and social integration)'. Livelihoods can be derived from a range of on-farm and off-farm activities, which together provide a variety of procurement strategies for food and cash. Thus, each household can have several possible sources of entitlement, which constitute its livelihood. These entitlements are based on the household's endowments and its position in the legal, political and social fabric of society. The risk of livelihood failure determines the level of vulnerability of a household to income, food, health and nutritional insecurity. Therefore, livelihoods are secure when households have secure ownership of, or access to, resources and income-earning activities, including reserves and assets, to offset risks, ease shocks and meet contingencies (Chambers, 1991). Since Irish Potato production is a significant sector of rural livelihood in Barikin Ladi and Plateau, a small percentage loss in its production would impose a larger proportionate income loss which will subsequently affects farmers' livelihood Ajani (2012). It is against this background that the study intent to determine the livelihood status of small-scale Irish potato farmers and also indicate factors influences their livelihood status in the study area.

Methodology

Study area

Barikin Ladi is one of the Irish potato producing Local Government Area (LGA) in Plateau State. The LGA lies between latitude 9°34′N and Longitudes 8°55′E. It has an estimated land area of 1,032 km^2 with an estimated population of 239,064 as at 2020 considering the 2.6% annual growth rate. It has also an elevation of about 1230m above sea level, with about 1400mm of annual rainfall which spans from April to October (NRCRI, 2015). The climate is characterized by two distinct seasons, the rainy season, and the dry season, which falls between November and March. High temperatures are recorded in the months of March – May while the lowest temperatures popularly called the Harmattan months are between December and January. These seasons are suitable for potato production because they meet the required 15^0C for tuber formation. Other crops produced in these areas include tomato, cabbage, carrots, lettuce, cucumber, green beans and onions. Cereal crops such as maize sorghum and millet are also grown in the area. Potato producing seasons were April – July (rainy season) and September – January (dry season). Over 80% of the potatoes are produced as a sole crop during the dry season and in mixtures during the rainy season. The climate of the State is ideal for Irish potato production as well as vegetables, fruits and other exotic crops.

Sampling procedure

Barikin Ladi LGA's was selected through convenience sampling method because they are among safe areas where research could be conducted without exposing the researcher to the frequent ethnic crisis in other potato producing areas in the state. Eight (8) communities namely Exland, Rarung, Kurra, Nding, Du, Kuru, Vwang and Gyel were purposively selected because they are among the locations where Irish potato is produced en-masse. Fifteen (15) farmers were randomly selected from each of the 8 communities and a total of 120 Irish potato farmers were interviewed using structured questionnaire. Data collected were subjected to analytical tools with the intension of achieving the research objective.

Statistical Tool

Constructing Livelihood Index Using the HLSA Livelihood Components

The Household Livelihood Security Assessment (HLSA) multidimensional framework was adopted for this study to develop the livelihood status index. The framework uses a 5 livelihood indicators viz; Economic Security Indicator, Food Security Indicator, Health Security Indicator, Educational Security Indicator, and Empowerment Indicator. To achieve the objectives of this study and just like other studies have done, other sub-indicators were composed to be able to conveniently provide data for the HLSA indicators. Research on livelihood usually involve an index which forms the basis for comparison between either farmer of the same group or otherwise or even for comparison across and between countries. The index as earlier said, comes about from different sets of livelihood indicators which vary depending on the framework a researcher chooses to adopt. Therefore, an index is a single number derived from a set of prices and quantities. In a broader term, it is a scale selected by a researcher which aid in grouping sets of people or countries into different group according to their level of livelihood. It gives a window for making a comparison between different groups. The five livelihood components were later collapsed to form the livelihood index using the Patnaik and Narayanan (2005) approach of index construction alongside the UNDP's Human Development Index (HDI) (UNDP, 2006). The livelihood index ranges between 0 and 1. Farmers having an index closer to 1 are having good livelihood standard and otherwise for those with a value closer to 0. The Livelihood status was classified into three groups (Low Livelihood, Medium Livelihood and High Livelihood Status), farmers having an index between 0.01-0.33 belong to the low livelihood group, 0.34-0.66 are the Medium Livelihood group and 0.67-1.00 are the High livelihood group.

Ordered Logit Regression Analysis

The ordered logit regression analysis was adopted to determine factors that influences Irish potato farmer's livelihood status. This is because the dependent variable used is ordered (1: Low Livelihood, 2: Medium Livelihood and 3: High Livelihood). The functional form of the model used is as follows;

$$Y_i^* = X_n\beta_n + \varepsilon_i$$

Y_i^*= Livelihood Status (Low, Medium and High Livelihood)

X_1= Age of Irish Potato Farmer (Years)

X_2= Sex (0: Female, 1: Male)

X_3= Experience in Farming (Years)

X_4= Extension Agent Visit (Number)

X_5= Household Size (Number)

X_6= Marital Status (0: Single, 1: Married)

X_7= Years in Education (Years)

X_8= Non-Farm Income (Naira)

$\beta_1 - \beta_8$= Odds rations of variables $X_1 - X_8$

ε_i= Error term

Results and Discussion

Livelihood status of Irish Potato farmers

The Livelihood status indicates the wellbeing of Irish potato farmers in the study area. It ranges between 0-1, having a scale of closer to 1 implies high living standard and otherwise for a livelihood scale tending towards 0.

Table 1: Distribution of Respondents according to Livelihood Class

Livelihood Classification	Frequency	Percent
Low Livelihood (0.01-0.33)	3	2.5
Medium Livelihood (0.34-0.66)	102	85.0
High Livelihood (0.67-1.00)	15	12.5
Total	120	100.0

Table 1 shows the distribution of Irish potato farmers according to the livelihood class they belong. Majority (85%) of the respondents falls under the medium livelihood group, 12.5% falls to the high livelihood group and the least (3%) are the low livelihood group. The study therefore implies that Irish potato farmers in the study area have at least a reasonable livelihood status and a such could be able to provide basic need of their dependents such as food, access to education, access to health facilities, having clean and portable drinking water. In addition, some group exists among the respondents that live within the low livelihood group and could only attend to few needs of their dependents as a result, they usually devise means of coping to such condition the most common of which is the household members render services within the community and get more income to such household unit.

Determinants of Livelihood Status of Irish Potato Farmers

Livelihood is synonymous to wellbeing. Its therefore indicate the level of wellbeing of the group been worked upon. The result from this section dwelt on the socioeconomic factors that determine the level of wellbeing of Irish potato farmers in the study area.

Table 2: Factors Affecting Livelihood Status of Irish Potato Farmers

Livelihood Status	Odds Ratio	Std. Err.	Z	P-Value
Age	0.978	0.024	-0.93	0.354
Sex	0.483	0.301	-1.17	0.243
Experience in Farming	0.940	0.046	-1.26	0.206
Extension Agents Visits	0.954	0.145	-0.31	0.755
Household Size	1.164***	0.095	1.88	0.061
Farm Size	0.644**	0.114	-2.48	0.013
Marital Status	3.079	2.369	1.46	0.144
Years in Education	0.819**	0.048	-3.44	0.001
Non-Farm Income	1.000*	0.000	-1.74	0.082
/cut1	-9.361	2.222		
/cut2	-1.540	1.757		

***, **, ***: Significance at 1%, 5% and 10%** **Prob > chi2:0.0002 Pseudo R^2:0.2686**

Table 2 indicated the factors that influences the livelihood status of Irish potato farmers in the study area. The prob Chi2 value (0.0002) was found to be significant and thus fits the scenario it was put to and the pseudo R^2 value is 0.2686. Starting from variables that were significant, the results indicated that a unit change in years of household size will increase the livelihood status of Irish potato farmers by 1.164 units and is significant at 10%. Number of household members in a farming community increases the labour force of such household as a result, the higher the number of people in a household unit, the more income in which that household will have and hence improved livelihood status. A unit increase in years of education will leads to a corresponding increase in livelihood status by 0.819 and was reported to be significant at 5% level of significance. This implies that, the livelihood status of a farmer is expected to increase with increase in education level. Increase in education level might translate into the ability of a farmer to be able to source for information that will improve his farming technique and it could also mean to diversify enterprise through what was learnt in the course of learning. In a nutshell, educated farmers are likely to have more livelihood standard than less literate farmers. A naira increase in non-farm income of a farmer will results in a corresponding increase in livelihood status by 1.000 and its reported to be significant at 1% level. This implies that farmers having secondary occupation are likely going to have a better livelihood status than those whom engage only in farming, which further support the research apriori assumption.

Other variables tested were not significant implying less contribution in the livelihood status of Irish potato farmers in the study area or the variables are not readily. Although, their odd ratios indicated a positive relationship with livelihood status.

Conclusion and Recommendation

The study therefore concludes that majority of the farmers sampled are having at least a bearable livelihood status since majority had a livelihood status ranging between 0.34-0.66 (i.e. Medium Livelihood). Also, socio-economic characteristics such as the household size, farm size, years in education and non-farm income were reportedly seen to influence the livelihood status of Irish potato farmers in the study area. The following recommendation were brought forth:

i. Irish potato farmers in the study sites should be trained on group formation and dynamics in order to make it easier for them in terms of input purchase and it could also help in collective marketing thereby improving the net returns and consequently their livelihood.

ii. There is need for Government to employ more extension personnel and engage in rigorous training for existing ones. This is because farmer's success depends on the existence of skilled and well trained extension personnel.

iii. It is also noteworthy that government implement and enforce policies intended to ensure price of inputs are regulated and controlled.

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Effect Of Farmers' Participation In "*Agric And You*" Inspiration Radio Broadcast On Cassava Production In Akwa Ibom State, Nigeria

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Abstract

This study examined the effect of farmers' participation in "*AGRIC AND YOU"* agricultural radio broadcast of Inspiration FM 105.9 radio station on cassava production. Data on participation and yield per hectare before after participation were obtained from 180 randomly selected farmers using a questionnaire on a 5-point rating scale. Data analysis was done using descriptive and inferential statistics. The technologies disseminated and level of adoption were, herbicide application ($\bar{x}$=3.13), input acquisition ($\bar{x}$=3.46), marketing opportunities ($\bar{x}$=4.33), Improved storage facilities ($\bar{x}$=3.34), fertilizer application ($\bar{x}$=3.97), harvesting ($\bar{x}$=3.22) showed that there was a high level of farmers participation in the agricultural radio programme. The result of the simple linear regression showed that 'Agric and You' agricultural programme was effective on the famers cassava yield, and was significant at 1% level of probability. The study concluded that farmers had high level of participation in the programme led to increase in yield. It is recommended that the programme should be sustained and stake holders and research institutes should make more use of radio as a means of reaching out to the farmers.

Keywords: **farmers' participation, agricultural radio broadcast, cassava production**

Introduction

Agriculture is a major sector of the Nigeria economy and a primary source of livelihood for the rural dwellers who contribute a large percentage in the production of Nigeria's food crops and livestock. Onyeagocha (2012) acknowledged that the rural dwellers contribute over 80% of Nigeria's food crops and livestock under unfavorable conditions.The significance of agriculture in the economy of Nigeria is so glaring, and even with the growth of other sectors the agricultural sector continues to be the key economic activity of Nigerians. Agriculture is predominantly important because of its employment generation and contribution to Gross Domestic Product (GDP) and export revenue earnings of the country.

Among the crops grown by the rural dwellers, cassava is among the most widely produced in Nigeria. In cassava production, Nigeria is rated the highest producers in terms of its volume of production (FAO, 2002). Cassava is a staple food crop with worldwide distribution and serves as a fundamental energy source and food security for about 80million people Worldwide (FAO, 2014). Cassava is a resourceful crop with various uses, the leaves are consumed as vegetable, it can be dried and fed to livestock as protein feed supplement, the tubers are processed for human and animal consumption and it also creates employment opportunities as well as contributing to the food security status of many rural families in Nigeria.

Looking at the importance of cassava as a staple food crop in Nigeria, its productivity can be increased and sustained through efficient utilization of improved research findings such as new varieties and improved agronomy practices. According to Ojuekaiye (2001), because of the significant contribution of cassava to food security and economic development of the country, the Federal Government of Nigeria embarked upon a number of programmes to boost its production These include, Cassava Multiplication programmes, Root and Tuber expansion programmes and Pro-vitamin A cassava production technologies, amongst others.

Currently, agricultural extension delivery has progressed from the personal contact of farmers by extension agents to the use of mass media in extending improved agricultural information and this is a hopeful resolution to the limited number of extension agents to reach rural farmers. For farmers to be productive there is need for them to be enriched with the relevant agricultural information at the right time. Notwithstanding the inadequate number of extension agents, farmers have to be reached with agricultural information irrespective of their locality. This is so because the rural farmers depend solely on agriculture for their source of livelihood and one cannot afford to deny them essential information to help increase their productivity. The urban dwellers are able to feed today because, the rural farmer in spite of all challenges still produce.

Efforts are being made by agricultural extension and other agencies to ensure that farmers are provided with relevant information. Radio, which is mass media communication method, has been known to be very effective in reaching a large number of farmers quickly as compared to the interpersonal method used by extension agents. Badiru and Yekinni (2015) acknowledged that mass media have become an important means of agricultural and rural development information dissemination in Nigeria. Among the mass media methods, radio has been identified to be one of the most effective. Radio is one broadcast medium that is effective for rural emancipation programme. It beats distances, and thus has immediate effect (Okwu *et al.*, 2007).

It has been identified as the only medium of mass communication that the rural population is very familiar with (Kuponiyi, 2000). Nazimi and Hasbullah (2010) also posited that, among the different modes of communication, radio has been acknowledged as a powerful communication tool. This could be due to the low and affordable cost of radio and portability compared to other sources of mass communication.

AGRIC AND YOU agricultural broadcast is a weekly radio programme used to enrich and educate farmers on improved agricultural innovations in Akwa Ibom State. The programme has been aired since 2016, and it covers areas such as crop production, livestock production, fish farming, input acquisition, co-operative societies, credit institutions, and market information. Till date, no study has been conducted to establish the effect of farmers participation in the program, hence the necessity of this study. The specific objectives of the study were to examine the extent of farmers participation in AGRIC AND YOU agricultural programme and determine the perceived effect of AGRIC AND YOU agricultural programme on cassava yield of farmers.

Methodology

The study was carried out in Akwa Ibom State, which is located in the coastal southern part of Nigeria. The State lies between latitudes 4° 32_ and 5° 53_ North and longitudes 7° 25_ and 8° 25_ East and has an area of 8,412 km. A multi-stage sampling procedure was used to select respondents for the study. The first stage involved the random selection of three zones from the six agricultural zones (Uyo, Etinan, Oron, Abak, Ikot Ekpene, and Eket) of the State which included (Uyo, Ikot Ekpene and Eket). In the second stage, simple random sampling was used to select 2 blocks from each of the selected zones making it 6 blocks. The third stage involved selecting 2 cells each from the 6 selected blocks using simple random sampling to give a total of 12 cells. Finally, 15 farmers were selected from the twelve cells using simple random sampling technique which gave a total of 180 respondents. Data collection was done through the administration of questionnaires and interview schedule. Descriptive statistics such as frequency, distribution mean and percentages were used to analyse data, while the inferential statistic such as simple linear regression model was used to determine the relationship between farmers' participation in the programme and cassava yield. A null hypothesis that, there was no significant relationship between farmers' participation in *AGRIC AND YOU* programme and cassava yield was tested at 5% alpha level.

Results and Discussion

Extent of farmers' participation in AGRIC AND YOU agricultural programme

The result in Table 1 shows the extent of farmers' participation in AGRIC AND YOU agricultural programme. The mean rating on a 5-point scale shows that improved cassava varieties ($\bar{x}$=2.88), proper pest and disease control($\bar{x}$=3.08), herbicide application($\bar{x}$=3.13),input acquisition($\bar{x}$=3.46), co-operative societies($\bar{x}$=3.05), credit, grant and loan acquisition($\bar{x}$=3.08), marketing opportunities($\bar{x}$=4.33), improved storage facilities($\bar{x}$=3.34),cassava processing($\bar{x}$=2.68),fertilizer application($\bar{x}$=3.97),timely weeding($\bar{x}$=3.12), harvesting($\bar{x}$=3.22). The result shows that, the extent of farmers'participation in AGRIC AND YOU agricultural programme was high. Ten out of twelve technologies were higher than the bench mean of 3.0. This shows that farmers need and value for agricultural information and this is in line with the findings of Okwu et al., (2007), who reported that there was high level of farmers' participation in agricultural radio programmes.

Table 1: Extent of farmers' participation in AGRIC AND YOU agricultural programme

	Always	Often	Seldom	Rarely	Never	$\sum fx$	SD	$\bar{x}$
A Improved cassava varieties	65(325)	35(140)	2(6)	0(0)	78(78)	504	0.8119	2.88
B Proper pest and disease control	35(175)	94(376)	1(3)	0(0)	50(50)	554	0.9980	3.08
C Herbicide application	47(235)	80(320)	2(6)	1(2)	50(50)	563	0.72246	3.13
D Input acquisition	38(190)	60(240)	36(108)	40(80)	6(6)	622	0.9777	3.46
E Co-operative societies	25(125)	73(292)	21(63)	11(22)	48(48)	550	0.6640	3.05
F Credit, grant and loan acquisition	27(135)	46(184)	31(93)	68(136)	8(8)	555	0.5667	3.08
G Marketing opportunities	65(325)	111(444)	3(9)	1(2)	0(0)	780	1.0862	4.33
H Improved storage facilities	96(480)	10(40)	12(36)	23(46)	0(0)	602	0.9220	3.34
1 Cassava processing	4(20)	25(100)	86(258)	43(86)	19(19)	483	0.8002	2.68
J Fertilizer application	106(530)	20(80)	12(36)	26(52)	16(16)	714	0.5211	3.97
K Timely weeding	4(20)	28(112)	89(267)	80(160)	3(3)	562	0.7442	3.12
L Harvesting	6(30)	34(136)	87(261)	44(88)	65(65)	580	0.8510	3.22

Grand mean	**3.28**
Benchmark mean	**3.00**

Source: Computed from field survey data, 2019.

Relationship between AGRIC AND YOU agricultural programme on cassava yield of farmers

The result on Table 2 shows the regression estimate of the effect of AGRIC AND YOU agricultural programme on cassava yield of farmers. Table shows that the R-square value was 0.732, indicating that 73.2% of the variation in the dependent (cassava yield) was accounted for by the independent variable, while others were due to other factors. The F-test was statistically significant at 1% indicating that the model used was fit for the analysis. The result implied that an increase in AGRIC AND YOU agricultural programme will lead to an increase in the cassava yield of farmers in the study area.

Table 2: Simple linear regression effect of AGRIC AND YOU agricultural programme on cassava yield of farmers in the study area

Parameters	Coefficient	Standard error	t-value
Constant	9.4303	0.576	2.953***
AGRIC AND YOU agricultural programme	0.828	0.348	2.752**
R-square	0.732		
R-adjusted	0.698		
F-ratio	18.634***		

Source: *Computed from Field Survey Data 2019* **(**** = significant at 5% and *** = significant at 1%)

Conclusion and Recommendations

The study revealed that farmers had high level participation in Agric and You Inspirational Radio Broadcast which resulted to high cassava yield among the participants. The paper therefore concluded that participation in the programme led to increase in cassava yield in the study area. Based on the findings of the study, the paper recommended that;

1. The *AGRIC and YOU* Programme should b*e* made to have a wider coverage to reach more farmers
2. The government, general public and Non-Government Organization (NGO's) should make effort to support and sponsor agricultural the *AGRIC and YOU* programme.

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Status of sweet potato seed systems Development in Nigeria

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Abstract

Nigeria can be said to have a poorly organized sweet potato seed system with farmer to farmer seed exchange and sourcing from volunteer crops dominating in most parts of the country. This is because sweet potato is seen as secondary and a "poor man's crop" with a poorly developed value chain unlike crops like maize, wheat and cassava. Most of the planting materials distributed in this system are local landraces and the quality is unknown. This practice is characterized by buildup and spread of pest and diseases which eventually leads to low yield. Diseases pressure, rainfall pattern which vary according to locations, availability of irrigation system, availability of wetlands or river banks and availability of market for roots controls the existing seed system. The international potato centre (CIP) in collaboration with National Root Crops Research Institute Umudike have been working tirelessly towards addressing most of the pressing challenges facing sweet potato seed systems development in Nigeria. The intervention have led to the development of draft protocol for seed inspection and certification, building of screen houses at Umudike and Iresi, setting up and training of DVMs in Abia, Osun and Kano states, introduction of the net tunnel and triple S technologies, continuous hosting of stakeholders and engagement of NGOs and private partrners to key into seed production etc. However, there are gaps that need to be filled to strengthen the existing seed system. While policies towards monitoring and development of national seed systems of some grain crops such as maize have been put in place by the national agricultural seeds council (NASC), such policy guideline is yet to be put in place for sweet potato seed system development. Major seed companies in Nigeria focus much attention and energy in the production of grain crops and are not yet interested in sweet potato. The information on protocol for inspection and certification of sweet potato seed system is yet to be operational. Provision of irrigation facilities, financial support to seed producers and making policies towards the overall development of sweet potato value chain will help strengthen the existing system. Institutional support services for sweet potato production and processing should be made in such a way as to encourage private sector participation.

***Keywords**: Sweetpoato, seedsystem, Nigeria*

Introduction

Sweet potato (*Ipomea batatas*) and in particular the orange-fleshed varieties can play a role in strengthening food security, reducing malnutrition and combatting vitamin A deficiency. In SSA sweet potato is grown as a staple food across a wide range of agro ecological regions (McEwan et al., 2015). Propagation is largely through the use of vine cuttings selected from the previous crop (Gaba and Singer, 2009). The crop is particularly adapted to marginal areas of low or erratic rainfall and low soil fertility; it tolerates high temperatures, is easy to propagate and maintain, and yields well even in adverse conditions. It is friendly to the environment, as chemical inputs are rarely used and it protects soil from erosion, as it closes its canopy in a short time with a well-developed root system (Woolfe, 1992).

Timely access to adequate quantities of quality vines has been cited as one of the major constraints facing sweet potato production (McGuire and Sterling, 2016.) In Nigeria, Local farmer-to-farmer seed systems predominate, with farmers sourcing planting material from their own fields or from the fields of neighbors and kinfolks. These seed systems may be resilient, but the amount of material available at the beginning of the rains is limited. Moreover, the recycling of material can lead to the build-up of pests and diseases and subsequent yield reduction also, extended or unanticipated dry periods can result in the loss of material. (McEwan, 2016). Realizing the full potential of sweet potato to increase the food security and nutrition of the poor requires, among others, good functioning seed systems, to effectively distribute new varieties and ensure access to high quality planting material (McEwen et al, 2015). There is urgent need to move the sweet potato seed systems in Nigeria from informal to formal in order to boost the yield at farmer's field which will have a multiplier effect on the overall value chain.

Existing Sweet potato Seed system in Nigeria

Nigeria can be said to have a poorly organized sweet potato seed system with farmer to farmer seed exchange and sourcing from volunteer crops dominating in most parts of the country. This is because sweet potato is seen as secondary and a "poor man's crop" with a poorly developed value chain unlike crops like maize, wheat and cassava. Diseases pressure, rainfall pattern which vary according to locations and availability of market for roots controls the existing seed system. The extended rainy season in the southern regions is weakly bimodal and due to shorter dry season, planting material is selected from existing or ratoon crops. In areas where sweet potato can be grown in three seasons (i.e. farmers have access to fadamas (low-lying irrigable plains)), vines are sourced from their own farms especially for the second and third season or from friends/neighbors. The northern regions are characterized by an increasingly short rainy season as one goes farther north, and a long, harsh dry season. Highly weathered, sandy soils and high temperatures (due to low elevation and latitude) exacerbate stresses and restrict dry season farming to irrigated areas. In dry, livestock system-dominated areas farmers are unable to conserve their own vines due to lack of water or damage by free-grazing cattle (Carey *et al*., 2013. McEwen et al, 2015). Vine conservation in Nigerian depends on the rainfall pattern, the availability of irrigation system and the availability of wetlands or river banks. Farmers around Kano and Kaduna where there is robust irrigation system engage in conserving vines around river banks or using irrigation system. Carey, *et al*, (2013) reported that there is a strong market for roots within this area and there is also significant specialized vine production. The farmers have identified a narrow window in the season when sweet potato vines can command a high price. Their customers are local or regional farmers who come to buy vines direct from source, using private or public means of transport. The multipliers ensure that the planting material is ready on time or otherwise they risk missing the market.

The existing seed systems have operated at a local scale, based on diverse farmer practices for selection, multiplication and exchange of planting material. However, until we have a better understanding of the dynamics of farmer demand and how to ensure a consistent supply of planting material at scale, we will be unable to address bottlenecks and take advantage of the opportunities to contribute to the transformation of food security and nutrition (McEwen et al, 2015). It will be difficult for farmers to make headway in sweet potato production in Nigeria if the current practice of farmer to farmer seed exchange and sourcing vines from volunteer crops continues. This practice is characterized by buildup and spread of pest and diseases which eventually leads to low yield. In most cases the system does not guarantee timely access to quality planting material and most importantly there is no inspection and certification protocol on ground to ensure that vine multipliers sell disease free vines to farmers and /or prosecuted accordingly when to go contrary to the Nigerian seed law. It is important to note that while policies towards monitoring and development of national seed systems of some grain crops such as maize have been put in place by the national agricultural seeds council (NASC) (the government body charged with the responsibility for the overall policy guidelines and monitoring of the development of the national seed system in Nigeria), Such policy guideline is yet to be put in place for sweet potato seed system development and hence, farmers multiple planting materials without regards to its quality.

Strengthening the existing seed system: Efforts made so far

Strengthening the existing seed system requires a holistic approach towards developing simple and affordable technologies that will ensure that quality planting materials are available to farmers all year round. However, this can only be possible if government recognizes that any policy made towards moving the seed system from informal to formal will strengthen the entire sweet potato value chain from seed production to value addition. The international potato center (CIP) (through the sweet potato action for security and health in Africa (SASHA 11) project) in collaboration with scientists at National Root Crops Research Institute Umudike made strong efforts towards addressing most of the pressing challenges facing sweet potato seed systems development in Nigeria. At least 10 decentralized vine multipliers have been established in various locations in Osun, Kano, and Abia states. This is in addition to training over 500 farmers across Nigeria on the available technologies and best agronomic practices in sweet potato seed production. This vine multipliers source their pathogen tested planting material from the screen house of NRCRI Umudike which produces the pre basic seed (foundation seed according to National agricultural seed decree of 1992) and multiply in their various locations using the net tunnel technology. Other notable achievements of this intervention By CIP includes:

- Cleaning up of the two released orange fleshed sweet potato varieties from CIP facility in Ghana and Kenya
- Establishment of net tunnels and screen houses in Umudike, Kano and Osun
- Established rapid multiplication of vines in Umudike, Kano and Osun in Net tunnels
- Engaged partners in Kano, Osun and Abia (Ehealth Africa, Kolping society of Nigeria and Bayero University Kano) to facilitate the production of sweet potato quality seed
- Established pre-basic seeds in the screen house in Umudike and Osun
- Built capacity of personnel in Tissue Culture and Screen house management
- Established business model for the production of pre-basic seeds
- Establishing the revolving funds for sustainable production of pre-basic seed
- Developed standard protocol for sweet potato seed inspection and certification which is awaiting approval by NASC.
- Training and retraining of decentralized vine multipliers and community seed inspectors
- Continuous hosting of sweet potato stakeholders to address some challenges facing sweet potato root and vine production as well as marketing
- Training of farmers across Nigeria on available technologies for sweet potato seed production

The intervention by CIP was designed in such a way that production of prebasic seed will be sustained at the end of the project by making use of the revolving fund where the proceeds from the the sale of prebasic seed are ploughed into. This is to overcome the limitations of poor funding .The fund should be able to the take care of the allowances of the personnel working in the screen house and other logistics needed for sustainable production.

Challenges

The existing sweet potato seed system in Nigeria faces a lot of challenges even though a lot have been done to strengthen it. The Nigerian governments have not adequately addressed the question of providing farmers with access to good quality sweet potato planting material, particularly of the modern varieties. According to USAID (2016) the most common problem facing the Early generation seed (EGS) systems in Nigeria is insufficient financial and technical support from the government to the NARIs, as well as Government's failure to educate farmers about improved varieties The intervention by CIP focuses more on the orange fleshed sweet potato but majority of the sweet potato farmers are producing local landraces available in their locations which they prefer for one reason or the other. Despite the level of training given to the Decentralized vine multipliers (DVMs), some of them still engage in recycling of planting materials thereby multiplying and distributing poor quality planting materials. Major seed companies in Nigeria focus much attention and energy in the production of grain crops and are not yet interested in vegetatively propagated crops like sweet potato. Also the information on protocol for certifying vegetatively propagated crops is still not much available. Farmers' lack of awareness of the benefits of planting improved varieties as well as demand and supply issues also affect the availability, quality, and best practices necessary to produce and deliver quality sweet potato seed in Nigeria.

Highlights of some Available technologies for sweet potato seed production

The net tunnel technology

The net tunnel technology is a product of intensive research by the international potato center (CIP) and partners on the best way to protect sweet potato planting materials from insect vectors such as whiteflies and aphids which transmit sweet potato virus diseases (SPVD). According to Ogero *et al* (2017) the technology can be successfully used by better resourced and trained farmers to maintain and produce high quality basic seed for two to three years. However, the use of this technology is more preferable in high virus pressure areas. The sweet potato quality seed production unit of NRCRI Umudike have trained sweet potato farmers across Nigeria (especially the decentralized vine multipliers) on this technology and is helping to reduce the high rate of recycling of diseased vines in Nigeria.

The net tunnel can be constructed using locally available materials such as

- elastic wooden materials or PVC pipes
- Binding wire or Sisal twine
- Optinet etc.


Pix 1: Harvesting inside the net tunnel pix 2: the net tunnel with sweet potato growing inside

The Triple "S" technology

Triple S stands for Sand, Storage and Sprouting which is the three main steps for using stored sweet potato roots to conserve planting materials during the dry season. Triple S involves a farmer selecting healthy undamaged sweet potato roots at harvest time, and storing them in layers of dry sand in an old basin lined with a piece of newspaper for the duration of the dry season. The stored roots need to be inspected monthly, and then 6-8 weeks before the rains start, planted out into a root-bed and watered twice a week. (Stathers et al 2017). In Nigeria, this technology can easily be adopted by farmers in the north because of the prolonged dry season experienced in the area. However, it is widely used by most sweet potato farmers in Nigeria. Materials required for this technology are;

- Old newspapers

- Small to medium sized healthy storage roots
- Plastic basin
- Dry and coarse sand
- Watering can
- Pegs, fork etc

Pix 1; already set up triple S technology

Pix 2; Sweet potato farmer with an already set up triple S

Rapid multiplication technique (Vine minisett)

The rapid multiplication technology involves planting of sweet potato vine cuttings in a slightly raised seed bed (1 x 5m). The standard measurement is 50 cm between beds, with a spacing of 10 cm between plants and 20 cm between rows. This has been recommended to allow for ease of management for planting, weeding, irrigation, and harvesting. Multiplication rates using RMTs can be 1:30–1:50 after 4 months with good fertilization and management ((Stathers et al. 2013). Single, two or three node cuttings can be used depending on the choice and expertise of the farmer. The cuttings are first dipped in fungicides for 30 minutes to prevent disease transmission before planting. Small to medium sized roots can also be used for this technology but at a spacing of 5-10cm and 5cm depth and mulched to promote sprouting.

Conclusion

Sweet potato is not just emerging as a food security crop in Nigeria but also as a source of income to farmers. Functional sweet potato seed system remains the key to good yield and therefore should not be neglected by any government or donor agencies. Development of functional seed system for sweet potato will bring an improvement in the value chain from seed system to value addition.

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Rice grain quality and consumers preference in Lavun and Paikoro local government areas of Niger State, Nigeria

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Abstract

The study analyzed the rice grain quality and consumers preference in Lavun and Paikoro Local Government Areas of Niger state, Nigeria. A total of 198 respondents were selected through a multi-stage sampling procedure from the three ward headquarters from each of the local government. Data were collected through structured questionnaire administered to the sampled respondents. Analysis of the data collected was done using descriptive statistics, Logit and multinomial regression models. Results showed that an average respondent was 37 years old, it was revealed from the study that rice consumption and purchase, was dominated by women in the study area. This implies that the actual purchase of rice is done mostly by women. The current study revealed that knowledge and awareness level among the surveyed consumers about local rice was adequate but the level of satisfaction with the quality was low. The study is therefore of the view that advertising and packaging of rice products, should be done to appeal to the emerging customers. The empirical results from the study shows that consumer choice of rice was influenced by certain quality attributes, and consumers were willing to pay for those desirable attributes. Food safety, aroma and long grain were the quality characteristics that most consumers preferred. It was recommended that government through relevant agencies should develop appropriate policies and strategies to promote the commercialization of smallholder agriculture in Niger State and farmers should effectively make worthwhile the efforts of government and other stakeholders to form and maintain effective farmer groups to take advantage of credit facilities other financial services offered by microfinance and other financial institutions available in the area. The study concluded that consumer choice of rice is influenced by food safety, aroma and long grain attributes, and consumers were willing to pay for those desirable attributes. Therefore, it is recommended that farmers should produce rice that have these attributes, since these attributes were found to affect market, consumer acceptance and willingness to pay.

Keywords: Rice, Grain, Quality, consumers, Preference

Introduction

Rice belongs to the family "*Gramineae''* and the genus "*Oryza*".Rice is the seed of the grass species *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice). Rice is the most commonly cultivated cereal throughout the world today (Oko and Ugwu, 2010). The African rice is believed to have originated from the wild rice (O. barthii) about 3500 years ago and was domesticated in the inland Delta area of Nigeria from where it spread to other parts of Africa. Rice accounts for over 20% of global calorie intake and has been an important food commodity for most people in Sub-Saharan Africa particularly in the West African region. Driven by changing food preferences in the urban and rural areas and compounded by high population growth rates, rice consumption in sub- Sahara Africa has been growing by 6 percent per annum, more than double population growth rate (African Agriculture Technology Foundation, 2012).

As a cereal grain, it is the most widely consumed staple food for a large part of the world's human population (Dutta, 2014). It is considered as the most important food crop and primary source of food for more than 30 percent of the world population. The planting of rice covers about 146 Million hectares of land annually representing about 11 percent of the world cultivated land (Kassali *et al.*2010). Other cereals of paramount importance include maize, sorghum, wheat and millet. Rice is the fastest growing staple food source in most African countries, providing the bulk of dietary energy to the growing population in most developing countries of Africa, rice accounts for 715kcal/caput/day, 27 percent of nutritional supply of energy, 20 percent of nutritional protein and 3 percent of nutritional fat (Kassali *et al* 2010). Rice is positioned as the 5th most prominent source of energy in diet responsible for about 9 percent of caloric intake (FAOSTAT, 2012). Rice also serves as raw materials for industries. In 2006, paddy rice production in the Sub-Saharan Africa (SSA) was estimated at 14.6 million tonnes. Rice production in Africa grew at 3.23% per annum from 1961 to 2005 (Kassali *et al,* 2010).

Rice is grown in every region in Nigeria including in semi-dry savannah of Middle Belt and the North. Cultivation is largely by small-holder farmers who are also involved in paddy processing by means of small scale mills with average capacity of two tonnes per day. Nigerians consume around 5.5 million tonnes of rice annually, of which about 3.6 million tonnes are produced locally, mostly subsistence farmers while the balance of 1.9 million tonnes is imported. The large size of the rice market in Nigeria, as well as the high duties and costs associated with importing the commodity, makes local production a fundamentally attractive industry (Claude,2011). According to Takele (2010), rice is sold and consume in all parts of the country , including Lavun and Paikoro Local Government Areas.

Rice quality is judged based on attributes, which could be classified several ways. Product characteristics could either be intrinsic, such as taste, texture, or color; or extrinsic to the product, such as packaging, brand, or label. Another attribute classification distinguishes between search, experience, and credence attributes. Search attributes are available for product evaluation before purchase, such as price, appearance, brand, and packaging. Experience attributes can be evaluated only upon product experience, thus after purchase or product use examples are taste, texture, ease of cooking, and swelling capacity. Credence attributes are attributes that consumers cannot evaluate or verify themselves. Instead, they rely on people or institutions, such as government controls or industry claims. Attributes relating to production, processing, and product contents are typical examples of the credence-type attributes. The aim of the study is to study rice grain quality and consumer's preference for foreign and local rice attributes in Lavun and Paikoro local government area of Niger State. The specific objectives to be achieved are to: i. describe the socio-economic characteristics of local and foreign rice consumers in the study area and assess the household willingness-to –pay for various characteristics of rice by income group.

Materials and Method (Methodology)

Study Area

The study was undertaken in two selected Local Government Areas (LGAs) Lavun and Paikoro (LGAs) of Niger State Nigeria. Niger State is located between Latitudes $8^0 22^/$N and $11^0 30^/$N and Longitudes $3^0 30^/$E and $7^0 20^/$E.

Method of Data Collection

Primary data was used for the study. The data was collected using a well-structured questionnaire administered to the respondents by the researcher through multi stage sampling techniques. Information on the socio-economic characteristics of the farmers such as age, gender, marital status, farm size, level of education, average income per month, householdweekly expenditure for food, household weekly expenditure for rice in the study area were the data required for the study.

Analytical Techniques

Combinations of analytical techniques were used to collect data in the study area. These include descriptive statistics and Logit regression was employed to analyze the data elicited from the field. Specifically, Objectives (i) was achieved using descriptive statistics such as frequency distributions and means. Logit regression was also used to achieve objective (ii)

Results and Discussions

Socioeconomic Characteristic of Farmers in the Study Area

The findings from the field survey reveal some personal and household characteristics of the respondents in this study are presented in Table 1. Results in Table 1 shows that greater proportions (74.2%) of respondents were females whiles (25.8 %) were males. This finding may not be unconnected with high female participation in the household work in traditional African household. Gender wise, rice purchase is dominated by female consumers. In a traditional Nigerian household, women (females) are responsible for purchasing and preparing of food. It is the women‘s duty in most African households Nigerian inclusive to take decisions on the types of food that are made available and the forms in which they are prepared for consumption by members of the household (Isife and Emodi,2000). The findings from the pool survey reveal that the mean age of respondents was 37 years with a minimum age of 19 years and a maximum age of 71 years. This implies that most of the respondents are within the working age group, likely to have some disposable income for household expenditure. It was also indicated in the table that majority (81.2%) of the respondents were married while the remaining (18.8%) were single. Cooking remains the exclusive responsibility of women that are married and the preferred food is rice (Basorun, 2008).

The findings on the size of household is determinant of both the amount of food that would be consumed and purchased by the household to a very large extent .The mean household size as shown in table 4.1 was approximately 510persons per household with the minimum household member of 1 and the maximum household members of 10 persons. Earlier studies (Stewart et al., 2004) have suggested that household size and a large number of dependants partly influence food choices. The Respondents stated the highest level of education obtained when answering questionnaires. Result from the table 1 indicates that about (12.6%) have attended, (24.2%) have attended secondary school, (16.1%) have attended tertiary, (19.1%) have attended adult education while, the remaining (28.0%) have attended informal education such as Quaranic school. The findings from the field signify that most of the consumers captured in this study are to some extent educated. Respondent occupation status of the respondents was examined and the findings reveals civil servants workers recorded 20.3% of the respondents, 25.8% of the respondents are into farming and 43.8% were traders respectively. For respondents ‘employment, the categories of employment were divided into four categories. The categories were; the government sector, self-employed, agricultural sector, and others. Respondents working with the government sector recorded 21.2%, 46.8% were from self- employed, 25.2% and 6.8% were working in the agricultural sectors and others respectively. The average monthly income of the survey consumers was indicated in the table as 54,400 Naira, with the minimum monthly income of 18,000 Naira and a maximum monthly income of 150,000 Naira. The results indicate that most of the respondents are probably in a more convenient financial position to buy rice. average respondents indicated that their household spent 12,500 Naira weekly on grocery stores and other food stuffs. On the other hand respondents indicated that their household spent 4000 Naira weekly on rice.

Table 1: Distribution of respondents according to personal and household characteristics

Characteristics	Frequency (n= 198)	Consumers (%)	Mean
Sex			
Male	51	25.8	
Female	147	74.2	
Age			37
Average household size			10
Marital status			
Single	37	18.8	
Married	161	81.2	
Educational level			
Primary	25	12.6	
Secondary	48	24.2	
Tertiary	32	16.1	
Adult education	38	19.1	
Informal education	55	28.0	

Occupation status			
Civil servant	59	30.3	
Farming	50	25.8	
Trading	89	43.9	
Main source of income			
Government	42	21.2	
Self-employed	93	46.8	
Agriculture	50	25.2	
Other	13	6.8	
Average income per month			54,400
Household weekly expenditure for food			12,500
Household weekly expenditure for rice			4000

Source: Field survey, 2020

Marginal willingness to pay estimates

The MWTP as shown in table 3 indicates, for each attribute, the average amount that a person would prepare to pay, indefinitely, for an increase (decrease) of one unit in the attribute level. Result in the table indicates that consumers are willing to pay more for food safety, with an associated MWTP estimated of 3.80. The size of the rice grain (long grain) which has significant utility for consumers is the second most favored attribute, with an associated WTP estimate of 2.64. This empirical result agrees with the studies conducted by Juliano *et al*., (1992) for consumers in Hong Kong which showed that consumers pay high premiums for long grain. This clearly indicates that consumers are more willing to pay for long grain rice than medium grain rice which had an estimated MWTP value of -0.20. This therefore creates opportunity for local rice farmers to produce more long grain rice to attract the needed consumers‘.

The third preferred attribute is aroma with estimated MWTP value of 1.40. This appears to support previous results that consumers generally have a strong preference for aromatic rice. The obtained result is similar to that of Galawat and Yabe (2010) study in Brunei where consumers were willing to pay for this attribute. However, consumers are found not willing to pay for the taste attribute where MWTP estimate showed negative sign (-3.20).

Table 3: Marginal Willingness to Pay (MWTP) estimates from conditional logit model

Attributes	Coefficients	Standard Error	Z-values	P>{z}	MWTP
Taste	-1.60	0.30	-4.56	0.004	- 3.20
Food safety	1.90	0.31	7.24	0.003	3.80
Aroma	0.70	0.30	1.20	0.038	1.40
Long	1.32	0.40	4.13	0.001	2.64
Medium	-0.10	0.35	-0.37	0.687	-0.20
Price	-0.50	0.02	-21.00	0.000	

Source: Author‘s own calculation, 2020

Conclusion and Recommendation

From the findings of this study, it was conclude that consumer choice of rice is influenced by food safety, aroma and long grain attributes, and consumers were willing to pay for those desirable attributes. Therefore, it is recommended that farmers should produce rice that have these attributes, since these attributes were found to affect market, consumer acceptance and willingness to pay. Also private sector should invest in modern processing facilities for local rice this would place the commodity in a better position when compared with imported rice commodity. This will encourage local rice consumption and also afford the farmers a good price for the local commodity being produced.

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Challenges and Coping Strategies of Fish Sellers in the COVID-19 Pandemic: A Study of Iddo and Boundary Markets in Lagos State, Nigeria.

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Abstract

This study investigated the challenges faced by fish sellers and the coping strategies adopted during the period of COVID- 19 lockdown in Iddo and Boundary fish markets in Lagos State. The study population comprised all the fish sellers in the selected markets. The study adopted the non-experimental research design, and was typically qualitative. The non-probability sampling techniques specifically the purposive and convenience sampling techniques were utilized. While the purposive sampling techniques was adopted in selecting the two markets- (Iddo and Boundary fish markets in Lagos Main Land and Ajeromi Ifelodun LGA respectively). Convenience sampling techniques was used to select a sample size of 40 participants in the study. Data collection was through In-Depth Interview (IDI) with semi-structured interview guide. Data collected were analysed using manual content analysis. The finding reveals that the major challenges faced by the fish sellers during the period included lack of customers, lack of preservation facilities, high cost of transportation, difficulty in complying with the COVID- 19 safety protocols and extortion from the security personnel. However, in order to survive in their business, they used paid security escorts and had to pay their way through at security check points to avoid harassment. They also used mobile phone to reach out to their customers while some of them hired some people to help dry and preserve their unsold stocks. The study recommends improved basic infrastructure, and provision of credit facilities and financial empowerment to fish sellers.

KEYWORDS: Fish, Market, Challenges, Sellers, Strategies.

Introduction

World Fish virtually met on Thursday 28th May, 2020 with several representatives from the Nigerian aquaculture community. They included representatives from Catfish and Allied Farmers Association of Nigeria (CAFFAN), *Tilapia* and Aquaculture Developers *Association* of *Nigeria* (TADAN), Fisheries Society of Nigeria (FISON), Nigerian Association of Fisheries Scientists (NAFS), IDIPR Cooperative Farms, fish processors, and corporate sector fish producers and traders. Several issues were brought into the discussion as compelling difficulties currently faced by the aquaculture community.

Most problems faced by fish farmers and processors appear to be centered on the current government-imposed Movement Control Order (MCO) in response to COVID-19. MCO has significantly reduced fish producers’ access to markets. Markets are not open throughout the week for fish sales and access to production inputs, such as feeds, fingerlings, and feed ingredients has also become limited. Consequently, transport costs have gone up significantly and long delays are experienced at checkpoints.

Reduced market access delays harvest resulting prolonged farming cycles. Keeping fish in ponds needs feed and other farm management inputs, requiring additional funds. Farmers are skeptical as to how long they can continue the process with no financial support, and that they will ever be able to sell their produce with profit once the lockdown is lifted. Unfortunately, no good cold-chain facilities exist in Nigerian aquaculture, which prevents possible cold storage during low demand times.

The sudden outbreak of COVID-19 pandemic which originated in China in late 2019 and Nigeria recording her index case on the 27 of February 2020 in Lagos state through an Italian contractor remains an unprecedented shock to humanity and it will take the whole World years to recover from its impacts (Osakwe, 2020). It is an unexpected inconceivable and unbelievable scenario that has shaken the world economy to its fabric. Before this pandemic for the first time in the history of this generation both the formal and informal sectors of the economy in Nigeria were completely lockdown for two weeks in order to control the spread of the COVID-19 pandemic. The closure adversely affected different households in Nigeria, and the artisanal fish sellers in Lagos State are no exception. Unfortunately, fish sellers just like other participants in the informal sector argue that during COVID-19 pandemic lockdown, they were not considered by the government as vulnerable people to benefit from government palliative.

In an attempt to check overcrowding, government gave an order that the opening of market should be shared between food sellers and other commodities sellers three days in a week each.

The Covid-19 safety protocol and lockdown orders exposed the fish sellers, to many challenges ranging from decrease in demand from large-scale buyers, particularly restaurants and hotel operators, party organizers (weddings, burials etc). Other challenges include transportation, preservation, and low consumer demand for fish due to the negative effect of the lockdown on consumers' incomes. However, the fish seller like other food items sellers lamented the consequent hike in transport costs due to rampant extortion of money from them by security operatives on duty at the various check points (The Guardian 22 April 2020, Punch, 18 April 2020). Furthermore, reduced market access delays offshore fishing efforts and delays harvest resulting to scarcity of fish from the fish mongers/merchants who supply to retail sellers. Fish sellers were sad with the hardship caused by the lockdown and skeptical as to how they could continue the process of MCO without financial support, imagining when normalcy would return to their business. Unfortunately, no good cold-chain facilities exist in Nigerian for fish marketers, which prevent possible cold storage and mechanized smoking equipments during low demand times.

Fish consumption accounts for about 45% animal protein consumption in Nigeria. Currently capture fisheries and the various value chain (especially its marketing and distribution) for fisheries and aquaculture productions is a vibrant and dynamic commercial sector in Nigeria, ripe with investment and employment opportunities (Abiodun & Cheke, 2014). Coastal artisanal fish marketing in Nigeria is dominated by females, (Nwezza, 2018).

The COVID-19 lockdown caused disruptions in supply chains for fish and fish products due to difficulties experienced by people in observing the COVID-19 safety lockdown protocols and challenges of transportation, trade and labour. As a result of restriction directive from the government, fish sellers' source of supply has been adversely affected because the fishermen/fish farmers who supplied to them were no longer operating at their full capacity and those sellers who managed to maneuver the security checkpoints usually sold at exorbitant prices. Thereby making the buyers to reduce their demand for fish and making the fish sellers to have a lot of quantity of unsold which can result to losses because of unavailability of storage facilities for them to preserve their unsold fishes in most cases. The fish sellers encountered a lot of difficulties during the period of total lockdown and the period of gradual easing of the lockdown because it was not planned, therefore, they were confronted with the challenges of managing their unsold products to avoid damage as a result of poor preservative facilities for them to preserve their unsold fishes. Even when there was government directive that vehicles carrying food items, drugs and those on essential services should be allowed passage on the road, there were evidence that the security operatives on duties were busy extorting different amount of money from the truck drivers that were conveying these goods to their different destinations. As a result of this extortion the cost of transportation has increased significantly thereby affecting the price of many food items in the skeletal food markets including fish.

This study therefore intends to investigate the challenges and coping strategies adopted by fish sellers during COVID-19 lockdown in Iddo and Boundary in Lagos Main Land and Ajeromi Ifelodun Local Government Areas respectively in Lagos State.

Methodology

This study was a non-experimental and essentially qualitative. The study was conducted between June 5 and August 28, 2020 at the Iddo and Boundary fish markets in Lagos Main Land and Ajeromi Ifelodun Local Government Areas of Lagos State. Lagos State is one of thirty six states in Nigeria located in the South West geopolitical zone of Nigeria. The study relied on mainly on In-Dept Interview (IDI) for data collection. The interviews were conducted in both English and pidgin English to allow both literate and illiterate participants to fully express themselves. Their voices were recorded after obtaining their permission. The recorded voices were later transcribed and quality control was ensured by listening to the audio and comparing with the transcript to ensure that the actual words of the participants were properly captured. The non-probability sampling technique (purposive sampling) was adopted for the selection of 40 study participants (at Iddo Market 25 respondents were selected because of the bigger size of the market while 15 were selected at the Boundary Market). A semi-structured in-depth interview guide was used to elicit data from the participants, and data collected were transcribed. Manual content analysis was adopted in analyzing the data collected (ie quotation of ethnographic field report).In the course of the face to face interview, all the COVID-19 safety protocols were strictly observed- use of face masks, social distancing etc.

Ethical Consideration

Ethical considerations were strictly observed during the field work. In the course of the study confidentiality was ensured and participation was voluntary and based on informed consent of the participants.

Results

Challenges and Coping Strategies of Fish Sellers

The COVID-19 lockdown caused disruptions in supply chains of fish and food items due to several challenges faced by the sellers in the course of doing their business. The study attempted to unravel the challenges faced by fish sellers and the coping strategies they adopted for survival during the lockdown. Responses to probing questions on the challenges revealed that they faced several challenges and adopted different strategies to cope with the challenges in doing their businesses during the period under study. A middle aged female participant revealed that some of the challenges included transportation cost hike and storage of the unsold stock. Hear her:

The money we spend on transportation this period is too much, unlike before, the corona virus has made transportation cost to increase. Despite the federal government directive that the security operatives should allow motors conveying food items to pass, the security operatives extort too much money from the drivers and the drivers normally pass the cost to us (IDI/23/08/20 a female fish seller).

When the participant was probed further on what they did to survive in such circumstances; she responded thus:

Sometimes we pay the security operatives to pass but when we see that it has become too much, we contribute and send one or two people to buy for all of us in our group to reduce the cost (ibid).

A female Business Administration graduate participant stated further:

As a result closure of hotels, bars, restaurants and ban on social gathering by government, most of our main buyers were not coming to the market as before, thereby affecting the quantity of sales and exposing us to loss, because of lack preservation facility to preserve our unsold fish which is highly perishable will either spoil or we sell it at cheap prices (UDI/22/07/20/ a female participant).

An elderly woman who spoke in pidgin disclosed:

This corona virus wahala don too much, fish don cost for where we de buy am and customers no de come market again because of transportation problems wen de road. We go carry our fish come market we no go sell, we go carry am go back. Sometimes we go sell am anyhow or pay people money to help us dry am (IDI/22/07/20/an elderly female respondent)

The above response was complemented by a younger more enlightened pregnant woman. She disclosed thus:

We are tired of this problem of corona virus, since this problem started the cost of transportation has increased as a result of frequent extortions by security operatives from the drivers conveying our goods which they always passed to us , thereby increasing our own selling *price which makes the price to go up. To worsen the situation, due to closure of bars hotels, restaurants and ban on social gathering must of the big customers no longer come to buy from us and this has really negatively affected our sales and profit (IDI/22/07/20/a pregnant respondent).*

On coping strategies, majority of the participants said that they have to meet in groups and engaged the services of security personnel to escort them to market and they usually pay them heavily. Some of them also revealed that instead going separately to buy their fish, they contributed money and sent one or two persons to go and buy for them to enable them reduce cost.

However, while majority of the respondents recounted their losses during the COVID-19 lockdown some said that they made profit in their sales during period because they engaged in delivery services to move their goods to their buyers who used to order for supply via SMS, WHATSAAP and other social media platform which they used in most cases to advertise their available fishes for sale. A female participant disclosed thus:

As am here, as soon as I get my delivery, my children help me to distribute them to some of my customers that have contacted me on phone and WHATSAP to give them specific qualities and quantities .Some even paid in advance. In fact, sometimes I don't bother to come here because after distribution, there might be nothing to come to market to sell. This COVID- 19 has opened my eyes to the importance of social media to business (IDI/23/07/20/a middle aged female participant).

Discussion of Findings

Fish selling is one of the main businesses in the informal sector that require little capital to start off. The business has employed a reasonable number of people both men males and females and has remained their major source of income for their daily survival. Just like other business, the fish sellers also had their own share of the negative impact of the COVID-19 lockdown.

Findings from the study revealed that fish sellers faced different problems ranging from high cost of transportation, extortion from security operative on duty, difficulty in observing the COVID-19 safety protocols, low sales as a result of the Movement Control Order (MCO) which hinders the movement people that will patronize them and lack of preservative facilities for them to preserve their unsold stocks.

On coping strategies the findings revealed that fish sellers had to illegally engage the services of some security personnel who escort them to the market to enable them have an easy passage at the various security check points or sometimes they contribute money for one or two persons to go and buy for them.

Conclusion

This study investigated the challenges and the coping strategies of fish sellers in the study areas during the covid-19 lockdown with the aim of understanding the true situation of their business during the time mentioned with a view to clarifying certain opinions that during the period that fish sellers and food sellers in general were having a free day and making a lot of money as a result of boom they were witnessing.

Recommendations

In view of the foregoing, the study presents the following recommendations as a way of mitigating such problems in the future.

1. The security operatives should be reoriented to understand that their duties are render service to humanity; therefore such emergency situation like covid-19 should not be an avenue to make money or to illegally enrich their pockets.

2. In view of the hike in the cost of transportation, government should make effort in providing mass transit vehicles with subsided fare which will ameliorate human suffering especially in the time of economic shock like covid-19 time.

3. Government should provide both credit and preservative facilities for fish sellers to encourage them sustain their business.

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EFFECT OF ADOPTION OF PROCESSING/UTILIZATION OF GINGER TECHNOLOGIES ON THE LIVELIHOOD OF RURAL WOMEN IN AGUATA AGRICULTURAL ZONE, ANAMBRA STATE, NIGERIA

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Abstract

The study assessed the effect of doption of processing/utilization of Ginger technologies on Rural Women Livelihood in Aguata Agricultural Zone of Anambra State, Nigeria; after participation during the National Root Crops Research Institute (NRCRI), Umudike on Root and Tuber Crops training programme. Twenty-four women Ginger value addition trainees were purposively selected from each of the five towns/communities bringing the sample size to 120 respondents. The analytical techniques used to test and analyze the data were descriptive statistics (mean, percentage and frequency). In comparing the difference between the trainees' incomes before and after the training, Paired Sample Z-Test was used. The major findings revealed that the level of adoption of processing/utilization of GINVAT for medicine to Ward-off Germs/Virus in Human Body when mixed with Lemon and Honey, GINVAT V had the highest level of adoption in percentage (56.60), followed by processing the ginger into Powder for Flavouring, GINVAT I (43.60), and Industrial Food/Confectionery, GINVAT II (39.00), and other cooefficient for GINVAT 1 – 5, were positive and significantly related to all the technologies, at 1% probability level. Also, the Paired Samples Test Income of the Trainees revealed that the difference between the rural women trainees income (N1,024,542.65 per annum) was greater after the training than their income (N241,411.32) before the training intervention by NRCRI, Umudike, with a difference (profit) of N753,121.23 per annum. It was recommended that government should ensure regular electricity supply to enhance the rural women farmers empowerment; release more funds for further Ginger Value Addition Technology training programme to cover more rural communities for improved well being, and

reduce the effects of post-harvest losses The researcher further recommended that food processing industries should be established, while more agricultural engineers should be trained to manufacture food processing machines in Nigeria.

Keywords: Ginger Technologies, Adoption and Farmers' Livelihoods

Introduction

Ginger *(Zingiber Officinate)*, is an indispensable economic crop which constitutes the major staple food items of some 58 per cent of Nigerians (Nwaogu, 2010). The crop plays a crucial role in the sociological, nutritional and economic development of the country (Amadi, 2016). The farmers still use the traditional tools to process ginger due to lack of modern ginger processing equipment. They have not been enjoying good pricing of the Ginger crop (NRCRI Annual Report, 2016). This was due to post-harvest losses, and there was little or no processing of this crop to make it valuable. Hence, farmers' earnings were not commensurate with the efforts they put in the ginger production. In an effort to guide against poor earnings and encourage people to produce and eat ginger (Aniedu, 2013), the Federal Government of Nigeria released funds for a Training Programme of the Rural Women on the Root and Tuber Crops Value Addition Technologies by the (NRCRI), Umudike. The purpose of which is to promote the new and improved forms of processing, utilization and packaging of the agricultural crops for sustainable food production, income generation, increased source of medicine for arthritis, female menstrual pains, rheumatic diseases, and possible foreign exchange earnings in the country (Oti, 2011).

Ginger (*Zingiber Officinate*) is consumed in different forms. It can be consumed fresh, processed into powder as spices, tea, drinks to reduce weight, treatment of skin irritation and industrial food flavouring/confectionery (Amamgbo, 2010).. Ginger juice is mixed with lemon juice and honey, which is then sipped slowly for treatment of varieties of health conditions, as remedy to ward-off germs/virus in human body. Hence it has high export value (Wikipaedia). Ginger is part of the mandate crop of (NRCRI), Umudike, from which several value added technologies have been developed by the Institute. This is aimed at addressing the high perishability of ginger and diversification of its use (NRCRI Annual Report, 2016). These technologies make it possible for an array of secondary products like the spices, ginger juice, tea/drinks to reduce human body weight, industrial food flavouring/confectionery and medicine etc., derived from ginger. Its leaves are used in weaving marts and local fans (FAO, 2010). All the practices involved in diversifying the processing, utilization and packaging of Ginger crop are termed value addition technologies (Asumugha, 2003). The challenges of meeting the rapidly growing food needs of the masses cannot be successfully overcome without harnessing the abundant knowledge and capacity in extension services (Nwachukwu and Kanu, 2011). Hence the crucial need to make the root crop products available in more widely and readily usable forms (Chinaka, 2017). This informed the study on the effect of adoption of utilization of ginger technologies on the livelihood of the beneficiaries.

Methodology

The study was conducted in five towns/Communities, namely: Igbo-ukwu, Isuofia, Uga, Umuchu, and Oraeri, in Aguata Local Government Area, Anambra State of Nigeria. Anambra State is in the South Eastern part of Nigeria, divided into four Agricultural Zones: Aguata, Anambra, Awka and Onitsha (ASADEP 2003). Aguata is one of the 21 Local Government Areas as well as one out of the four Agricultural Zones in Anambra State, comprising 14 town/communities (Asiedu, 2007). The main food crops grown are yam, cassava, ginger, rice, cocoyam and maize while the cash crops include oil-palm, banana etc. From the ADP Extension Agent supervising the survey in Aguata LGA, the list of trained women ginger farmers was obtained. Five Communities namely: Igbo-ukwu, Isuofia, Uga, Umuchu and Oraeri were purposively selected as a result of their involvement in ginger production This supports the proposition that women tend to experience increased work participation more in times of food crisis, so as to explore other opportunities for earning extra income for sustenance of their household (Ekwe, 2011). Twenty four ginger value addition trainees were purposively selected from each of the five Communities making a total of one hundred and twenty respondents as sample size for the study. The analytical techniques used to test and analyze the data were descriptive statistics (mean, percentage and frequency) and. In comparing the difference between the trainees' incomes before and after the training, Paired Samples Test. Knowledgeable Agricultural Development Project (ADP) Agents were engaged to facilitate accuracy of data collection. Both primary and secondary data were used for the study.

Analytical Techniques

The analytical tools used were descriptive statistics such as mean, frequency, percentages and Z test.

$$Z_{cal} = \frac{X_1 - X_2}{\sqrt{\frac{S^2X_1}{n_1 -} + \frac{S^2X_2}{n_2 -}}}$$

Where,

X_{ij} = mean income before intervention (adoption) (measured in Naira)

X_j = mean income after intervention (adoption) (measured in Naira)

S^2X_i= variance of mean income before intervention measured in Naira

S^2X_j= variance of mean income after intervention measured in Naira

n_i= number of respondents sampled before intervention

n_j= number of respondents sampled after intervention

Results and Discussion

Table 1 revealed that majority (47%) of the respondents attended secondary education. According to Ibe (2013), educated farmers are expected to be more receptive to improved techniques while farmers with little or no education are less receptive to improved technologies. About 75% of the beneficiaries were full time farmers. This supports Asumugha (2003) who observed that full-time farmers tend to be less amenable to income diversification than their part-time counterparts. Majority (52%) of the respondents had large family sizes of 9-12 persons. This is in line with the perception of **Ikeorgu,** (2011) who posited that large family size necessitated respondents to learn new technologies for increasing their returns, to sustain their families. About 47% of the respondents had income ranging from N800,000 - N10,297,899 per annum, 58% of them had farming experience ranging from 21 – 30 years. (Okoye, 2009) propounded that experience is a major factor in the adoption of technologies and should serve as an advantage for increased investment and technology utilization. Majority (68%) of the respondents were married. This must be, not only to boost food production but also to argument their family income, as mothers and home makers. The result in Table 2 shows that the trainees major constraints are lack of electricity supply, lack of transport facilities, dearth of value added products processing materials, and inadequate funding. Table 3 shows the distribution of Trainees by Adoption Level in percentage. It was observed that processing ginger for medicine to Ward-off Germs/Virus in Human Body when mixed with Lemon and Honey, GINVAT V had the highest level of adoption (56.60), followed by processing the ginger into Powder for Flavouring, GINVAT I (43.60), and Industrial Food/Confectionery, GINVAT II (39.00), among the five new ginger technologies.Table 4 shows the Paired Samples Test Income of the Trainees and revealed that the difference between the rural women trainees income (N1,024,542.65 per annum) was greater after the training than their income (N241,411.32) before the training by NRCRI, Umudike with a difference (profit) of N753,121.23 per annum which was highly significant at 1% leve/.

Conclusion

The research showed that GINVAT is viable, having recorded higher income per annum after the beneficiaries agro-business, than their income before they embarked on the GINVAT venture. Therefore, it was concluded that GINVAT training programme by the National Root Crops Research Institute, Umudike had positive effect on the beneficiaries' adoption/utilization level and their livelihood. Farmers should be encouraged to acquire basic education so as to enhance their productivity. Lack of electricity supply constrained the GINVAT agro-business. Extension agents should increase their visits to the rural women farmers to enhance their access to information on the GINVAT. **G**INVAT should be adequately funded and replicated by government to National Root Crops Research Institute, Umudike, to cover more rural communities for improved well being of the rural women, and reduce the effects of storage losses. The Youth should be encouraged to embark on this agro-business, thereby creating employment opportunities for themselves. Government should ensure regular electricity supply to enhance the youth and the rural women farmers empowerment. The researchers further recommended that food processing industries should be established, while more agricultural engineers should be trained and employed in Agricultural Sectors of the economy to manufacture food processing machines in Nigeria. This will not only boost food production in Nigeria, but it will also create more job opportunities and increase foreign exchange earnings in the country.

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Table 1. Distribution of socio-economic profile of the respondents (n = 120)

Variables	**Trainee (GLS Before Intervention)**		**Trainee (GLS After Intervention)**	
Age (years)	Frequency	Percentage	Frequency	Percentage
25-34	7	5.00	5	4.00
35-44	25	21.00	20	16.00
45-54	52	44.00	58	48.00
55-64	36	30.00	37	32.00
Education (years)				
No. Formal Education	25	21.00	8	6.00
Primary Education	45	37.00	55	46.00
Secondary Education	50	42.00	57	48.00
Occupation				
Full time farming	64	53.00	75	62.00
Part time farming	56	47.00	45	38.00
Family Size				
1 – 4	52	43.00	15	13.00
5 – 8	28	23.00	42	35.00
9 – 12	40	34.00	63	52.00
Income (Naira)				

400,000 – 699,489	4	3.00	3	2.00
600,000 – 859,969	26	30.00	10	9.00
800,000 – 10,297,899	55	46.00	57	47.00
900,000 - 12,919,909	35	29.00	50	42.00
Experience (years)				
1 – 10	5	4.00	9	7.00
11 – 20	36	30.00	21	18.00
21 – 30	55	46.00	57	47.00
31 – 40	24	20.00	33	28.00
Marital Status				
Married	76	64.00	81	68.00
Single	44	37.00	39	32.00
Membership of Coopve.				
None	67	55.00	80	67.00
Cooperative Group	53	45.00	40	33.00

Source: Field Survey (2019)

Table 2: Problems encountered by trainees before and after NRCRI Intervention(n = 120)

Constraint	**Mean Score of Trainees (After)**	**Mean Score of Trainees (Before)**
Lack of Electricity Supply	4.01	2.71*
Fuel Scarcity	2.21	2.32
Marketing of Products	2.04	2.31
Crop rot	1.14	1.73
Lack of transport facilities	3.91*	3.25*
Inadequate value addition facilities	3.14*	3.43*
Inadequate funds/funding	4.50	4.71*

Source: Field Survey (2019) ***Severe constraint ≥ 2.6**

Table 3: Distribution of Trainees by Level of Adoption of GINVAT (AIETA) (n = 120)

Adoption Level of Technology	Aware	Inter-rest	Effect	Trial	Adoption	Adoption Score
GINVAT I (Powder for Flavouring of Beverages)	23	58	58	43	36	43.60*
GINVAT II (Industrial Food Confectionery)	14	43	44	57	37	39.00
GINVAT III (Tea/Drinks to Reduce Human Body	10	59	48	39	36	38.20

Weight)						
GINVAT IV (Treatment of Arthritic and Menstrual pains)	28	38	30	16	10	24.40
GINAT V (Remedy to Ward-off Germs/Virus in Human Body when mixed with Lemon and Honey)	11	29	63	57	73	56.60*

Source: Field Survey (2019)

Table 4: Paired samples test incomes of trainees (Before) and (After) GINVAT Training (n = 120)

Variables Mean (Per Annum)	Paired 95% Confidence Interval of the Difference Lower	Mean Upper
Trainees' Income After GINVAT N1,024,542.65**	N753,121.23	N21,010.01
Trainees' Income Before GINVAT N251,411.42		

**P $\leq$ 0.05

Source: Field Survey (2019)

EFFECT OF LEVEL OF ADOPTION OF TURMERIC VALUE ADDITION TECHNOLOGIES ON LIVELIHOOD OF RURAL WOMEN IN NKANU EAST LOCAL GOVERNMENT AREA, ENUGU STATE, NIGERIA

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Abstract

The research study assessed the effect of adoption of Turmeric (Curcuma long L) value added products on Rural Women Livelihood in Nkanu East Local Government Area (LGA) of Enugu State, Nigeria. The analytical techniques used to test and analyze the data were descriptive statistics (mean, percentage and frequency) and Paired Sample Z-Test The major findings revealed that the level of adoption of the Technologies of processing into Food Flavouring and Colouring for Confectioneries had the highest percentage adoption score of (43.20), followed by Medicine for Treatment of Viruses/Diseases (41.20). The mean income of the trainees after adoption was N1,360,840.32, while the trainees income before was N600,720.00 with a paired mean (difference) of N760,120.32, which was highly significant at 1% level. Given that the variables were significant at 1% level of probability, it shows that there is significant difference between their incomes. It was recommended that the intervention on the Turmeric Value Addition Technology be adequately funded and replicated by government to cover more rural communities for improved well being, and reduce the effects of post-harvest losses. It was further recommended that the more rural women be encouraged to embark on production and processing of turmeric, and that food processing industries should be established, while more agricultural engineers should be trained to manufacture food processing machines in Nigeria.

Keywords: Level of Adption, Turmeric, Technologies and Value addition

Introduction

Turmeric is an indispensable crop being used as food flavouring and colouring for confectioneries, as well as medicine for treatment of viruses/diseases in human body. The crop plays a crucial role in the sociological, nutritional and economic development of the country (NRCRI Annual Report, 2016). Turmeric as an economic important Rhizome, has been in existence in Nigeria for many decades, and farmers have not been enjoying good pricing of the crop. This was due to post-harvest losses, and there was little or no processing of this crop to make it valuable (Akidi, 2012). Hence, farmer's earnings were not commensurate with the efforts they put in turmeric production. In an effort to guide against poor earnings and encourage people to eat turmeric (Aniedu, 2013). The Federal Government of Nigerian released funds for a Training Programme of training the Rural Women on the Root and Tuber Crops Value Addition Technologies. The purpose of which is to promote the new and improved forms of processing, utilization and packaging of the crops for sustainable food production, income generation, increased source of medicine for cancer and heart disease patients and possible foreign exchange earnings in the country (Asumugha and Amamgbo, 2003).Turmeric *(Curcuma long L)* is consumed in different forms. Turmeric known as golden spice, can be processed into Curry powder, Antiseptic spice, Cosmetics, Medicine for Treatment of Viruses/Diseases in human body, Food Colouring and Flavouring for Confectioneries (such as doughnuts, chin-chin, and cakes). Turmeric as industrial crop for production of medicines has high value for foreign exchange earnings (Amamgbo, 2010). Turmeric as part of the mandate crop of National Root Crops Research Institute (NRCRI), Umudike, Nigeria has become the fourth largest world's producer of Turmeric with about 3% of the global annual production. National Root Crops Research Institute (NRCRI), Umudike recently developed several Turmeric value added technologies aimed at addressing the high perishability of Turmeric, as well as diversifying its uses. These technologies make it possible for an array of secondary products like Biscuits, Cakes, Chin etc., to be derived from of Turmeric Powder (NRCRI Annual Report, 2016). Through the various processing, utilization and packages techniques, alternative uses of Turmeric has resulted in the emergence of wide array of food recipes through value addition (Annual Report, 2017). All the practices involved in diversifying the processing and utilization of Turmeric tubers are termed value addition technologies. According to Obinne (2012), the need to enhance income earnings for the rural development, and rising demand for the economic important rhizomes emerged making the crops products available in more widely and readily usable forms. This informed the study on impact assessment of Turmeric Value Addition Training Programme on the livelihood of the beneficiaries.

Methodology

The study was conducted in five Communities namely: Oruku, Owoh, Amagunze, Akpawfu and Ugbakwa in Nkanu East Local Government Area, Enugu State in the South Eastern part of Nigeria.

Nkanu East is one of the 17 Local Government Areas in Enugu State with about a population of 148,774. It occupies up to 307 square kilometers and bordering Ebonyi State to the East (Onoja, 2003). Enugu State has a fertile soil for Turmeric production and other farm activities (F.A.O., 2013). Nkanu East was purposively selected because, it has a vast land and a major turmeric producing area in the State; and it is where the technologies had been transferred. From the ADP Extension Agent supervising the survey, the list of trained women turmeric farmers was obtained. The five Communities in Nkanu East LGA were purposively selected as a result of their involvement in Turmeric production. Twenty four turmeric value addition trainees were purposively selected from each of the five Communities making a total of one hundred and twenty respondents as sample size for the study. The analytical techniques used to test and analyze the data were descriptive (mean, percentage and frequency and inferential statistics. In comparing the difference between the trainees' incomes before and after the training, Paired Sample Z-Test was used. The five step adoption model (AIETA) was used to assess the Ievel of adoption of the five Value Addition technologies by the beneficiaries in the study area.

Analytical Techniques

The analytical tools used were descriptive statistics such as mean, frequency, tables and percentages and Z-test specified thus;

$$Z_{cal} = \frac{X_1 - X_2}{\sqrt{\frac{S^2 X_1}{n_1 -} + \frac{S^2 X_2}{n_2 -}}}$$

Where,

X_{ij} = mean income before adoption

X_j = mean income after adoption

S^2X_i= variance of mean income before adoption

S^2X_j= variance of mean income after adoption

n_i= number of respondents sampled before adoption

n_j= number of respondents sampled after adoption

Results and Discussion

The result in Table 1 on the trainee's constraints revealed that their major problems are inadequate funding, lack of transport facilities, lack of electricity supply, and lack of value added products processing materials. Table 2 shows the distribution of Trainees by Adoption Level, it was observed that processing Turmeric into Food Flavoring for Confectioneries had the highest adoption score (43.20), followed by Food Colouring (41.20) among the five new Turmeric technologies. Important constraints militating adoption include: lack of electricity supply, transport and value addition facilities and income (Table 3). Table 4 showed that the difference between the rural women trainees incomes (N1,360,840.32 per annum) were greater after the training than their incomes (N600,720.00 per annum) before the training intervention by NRCRI, Umudike. This was highly significant at 1% level.

Conclusion

Results show a significant difference between level of income before and after adoption of turmeric value added products in the study area. It was recommended that the TVAT be adequately funded and replicated by government to cover more rural communities for improved well being, and reduce the effects of losses. It was further recommended that food processing industries should be established, while more agricultural engineers should be trained to manufacture food processing machines in Nigeria.

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Table 1: Problems encountered by trainees before and after NRCRI Intervention

Constraint	**Mean Score of Trainees (After)**	**Mean Score of Trainees (Before)**
Lack of Electricity Supply	1.20	2.84*
Fuel Scarcity	2.22	1.12
Marketing of Products	2.35	2.23
Crop rot	1.26	1.21
Lack of transport facilities	2.61*	3.62*

Inadequate value addition facilities	3.61*	2.63*
Inadequate funds/funding	2.11	4.51*

*Severe constraint ≥ 2.5

Source: Field Survey (2020)

Table 2: Level of adoption of Processing/Utilization of Turmeric value added products in the study area

Adoption Level of Technology	Aware	Inter-rest	Effect	Trial	Adoption	Adoption Score
TVAT I (Curry Powder)	11	35	31	33	16	25.00*
TVAT II (Food Flavouring)	-	19	75	51	68	43.20
TVAT III (Food Colouring)	-	17	73	49	66	41.20*
TVAT IV (Cosmetics)	23	35	25	98	-	18.60
TVAT V (Treatment of Viruses/Diseases)	-	36	**48**	48	25	32.40*

Source: Field Survey (2020)

Table 3: Paired samples test incomes of trainees Before and After TVAT (n = 120)

			95% Confidence Interval of the Difference	
		Paired		

Variables	Mean	Mean	Lower	Upper
Trainees' Income Per Annum (p.a.) After TVAT	N1,360,840.32	272,168.10	N760,120.32	17,233.43
Trainees' Income Per Annum Before TVAT	N600,720.00			

**P $\leq$ 0.05

Source: Field Survey (2020)

Effects of household poverty status on amount spent on food in Atiba Local Government Area of Oyo State.

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Abstract

The study was conducted to focus on the effects of poverty status on amount spent on food in Atiba Local Government Area of Oyo State. An interview guide was used to elicit information from the 80 households in the study area. The study reveals that the majority of the respondents were male and married. The mean age of the respondent is 40 years meaning that there should be higher demand of food spent based on the family setting. The result of the regression shows that (64.63%) of the explanatory variables (sex, household size, nature of household, education level and major occupation) are responsible for amount spent on food by household while other variables (35.37%) are due to error.

Keywords: Household, poverty status and food

Introduction

The global food crisis of mid-2000s resulted in a several-fold increase in the prices of essential food items. Resultantly, the incidence of food insecurity, hunger, and poverty has increased in many developing countries Andreyeva, *et al.* (2010). . Consequently, nearly half of the population is currently unable to meet its minimum (subsistence) caloric requirements for healthy and productive living [Malik, *et al.* (2014)]. A large proportion of household expenditure is spent on food (on average about 48 percent in 2010) and thus very little is left for the other expenditures necessary for human welfare, such as, health and education. Moreover. nearly 70 percent of food expenditure is on cereals, dairy, sweeteners, and fats.. Existing analyses indicate that these price shocks entail significant additional expenditures to maintain their pre-crisis consumption levels [Haq, *et al*. (2008); Friedman, Hong, and Xiaohui (2011)]. There is thus overwhelming evidence that rising food prices and the decline in real wages have serious implications for poverty, food security, and nutrition through food consumption patterns in the country. In Pakistan, several studies have examined the effect of price change on consumption patterns during the last four decades [Siddiqui (1982); Burney and Khan (1991); Malik and Sarwar (1993); Burki (1997); Farooq, *et al*. (1999); Shamim and Ahmad (2007); Haq, *et al*. (2008, 2011)]. However, the analysis in these studies is based mostly on the data collected before the food price hike (i.e., before 2008). Some post- price-crisis studies, for example, Haq (2008, 2011) and Friedman, Hong and Xiaohui (2011), provide useful information on the impact of food price crisis on the welfare of Pakistan‘s population..

Global trends suggest that food prices will increase year on year and thus affect the welfare of households. According to Attanasio et al. (2013:136), the considerable rise in global food prices over the last decade has concerning effects on the welfare of poorer households. The instability caused by price hikes is not a short-term problem and can have a lasting effect on poverty. Whether the consumers are poor or wealthy, the amount and quality of a consumer’s food basket depend on its affordability, related to the consumer income. South African households depend on household income for consumption. According to Ssebagala (2016:1), rising living costs have caused South African households to focus more on utilisation of income for consumption expenditure instead of savings. Survey data have indicated that South African household consumption expenditure was recorded at an average of R16 122 per month (Statistics South Africa 2016:177). Against this global crises on food prices that research examined the relationship between food prices and poverty status of the respondents in the study area and describe the socio-economic characteristics of the respondent in the study area and investigate the relationship between food prices and household welfare in the study area.

Methodology

Atiba Local Government is one of the 33 local Government area in Oyo state, Southwest of Nigeria. It has it headquarter located at Ofa meta and it is made up of towns and villages like Abolupe, Afonja, Alusekere, Gbanta, ijawaya, Olugbile and Sangolokeke. The population of Atiba is estimated at 121,180 (NPC 2006). Data was collected through the administration of questionnaire Also 70% was chosen from high density area while 30% from medium density area in each neighborhood making the total of 80.

Ordinary least square (OLS) was used to determine the effect of household poverty status on amount spent on food and the model is specified as:

$Y= b_0+b_1X_1+ b_2X_2 + b_3X_3 + b_4X_4 +b_5X_5 +b_6X_6 +b_7X_7 +U$

X_1= Ages in years ,X_2= SexX_3= Marital status X_4= Nature of householX_5= Size of household X_6= Education level

X_7= Major occupation b_0= Constant b_1- b_7= Coefficient to be estimated U= error term

Results and Discussion

The table 1 below shows the information on the socio-economic characteristics of the respondent in the study area

The result reveals that majority of the respondents fall between the age of 41-60years while the mean age is 40 years. This is an indication to produce and to purchase food for their need .The percentage of male to female is wide it was observed that male(68.75%) while 31.25% accounted for female distribution, this is an indication that there is no gender discrimination. Also the results of marital status revealed that majority (75.25%)while the remaining 24.75% were distributed among single ,divorce ,widow and separated respectively .The size of household is function of food demand. Jacobs (2009:413) suggests that the poorer households cope with rising food prices by reducing their purchases of food items and changing their consumption behavior, which could change a household's status from one that is food secure to one that is not. Results of education level shows that 48.75% had tertiary education ,this implies that majority of the respondents in the study area were educated. Education according to Shaikh (2007), enhance individual's capacity to process and apply the information passed on them while FAO (2012) posited that lower education levels hinders access to livelihood activities and reduce the ability of the individual to manage his/her enterprise adequately.

Table 1: The table below shows the socio-economic characteristics of the respondents in the study area.

Variables	Frequency	Percentage	Mean
Age			
0-20	1	1.25	

21-40	26	32.50	40
41-60	37	46.25	
60 & above	16	20.00	
Sex			
Male	55	68.75	
Female	25	31.25	
Marital status			
Single	12	15.00	
Married	57	71.25	
Divorced	4	5.00	
Widow	5	6.25	
Separated	2	2.50	
Nature of household			
Monogamy	56	70.00	
Polygamy	24	100.00	
Size of household			
0-5	53	66.25	4
6-10	23	28.75	
10 & above			
	4	5.00	
Religion			
Christianity	34	42.50	
Islam	31	38.75	
Traditional worshipper	39	43.75	

Education level		
Primary education	4	5.00
Secondary education	31	38.75
Tertiary education	39	48.75
No formal education	6	7.50

Source: Field Survey 2019

Level of Income and information on feeding satisfaction

The table2 below reveals the level of income it was that majority of the respondents 73.75%earned about ₦10,000 monthly. It follows that food price increase can have marked effect on the welfare and nutrition in line with Block et al (2004) found out that when price increased in Indonesia in late 1990's mothers in poor families responded by reducing their calories intake in order to feed their children better.

The averagely satisfied respond on feeding information is about (53.75). This is a clear indication that awareness about the feeding information is clearly perceived.

Table 2: Level of Income and Information on feeding satisfaction of the Respondent in the Study Area

Variables	Frequency	Percentage
Income per month		
₦500 - ₦1,000	4	5.00
₦1,100- ₦10,000	59	73.75
₦11,000 - ₦20,000	12	15.00
Above ₦20,000	5	6.25
Feeding Information		
Satisfy	33	41.25
Averagely satisfy	43	53.75

Poor	4	5.00

Source: Field Survey 2019

Regression result of poverty status and amount spent on food in the study area.

The table 3 below shows the regression result of poverty status and amount spent on food in the study area. The value of R^2 is 0.6463 which means that 64.63% of the explanatory variables was responsible for poverty status in the study area. This implies that other factors (35.37%) were accounted for remaining percentage. This is a good value indicating that the model fit the observation properly and most of the variations in poverty status on amount spent on food are influenced by other factors. It observed that six variables are statistically significant. Nature of household, education level and major occupation of the respondent were significant at 1%, size of household was significant at 5%, while poverty status and sex of the respondents were significantly at 10%. The co-efficient of major occupation is found to be positive and statistically significant at 1%.

Table 3: Regression result of poverty status and amount spent on food in the study area.

Amount spent on food	**coefficient**	**Std**	**T**	P>H
Poverty status	-3422.427	2047.101	-1.67	0.099*
Age	5.764068	49.30744	0.12	0.907
Sex	-2660.718	1640.281	-1.62	0.109*
Marital status	-790.7954	1071.992	-0.74	0.463
Nature of household	-6280.36	1948.35	-3.22	0.002***
Size of household	179.4591	101.5994	1.77	0.082**
Educational level	3748.333	1051.784	3.56	0.001***
Major occupation	4206.256	1338.238	3.14	0.002***
Constraint	2100.579	4700.238	0.47	0.641
F(8,71)= 16.22				
Prob>f= 0.0000				
R^2 = 0.6463				

Adj R^2= 0.6065

*****---significant at 1%, **-----significant at 5% ,*--------significant at 10%**

Conclusion

This research work was able to assess the socio-economic characteristics of the respondent, Based on the findings, the study therefore concluded that household in Atiba are food secured and are living above poverty line. Also, sex, nature of household, size of household, educational level and major occupation are factor influenced the poverty status on amount spent on food.

Against this background, the study recommends that mass literacy programmes should be introduced and encouraged since educational status of the head had positive effect on poverty status .Also Price of food should be stabilized in the study area to encourage more consumption in the study area.

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Resource use Efficiency of credit and non-credit cassava farmers in Enugu State, Nigeria

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Abstract

The study analyzed resource efficiency of credit and non-credit cassava farmers in Enugu State, Nigeria. Multi-stage, simple random techniques were employed to select 120 respondents, consisting of 60 credit user and 60 non- credit user. Relevant descriptive and inferential statistics such as frequencies, percentages, means, standard deviation and ordinary least square regression were used for data analysis. The result showed that majority (60.0%) of the farmers in the study area were males, for credit, while majority (61.7%) of the farmers in the study area were females for non-credit. However, the mean ages were 42 and 41 years for both credit user and non-credit user respectively. Majority of the respondents were married for both credit user (53.3%) and non-credit (50.0%). The estimated production function of the credit users and non-credit users revealed the coefficient of multiple determination as 0.93 and 0.39 for credit users and non-credit users respectively. Farm size (1%), labour (5%) and fertilizer (1%) are the significant variables influencing the output of the credit user's. While planting material (1%) and fertilizer (1%) are the significant variables influencing the output of the non-credit users. However, the estimate of recourse-use efficiency revealed that farm size and fertilizer has resource use efficiency greater than one, while labour, planting materials and capital has resource use efficiency less than one (1). Also estimate of resource use efficiency by non-credit users shows that farm size and planting materials have resource use efficiency greater than one, while labour, fertilizer and capital has resource use efficiency less than one (1). It is suggested that credit/loan facilities should be made available and accessible to target cassava at moderate interest rates.

Keywords: Resource use, efficiency, credit, non-credit, cassava farmers, Enugu state

Introduction

For many centuries agriculture has played a pivotal role in economic growth worldwide. Agriculture is the backbone of Africa's economy, about 70% of Africans and roughly 80% of the continent's poor live in the rural areas and depends mainly on agriculture for their livelihood and the main source of income for 90% of rural population in Africa. Farmers output also represents a great part of the Africa's share in world trade and increasing agricultural production is a vital pre-requisite for rapid economic growth and development of a country, especially developing country like Nigeria (Idu *et al*., 2020)

One way of increasing production by farmers is to efficiently use all the resources available in the production process (Mesike *et al.* 2009). An increase in efficiency in production could present a ray of hope and could lead to an improvement in the welfare of the farmer and consequently a reduction in their poverty level and food insecurity. Low yields are as a result of inefficient production techniques manifested in technical and allocative inefficiencies, over-reliance on household resources, labour-intensive agricultural technology and rapidly declining soil productivity (Amaze, and Manrice, 2005). One way of approaching the problem of increasing production therefore, is to examine how efficient the farmers use their resources, if resources use is inefficient, production can be increased by making adjustment in the optimal use of factors of production in optimal direction. In case it is efficient, the only way for increasing production would be through the adoption of modern inputs and improved technology of production. (Mesike *et al*. 2009).

Despite all human and material resources devoted to Nigerian agriculture, the productive efficiency of farmers for most crops still fall below 60%. The inefficiency problem is attributed to factors such as use of low input technologies, lack of knowledge of high input technologies and poor farm management skills, poor extension services, unavailability and high cost of inputs (Anyanwu, 2010). Also, **a**gribusiness farmers lack access to capital and money markets. Despite efforts by financial institutions and public-sector bodies to close funding gaps, farmers continue to experience difficulties in accessing credits (Idu and Sunday 2016). The ability of Farmers to grow depends highly on their potentials to invest in restructuring, innovation etc. All of these investments need capital and access facilities. Access to credit is important for the growth and development of **cassava** production. Availability of collateral, linked with minimum interest rate and decision-making skills influence the farmers access and demand for credit.

Credit facilities are provided for farmers to enable them meet their fixed and variable cost needs if they cannot meet such needs with their personally generated/earned funds or retained earnings. Credit helps farmers to enhance their social relations and to keep them out of poverty as it equally enhances the livelihood status of the farmers (Akpan *et al*., 2013). According to Konu (2013) credit is defined as the present and temporary transfer of purchasing power from a person who owns it to a person who wants it, allowing him an opportunity to command another person's capital for agricultural purposes but with confidence in his willingness and ability to repay at a specified later date (Konu, 2013). Therefore, an increase in resource use efficiency in crop production could present a ray of hope and could lead to an improvement in the welfare of the farmer and consequently a reduction in their poverty level and food insecurity. Efficient farms make better use of existing resources and produce their output at the lowest cost.

Methodology

This study was carried out in Enugu State of Nigeria. Enugu state lies between latitude 6° 30' North of the equator and longitude 7° 30' East of the meridian and has a total land area of 7161 square kilometer with a population of 3,267,837 (2006 census) which is now estimated at over 3.8 million in 2012. The State has a total of 17 local government areas: The main produce is yam tubers, palm produce and rice. A multi-stage sampling technique was used to select respondents in the study area. In the first stage, one local government area (Ezeagu L.G.A) was purposively selected. The second stage involved purposive selection of six (6) communities/towns. The third stage involved randomly selecting two villages each from the six communities. Finally, ten cassava farmers (5 credit and 5-non-credit users) from the 12 villages were selected using the simple random sampling techniques to make a total of one hundred and twenty cassava farmers for this study**.** The study used only primary data sources. The primary data were obtained through aid of questionnaire and interview schedule.

To estimate the production function for credit and non-credit cassava in the area famers in the study area, ordinary least square regression model was specified implicitly as follows;

$Y_{1,2} = f(X_1,X_2,X_3,X_4,X_5,e)$ - - - - - (1)

Where;

Y_1= Value of output for credit

Y_2= Value of output for non-credit

X_1=Total area of farmland under cultivation (ha),

X_2=labour input in man-days,

X_3= Cost of planting materials (N) (such as improved seeds, agrochemicals,etc.),

X_4=Fertilizer input (kg),

X_5= Capital (Depreciation, insurance, tax, interest and rent on land)

e = Error term

Resource use efficiency of the farmers was assessed on the ratios of MVP to MFC

$E_i = \frac{MVP}{MFC}$ - - - - - - - (2)

Where E_i= Resource use efficiency of farmers

MFC=Marginal Factor Cost of inputs (The unit price of the input was used as proxy for the MFC.

MVP = Marginal Value Product.

MVP $=b_i \frac{\bar{Y}}{\bar{X}}$ - - - - - - - (3)

Where

bi=regression coefficient of input

$\bar{Y}$=geometric mean value of cassava output

$\bar{X}$==geometric mean quantity of input used.

Results and Discussion

Table 1: Distributions of Respondents according to socioeconomic characteristics (n= 120)

Variables	Credit users		Non- credit users	
	Frequency	Percentages	Frequency	Percentages
Sex				
Female	24	40	38	61.7
Male	36	60	22	38.3
Age (years)				

20-29	8	13.3	14	23.3
30-39	16	26.7	10	16.7
40-49	20	23.3	16	26.7
50-59	14	33.3	18	30.0
60-69	2	3.3	2	3.3
Mean	**42**		**41**	
Marital Status				
Single	8	13.33	9	15.00
Married	32	53.33	30	50.00
Widowed	13	21.67	14	23.33
Divorced	7	11.67	7	11.67

Source: field survey, 2019

Table 1 shows that majority (60.0%) of the farmers in the study area were males, for credit users, while majority (61.7%) of the farmers in the study area were females for non-credit users. This result showed that more males were amongst the credit users and more female were among the non-credit users in the area. Doan *et al.,* (2010) reported that gender does not really matter in participation financial service but plays a role in explaining loan size. This notwithstanding women may be restrained in terms of making major decisions as show for financial service. The result indicates the mean ages were 42 and 41 years for both credit users and non-credit users respectively; this is expected to impact positively on their productivity. This represents an active stage in life. This justifies the findings of Sunday *et al* (2014) that describe this age range as "working age". It is obvious that people within a certain age range would have acquired some good level of experience.

Table 2 Estimated Production Functions of the Farmers

	Credit users		Non-credit users	
Variables	**+Coefficient**	**t-ratio**	**+Coefficient**	**t-ratio**
Intercept	12.104	111.54****	7.2134	4.07***
Farm size (X_1)	0.185	16.67***	0.191	1.29
Labour (X_2)	-0.028	-2.33**	-0.262	-1.12
Planting materials (X_3)	-2.18E-06	-0.68	2.547	2.94***
Fertilizer (X_4)	5.021	6.597***	-1..188	-3.57***
Capital (X_5)	9.19E-06	-0.86	0.087	0.84
R^2	0.929		0.394	
R^{-2}	0.915		0.269	
F-ratio	63.08***		3.13***	

Source: field survey (2019)+ lead equation, *** Significant at 1%, ** Significant at 5%,*significant at 10%,

The estimated production function of the Credit users and Non-credit users is presented in Table 2. The exponential functional form was chosen as the lead equation for Credit users while the double log functional form was chosen for the Non-credit users respondent. The choice of the lead equation was based on the number of significant variable, the magnitude of the coefficient of multiple determinations (R^2), the conformity of signs borne by the variables to with a priori expectation as well as the significance F-ratio. The coefficient of multiple determination were 0.93 and 0.39 for credit users and non-credit users respectively which implies that 93.0% and 39.0% of the farmers output was explained by the explanatory variable for the Credit users and Non-credit users respondent respectively. Farm size, labour and fertilizer are the significant variables influencing the output of the Credit users' respondent. While planting material and fertilizer are the significant variables influencing the output of the non-credit users.

The coefficient of the farm size was significance at 1% and positively related to output for both the credit users. This implies that output increases with increases in the farm size. Meaning that, the more the available land for agriculture production the greater the output level. This is in contrary to several research between farm output and farm size *(*Okoye *et al*, *2008)* where they conclude that more hectare in cultivation invariable means increased level of output. Labour was significant at 5% and negatively related for credit user's, this implies that unit increase in labour use causes output to decrease. This result is in line with the finding of *Mbam and Edeh (2011)* where the labour input was negatively related with farm output. The fertilizer use was significant at 1% and positively related to the farmers output for the credit user's famers, this implies that an increase in fertilizer lead to significant improvement in the output level of the Credit users respondent; while for non-credit users fertilizer was significant at 1% and negatively related to output of the farmers. Planting materials was significant at 1% for non-credit users and positively related to output; this implies that planting material significantly affect output. Sunday *et al* (2014) reported that use of yield increasing seed is sine-qua-none to increased farmers output.

Table 3: Estimate of resource use efficiency of Credit users farmers.

Resources	**MPP**	**MVP**	**MFC**	***Resource use efficiency***	***Efficiency Level***
Farm size	0.185	5432.83	3850	1.120	Under utilized
Labour	-0.028	-822.27	3776.66	-0.218	Over utilized
Planting materials	-2.18E-06	0.064	-1896.67	-0.000	Over utilized
Fertilizer	5.021	147450	5233.33	28.175	Under utilized
Capital	9.19E-06	0.027	4164.162	0.148	Over utilized

Source: Field Survey data, 2019

Estimate of resource use efficiency by credit users' farmers are shown in Table 3. It can be seen from table 3 that farm size and fertilizer has resource use efficiency greater than one. This indicates that additional income can be made from production by using more of these inputs. For these resources to attain optimality, they should be increased in their usage respectively. Ogunniyi *et al* (2012) reported farm size and fertilizer to be under-utilized. Labour, planting materials and capital has resource use efficiency less than one (1). This implies that these resources were not efficiently used and were over utilized since the efficiency index is less than one. The implies that a reduction in the quantity of planting materials and farm implements purchased, in other to increase the farmer's revenue. Thus, by reducing the use of the resources, optimality can be obtained or attained.

Table 4: Estimate of resource use efficiency of Non-credit users crop farmers.

Resources	**MPP**	**MVP**	**MFC**	***Resource use efficiency***	***Efficiency Level***
Farm size	0.191	4857.77	3650	1.331	Under utilized
Labour	-0.262	-6663.53	-1860	-3.583	Over utilized
Planting materials	2.547	64778.69	6426.667	10.080	Under utilized
Fertilizer	-1.188	30214.80	8673.33	-3.484	Over utilized
Capital	0.087	2212.70	12509.78	0.177	Over utilized

Source: Field Survey data, 2019

Table 4 shows that farm size and planting materials have resource use efficiency greater than one. This indicates that additional income can be made from the production of cassava by using more of this inputs. For these resources to attain optimality, they should be increased in their usage respectively. Also Labour, fertilizer and capital has resource use efficiency less than one (1). This implies that these resources were not efficiently used and were over utilized since the efficiency index is less than one. should be noted that apart from labour, the MVP of the rest input used were positive indicating that cassava farmers still use the resources within the economic range even though they are not optimally used (Ogunniyi *et al.*, 2012).

Conclusion

Based on the finding on resource use efficiency of credit and non-credit cassava farmers in Enugu State, Nigeria, the following conclusion have been drawn, the most important variable that have positively influenced output of the small holder cassava farmers are farm size, labour and fertilizer for the credit user while planting material and fertilizer are the significant variables influencing the output of the non-credit farmers. Also farm size and fertilizer under utilized while labour, planting materials and capital are over utilized. Also estimate of resource use efficiency by non-credit users shows that farm size and planting materials were under utilized, while Labour, fertilizer and capital were over utilized.

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THE ROLE OF WOMEN IN AGRICULTURAL DEVELOPMENT OF NIGERIA

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Abstract

Gender refers to affairs between men and women, not an exclusive focus on women. In much of agricultural development, the focus has been on men, so achieving gender equal opportunity requires rebalancing by paying greater attention to women. However, the importance of relations between women and men, as well as the differential roles, resources, and responsibilities of women and men of different ages, ethnicity, and social class need to be kept in mind in both analysis and programming.

Women equality is a basic human right –with value in and of itself. The importance of gender is highlighted in its prominence in the united Nations. Millennium Development Goals (MDGs), which have been commonly accepted as framework for measuring development process. Of the eight goals, four are directly related to gender: achieving universal primary education, promoting gender equality and empowerment of women, reducing infants and child mortality, and improving maternal health. Closing gender gaps – which tend to favour males – has also been seen to contribute to women's empowerment . however , the term "empowerment " is a broad concept that gets used differently by various writers, depending on the context or circumstance. In an attempt to come to a common understanding applicable across multiple domains and disciplines, empowerment as expansion of people's ability to make strategic life choices, particularly in contexts where this ability had been denied to them.

Keywords: Women, Policies, Empowerment, Farmers.

Introduction

Women make essential contributions to agricultural countries, but their roles differ significantly by region and are changing rapidly in some areas. Women comprises on average, 43 % of agricultural labor force in developing countries, ranging from 20% in Latin America to 50% in sub-Sahara African and East Asia. Their contribution to agricultural work varies even more widely, depending on the specific crop and activity.

Women in agriculture and rural areas have one thing in common across regions: they have less access than men productive resources and opportunity. This gender gap is found is found for many assets, inputs and services ,land , livestock, labor, technology , education and extension financial services and its imposes costs on the agricultural sector, the broader economy and society , as well as on women themselves.

Closing the gender gap in agriculture would generate signifant gains for the agricultural sector and or society. If women had the same access to productive resources as men, they could increase yield on their farms by 20-30 %. This could raise total agricultural output in developing countries by 2.5–4% which could in turn reduce the number of hungry people in the world by 12 – 17 %. The potential gains would vary by region, depending on how many women are currently engaged in agriculture, how much production or land they control, and how wide a gender gap they face. strategy intervention can help close the gender gap in agriculture rural labour markets.

A woman who is empowered to make decisions regarding what to plant and what (and how many) inputs to apply on her plot will be more productive in agriculture. An empowered woman will also better able to assure her children's health and nutrition, in no small part because she is able to take care of her own physical and mental wellbeing.

Women and Agricultural Extention

Several agricultural programs with a strong extension component have been introduced in Nigeria, by Government, NGOs and development partners. However, these initiatives were established to promote agriculture and agricultural extensions delivery services in the country, with a limited focus on gender. The agricultural Development programmes (ADP) is the agency responsible for public extension service delivery at grass root levels, in collaboration with the LGAss The WIA (Women in agriculture) programme as a unit was created within the ADP system in 1987, in order to make extension services available to women farmers in Nigeria. This was in recognition of the important role played by women farmers in agricultural activities.

The majority of women farmers across all the states were not aware of the existence of extension and advisory services. However in localities /areas where there are interventions by development partners / special projects, women have access to agricultural extension workers, training and advisory services and the opportunity to share information and learn from successful private farmers. Also, the special projects provide support for both men and women (in cash and kind) to boost their agricultural activities. Services provided by extension workers to farmers include training and linkages to markets, sources of credit and farm inputs (agro service providers), as well as improved technologies for poultry, fish and small ruminant production. Skills taught include soap and pomade making, strip planting of soybeans dippling planting of crops and improved processing and value addition for crops such as cassava, rice and palm crops.

Women and Agricultural

According to National Bureau of Statistics (NBS), women dominate the buying and selling of agricultural products (37 percent of women participate , compared with 10.5 percent of men), while women dominate in the case of mining and forestry products. However, men who trade in agricultural products have an advantage, because they are often selling their own produce .

Men also dominate the service sector, while women and men trade equally in industrial goods. Disparity exists in rural households marketing on women's rights to their own savings and financial assets and assistance in claiming fair remuneration for their contribution for the family business. The information available suggests that women increasingly supply national and international markets with traditional and high value produce (garri, fish, vegetables), compared with men. However, women farmers and entrepreneurs face a number of advantages; including lower mobility and poor access to training, market information and production resources.

The most important challenges faced by women are poor gender power relations in the household, religions and cultural practices and traditional norms, which are both related as they impose negative practices that, devalue women's contributions and limits their rights to resources and mobility.

Women and Rural Finance

Agriculture is critical to achieving sustainable development, by generating a greater proportion of rural households' incomes. In Nigeria, women are involved in food production and provide a majority share of the total agriculture labour force. Despite their significant contribution, women still face challenges in participating in agricultural production, for example, both men and women have different levels of access to agricultural resources, despite the equal roles they play in agricultural activities. It has been argue that if women's incomes were increased, they would have more access to resources and invest in their children's education, health care and nutrition.

Women are often hampered in accessing new opportunities by poor access to resources, including new markets, due to their limited education background, poor networks and mobility restrictions.

Also, women have poor access to financing, which hinders them from hiring labour for agiculture activities, forcing them to depend on their own labour and that of family members. Women face high transaction costs for credit, a situation that is exacerbated by their limited property rights and their poverty. Although men also face this barrier, women are more vulnerable in rural areas. In cases where women have access to credits, the amounts are usually very small awnd repayment conditions are unsuitable (analog *et.al* 2014). As such, poor access to credit facilities prevents women from purchasing the inputs they need for agricultural production .in addition, most rural financial programs have been designed, crafted and implemented with the male head of household as the intended client, and fail to recognize that women are active, productive and engaged economic agents, despite their own financial needs and constraint . Similarly, there are considerable gender inequalities in household decision-making and management of income from agricultural gender inequalities in household decision making and management of income from agriculture. Men tend to spend more on financial management of agriculture than women do.

Women and Climate Change

Gender equality and women's empowerment are vital for environmental sustainability. Gender equality gaps that need to be addressed are participating in decision-making and resource management, and access to social protection measures, education, height and early warning . Women and girls are particularly exposed to climate related disaster risk . According to UNDP (2013). Women and children are 14 times more likely than men to die during a climate disaster. Indeed low income, coupled with prevalent gender inequalities, aggravates women's vulnerability to the impacts of climate change. Agwu and Okhimamhe (2009) reported that the social impacts of climate change, such as male migration, increase the workload of women since they expose them to physical and sexual abuse and encourage early marriages. The International Food Policy Research lnternational (IFPRI) asserts that inequality exists in men's and women's differing abilities to adapt to the negative impacts of climates change; women perceive climate change as an environment issue, due to the fact that they have less access to climate information. Thus, climate change can be said to reflect great injustices for both women and men, posing an increased threat poor women and other vulnerable sectors of the community. As a result, policies need to consider gender issues and women's involvement, if climate change knowledge is to be advanced.

Women and Social Protection in Agriculture

Nigeria currently spends less on social protection than many other Africa countries, despite its comparative wealth . however, the federal Government of Nigeria (FGN) in collaboration with state Governments and development partners, has sought to develop a social protection mechanism to tackle high rates of poverty and exposure in the country. To this end, FGN in 2006 budget 500 billion Naira to provide for social assistance targeting vulnerable citizens, including women, then elderly and disabled, through social protection progammes food and nutrition security. However, many such groups need capacity-building in group dynamics, technical knowledge and management. Ogunlela and Mukhtar (2009) observe that women hold extremely low numbers of decision-making positions in organization dealing with agriculture and rural development.

However, states face problems in managing the groups, due to lack of understanding of group dynamics. Women have opportunities to organize themselves into agricultural production, processing and marketing groups, but they hold few leadership positions, excepts in the case of women only groups. Gender disparity exists in levels of participation at cooperatives meetings, especially regarding the approval / disapproval of financial statements, decisions and internal issues and candidate for elections as leaders, women play a dominant role in loan repayment Wand solving problems among members.

Women and Technology

The majority of farmers (men and women) in Nigeria still produce crops using manual or traditional methods, and plant local varieties. Some of the methods and technologies used by farmers include mixed farming, intercropping and crop rotation, which are handed down by their forefathers. Very few have access to improved and mechanized farming methods, or improved varieties such as cassava, maize and rice. Female farmers tend to apply fewer fertilizers per hectares than men in the north and according to the World Bank (2014) this disparity accounts for a substantial proportion of the overall gap in productivity. Also women in the south use less herbicide per hectares compared with men and this imbalance has further contributed to widening the gender productivity gaping the south.

Most women with access to improved technologies were introduced to these through special projects, adopting them because the technologies improved their yield and income and reduce the drudgery associated with farm labour. Reasons for preferring to continue using traditional farming methods and local varieties include inheritance from parents, availability of better alternatives, and lost cost of these technologies.

An analysis of ownership agro-input businesses gender shows that 84 percent belong to men , compared with 16 percent to women. Results on sources of funds for starting the business indicates personal savings in first place (53 percent) followed by loans (26 percent) and cooperatives (11 percent).regarding staffing majority of agro – inputs business have 65 percent male employees, compared with 35 percent women. The gender of customers is 70 percent to 30 percent in favour of men. The type of operations carried out by employees indicates that loading/off-loading, trainings of field workers and security guards were all performed by men. Operations such as sales and record-keeping are mostly done by women (53 percent), with men accounting .47 percent.

Conclusion

There is a need for federal and state government to conduct gender responsive budgeting (GRB) as a step not only towards accountability for women's rights, but towards greater public transparency, economic stability and output for women's empowerment. In addition, GRB with the Government will understand how it may adjust its priority and reallocate resources to live up to it commitment to achieving gender equality and advancing women's rights including those stipulated in CEDAW, the Beijing platform for Action and Sustainable Development Goals.

Agricultural project development processes at all levels should involve vulnerable groups from the ontset, in order to enhance satisfaction and ownership.

Due attention should be given to the formation and strengthening of women's and youth farmers' groups, to empower them in production income- generating activities and entrepreneurship development, so as to increase accumulate capital and asset ownership at household level.

Government / financial institutions should facilitate women farmers' access to credit through cooperation groups before the onset of the planting season, to enable them to purchase production inputs such as fertilizer and agrochemicals, and pay for hired labour.

FGN, in collaboration with appropriate institutions, should create women in agricultural Development Tax Fund, which will serve as a social protection mechanism to minimize vulnerability and farm losses for women, and improve their livelihood status.

FGN should increase investment in critical infrastructures in rural areas such as improved power, potable water supply, transport, roads, and sanitation, to reduce women's drudgery and minimize rural/urban migration.

Government at all levels to initiate a deliberate commitment to ban or prescribe strict penalties for negative traditional and cultural practices that poses obstacles to national and individual development of women, as well as increased advocacy and sensitization to traditional rulers, religious and community leaders, women's / men's groups, policy – makers and other stakeholders.

FGN to put in place a law to compel state, local government and private organization in Nigeria to establish gender units for the purpose of mainstreaming gender in agricultural and rural development activities.

The current agricultural promotion policy of FMARD should include a detailed guide on how to mainstream gender in all agricultural value chain activities for crops, livestock and fisheries, with FAO support.

Land ownership and control by gender in Nigeria is still male dominated, in terms of average land size apportioned to farming activities. Government to establish programmes and partnerships that will specially target women in order to improve access to and control over land, to enable them to increase their productive capacities, promote involvement in cash crop production and improve livelihood status.

FGN should put in place a mechanism for monitoring and evaluation of rural women and youth activities in agriculture and rural development.

FGN efforts to reduce poverty and achieve inclusive agricultural growth should tailor provision of production resources to regional differences, by ensuring that women in the south have access to, and use similar quantities of inputs, including herbicide and labour – saving devices as men. In the north, provision to women farmers should also take into into account sthe structural disadvantages that prevent women and their households from fully benefiting from agricultural production and modernization.

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GENDER CHALLENGES OF SMALL-HOLDER FARMERS IN HOME- GROWN RICE (*Oryza glaberrinia*) PRODUCTION IN ABIA STATE, NIGERIA

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Abstract

This study on gender challenges of small-holder farmers in home-grown rice production was conducted in Abia State, Nigeria. Multi-stage random sampling technique was used to select 120 farmers (60 males and 60 females) in home-grown rice on which 2 sets of structured questionnaires were administered to the respondents. Data collected were presented and discussed using descriptive statistics such as percentages, frequencies, tables and mean. The result showed that more males were younger than females. Both gender had low level of education, no access to extension contact and were married. Most males had more farm size than the females, belonged to cooperative societies and had farming experiences. The result also revealed that the most constraints of home-grown rice production by both gender include; pests and diseases, inadequate credit/capital, environmental factors and high cost of transportation in the study area. It was therefore recommended that the intensification of compulsory education at the secondary school level, implementation of land use act of 1978, and availability of extension workers for capacity building of the respondents' in the study area.

Keywords: Gender, challenges and home-grown rice.

Introduction

Rice (Oryza glaberrinia) African rice and Oryza sativa (Asian rice) is the seed of the grass species which is the seed of the monocot plant Oryza species which is the seed of the Poceae family (F.A.O 2006). Rice provides for more than half of the world's population, about 80% of its food calorie and food security minimum of 2400 calories per person per day (Bamidele, Abayomi and Esther, 2010). The total demand of milled rice in nigeria was estimated to be about 5 million metric tonnes out of which 3.2 million metric tonnes of paddy rice (2.21 million metric tonnes of milled rice was produced locally with the deficit of 2.29 million metric tonnes was bridged by imporatation) and 2.9 million metric tonnes is produced locally (Aiyedum, 2016).

National Cereals Research Institute, Badagary has the mandate of breeding local rice varieties and has developed some popular home-grown rice such as: FAR055, FAR044, FAR060, FAR061 and FAR062. The above rice varieties developed and selected have high yielding tendencies under recommended good agronomic production practices (Ogunremi, 2016).

Gender is not the biological or sex differences (man and woman) but word used to describe the roles, activities, works, needs, responsibilities, contribution and problems of male and females in relation to their importance in agricultural production processes (Onunka, 2011).

Gender studies define the technologies meant for male and female farmers. It also examines and conceptualizes farming activities in terms of men and women with regard to responsibilities which determine constraints and strength. But unfortunately, resources allocation along gender lines are credited to males and to the detriment of females. This situation has been attributed to gender insensitivity in agricultural production in Nigeria and sub-Saharan Africa. When Okoye*et al.*, (2009) reported that 70% of total food supply are produced by women yet they least benefit from agricultural technologies that would improve their production.

In other to bridge the gap of rice importation and increase home grown rice for population explotion and attaining self-efficiency, the Nigerian government is putting everything in place such as stopping the importation of rice and encouraging home-grown ones. It is projected that in 2050, the country demand for milled rice is 36 million metric tonnes as a result of population increase and urbanization which will cause her to spend 150 billion US dollars (about N23.4 trillion) on importation (Usanga *et al.*, 2019).

Whence, the specific objectives were to; identify the social economic characteristics of home grown rice farmers by gender and the constraints encountered in the study area.

Methodology

The study was conducted in Abia State, Nigeria. The state occupies a total land area of 620km^{2}and situated at 75 km inland from the coastal plains of south-east Nigeria. Multi-stage random sampling technique was purposefully employed to select the respondents from three local government areas, autonomous communities and two villages from each communities making it six villages. A total of 120 respondents (60 males and 60 females) were selected and interviewed with two setsof structured questionnaires by gender. The objectives of the study were to identify the socio-economic characteristics of the respondents and ascertain their constraints in the production in the production of home-grown tice by gender. Data collected were analyzed with descriptive statistics.

Results and Discussion

Table 1 presents the socio-economic characteristics of respondents by gender. The results show that the mean age of the males were 40 years while females were 52 years. This implies that the male respondents were younger than the females. This indicates that more male rice farmers than females where within the active labour force and greater potential for increased production which agrees with report of Onunka, Emerole and Ezeh (2016). The result reveals that both male (46.67%) and female (50%) respondents had highest (primary education) level of education which indicates low level of education. Education obviously influences people's basis for acceptance of new innovation. The result also shows that both gender (males 58.3% and females 78.3%) had no access to extension contact. The result agrees with the finding of Onunka (2011) that most male and female African eggplant farmers have low education in Abia State, Nigeria. The result further shows that more males (81.67%) than females (33.33%) belonged to cooperative society. This might imply that more males than female rice farmers were more socialized and can adopt new finding. This confirms above result that more males have more contact with extension agents than females in the table.

The result shows that majority (53.33%) of male respondents have mean farming experience of 9 years while female (50%) had 8 years. It implies greater percentage (53.33%) of farming experience of the males than the females (50%). Effiong (2005) opined that freshers in farming business are prone to efficient utilization of available resources than the older one.

Table 2 presents the constraints to the production of home-grown rice by gender. The result reveals that both male (87%) and female (91.66%) respondents had pests and diseases as number one constraint to the production of home-grown rice. The result is in line with the findings of Usanga *et al* (2019) who reported that weever bird and rodents cause about 60% of local rice production in Ebonyi State Nigeria. The result also shows that male respondents had the following constraints- inadequate credit/capital (2), presence of stones, grave and dirts (3), environmental factors (4) and high cost of transportation (5) while female respondents had inadequate credit/capital as number one, high cost of labour and inadequate rice processing machine (2), land limitation (3), high cost of transpotation (4) and environment problems (5). It implies that both male and female respondents had inadequate credit/capital, environmental factors and high cost of transportation constraints as most challenging. This result is line with the findings of Onunka *et al.*, (2016) and Onunka (2009) that inadequate credit, environmental issues and high transportation were the most constraints to crop production in Nigeria.

Conclusion

The result of the study reveals that more males were younger in age than females. Both gender had low level of education (primary education), no access to extension contact and were married. Most males had more farm size than the females, belonged to cooperate societies and had more farming experiences. The result also reveals that the most constraints of home-grown rice production includes; pests and diseases, inadequate credit/capital, environmental factors and high cost of transportation by both male and female respondents in the study area. Therefore, intensification of compulsory free education up to secondary school level (formal and informal) programme will go a long way increasing production of home-grown rice in the study area. Furthermore, implementation of land use decree act of 1978 to sustain small holder farmers especially the females and availability of extension workers in building the capacity of respondents especially the females will enable them tackle the above constraints to home-grown rice in the study area.

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Table 2: Constraints to Home-Grown Rice Production by Gender

Constraints	**Males**		**Females**	
	frequency (%)	**rank**	**frequency (%)**	**rank**
Inadequate credit capital	50(83.33)	2	55(91.66)	1
High planting material	15(25.0)	11	20(33.33)	11
Limited land	25(41.7)	9	48(80.0)	3
High labour cost	35(58.3)	7	50(83.33)	2
Inadequate storage	20(33.33)	10	25(41.7)	10

facilities				
Poor market information	10(16.67)	12	8(13.33)	13
High cost of transportation	42(69.06)	5	47(78.33)	4
Seasonal price variation	40(66.66)	6	40(66.67)	7
Poor infrastructural facilities	30(50.0)	8	40(66.77)	7
Inadequate rice processing machine	45(75.0)	4	50(83.33)	2
High cost of home grown rice	35(68.33)	7	35(68.33)	8
High cost of rice processing	30(50.0)	8	30(50.0)	9
Availability of extension contact	15(25.0)	11	10(16.67)	12
Poor feeder roads	10(16.67)	12	8(13.33)	13
Presence of stone, gravels & dirts	48(80.0)	3	35(68.33)	8
Environmental problems	45(75.0)	4	45(75.0)	5
Non-packaging of the final products	40(66.67)	6	42(69.06)	6
Pest and disease	52(87.00)	1	55(91.66)	1

Source: Survey data, 2019. *Multiple responses recorded figures in brackets represent percentages

Table 1: Socio-Economic Characteristics of Home-Grown Rice Farmers byGender

Socio-economic characteristics	males		females	
	frequency	mean	frequency	mean
Age (years)				
20 and below	2(3.33)		0(0)	
21-30	10(16.67)		4(6.6)	
31-40	20(33.33)		12(20.0)	
41-50	8(13.33)		13(21.7)	
51-60	6(10.00)	40	25(41.7)	52
61 and above	7(11.67)		6(10.0)	
Total	60,100		60,100	
Educational status				
Non-formal education	20(33.33)		11(18.33)	
Primary	28(46.67)		30(50.0)	
Secondary	14(23.33)		12(20.0)	
Tertiary	8(18.33)		7(11.67)	
Total	60,100		60,100	
Contact with extension agent				
Yes	25(41.7)		13(21.7)	
No	35(58.3)		47(78.3)	

Total	60,100		60,100	
Marital status				
Married Single Divorced Widow/widower Total	45(7.5) 10(16.67) 2(3.3) 3(5.0) 60,100		43(71.66) 2(3.3) 1(1.67) 14(23.33) 60,100	
Farm size (ha)				
less than 1 1.0 – 2.00 2.1-3.00 3.1-4.0 Total	6(10) 8(18.33) 21(35) 55(46.67) 60,100	3.2	10(16.67) 30(45) 12(20.0) 8(13.33) 60,100	2.1
Membership of cooperatives				
Yes No Tota1	51(85) 9(15) 60,100		20(33.33) 40(66.37) 60,100	
Farming experience (yrs)				
1-5 6-10	11(18.33) 32(53.33)	9	20(33.33)	8

11-15	12(20)		30(50.0)	
15 and above	5(18.34)		8(13.33)	
Total	60,100		2(3.34)60,100	

Source: Field survey, 2019. *No in bracket represent the percentages (%)

Perceived Health Benefits and Utilization of Moringa Tree Products (*Moringa Oleifera*) among Rural Households' of Nasarawa State, Nigeria

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Abstract

The study assessed the perceived health benefits and utilization of Moringa tree products *Moringa oleifera* among rural households of Nasarawa State, Nigeria. Multi-stage sampling technique was used to select 244 respondents on which structured questionnaire was employed to obtain primary data. Data collected were analysed with descriptive Statistics as well as attitudinal measuring scale such as Likert rating scale. The results revealed that most (60.7%) of the respondents were within the age range of 31 – 60 years with a mean age of 40 years, while majority (84.0%) of the respondents acquired one form of formal education or the other (primary, secondary and tertiary) with a mean of 13 years of formal schooling. More so, majority (99.2%) of the respondents utilized Moringa leaves, followed by Moringa Fruits/Seeds (89.8%), Moringa roots (87.7%) and Moringa barks (64.3%). In terms of extent of utilization, Moringa leaves ($\bar{X}$ = 2.84), Moringa fruits/seeds ($\bar{X}$ = 2.07) and Moringa roots ($\bar{X}$ = 2.05) recorded the highest extent of utilization among the Moringa tree products in the study area. On the perceived health benefits of Moringa oliofera tree products, the respondents agreed to all the health benefits of Moringa tree products that it is effective in the treatment of High Blood Pressure ($\bar{X}$ = 4.23) ranked 1st. he major constraints indicated by the respondents were inadequate finance to purchase Moringa ($\bar{X}$ = 1.87), poor access to credit facilities ($\bar{X}$ = 1.71) and inadequate extension services ($\bar{X}$ = 1.69) ranked 1st, 2nd and 3rd, respectively. In conclusion, Moringa oliofera tree products were perceived by the respondents to have health benefits with the leaves, fruits/seeds and roots the most utilized tree products. It was therefore recommended that adequate awareness should be created through extension agency on the need to utilize Moringa oliofera tree products.

Keywords: Perceived health benefits, Utilization, Moringa tree products, Rural households.

Introduction

Moringa tree also known as Horseradish tree, drumstick tree and ben oil tree is a widely cultivated species of the tropical flowering plant 'family Moringaceae' containing thirteen diverse species (Shahzad *et al.,* 2013). It is considered as one of the World's most useful trees, as almost every part of the Moringa tree can be used for food, medication and industrial purposes (Hadiza, 2011). *Moringa oleifera* has the potential to significantly add to rural household income and improve quality of life in Nigeria (Adikuru *et al.,* 2011). The perceived Health benefit of *Moringa oleifera* is limitless. It used as a blood cleanser and blood builder in wound healing, and boosts the immune system (Mehta *et al.,* 2011). It has strong anti-inflammatory properties ameliorating rheumatism, arthritis as well as effective against digestive disorders, diarrhea, ulcer or gastritis and skin cancers. It can also control other severe diseases such as epilepsy, migraine and headaches. In traditional medicine, the leaves are used to treat ailments including malaria, typhoid fever, parasitic diseases, arthritis, skin diseases, genito-urinary ailments, hypertension and diabetes (Leone *et al.,* 2015). *Moringa oleifera is* perceived to be an anti-bacterium, anti-microbial and anti-viral agent against urinary tract infection, typhoid, syphilis, dental carries and toothaches, fungus, common cold, HIV, worms, and trypanosomes. It curbs other health complications such as diabetes, anemia and high blood pressure, liver, kidney, stomach and thyroid problems (Leone *et al.,* 2015). *Moringa oleifera* is perceived to be medicinal plant with high nutritional value in terms of high protein, vitamins, beta-carotene and amino acids, hence could be useful as a food supplement for both human and animals (Hashim *et al.,* 2013). Photochemical analysis have also shown that its leaves are particularly rich in potassium, calcium, phosphorous, iron, vitamins A and B, essential amino acids as well as known antioxidants such as B-carotene, vitamin C and flavonoids (Amaglo *et al.,* 2010).

Utilization of Moringa tree products has been in use by human race for many years ranging from domestic consumption to usage as animal forage, plant manure, bio-pesticides and as ornamental plants (Adebayo *et al.,* 2011). The key area of utilization of Moringa tree products covers human nutrition (leaves, seeds, flowers), water purification (powdered seeds), alley cropping (bio-mass production for bio-diesel and fertilizing), animal forage (leaves and treated seedpod-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves) (Adebayo *et al.,* 2011; Popoola and Obembe, 2013). Despite the potential health benefits of *Moringa oleifera*, it has not enjoyed the full patronage expected from the vast populace of Nigeria especially those in rural areas. *Moringa oleifera* is still not well exploited and hence considered as under-utilized. However, number of factors could be responsible for poor perception of the people in relation to utilization which include lack of technical knowledge, poor entrepreneurial skills and meager access to communication technologies that could help farmers, extension workers and other information sources. It is against the backdrop of aforementioned underlines the need for this study to provide answer to the following specific research objectives which are to:

i. describe the socio-economic characteristics of the rural households in the study area;

ii. identify the *Moringa oleifera* tree products utilized by the rural households;

ii. examine the extent of utilization of *Moringa oleifera* tree products by the rural households;

iv. assess perceived health benefits of *Moringa oleifera* tree products by the rural households, and

v. examine the constraints associated with utilizing *Moringa oleifera* tree products in the study area.

Methodology

Study Area

The study was conducted in Nasarawa State which is located in the middle belt zone of the country and covers land area of 5,645 square kilometer. It lies between Latitude 7^{o}45'and 9^{o}25' North and Longitude 7^{o}00'and 9^{o}37' East of the equator, and shares common boundaries with Benue State to the South, Kogi State to the West, the Federal Capital Territory (FCT), Abuja, to the North-West, Kaduna and Plateau States to the North-East, and Taraba State to the South-East. Nasarawa State is predominantly agrarian with over 80% of the people living in the rural areas and engaged in farming with annual rainfall vary from 313.73cm in some places to 145cm in other areas (Nasarawa State Geographical Information System (NAGIS), 2018).

Sampling Procedure and Sample Size

The population involved in this consisted of rural farming households residing in Nasarawa State. The State was divided into three (3) Agricultural Zones (South, North and West). Multi-stage sampling procedure was employed to select the respondents for the study. First stage was random selection of two (2) Local Government Areas, from each Agricultural Zones of the State.

The second stage involved random selection of two (2) villages from each of the Local Government areas selected. The third stage involved proportionate selection of 244 respondents from the sample frame obtained from each of the selected villages using Taro Yamane formula.

Method of Data Collection and Analysis

Data were obtained from primary sources with the aid of structured questionnaire. The data collected were analyzed using the descriptive statistics (such as frequency counts, percentage and mean) while attitudinal measuring scale such as Likert rating was used to measure extent of utilization, perception response and severity of constraints.

Results and Discussions

Socio-economic characteristics of the rural households

The socio-economic characteristics of the respondents described include age, gender, marital status, household size, educational status, farming experience and farming status. As revealed in Table 1, most (60.7%) of the respondents were within the age range of 31 – 60 years with a mean age of 40 years implying that the respondents were in their mid-age and most productive stage of life where they could utilize *Moringa oliofera* tree products and appreciate it health benefit. This result is in agreement with Etonihu *et al.* (2013) who posited that active farming age was between 41 – 60 years with a mean age of 43 years. Also, most (64.8%) of the respondents were males, while 35.2% were females implying that males were the dominant household heads and breadwinner of most homes in the area. More than half (54.9%) of the respondents were married, while 30.3% were single and others were either widowed (8.2%), divorced (4.9%) or separated (1.6%), implying that they are responsible individuals with sense of responsibility to provide for the needs of their families. More so, 56.6% of the respondents had household size of less than 6 people with a mean household size of 5 people, implying relatively large households. In terms of the educational status of the respondents, majority (84.0%) of the respondents acquired one form of formal education or the other (primary, secondary and tertiary) with a mean of 13 years of formal schooling. This implies that Most of the respondents are educated (i.e. could read and write), passing through at least secondary education. Thus, there is high literacy level in the study area which could enhance the utilization of *Moringa oliofera* tree products. Furthermore, more than half (57.4%) of the respondents had been into farming between 6 – 20 years with a mean farming experience of 23 years. This implies that the respondents are experienced which is an asset in farming because it inspires farmers' rational decision making with respect to inputs utilization.

Table 1: Distribution of respondents based on their socio-economic characteristics (n = 244)

Variable	Frequency	Percentage	Mean
Age (years)			
< 31	70	28.7	40
31 – 40	89	36.5	
41 – 50	38	15.6	
51 – 60	21	8.6	
> 60	26	10.7	
Gender			
Male	158	64.8	
Female	86	35.2	
Marital Status			
Single	74	30.3	
Married	134	54.9	
Divorced	12	4.9	
Separated	4	1.6	
Widowed	20	8.2	
Household size (No)			
< 6	138	56.6	7

6 – 10	63	25.8	
11 – 15	17	7.0	
16 – 20	9	3.7	
> 20	17	7.0	
Educational status			
No formal	39	16.0	13
Primary	42	17.2	
Secondary	72	29.5	
Diploma/NCE	55	22.5	
Degree/HND	36	14.8	
Faming experience (years)			
< 6	14	5.7	23
6 – 10	29	11.9	
11 – 15	46	18.9	
16 – 20	65	26.6	
> 20	90	36.9	

Source: Field Survey, 2020

Moringa oleifera tree products utilized by the rural households

The distribution of the respondents based on the *Moringa oliofera* tree products utilized in the study area is presented in Figure 1. The result revealed that majority (99.2%) of the respondents utilized Moringa leaves, followed by Moringa Fruits/Seeds (89.8%), Moringa roots (87.7%) and Moringa barks (64.3%). This implies that the leaves, fruits/seeds, roots and barks are the most utilized Moringa tree products by the respondents in the study area. However, less than half (45.5%) of the respondents utilized Moringa branches as the tree products, while 44.3% of the respondents utilized Moringa stems and 32.1% utilized Moringa flowers.

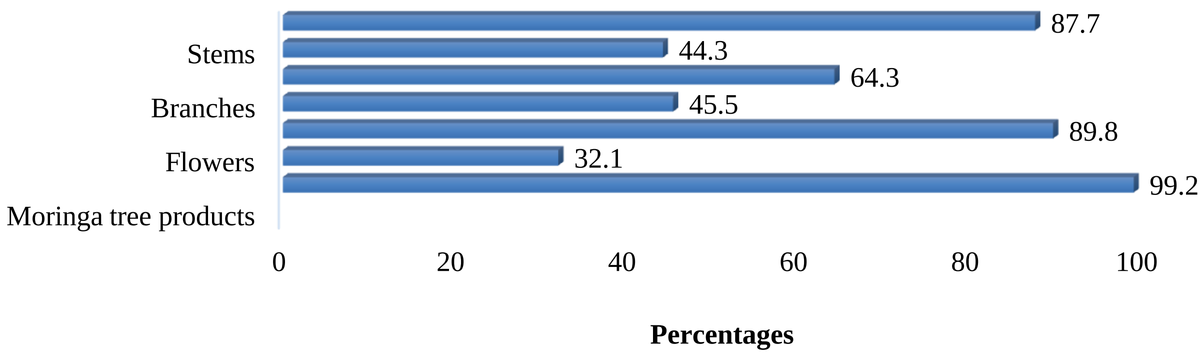

Figure 1: Distribution of *Moringa oliofera* tree products utilized by the respondents

Extent of utilizing *Moringa oleifera* tree products by the rural households

The result on the extent of utilizing Moringa oliofera tree products as presented in Table 2 revealed that Moringa leaves ($\bar{X}$ = 2.84), Moringa fruits/seeds ($\bar{X}$ = 2.07) and Moringa roots ($\bar{X}$ = 2.05) recorded the highest extent of utilization among the Moringa tree products in the study area. However, low extent of utilization was recorded for Moringa barks ($\bar{X}$ = 1.75), Moringa branches ($\bar{X}$ = 1.60), Moringa stems ($\bar{X}$ = 1.59) and Moringa flowers ($\bar{X}$ = 1.47) in the study area. This implies that Moringa tree products such as leaves, fruits/seeds and roots were highly utilized by most of the rural households in the study area as compared to barks, branches, stems and flowers.

Table 2: Respondents' extent of utilizing *Moringa oleifera* tree products (n = 244)

Constraints	HE (3)	ME (2)	LE (1)	Sum	Mean	Remark
Moringa leaves	215 (88.1)	20 (8.2)	9 (3.7)	694	2.84	High Extent
Moringa fruits/Seeds	43 (17.6)	175 (71.7)	26 (10.7)	505	2.07	High Extent
Moringa roots	55 (22.5)	145 (59.4)	44 (18.0)	499	2.05	High Extent
Moringa barks	35 (14.3)	114 (46.7)	95 (38.9)	428	1.75	Low Extent

Moringa branches	30 (12.3)	86 (35.2)	128 (52.5)	390	1.60	Low Extent
Moringa stems	34 (13.9)	77 (31.6)	133 (54.5)	389	1.59	Low Extent
Moringa flowers	23 (9.4)	68 (27.9)	153 (62.7)	358	1.47	Low Extent

Sources: Field Survey, 2020

Note: HE = High Extent, ME = Moderate Extent and LE = Low Extent (Bench mean score = 2.0)

Perceived health benefits of *Moringa oleifera* tree products by the rural households

Table 3 revealed the result of perceived health benefits of utilizing Moringa oliofera tree products in the study area. As shown in Table, the respondents agreed to all the health benefits of Moringa tree products that it is effective in the treatment of High Blood Pressure ($\bar{X}$ = 4.23) ranked 1st. They also agreed that Moringa is effective in providing vitamins/minerals ($\bar{X}$ = 4.10), Moringa is effective in treatment of malaria ($\bar{X}$ = 4.06), Moringa is effectively helpful in aiding digestion ($\bar{X}$ = 4.02), Moringa is effective in the treatment of Diabetes ($\bar{X}$ = 4.01) and Moringa is effective in the treatment of stomach pains ($\bar{X}$ = 4.00) ranked 3rd, 4th, 5th and 6th, respectively. Other perceived health benefits of Moringa oliofera tree products as agreed to by the respondents were that Moringa is effective in the treatment of Typhoid fevers ($\bar{X}$ = 3.91), Malnutrition ($\bar{X}$ = 3.90), stimulating appetite ($\bar{X}$ = 3.89), Arthritis ($\bar{X}$ = 3.83), Eye/Ear infection ($\bar{X}$ = 3.82), enhancing low Libido ($\bar{X}$ = 3.79), Skin diseases ($\bar{X}$ = 3.68) , Liver/Kidney disease ($\bar{X}$ = 3.60), Anti-microbial agents ($\bar{X}$ = 3.59), overcoming Depression ($\bar{X}$ = 3.59), Fibroid ($\bar{X}$ = 3.57), Anemia ($\bar{X}$ = 3.50), Infertility ($\bar{X}$ = 3.41) and Sexual diseases ($\bar{X}$ = 3.41) ranked 7th, 8th, 9th, 10th, 11th, 12th, 13th, 14th, 15th, 17th, 18th and 19th, respectively.

Table 3: Respondents' perceived health benefits of *Moringa oleifera* tree products (n = 244)

Perception Statement	Weighted sum	Mean score	Rank	Remark
Moringa is effective in treatment of High Blood Pressure	1032	4.23	1st	Agreed
Moringa is effective in providing vitamins/minerals	1000	4.10	2nd	Agreed

Moringa is effective in treatment of Malaria	991	4.06	3rd	Agreed
Moringa is effectively helpful in aiding digestion	980	4.02	4th	Agreed
Moringa is effective in treatment of Diabetis	979	4.01	5th	Agreed
Moringa is effective in treatment of Stomach pains	977	4.00	6th	Agreed
Moringa is effective in treatment of Typhoid fevers	954	3.91	7th	Agreed
Moringa is effective in treatment of Malnutrition	951	3.90	8th	Agreed
Moringa is effective in stimulating appetite	949	3.89	9th	Agreed
Moringa is effective in treatment of Arthritis	935	3.83	10th	Agreed
Moringa is effective in treatment of Eye/Ear Infection	932	3.82	11th	Agreed
Moringa is effective in treatment of Low Libido	925	3.79	12th	Agreed
Moringa is effective in treatment of Skin diseases	898	3.68	13th	Agreed
Moringa is effective in treatment of Liver/Kidney diseases	878	3.60	14th	Agreed
Moringa is effective as Anti-Microbial agents	877	3.59	15th	Agreed
Moringa is effectively helpful in overcoming depression	875	3.59	15th	Agreed
Moringa is effective in treatment of Fibroid	872	3.57	17th	Agreed
Moringa is effective in treatment of Anemia	854	3.50	18th	Agreed
Moringa is effective in treatment of Infertility	833	3.41	19th	Agreed
Moringa is effective in treatment of Sexual diseases	831	3.41	19th	Agreed

Sources: Field Survey, 2020

Note: Bench mean score = 3.0

Constraints associated with Utilizing *Moringa oleifera* tree products

The constraints faced by the respondents to utilization of Moringa tree products in the study area is presented in Table 4. The major constraints indicated by the respondents were inadequate finance to purchase Moringa ($\bar{X}$ = 1.87), poor access to credit facilities ($\bar{X}$ = 1.71) and inadequate extension services ($\bar{X}$ = 1.69) ranked 1st, 2nd and 3rd, respectively among the constraints perceived to be severe. Other severe constraints include inadequate awareness of Moringa products ($\bar{X}$ = 1.56), poor market value for Moringa products ($\bar{X}$ = 1.55), small farm size of Moringa production ($\bar{X}$=1.48) and crude nature of processing Moringa products ($\bar{X}$ = 1.47) ranked 4th, 5th, 6th and 7th, respectively. However, lack of knowledge about Moringa benefits ($\bar{X}$ = 1.56), high cost of purchasing Moringa products ($\bar{X}$ = 1.55), problem of pests and diseases ($\bar{X}$=1.48) and poor access to Moringa tree products ($\bar{X}$ = 1.47) ranked 8th, 9th, 10th and 11th, respectively were the constraints perceived not be severe by the respondents.

Table 4: Respondents' constraints to utilization of *Moringa oleifera* tree products (n = 244)

Constraints	VS (3)	S (2)	NS (1)	WS	WM	Rank	Remark
Inadequate finance to purchase Moringa	187	40	17	658	2.70	1st	Severe
Poor access to credit facilities	165	64	15	638	2.61	2nd	Severe
Inadequate extension services	127	68	49	566	2.32	3rd	Severe
Inadequate awareness of Moringa products	128	59	57	559	2.29	4th	Severe
Poor market value for Moringa products	120	33	91	517	2.12	5th	Severe
Small farm size of Moringa production	108	50	86	510	2.09	6th	Severe
Crude nature of processing Moringa products	105	48	91	502	2.06	7th	Severe
Lack of knowledge about Moringa benefits	83	74	87	484	1.98	8th	Not severe
High cost of purchasing Moringa	47	92	105	430	1.76	9th	Not severe

products							
Problem of pests and diseases	43	97	104	427	1.75	10th	Not severe
Poor access to Moringa tree products	26	114	104	410	1.68	11th	Not severe

Sources: Field Survey, 2020

Note: VS = Very Severe, S = Severe, NS = Not Severe (Bench mean score = 2.0)

Conclusion and Recommendations

Based on the empirical evidence from the findings of this study, it could be concluded that majority of the respondents were male, married and educated. Leaves, fruits/seeds and roots are the most utilized Moringa tree products utilized by the respondents and were perceived to have health benefits as it is effective in the treatment of various ailments. It was therefore recommended that adequate awareness should be created through extension agency on the need to utilize Moringa oliofera tree products. Natural medicine stakeholders should also endeavour to educate rural farmers on the health benefits of utilizing Moringa tree products.

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SUB-THEME G

LIVESTOCK PRODUCTION, FISHERIES AND AQUACULTURE

Comparative Studies on the Binding Potential of Yam Starch (*Discorea rotundata*) and Cassava Starch (*Manihot esculenta*) In Aquatic and Livestock Feeds

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Abstract

The study was carried out to compare the suitability of yam starch and cassava starch as local alternative binding agents in Aquatic and micro-livestock feeds. Meanwhile, the binding property of yam starch in feed pellet increased significantly with the levels of inclusion in fish feed production. Five percent (5%) Yam Starch inclusion level was found to be appropriate in producing desirable water stable pellet that is also firm to handling during transportation and storage. Conversely, 5% Cassava starch inclusion level was the worst while binding was at its best at Cassava Starch level of 20%. Generally, four levels of cassava starch inclusion on binding property were found to be significant ($p<0.05$) in grasscutter feed. Maximum values were obtained at 10,15,20 and 20% levels of cassava starch inclusion for diets 1,2,3 and 4 respectively in terms of pellet forming index and dust level generated. The binding characteristics of the cassava starch in the pelleted fed diets increased as the level of inclusion increases and decreases with increase in the level of grass meal inclusion with values specific to a particular diet sample. This binding is of immense importance to aquatic and livestock feed production industries.

Keywords: Binding potential, Yam, Cassava starch, in Aquatic and Livestock feed.

Introduction

One of the greatest problems militating against the production of fishes and livestock in Nigeria is the problem of high cost of feed. Consequently, there is need for both fish and livestock farmers to source for locally available feed produced at best comparative cost for optimum profit. In some tropical countries like Nigeria, the world largest producer of cassava and yams, establishment of cassava and yam based agro-allied industries will be beneficial with a potential to export processed cassava starch and yam starch. There is high demand for binder in the feed industry (Kosoko et al 2011). Conventional binders are synthetic and often imported into most African countries (Falayi et al 2000, Nweke et al 2002).

Farm made aqua feed unlike livestock feed need adequate processing and compounding to ensure optimum nutrient availability and utilization by the target fish and livestock. In recent years, the utilization of pelleted animal feed in the feeding of animal has increased among farmers because of its numerous advantages which include wholesome delivery and increase nutritional utilization of the feed components among others (Tiamiyu et al 2003).

Meanwhile, when the composition of a feed is considered, more attention is given to these components, which provide nutrient to the cultured species at the required level (Annor et al 2008). The importance of binders in aquaculture and livestock industries cannot be over emphasize since they are used in animal feed to improve the feed consistency, minimize wastage, reduce disintegration and loss of nutrients, thereby increasing feed efficiency (Kosoko et al 2011). Therefore, this study aims at establishing the range of natural binders such as cassava and yam starch in aquaculture and animal feed.

Materials and Method

The materials used in this project work include yam and cassava that were obtained from a private farm while soyabean, vitamins supplement, fish and bone meals were obtained from an animal feed shop.

A. Yam Starch Processing: A yam tuber of 2kg size of the variety *Discorea rotundata* (white yam) was peeled, washed and grated. The paste (4 litres) was then mixed with sufficient quantity of water to allow for proper exudation of the starch from the fiber. The supernatant was decanted to obtain the starch, which was dried in the sun at about 36^0C for 6 hours and then packaged in 5, 10, 15 and 20 grams for incorporation in the five (5) diets.

Feed Preparation and Pelleting: Binder level in an exist Isonitrogenous diet formula of 30% crude protein was reconstituted with the use of yam starch at inclusion levels of 0, 5, 10,15 and 20% in diets 1, 2,3,4 and 5 respectively (Table 1). For effective inclusion of the starch, the yam starch was mixed in its powdery form with other feed ingredients and on which a 120% v/w boiled water was added and stirred thoroughly to obtain a good dough. The formed dough was then fed into an Atlas Motorized Bohr Miller (pelleter) with a 3mm die pellet size.

Experimental Design for Yam Starch Inclusion: Completely Randomized Block Design was used to analyze parameters such as pelletability, hardness, dust and water stability while 5x4 factorial design was adopted for pellet friability.

Statistical Analysis: The data was analyzed using a one way Analysis of variance (ANOVA).

B. Cassava Starch Processing: The raw cassava tubers (*Manihot esculenta*) were peeled, washed and grated with electrically powered mechanical grater in line with the method describe by Kordylas (1990). Meanwhile, the pulp obtained was then mixed with sufficient quantity of water to allow for proper exudation of the starch from the fibre. The solute was then poured into a muslin cloth and squeezed to obtain the starch solution filtrate. The filtrate was allowed to settle for about 6-8 hours and the supernatant poured away. The thick starch remaining was washed again by re-suspending in water and left to settle for overnight for thorough separation.

Preparation of Pelleted Feed: The cassava pelleted feed was prepared by mixing the required quality of starch powder with water in ratio(1:1) and heated on fire with constant stirring and thoroughly mixed separately using Hammer Milling Machine and mixed together to form a dough.

Experimental Design for Cassava Starch Inclusion: Unlike the yam experiment, a 4x6 factorial design consisting of 4 diets levels (0, 10, 20 and 30 percent of grass meal inclusion) and 6 levels (5%, 10%, 15%, 20%, 25% and 30%) of cassava starch inclusion in the diets was adopted for the pellet feed production.

All data collected during the experiment was subjected to a one-way Analysis of Variance (ANOVA) procedure.

Results and Discussion

From the result obtained in Table 2, the pelleted yam starch (binder) exhibited significant differences among the parameters measured; the percent Dust level shows a significant ($P<0.05$) difference among different level of starch inclusion. Highest percent of dust was recorded at 0% level of inclusion. The pelletability among starch levels also showed significant ($P<0.05$) difference, with highest percent pelletability in 0% level of starch inclusion and lowest in 15% level of inclusion. As for pellet hardness, it exhibited the high degree of hardness (Table 2) at 0% level of starch inclusion, which shows that the pellet is the best. But the dust level was the highest (Table 2), which is an indication for insufficient binder in the feed that resulted in the softness of the pellets. More so, at 20% level of starch inclusion, the dust level was lowest but lowest percentage of pelletability was obtained (Table 2). This is due to gumming together of the pellets which is an indication of over binding, advantage of our starching. The gumming together of the pellet strands is a function of the adhesive property of the binder (Somsverb, 1993;). However, at 5% level of starch inclusion, the best obtainable pellets were achieved. This is in line with the work done by Orire et al 2010. The pellet displayed good pelletability, hardness, water stability and minimum dust level of 0.9% (Table 2) that would ensure stable pellets that will not easily disintegrate in the aquatic medium,(Desilva and Anderson, 1995)

Measurement for the friability indicated no significant (P>0.050) difference among starch levels irrespective of the variations in the rpm. However, there was a significant (P<0.05) difference among rpms irrespective of starch levels. Moreover, friability percentage was found to be highest at 100 rpm and lowest at 40rpm, which was also significant (P<0.05). (Table 3).

Meanwhile, friability was best at 40rpm and at most 63rpm but could not withstand rpm as high as 100rpm (Table 3). Therefore it can be concluded that the use of yam starch as binder for fish feed is best at 5% of inclusion and that would ensure the desirable pellets.

The results obtained from correlation analysis of the grasscutter's diet (Table 5) clearly showed that there was high level of variability among the Test Diets in terms of the physical characteristics such as pellet forming ability, pellet forming index, dust level and densities with respect to the experimental variable, i.e. level of starch inclusions. The pellet forming index is often used to assess the mechanical strength (durability) of a pellet and is therefore an important quality parameter in feed (Rosentrator et tal 2005). The Bulk Density (BD) is a measure of packaging characteristics of particulate solids. This is an important factor as it determines the inter-particulate bonding that facilitates closer packing. The result obtained from Table 5 revealed that there is variation in both the loose and the bulk densities of the diet samples. The higher the density, the better its ability in resisting outside forces that breaks it. In most cases high quality pellets were the denser, which also corresponded to high quality durability (Kosoko et al 2011). A higher bulk density also reduces shrinkage as less material is lost to dust and also improves handling in feeding equipment when compared to lower bulk density (Dozier, 2001).

Conclusion

From the result of this study, it was observed that yam starch was suitable as a local alternative binding agent in aquatic feed, which is effective and nutritive. The binding property of yam starch in feed pellet, increased significantly with the levels of inclusion in fish feed production. Five percent (5%) Yam Starch inclusion level was found to be appropriate in producing desirable water stable pellet that is also firm to handling during transportation and storage.

Conversely, it was observed that 20% Cassava Starch inclusion level brought about a desirable pellet for grasscutter's feed which is in line with the work done by Orire et al 2001 which disclosed that binding was at its best of Cassava Starch level of 20% and 5% cassava starch inclusion level was the worst due to under-binding and consequently poor pelletability. This is an indication that both yam starch and cassava starch can serve as good binders in Aquaculture and livestock feed industries when they are used in appropriate levels of inclusions as stated above.

Table 1: Percentage Composition of Diets with varying levels of Yam Starch as Feed Binder

Feedstuff	Diets %				
	1	2	3	4	5
Soyabean meal	33.19	32.60	31.90	29.40	28.20
Fish meal	25.70	22.64	22.10	20.20	18.10
Guinea corn bran	36.11	34.76	33.60	30.40	28.70
Yam starch	0	5	10	15	20
Vit. min. premis	5	5	5	5	5
Total	**100**	**100**	**100**	**100**	**100**
Proximate Composition					
Moisture	7.43	13.40	16.81	20.21	23.61
Crude protein	28.91	28.91	28.91	28.91	28.91
Ether Extract	9.9	9.9	9.9	9.9	9.9
Ash	26.19	21.19	16.19	11.19	6.19

Source: Orire et al 2010.

Table 2

Physical Parameters of Yam Starch Based Feed Starch Level

Parameter	0%	5%	10%	15%	20%
Dust	0.12^{c}	0.09^{bc}	0.09^{bc}	0.06^{ab}	0.02^{a}
Pelletability	90.5^{e}	84.96^{d}	80.91^{c}	65.75^{a}	79.11^{b}
Hardness	5.16^{c}	5.24^{d}	4.16^{b}	6.52^{d}	3.68^{a}
Water stability	46.05^{bc}	47.74^{d}	46.31^{c}	45.74^{b}	41.71^{a}

Data on the same row carrying different letters differ significantly from each other ($p<0.05$).

Source: Orire et al 2010.

Table 3: Friability of Yam Starch Based Feed

Rpm	0%	5%	10%	15%	20%
40	0.04^{a}	0.5^{ab}	0.05^{ab}	0.05^{ab}	0.05^{ab}
63	0.07^{abc}	0.07^{abc}	0.09^{abcdf}	0.09^{abcd}	0.10^{bcd}
80	0.09^{abcd}	0.10^{bcd}	0.09^{abcd}	0.09^{abcd}	0.13^{d}
100	0.14^{d}	0.12^{cd}	0.11^{cd}	0.13^{d}	0.13^{d}

Data on the same row carrying different letters differ significantly from each other ($p<0.05$)

Source: Orire et al 2010.

Table 4: Formulation Used for the Production of Grasscutter Feed Per 100g.

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4
Maize	40	36	32	28
Wheat offal	30	24	18	12
Grass meal	0	10	20	30
Soya bean meal	22	22	22	22
Fish meal	5	5	5	5
Bone meal	2	2	2	2
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Vitamin and mineral premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated Chemical Composition%				
Protein	24.98	24.74	24.51	24.27
Fibre	5.41	12.81	20.53	27.64

Source: Kosoko et al 2011

Table 5: Person's Correlation Matrix between levels of Cassava Starch inclusion

Sample Diets and Test Parameter

Parameters	**Level of Starch Inclusion**	**Diet Type**	**Pellet forming Ability**	**Pellet Forming Index**	**Dust Level**	**Loose Density**	**Bulk Density**
Level of Starch Inclusion	1						
Diet Type	0.000	1					
Pellet Forming Ability	0.261*	0.259*	1				
Pellet Forming Index	0.454**	0.849**	0.449**	1			
Dust Level	0.788**	0.603**	0.539**	0.894**	1		
Loose Density	0.009	0.967**	0.251*	0.825**	0.581*	1	
Bulk Density	0.006	0.960**	0.252*	0.790**	0.562**	0.937**	1

Source: Kosoko et al 2011

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Comparative profitability analysis of means of fishing craft motorization by artisanal fisherfolks on Epe Lagoon, Lagos State Nigeria

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Abstract

This study undertook a comparative profitability analysis of means of fishing craft motorization by artisanal fisherfolks on Epe Lagoon, Lagos State Nigeria. The craft motorization was grouped broadly into Manual Propulsion Technology (MPT) and the Motorized Technology (MT). A multistage sampling technique was used to select 100 respondents, stratified equally in the two strata MPT and MT. Primary data on monthly production cash expenses and revenue were collected using structured questionnaire as interview guide. The data were analysed using profitability ratios. The comparison of Net Income per month for MPT was ₦70,602.55 and for MT, ₦168,447.25. The Cost and Returns analysis indicate that for every N1.00 invested, a MPT fisherfolk will have a return of ₦ 2.77 while a MT fisherfolk will have a return of ₦ 2.27. The BCR values suggested that the ability of MPT to make substantial catch may depend on some socioeconomic factors such as skills and experience and fishing frequency and duration. The study recommended that the unemployed youth should seek employment in this sector; the government and other institutions should provide incentives to assist the fisherfolks purchase the MT; the fisherfolks in the study area need to be educated on the merits of their forming cooperatives to solve their mutual felt needs; government should legislate on the open access fishing, arisen from excess profit accruable; while ADPs should continually give technical advice to the fisherfolks on how best to use the various fishing technologies, in order to ensure sustainable artisanal fishing.

Keywords: Craft motorization, Manual Propulsion Technology (MPT), Motorized Technology (MT)

Introduction

Fish supports over two hundred million Africans as a source of food, nutritional security and income for small-scale fisherfolks and entrepreneurs in many coastal developing countries like Nigeria (Oyediran, Sodiya, Omoare & Ogbonna, 2017). Fish consumption is considered a key element in a healthy diet because it is a unique source of micronutrients and long chain omega-3 fatty acids (FAO, 2020). The artisanal fisheries in Nigeria cover the operations of small motorized and non-motorized canoes by fisherfolks in the coastal areas, and is always characterized by low capital outlay, low operational costs, low technology application and high labour intensity, but provides jobs and source of income for over 400,000 fisherfolks, fish processors, fish marketers in the coastal areas of Nigeria as well as members of their families (Bolarinwa, 2012; FAO, 2017). Although there have been technological changes in artisanal fishery in three main sectors: the capture sector; post-harvest marketing and processing sectors and those engaged in rural aquaculture, the artisanal fishery in Nigeria is still underdeveloped with little or no technological improvement. A major technological change in capture sector is the means of fishing craft propulsion. There are two means of propulsion by which fishing crafts are moved along the body of water: Manual Propulsion Technology (MPT), using paddles and sails and the Motorized Technology (MT), using outboard mounted engines or inboard diesel engines. The profitability of artisanal fishing is directly related to available capital invested improved fishing equipment and the fishing method. Possession of motorized craft is advantageous because the ability of the craft to transverse depends on whether it is motorized or manually propelled (Ogundiwin, 2014). Motorized boats save the fisherfolks' time, energy and provide easier and deeper navigation within the water bodies (Olaoye, Idowu, Omoyinmi, Akintayo, Odebiyi & Fasina, 2012). The fisher folks are aware of the technological improvement in craft motorization and its attendant benefits. Their inability to attain their capabilities and reap the rewards of their labour by adopting MT is to a large extent, linked with poverty and inaccessibility of credit. This paper is therefore set against this background to conduct a comparative analysis of the profitability of MPT and MT fisherfolks.

This study is significant because increased awareness of the health benefits of fish has increased its demand. A lacuna therefore exists in production relative to consumption. This may have contributed to the massive importation of fish to augment local production. Nigeria is a net importer of fish and fish products. In 2013, Nigeria total fish imports was about USD 1.2 billion (FAO, 2017). For a country with a fragile post-recession economy, spending over $1billion dollars in fish importation will be catastrophic because importation especially of goods that can be produced locally is a major source of leakage in an economy (FAO, 2017). Yet more than 80 percent of Nigeria's total domestic production is generated by artisanal small-scale fishers from coastal, inshore, creeks of the Niger Delta, lagoons, inland rivers and lakes and so there is need to encourage the improvement of the sector (FAO, 2017). It is therefore an encouraging report that the Minister of Agriculture and Rural Development, Sabo Nanono, disclosed that following Federal Government's effort to encourage local production, Nigeria may stop fish importation by 2020.

Materials and Methods

Study area

Epe lagoon is located in Lagos State, South-West, Nigeria. It is one of the ten lagoons in Lagos state. The lagoon is sandwiched between two lagoons: Lagos and Lekki lagoons while River Oshun flow into it, making it to be relatively fresh and stable all through the seasons. Epe lagoon has 460 km^2 brackish water areas, with its salinity ranging between 0.24±0.19, pH 7.56±0.05 and temperature 30.35^o C±0.17 (Soyinka and Ebigbo, 2012). Although Epe Lagoon is not one of the major lagoons in Lagos State, it supports major fishing activities in Lagos State (Badejo et al., 2014).

Sampling technique

A multistage sampling approach was adapted. Eight communities living on the banks of the lagoon were purposively selected based on the ease of accessing the communities. 120 artisanal fisherfolks respondents were selected using snowballing method. The respondents were stratified into two mutually exclusive strata based on means of craft motorization employed: MPT crafts (i.e. paddles, sails etc.) and MT crafts (i.e. inboard engines or outboard engines). Data was obtained using structured questionnaire as interview guide. Respondents were interviewed in either Yoruba or pidgin English by enumerators. Out of the initially intended sample size of 120 fisherfolks, only 100 interview schedules were appropriately filled and used for the analysis. The 100 respondents comprised 50 MPT fisherfolks and 50 MT fisherfolks.

Analytical tools

Profitability ratios of Gross Margin, Net Margin, Net Returns on Investment and Benefit Cost Ratios, were used in comparing the profitability of the two technologies. Depreciation values of the components of fixed cost like craft, gears and propulsion technology i.e. engines, paddles, were estimated using straight-line method based on the assumption that canoes and engines were used for a period of five years before scrapping them without salvage values (Anyanwu, Mkpado & Ohaka, 2009). The profitability ratios for an average fisherfolk for each stratum were calculated:

$NI_{ij} = TR_{ij} – TCE_{ij}$- Depreciation ………………………. (1)

$NROI_{ij} = NI_{ij}/TCE_{ij}$ ……………………..(2)

$BCR_{ij} = TR_{ij}/TCE_{ij}$ ……………………. (3)

$TCE_{ij} = TVC_{ij} + TFC_{ij}$……………………...(4)

Where:

NI_{ij} = Net Income (₦) of ith fisherfolk using jth technology

$NROI_{ij}$= Net Returns on Investment of ith fisherfolk using jth technology

BCR_{ij}= Benefit Cost Ratio of ith fisherfolk using jth technology

TR_{ij} = Total Revenue (₦) accruing to the ith fisherfolk using jth fishing technology

TCE_{ij}= Total Cash Expenses (₦) incurred monthly by the ith fisherfolk using the using jth fishing technology

TVC_{ij} = Total Variable Cost (₦) incurred monthly by the ith fisherfolk using jth technology

TFC_{ij} = Total Fixed Cost (₦) incurred monthly by the ith fisherfolk using jth technology

Results and Discussions

The Table I shows that the monthly Total Revenue earned by a MPT and MT fisherfolks were ₦110,475.00 and ₦300,989.90 respectively, while their Total Cash Expenses were ₦39,872.45 and ₦132,542.65. Further analysis showed that although the Net income of the MT (₦168,447.25) is higher than MPT (₦70,602.55), This result corroborates the findings of Kareem *et al*. (2013) who also reported a higher monthly revenue for MT fisherfolks in Ijebu Waterside, Ogun State. It further lays credence to Alfred-Ockiya (1986) argument that the mean monthly income of artisanal fisherfolks in River State, Nigeria, compared favourably with the income of many white-collar jobs in the country. MT returned less on investment due to very high contribution of the outboard engine and fuel to the Total Cash Expenses of the MT fisherfolk. The depreciated cost of Outboard engine and the cost of fuel contributed 37.88% and 20.78% respectively of the Total Cash Expenses. The Benefit-Cost ratio accruable to MPT and MT were 2.77 and 2.27 respectively. These results indicate that for every ₦1.00 invested the MPT fisherfolk will have a return of ₦2.77 while the MT fisherfolk will have a return of ₦2.27. The results of this comparison revealed that though, the MT had the better access to cover a long distance and make more and bigger catch, the operators of MPT will make substantial catch, though this may largely depend on some socioeconomic factors such as skills and experience of the fisherfolk and fishing expedition duration and efforts put in. However, both technologies are profitable because their B-C ratio were greater than 1, which supports with the findings of Kareem *et al.* (2013) that explained that artisanal fishery enterprise is a profitable business.

Table I: Comparative analysis of the monthly profitability of an average fisherfolk based on technology

ITEMS	**MPT**		**MT**	
	Amount (₦)	Percent of TC	Amount (₦)	Percent of TC
Variable Cost VC				
Hiring of a fishing boat	200.00	0.50	0.00	0.00
Fuel	0.00	0.00	27,539.39	20.78
Kerosene	1,490.00	3.74	1,000.08	0.75
Bait	8,362.50	20.97	6,904.76	5.21
Battery	1,657.50	4.16	1,034.38	0.78
Repairs/maintenance of crafts	4,150.00	10.41	6,931.82	5.23
Repairs/maintenance of engine	0.00	0.00	8,765.15	6.61
Repairs/maintenance of gears	2,375.00	5.96	3,133.87	2.36
Cooperatives membership dues	0.00	0.00	0.00	0.00
Landing/fishing levy	0.00	0.00	0.00	0.00

Government levy	0.00	0.00	0.00	0.00
Miscellaneous expenses	303.57	0.76	303.57	0.23
Total Variable Cost TVC	**18,538.57**	**46.94**	**55,613.02**	**41.96**
Fixed Cost FC				
Depreciation (at 5 years with zero salvage value):				
Cost of one craft	18,200.75	45.65	23,720.00	17.90
Cost of one outboard engine	0.00	0.00	50,209.38	37.88
Cost of one paddle	283.00	0.71	0.00	0.00
Cost of fishing gears	2,850.13	7.15	3,000.25	2.26
Total Fixed Cost TFC	**21,333.88**	**53.51**	**76,929.63**	**58.04**
Total Cash Expenses (TCE)	**39,872.45**	**100.00**	**132,542.65**	**100.00**
Total Revenue TR	**110,475.00**		**300,989.90**	
Gross Margin GM	**91,936.43**		**245,376.88**	
Net income NI	**70,602.55**		**168,447.25**	
Net Returns on Investment NROI	**1.77**		**1.27**	
Benefit-Cost Ratio BCR	**2.77**		**2.27**	

Source: Field survey data, 2019

Conclusion and recommendations

The following recommendations arising from the findings are proffered with a view to put in place appropriate measures that would enhance fishery sustainability in the study area and the country in general:

i. the unemployed youth should be encouraged to exploit the artisanal fishery sector as a source of employment and income generation;

ii. the Nigerian government should monitor financial organizations to ensure that credit facilities are given to fisherfolks to enable them purchase the outboard engines that enhances their catch per unit effort;

iii. the agencies can help fisherfolks to own the outboard engine by granting them hire purchase incentives or other soft financial incentives like subsidized the cost of outboard engine;

iv. non-payment of cooperatives membership dues/ levies shows a non-existence of active cooperative societies in the study area. The fisherfolks need to be educated on the potentials of their coming together in a cooperative society to solve their mutual felt needs instead of relying on external assistance;

v. the government through the ADPs should continually give technical advice to the fisherfolks on how best to use the various fishing technologies in the study area;

vi. there is also need for legislation on the open access (unlimited) fishing, arisen from excess profit accruable (profitability) to artisanal fisherfolks in the study area through the enforcement of closed season to enhance species regeneration.

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Effects of Sodium Bicarbonate on Some Antioxidant Enzymes and Lipid Peroxidation in *Clarias gariepinus*

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Abstract

The effect of sodium bicarbonate on some antioxidant enzymes (catalase (CAT), Superoxide dismutase (SOD), Glutathione-S- Transferase (GST) and Lipid peroxidation (LPO))) in the plasma of juvenile and adult life stages of *Clarias gariepinus* was investigated in this study. After exposing the fish to different concentrations (0.00 - control; 50, 100, 150, and 200 mg/L) of sodium bicarbonate solution, blood plasma samples were collected and the antioxidant enzymes activities were measured. Results from the analysis showed that the activities of SOD, LPO and GST increased significantly ($P<0.05$), while the values of CAT reduced in both sizes when compared to the control. Results indicate concentration dependent activation of oxidative stress and subsequent alterations in the activities of these antioxidant enzymes, which were more pronounced in the juveniles than the adult fish. The result from this study, therefore suggests that sodium bicarbonate may induce oxidative stress, which is capable of overwhelming the antioxidant system of this species, especially at higher concentrations of exposure.

Keywords: African **c**atfish, Sodium bicarbonate, Oxidative biomarkers, Aquaculture, Anaesthetics.

Introduction

Aquaculture industry in Nigeria has expanded tremendously in recent times, making it one of the fastest food producing sector in the country (Akinrotimi *et al*., 2011a). As a result of this growth, fish in the cultured medium are being intensively manipulated from the hatchery to the final commercial stage. Consequent of this, the culture fish are subjected to handling stress on a regular basis (Akinrotimi *et al.*, 2011b). Anaesthetics are widely used to reduce the incidence of stress in aquaculture (Coyle et al., 2004). Sodium bicarbonate, commonly referred to as baking soda, is a white substance that gives carbon-dioxide when dissolved in water (McFarland and Klontz, 1969). Its main advantages lie in its low cost, wide availability and safety to both fish and humans (Altun *et al*., 2009). Sodium bicarbonate has been effectively used as an anaesthetic in common carp (*Cyprinuscarpio*) in both cold and warm water conditions (Booke *et al.*, 1978, Altun et al., 2009), Rainbow trout (*Oncorhyncusmykiss*) (Keen et al., 1998), Nile tilapia (*Oreochromis niloticus*) (Opiyo *et al*., 2013) and in *Clarias gariepinus* (Akinrotimi *et al*., 2014).

Conversely, oxidative stress is an imbalance between the production of reactive oxygen species and antioxidant mechanism in cellular systems that results in damaging of the cells (Weidinger and Kozlov, 2015). Chemical applications induce reactive oxygen species through several biochemical mechanisms which results in lipid peroxidation, alterations of cellular redox status and certain aging disease conditions (Blanco-Ayala *et al.*, 2014). Exposure of fish species to anaesthetics by sodium carbonate have been reported to cause changes in internal physiology of fish (Pawar *et al.*, 2011; Solomon *et al.*, 2014). A study by Akinrotimi *et al.* (2014), demonstrated changes in the haematological parameters of catfish (*Clarias gariepinus*) exposed to sodium carbonate. Also, in an extensive study by Akinrotimi *et al.* (2018), alterations were observed in some plasma enzymes, of fish exposed to sodium carbonate anaesthetics, Changes in antioxidants in fish exposed to anaesthetics, sodium chloride inclusive were limited, thus necessitating the need for this work. The aim of the current study is to determine the effects of sodium bicarbonate on antioxidant enzymes in different sizes of *C. gariepinus* which hitherto has not been reported.

Materials and Methods

Experimental Location and Fish

The study was carried out in African Regional Aquaculture Center, an outstation of Nigerian Institute for Oceanography and Marine Research, Aluu, Rivers State, Nigeria. A total of 150 *Clarias gariepinus* which comprised of 75 juvenile (mean length 26.75± 5.98 and mean weight 265.06± 17.24) and 75 adult (mean length 46.88± 12.07 and mean weight 788.91± 45.70) were sourced from the center. The fishes were transported in six open 50 litre plastic containers to the laboratory and acclimated for a period of seven days.

Source of anaesthetics agents

The test chemical, sodium bicarbonate was purchased off shelf from a chemical shop in Port Harcourt. It is manufactured by Hunan Chembird Industrial Company Limited, Changhsha, China, for use in fish transportation

The concentrate is prepared at 9 g/100 ml of water following the method of Booke *et al.* (1998). And it is administered by immersion.

Preparation of test solution

A stock solution of the anaesthetics was prepared by adding 1 ml of the anaesthetic concentrate to 1 litre of water. Exposure concentration of anaesthetics were 0.00 (control); 50, 100, 150, and 200 ml/L. Thirty, (15 for each size) of 50 L plastic containers were labeled and each filled with water from the borehole to the 30 L mark. The different concentrations were prepared by serial dilution by measuring 50, 100, 150 and 200 of the stock solutions (×30) that was made into 30L with the borehole water that gave the desired concentrations.

Experimental Design and procedure

The experimental design is a 1x2x3 complete randomized design. The chemical is hydrophilic in nature and the anaesthetic solution was then stirred with a glass rod (50 cm in length) for homogeneous mixture. Within 10 minutes, the tanks were randomly stocked with five juveniles per tank and five adults per tank, using a scoop net. Three tanks were used for each concentration as well as the control for each of the fish sizes. The tanks were not aerated during the experimental period. Water quality parameters were also determined using the methods APHA (1998). Duration of fish exposure to various anaesthetics at different concentrations depends on the induction and recovery time.

Antioxidants Enzymes Assay

At the end of each experimental period (90 minutes), 2ml of fresh blood sample was collected from the caudal region with a fine needle and poured into heparinized sample bottles.Blood samples were centrifuged immediately for 15 minutes at 5000 rpm.Plasma specimens were separated, pipetted into eppendorf tubes and stored in a refrigerator at -20°C until assayed (Ellman, 1959). The results were read using a universal microplate reader on a Jenway visible spectrophotometer (Model 6405, Shanghai, China). The activity of antioxidants in centrifuged plasma was determined spectrophotometrically using the method of Beechey *et al.* (1975). LPO was estimated by measuring TBARS (thiobar-bituric acid-reactive substances) in serum samples according to a modified method of Jentzsch (1996). Briefly, 0.2 ml of serum was added to the reaction mixture containing 1 ml of 1% ortho-phosphoric acid, 0.25 ml alkaline solution of thiobarbituric acid-TBA (final volume 2.0 ml) followed by 45 min heating at 95℃. The results were expressed as nmol MDA per milliliter of plasma.

Statistical Analysis

All the data were expressed as mean and standard deviation of mean. The statistical package, SPSS Version 22 was used for the data analysis. The means were separated using tukey multiple comparasion test and the two means were considered significant at 5 % (P<0.05).

Results

The water quality parameters (Table 1) were within the same range except in DO and pH.. The effects of Sodium bicarbonate on the antioxidants in the plasma of *C.gariepinus* juveniles are presented in Table 2. It was observed that the values of SOD, GST and LPO increased with increasing concentrations of the chemical. While CAT decreased significantly when compared to the control values. The same trend was observed in the antioxidants of adult fish exposed to the chemical (Table 2).

Table1: Physico-Chemical Parameters of Test Media

Concentration (mg/l)	DO (mg/l)	Temperature (^oC)	pH	NH_3 (mg/l)
0.00	$5.92{\pm}0.39^{b}$	$29.54{\pm}2.09^{a}$	$6.66{\pm}1.21^{a}$	$0.01{\pm}0.01^{a}$
50.00	$5.71{\pm}0.54^{b}$	$29.33{\pm}3.48^{a}$	$6.71{\pm}1.44^{a}$	$0.02{\pm}0.01^{a}$
100.00	$5.43{\pm}0.29^{b}$	$29.74{\pm}1.79^{a}$	$6.92{\pm}1.82^{a}$	$0.02{\pm}0.01^{a}$
150.00	$5.08{\pm}0.69^{b}$	$29.65{\pm}3.32^{a}$	$7.99{\pm}0.32^{b}$	$0.03{\pm}0.01^{b}$
200.00	$4.39{\pm}0.44^{a}$	$29.88{\pm}5.54^{b}$	$8.32{\pm}0.66^{c}$	$0.03{\pm}0.01^{b}$

Means within the same column with different super scripts are significantly different (P<0.05)

Table 2: Antioxidants Enzymes Activities in *C. gariepinus* Juveniles Exposed to Sodium bicarbonate

Concentration (mg/l)	Antioxidants Enzymes (IU/L)			
	CAT(IU/L)	**GST(IU/L)**	**SOD(IU/L)**	**LPO(nmol/ml)**
0.00	0.69±0.02 [b]	0.33±0.01[a]	0.43±0.07[a]	6.06±0.78 [a]
50.00	0.62±0.15 [b]	0.36±0.01 [a]	0.49±0.07 [a]	7.99±0.89 [a]
100.00	0.55±0.03 [b]	0.53±0.01 [b]	0.77±0.00[b]	10.00±1.62 [b]
150.00	0.30±0.02 [a]	0.63±0.02 [b]	0.89±0.01[b]	12.00±1.71 [b]
200.00	0.18±0.06 [a]	0.86±0.01 [c]	1.41±0.02[c]	14.32±2.57 [b]

Means within the same column with different super scripts are significantly different (P<0.05)

Table 3: Antioxidants Enzymes Activities in *C.gariepinus* Adults Exposed to Sodium bicarbonate .

Concentration (mg/l)	**CAT (IU/L)**	**GST(IU/L)**	**SOD(IU/L)**	**LPO(nmol/ml)**
0.00	0.77±0.05 [b]	0.40±0.05 [a]	0.51±0.04 [a]	8.81±1.32 [a]
50.00	0.71±0.03 [b]	0.43±0.01 [a]	0.59±0.01 [a]	10.66±1.52 [b]
100.00	0.69±0.01 [b]	0.60±0.20[b]	0.99±0.07 [a]	12.00±1.00 [b]
150.00	0.54±0.05 [a]	0.69±0.10[b]	1.43±0.02[b]	13.66±2.88 [b]

200.00	0.35±0.08 [a]	0.96±0.07[c]	1.96±0.09[b]	19.09±2.03 [b]

Means within the same column with different super scripts are significantly different (P<0.05)

Discussion

Reactive oxygen species (ROS) which include hydrogen peroxide (H_2O_2), superoxide anion and hydroxyl radicals are generated during biochemical reactions and the antioxidant enzymatic systems protects organisms from the toxic effects of the free radicals and help to maintain cellular homeostasis by neutralizing the ROS (Zhou et al., 2012). When there is an imbalance between the ROS and the antioxidant system due to excessive generation of the free radicals, cellular oxidative stress develops (Adeyemi, 20014). Free radicals generated reacts with biological macromolecules causing increase in lipid peroxidation (LPO), deoxyribonucleic acid damage and protein oxidation with ultimate disturbance in the physiological processes (Chandra *et al*., 2015). In this study, the data showed that lipid peroxidation significantly increased in a concentration dependent manner. The elevated values of lipid peroxidation obtained in this study agree with previous reports in fish exposed to different herbicides and other toxicants (Adeyemi, 2014).

Increased activities of the superoxide dismutase, catalase and the GST within the exposure time indicate that the rate of reactive oxygen species production may have increased with change in concentration from control to 200mg/l of sodium bicarbonate. Increased production of the free radicals may result to oxidative stress as the antioxidant enzyme system is overwhelmed. Dabas *et al.* (2011)] reported that fish has limited capacity of the antioxidants to neutralize the effects of the free radicals. The decreased CAT when compared with the control may be due to free radical damage on the macromolecules of the fish. Puerto *et al*. (2010) reported that decreased CAT activity may be attributed to direct damage of protein structure and an increased production of hydrogen peroxide. This result suggests the onset of oxidative damage of macromolecules due to the overwhelming presence of reactive oxygen species generated from the exposure of catfish to different concentrations of sodium bicarbonate.

Conclusion

The results of the current study highlight the importance of considering all potential physiological and biochemical effects of a prospective anaesthetic agents used in aquaculture. It is clear that different anaesthetics can have marked effects upon blood chemistry of fish. Thus, careful consideration should be taken when selecting an anaesthetic for use in aquaculture. ,

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Impact of slaughterhouse waste on broiler production

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Abstract

This study was conducted to ascertain effect of slaughterhouse waste on broiler production. The broiler performance has compared together with using completely randomized design (CRD) with 3 treatments and 4 replicates. A total of one hundred and twenty (120) one day old broiler starters were used. These birds were assigned to three experimental diets in which diet T_1 contained 0% goat blood-rumen content mixture (GBRCM). Diet T_2 contained (10% GBRCM) and diet T_3 contained (10% GBRCM with 5% garlic (*Allium sativum)* supplementation. The three (3) groups were replicated four (4) times with ten birds per replicate and the experiment lasted for five weeks (35 days). Parameters evaluated were; body weight gain, feed intake, feed conversion ratio, protein intake, protein efficiency ratio and economics of production. The results of this study revealed that birds fed (GBRCM) supplemented diets had significantly ($P<0.05$) superior body weight gain, feed intake and feed conversion ratio than birds fed the unsupplemented diet. There was no significant ($P>0.05$) difference on the parameters of the birds fed the control diet (T_1) and diet (T_2) among the treatments. Diet 3 had the best feed conversion ratio than diets T_1 and T_2 respectively. The lowest cost per kilogramme body weight gain of N 168.24 was obtained for diet T_2 (10% GBRCM) while the highest cost per kilogramme body weight gain of N 220.05 was recorded for diet T_1 (control). The supplemented GBRCM) in the broilers starter diets enhanced the growth performance, reduced the cost of production and improved feed conversion ratio.

Introduction

The poultry feed shortage with increases in price of feed materials has been a serious setback of expanding poultry industries in Nigeria. This limited feed ingredients and high price of these materials motivated the search for alternative feed sources to tackle the problem. Broiler production use smaller amount of feed per kilogram of meat produced, use smaller land and water for both farming and feed production (Flachowsky *et al*., 2017). The use of antimicrobial growth promoters added to the diet at low level is a practice that has been banned in the EU since 2006, but the use of therapeutic antimicrobials in the animal production industries is still high (Van Boeckel *et al*., 2015). Recently, use of antimicrobials is decreasing, in some cases leading to an increase in intestinal health problems. To reduce such problems, feed additives have been used to improve digestive processes. Feed additives have been administered to enhance digestion (Amerah *et al*., 2017; Gonzalez-Ortiz *et al*., 2017).

Out of the several constraints facing the poultry industry, feed availability remains the most challenging of them in the tropics (Girma *et al.*, 2011).The use of appropriate feedstuff and adoption of new innovations supplementary diets will enhance broiler production. For instance, a slaughterhouse wastes is generated on daily basis at slaughterhouse. It is undigested grasses in the rumen especially from ruminant animals and can serve as poultry nutrition. Generally, it can enhance growth and reduce the cost of rearing poultry and other monogastrics. Slaughterhouse utilization as poultry feedstuff will also alleviate and reduce the environmental pollution and its disposal. (Onu *et. al*., 2011; Esonu *et. al*.,2011). Goat blood-rumen content used in addition with aromatic plants can qualify it as a viable alternative protein substitute in poultry diets (Onu *et. al*., 2011). The protein quality of goat blood-rumen content compares adequately with costly soya bean meal. Grass contains back-up nutrients such as proteins, vitamins, fibre and compounds like omega-3 fatty acid to prevent any deficiencies of feed from affecting the chickens (The Poultry Site, 2013). It has been obtained by (Mohammed *et al.*, 2011; 2013 and 2014) that inclusion of blood-rumen content mixture up to 40% level in the diets had not adversely affect performance, digestibility, blood parameters and carcass measurement of growing rabbits. Again, the effective use of this nutritional feedstuff can reduce feed cost, improve the stock size and number of chicken sold. Hence, this study was designed to investigate the impact of supplementing slaughterhouse waste on the performance of broilers.

Materials and Methods

The research was carried out at the Teaching and Research Farm (Poultry Unit) of the Department of Animal Science, Ebonyi State University, Abakaliki in Ebonyi State Nigeria. **Source and Processing of Goat** Blood-Rumen Content Mixture

Goat blood-rumen content was collected from the abattoir at Igboji market in Ebonyi State, Nigeria. The rumen was split open with the aid of sharp knife and the content was emptied into a 25 litres plastic bucket. The rumen content was mixed with blood collected at the ratio of 3:1.

It was poured into a pot and boiled for 30minutes, sun-dried on concrete floor t about 12% moisture and was stored for mixing with other feed ingredients.

The results of the proximate composition of the feed ingredients used in the formulation of the experimental diets are shown in Tables 1.

Table 1: Proximate Composition of Feed Ingredients: GBRCM

Parameter%	GBRCM
Dry matter	93.10
Crude protein	35.00
Crude fibre	27.96
Ether Extract	4.32
Total Ash	13.50
Nitrogen free extract	48.92

Experimental Diet

Three experimental broiler starter diets shown in Table 2 were formulated such that diet I (T_1) contained 0% GBRCM without supplementation (control). Diet 2 (T_2) contained 10% GBRCM without supplementation. Diets T_3 contained 10% GBRCM supplemented with 0.5% garlic in 1kg of feed.

Table 2: Ingredients Composition (%) of the Experimental Broiler Chicken diets

Ingredients %	T_1 (0% GBRCM)	T_2 (10% GBRCM)	T3 (10% GBRCM & Garlic 0.5%)
Maize	50	50	50
Soyabean meal	22	12	12
Wheat offal	13	13	13

GBRCM	00	10	10
PKC	10	10	10
Fish meal	2.0	2.0	2.0
Bone meal	2.0	2.0	2.0
Lysine	0.25	0.25	0.25
Methonine	0.25	0.25	0.25
Premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Total	100	100	100

Premix supplied (Univit 15 Roche) contained: 15001.U, Vit.A;15001.U, Vit.D;30001.U, Vit.E;3.0g, Vit.K;2.5g, Vit,B2;0.3g, Vit.B6; 8.0mg, Vit.B12;8.0g, Nictinic acid; 3.0, Ca-Panthothenate;5.0mg, Fe;10.0g, Al;0.2g, Cu;3.5mg, Zn;0.15mg, I;0.02g, Cu;0.01g,Sc. GBRCM =Goat blood rumen content mixture.PKC =Palm kernel cake

Table 3: Calculated Chemical Composition of the broiler Experimental starter diets

	T_1	T_2	T_3
Ingredient %	%	%	%
Crude Protein	21.32	21.31	21.31
Ether Extract	3.84	3.79	3.79
Crude Fibre	4.26	6.40	6.40
Total Ash	3.57	3.21	3.21
Total ME/Cal (kg)	307060	299120	299120

Total ME/Cal (kg) = Total Metabolizable Energy per Calorie in Kilogramme.

Experimental Animal and Management of the Broiler Chicken

One hundred and twenty day old chicks were used for this experiment. Each bird was weighed using weighing balance (Cambry model) before the commencement of the experiment and weekly throughout the experiment period. The birds were randomly allotted to three (3) dietary treatments in a completely randomized design (CRD). Other poultry management practices were maintained and the experiment lasted for five (5) weeks (35days).

Statistical analysis

All data obtained were statistically analyzed.

Results and Discussions

The proximate composition of the experimental diets is presented in Table 4. The results of proximate composition of experimental diets were showed the following parameters determined the dry matter, crude protein, crude fibre, ether extract values, ash content and metabolizable energy content respectively. Goat blood-rumen content has superior crude protein; crude fibre and ether extract values than the control diet but lower in metabolizable energy content. The nutrient content of the unsupplemented diets (T_2 10% GBRCM) and the supplemented (T_3) were similar. The disparity in nutrient composition may be due the type, chemical composition and stage of growth of grass consumed by the animals and the proportion of the constituent mixtures. This could also be influenced by the period of fasting prior to slaughter and stage of digesta degradation in the rumen (Onu *et al*., 2011). The high crude protein value of GBRCM suggests its utilization as a protein supplement in diets for broilers.

Table 4: Proximate Composition of Experimental Diets

Treatment (%) GBRCM & APs	DM	CP	CF	EE	ASH	ME(Cal/g)
0%	92.73	19.18	8.57	8.19	9.10	3189.71
10% GBRCM	92.66	21.48	12.34	9.39	9.50	3110.95
10% GBRCM & 0.5% Garlic	92.19	21.68	12.50	9.53	9.68	3125.30

GBRCM = Goat blood-rumen content mixture DM = Dry matter, CP = crude protein, CF = Crude fibre, EE = Ether Extract, Ash = Total Ash, ME (CAL/kg) = Metabolizable Energy (calories per kilogram).

GBRCM and GBRCM with garlic supplementation of the diets significantly ($P<0.05$) improved the weight gain of birds than the control diet. There was no significant ($P>0.05$) difference in the weight gain of broilers fed the control (T_1) and unsupplemented (T_2) diets.

The improved growth of broiler chicks may have emanated from enhanced digestion of food nutrients and probably improved food absorption through the wall of gastrointestinal tract (Ademola *et al.*, 2005).

The results of the effect of the experimental diet on the performance of broilers are presented in table 3 below

The results showed that the supplemented diets significantly ($P<0.05$) improved the weight gain of birds than the control diet. The improved body weight gain obtained in this work strengthened the reports of Onu *et al.* (2011) who reported weight gain of birds fed blood-rumen. There was higher weight gain and better feed conversion ratio of the supplemented diets than the control. This shows that the percentage of GBRCM was mote utilized than control.

Table 5: The Effect of Experimental Diet on the Performance of Broilers

Parameters (g)	T1 (0%)	T2 (10% GBRCM	T3 10% GBRCM & 0.5% Garlic	SEM (+)	SIGN
Initial Body Weights (g)	147.50^{a}	143.75^{a}	145.65^{a}	1.47	*
Final Body Weights (g)	1139.58^{b}	1118.75^{b}	1279.17^{a}	26.22	*
Daily Body Weights (g)	28.33^{b}	27.86^{b}	32.38^{a}	0.75	*
Daily Feed Intake (g)	86.81^{b}	87.05^{b}	90.00^{a}	0.50	*
Feed Conversion Ratio	3.07^{a}	3.15^{a}	2.81^{b}	0.07	*

Daily Protein Intake	18.51^{b}	18.55^{b}	19.18^{a}	0.11	*
Protein Efficiency Ratio	1.51^{b}	1.50^{b}	1.69^{a}	0.03	*

GBRCM =Goat Blood-Rumen Content Mixture, SEM=Standard Error of Mean

Table 8: Result of the Economics of Production of Broilers

Parameters (₦)	T1 ₦	T2 ₦	T3 ₦
Cost of feed per kilogramme (₦)	73.04	56.64	58.64
Total Daily Feed Intake (g)	86.81	87.05	90.00
Cost of feed consumed (₦)	221.90	172.55	184.72
Total Body Weight Gain (g)	991.67	975.00	1133.33
Cost of feed/kg Body Weight Gain (₦)	220.05	168.24	209.35
Cost savings (%)	-	51.81	10.70

The results showed that the cost of feed per kilogramme, cost of feed consumed, and cost of feed per body weight gain decreased with the inclusion of GBRCM in the diets. The supplemented of GBRCM based-diets reduced the cost of feed consumed, cost of feed per body weight gain and improved cost savings.

The higher weight gain and better feed efficiency of the supplemented diets are two major possible influences which resulted in increased cost saving and consequent increased profitability of the broilers fed supplemented diets.

Summary/Conclusion

The supplementation of soyabean meal with goat blood-rumen content enhanced broiler starter growth improved feed conversion ratio and reduced cost efficiency of broiler production. The results obtained in this research could be concluded that feeding goat blood-rumen content can be included in broiler diets up to 10% improved growth performance without any adverse effect on the birds. Its inclusion in broilers rations will improve broilers production and reduce the cost of rearing broilers. Again, the effective use of this nutritional feedstuff can reduce feed cost; improve the stock size and number of chicken sold. The lower price of the diets containing GBRCM supplementation would help reduce pollution problems.

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Effects of dietary selenium nanoparticles on the growth performance of African catfish, *Clarias gariepinus* (Burchell, 1822)

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Abstract

This study assessed the effects of dietary Selenium nanoparticles (SeNP) supplementation on the growth performance of African catfish, *Clarias gariepinus.* One hundred and fifty (150), apparently healthy *C. gariepinus* fingerlings with the average weight of 4.69 ± 0.10 were randomly distributed into a rectangular tank of 40x30x35cm^3 at ten(10) fish per tank. Selenium nanoparticles (SeNP) was supplemented in the fish diets at 0, 0.50g, 1.00g, 1.50g and 2.00g /100g levels in treatments T1 (control), T2, T3, T4 and T5 respectively. The experiment was in three replicates.The fish were fed for 56days at 5% body weight twice daily at 8.00hours – 9.00hours and 16.00hours – 17.00hours GMT. The fish were weighed weekly and the feed intake adjusted according to the fish weight gain. After the feeding trials, results showed that Selenium nanoparticles supplementation significantly improved the growth performance of fish with increasing Selenium nanoparticles supplementation. Fish fed with 1.00gSe/g had the highest protein efficiency ratio (1.04 ± 0.18), weight gain (10.13g ± 0.34) and growth performance. In conclusion, this study showed that 1.00gSe/g is sufficient to ensure good nutrient utilization and growth performance of *Clarias gariepinus* fingerlings.

Keywords: *Aquaculture, aquafeed, nanotechnology, nutrient utilisation, supplements*

Introduction

Fish is an excellent source of amino acid, vitamins and high quality unsaturated fatty acid, it is a food of excellent nutritional value, providing high quality protein and a wide variety of vitamins and minerals including vitamin A and D, Phosphorus and Selenium (Agbabiaka 2014). The aquaculture industry has been globally recognized as the fastest growing food producing industry (FAO 2010). One current idea is that nanoparticles will enhance aquafeeds by increasing the proportion of fish food nutrients that pass across the gut tissue and into the fish, rather than passing directly through the fish digestive system unused (Handy 2012). Nanotechnology involves the applicationof materials at the nanoscale to new products or processes (Handy 2012). Among the multifaceted applications of nanoparticles in the fisheries and livestock world, reports are also appearing on enhanced efficacy of nanoscale selenium in reproduction, digestion, growth, and immunomodulation (Hassan et al2004). It is one of those areas that many aquaculture experts are turning to (Handy 2012). Therefore, Nanotechnology and nanoparticles are increasingly recognized for their potential applications in various aspects of human and animal welfare like development of various healthcare or cosmetic products, nano-electronics and techniques for environmental remediation, and many consumer products (Ahamed et al 2010).

Selenium is a very important trace element that show significant efficiency at nanoscale level. The inclusion of Selenium in the diet of cultured fish has generated much interest as it has been found to have benefits for production, reproduction , normal growth, development and flesh quality, maintenance of fish health, in particular fish immunity(Bell and Cowey1989). In Nigeria, the African catfish *Clarias gariepinus* is a fish of choice by fish farmers because of its biological attributes that include faster growth rate, resistance to diseases and possibility of high stocking density (Gbadamosi 2019). The fact that fish, especially African Catfish that is widely consumed is a good source of Selenium in the human diet presents an opportunity for fish farmers to produce Selenium-enriched fish for improved human health (Rayman 2012). Therefore, it is important to know the effect of selenium nanoparticles on cultivated fish species like *C. gariepinus* and the required doses for metabolism and proper body functioning. Hence this research is intended to examine the effects of dietary Selenium nanoparticlessupplementation on growth performance, nutrient utilization and gut health of *Clarias gariepinus*.

Materials and Methods

Experimental site and Preparation of Experimental diet

The study was carried out at the Research and Teaching farm of the Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure, Ondo State, Nigeria. The feed ingredients were purchased at Animal Concept, Akure, Ondo State. Selenium nanoparticles was purchased from T2Biosystems, Lexington, USA. Five isonitrogenous diets were formulated to provide 45% crude protein with increasing supplementation levels of selenium nanoparticles (0.00g/100g, 0.50g/100g, 1.00g/100g, 1.50g/100 and 2.00g/100g) designated as T0, T1, T2, T3, T4 and T5 respectively asshown in Table 1. All dietary ingredients were weighed with a sensitive weighing top balance. The ingredients were then ground to a small particle size, ingredients such as selenium nanoparticles, and vitamin premix were thoroughly mixed in the mixture to obtain a homogenous mixture. Cassava starch was added as a binder. The homogenized feed mixture was then pressed without steam through a mincer attached to a pelleting machine (Hobart A-200T) using a 2mm diameter die. After pelleting, the feeds were immediately sun-dried for 72 hours at ambient temperature of 27-30^{o}C and air dried. After drying, the diets were sieved and stored prior to the start of the feeding trial. Standard and official methods (AOAC 2000) were used to carry out the proximate analyses of the experimental diets in the study.

Table 1: Composition of the experimental diet in g/100g dry matter containing varying inclusion level of Selenium nanoparticles for *Clarias gariepinus*

	TREATMENTS				
INGREDIENTS	T1(Control)	T2	T3	T4	T5
Fish meal 70%	25.30	25.30	25.30	25.30	25.30
Soybean meal 48%	20.50	20.50	20.50	20.50	20.50
Groundnut cake 45%	23.40	23.40	23.40	23.40	23.40
Yellow maize 10%	20.80	20.80	20.80	20.80	20.80
Starch	3.00	2.50	2.00	1.50	1.00
Selenium NP (g)	0	0.50	1.00	1.50	2.00

Total (g)	100	100	100	100	100

Vitamins premix contains vitamin A (25,000,000 I.U), Vitamin D3 (2,000,000 I.U), Vitamin E (200,000 I.U), Vitamin K3 (8,000mg), Folic Acid (4,000mg), Niacin (150,000mg), Vitamin B2 (20,000mg), Vitamin B12 (10mg), Vitamin B1 (1,500mg), Vitamin B6 (12,000mg), Biotin (800mg), Antioxidant (100,000mg), Vitamin C (500,000mg). Mineral premix contains Selenium (200mg), Iodine (5,000mg), Iron (40,000mg), Cobalt (2,000mg), Manganese (50,000mg), Copper (4,000), Zinc (40,000mg), Choline chloride (600,000mg), Lysine (100,000mg), Methionine (100,000mg)

Feeding Trials

The experimental design was five treatments with three replicates each. A total of fifteen tanks were used. Ten fish (5.61±0.04g) were randomly stocked in each tank and fed to apparent satiation twice daily for 70 days. Fish in each tank was weighed bi-weekly to measure the growth performance. Water parameters were maintained at temperature 27 - 30 ^{o}C; dissolved oxygen 6.5-8.3 mg/L and pH 6.0 - 8.5. After 70 days, fish in each tank was counted and weighed. Fish performance evaluation was measured using the following indices as described by Gbadamosi (2019). Mean Weight Gain (MWG), MWG $=W_F-W_I$. Where; W_F = Final weight, W_I= Initial weight. Specific Growth Rate (SGR), SGR % = Log_e Final weight – log_e Initial weight/ Culture period x100. Feed Conversion Ratio (FCR**)**, FCR = Total Feed Intake/ Total Weight Gain. Gross Feed conversion efficiency (GFCE**):** GFCE = 1/ FCR X 100.Protein Intake(PI),PI = feed intake x crude protein in the diet/1000. Protein Efficiency Ratio (PER**),** PER = MWG/Mean PI.

Statistical Analyses

All data collected during the trial were tested for normality using the Kolmogorov–Smirnov test and homogeneity of variance using Levene's test. All analyses were performed using SPSS software version 13 (SPSS Inc.). All values are shown as arithmetic mean ± standard deviation.

Table 2: Growth parameters and nutrient utilization of *Clarias gariepinus* fed varying level of Selenium Nanoparticles.

PARAMETERS	T1(control)	T2	T3	T4	T5	*p*
Initial weight (g)	4.69±0.10[a]	4.69±0.10[a]	4.75±0.13[a]	4.82±0.32[a]	4.77±0.16[a]	0.59
Final Weight(g)	11.57±0.35[a]	12.50±0.39[a]	14.88±0.26[b]	12.70±0.31[a]	11.63±0.26[a]	0.04
Weight Gain (g)	6.88±0.36[a]	7.81±0.41[a]	10.13±0.25[b]	7.88±0.14[a]	6.86±0.31[a]	0.039
Feed Intake (g)	15.96± 0.15[a]	18.82 ± 0.13[a]	19.75 ± 0.32[b]	18.59±0.14[a]	16.26± 0.13[a]	0.034
FCR	2.32 ± 0.06[a]	2.41 ± 0.08[a]	1.95 ± 0.13[b]	2.36 ± 0.38[a]	2.37 ± 0.16[a]	0.03
PER	0.84 ± 0.02[a]	0.83 ± 0.01[a]	1.04 ± 0.18[b]	0.85 ± 0.17[a]	0.75 ± 0.28[a]	0.04
SGR (g)	1.64 ±0.06[a]	1.71 ±0.06[a]	2.13 ±0.34[b]	1.75 ±0.21[a]	1.56 ±0.50[a]	0.04
Survival rate (%)	86.66±15.27[b]	96.66±5.77[c]	96.66±15.27[c]	76.66±15.27[a]	76.66±15.27[a]	0.04

Figures in each row (mean ± SEM) having different superscripts are significantly different ($P < 0.05$).

FCR = Feed conversion ratio, PER = Protein efficient ratio, SGR = Specific growth rate.

Results and Discussion

After eight (8) weeks of feeding trials, the growth performance of *Clarias gariepinus* fed diets supplemented with varying levels of dietary nano-Se is presented in Table 2. Fish that were fed diet supplemented with 1.00g Se/g (T3) displayed significantly better growth performance(P< 0.05) than other dietary treatments. Selenium nanoparticles supplementation was found to contribute to fish growth performance, it significantly enhanced the final weight, specific growth rate and weight gain of fish fed 1.00gSe/kg compared to other inclusion levels. Selenium is an essential element for fish normal growth and development (Hamilton,2004). This result was similar to that of Olsonet al(2005), which reported that selenium is a structural component of the physiological antioxidant properties and it acts as a growth promoter. It clearly indicated that Se supplemented diet could improve the final weight and relative gain rate of *Clarias gariepinus*, these results were similar with the ones demonstrated by Xuxiaet al(2009)on crucian carp (*Carassius auratus gibelio*).Xuxia et al (2009) concluded that Selenium nanoparticles improves adsorbing ability which result into higher proficiency in digestion and nutrient utilisation exhibited by higher absorption efficiencies in fish.

Conclusion

From this study, supplementary Selenium nanoparticles has been shown to increase growth performance of *C. gariepinus.* The results demonstrate that the weight gain, growth performance and feed utilization parameters of *C.gariepinus* were optimal with the diet contained 1.00gSeN/g. Thus, increasing demand from consumers for higher quality fish which also provides an excellent opportunity to produce fish rich in selenium. Furthermore nanotechnology may help aquaculture production by improving feed formulation and health of *C. gariepinus.*

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Effect of the blend of Fish Meal and Rubber Seed Meal (*Hevea brasiliensis*) feed on the Growth Performance of *Clarias gariepinus* juveniles.

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Abstract

The average initial body weight of experiment catfish was 10.18g±0.11g. a total of 300nos were distributed into 15 groups of 20 fish each group (i.e 5 diet treatments with triplicate group).experimental diets were identical in all composition except for the variation in RSM level. Non-inclusion of RSM was used at 0% (control) and other levels are 5% (diet 2), 10% (diet 3), 15% (diet 4) and 20% (diet 5). The fish exhibited remarkable weight gain in all the trails. However, the growth performance and nutrient utilization including total weight gain, specific growth rate (SGR), protein efficiency ratio (PER) were significantly ($P<0.05$) higher between fish fed control diet and other diet except SGR ($P>0.05$) in diet fed 5% RSM inclusion level. Highest body weight gain (35.73±3.11g) was recorded in the group of fish fed control diet (0% inclusion level). This was follow by 33.67±1.45g in fish fed 5% RSM inclusion level while the least weight gain (26.17±0.44g) was observed in the fish fed 20% RSM inclusion level. Based on the result of the present study it is concluded that RSM positively influence growth performance and feed utilization of African Catfish juvenile at 5% inclusion level.

Keywords: Rubber seed meal, Feed ingredients, Growth performance, African Catfish

Introduction

The over dependence on foreign floating fish feeds in addition to their exorbitant cost in Nigeria in the face of increased intensification of fish culture have necessitated the development of cost effective and sustainable local floating feeds using available feed stuff.

The relevance of good quality cost effective fish feed is very critical in the success of commercial aquaculture operations because it does not only reduces over-head cost of the fish farming but also provide suitable diet with required nutrient for optimum growth. Feed is a major input in aquaculture production and a fundamental challenge facing the development and growth of aquaculture (Gabriel *et, al*., 2007; Ibiyo *et, al*., 2011). Studies have shown that feed account for 60% of the total cost of fish production in Africa and to a large extent determines the viability and profitability of fish farming business (Jamu and Anyinla 2003).

An important aspect in fish farming is to identify economically viable and easily available ingredients for formulating diets that are nutritive, tasteful, acceptable and with maximum conversation ratio to give greater fish yield per application (Gull *et al*; 2005). It is also obvious that the low quality of fish and its cost are major factors limiting the development of aquaculture in Africa (Gabriel *et al*; 2007). Therefore research in fish nutrition geared toward utilization of locally available ingredients becomes very necessary for sustainable fish farming business.

The present study was undertaken to qualitatively and quantitatively analyze efficiency of Rubber seed as feed ingredient in relation to growth of juveniles of *Clarias gariepinus*. Rubber Seed meal (RSM) has been found to be a valuable feed stuff for growing livestock (Mmereole, 2008). Apart from serving as alternative source of protein in livestock feed ingredient (Deng, *et al;* 2017*;* Junming *et al; 2015*), it is not utilized by the human population which could have affected its availability and cost negatively. Rubber Seed Meal has been incorporated into ration at different inclusion levels for poultry, pigs (Lu Tong Due, 2001; Nguyen Thi Thuy and Ly 2001; Duong Duy Ding 2003). The present study was conducted to assess the suitability or otherwise of Rubber Seed Meal as a feed stuff in the artificial diet for *Clarias gariepinus* juveniles.

Materials and Methods

Experimental Fish:-

The African Catfish, *Clarias gariepinus* (Burchell, 1822) has been one of the most cultured species of fish for food in Nigeria. It was selected for the present study because it has excellent growth rate, easily availability, widely distributed, very acceptable and of high commercial importance etc.

Juveniles of *Clarias gariepinus* were collected from Almond fish farm, a reputable farm in Uyo, Akwa Ibom State. They were kept in the large tarpaulin pond and acclimatized for 15 days on the control feed in order to habituate them for artificial feeding. Thereafter, during experiment period of 90 days, the fishes were fed the formulated experimental diets at 5% of body weight/day. The weight of juveniles were measured after every 14 days and based on the increase in body weight of juvenile and their ration was readjusted at 5% of their body weight fortnightly.

Experimental Diets:-

Table 1 shows the five isonitrogeneous and isocaloric diets that were formulated for the purpose of the experiment. The control diet had no Rubber Seed Meal (RSM) while the other four diets contained RSM at 5.0, 10.0, 15.0 and 20.0 levels respectively. The fish meal, soy bean meal and corn flour were procured from local market and were dried and grounded to powdered form. The diets were fortified with vitamins, salt and fish oil.

Experimental Procedure:-

The experiment was in 15 Hapa in triplicate for each dietary treatment. The working dimension of each Hapa was 1x1x1.5 m^3. A total of 300nos. of *Clarias gariepinus* juveniles of 10.00±0.11g mean body weight were distributed into 15 groups of 20 fish each group. The study was conducted for 90 days. The water quality parameters, temperature, pH, DO were analyzed through the methods outlined by APHA (1985) and monitored daily. Water samples from all Hapa also taken on fortnightly basis to see the changes in physicochemical factors and their average values were calculated on monthly basis.

Statistical Analysis:-

Statistical analysis of data was performed by SPSS general linear models (GLM) procedure (SPSS 7.5) for significant differences among treatment means. The Duncan's multiple range tests was used to rank the means.

Table 1: Percentage Composition of Experiment Feed.

Ingredients	**Percentage Inclusion of Rubber Seed Meal**				
	0%	**5%**	**10%**	**15%**	**20%**
Rubber Seed Meal (RSM)	0.00	5.00	10.00	15.00	20.00
Fish Meal (FM)	28.00	28.00	28.00	28.00	28.00

Soy Bean Meal (SBM)	44.80	42.93	41.04	39.17	37.27
Corn Flour	19.20	16.09	12.96	9.83	6.73
Starch	1.00	1.00	1.00	1.00	1.00
Fish Oil	5.00	5.00	5.00	5.00	5.00
Salt	1.00	1.00	1.00	1.00	1.00
Premix	0.25	0.25	0.25	0.25	0.25
Vitamin C	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methonine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100

Table 2: Proximate Composition (%) of Experimental Feed.

Experimental Feed	**% Moisture**	**% Crude Protein**	**% Crude Lipid**	**% Ash**	**%Crude Fibre**
0 %	8.16±0.06	32.15±0.09	5.08±0.18	5.36±0.93	3.19±0.33
5%	8.12±0.05	32.12±0.25	5.15±0.25	5.33±0.13	3.26±0.10
10%	8.28±0.09	32.37±0.14	5.43±0.06	5.40±0.04	3.25±0.33
15%	8.12±0.06	32.86±0.59	5.21±0.28	5.39±0.04	3.08±0.35
20%	8.19±0.07	32.01±0.39	5.62±0.16	5.21±0.06	3.16±0.84

Results

The four inclusion levels of Rubber seed meal in experimental feed enhanced the growth of *Clarias gariepinus* in term of weight gain. The experimental diets are represented in Table 1. The proximate composition of the experiment diets are recorded in Table 2. The fish meal was blend with 0%, 5%, 10%, 15%, and 20% Rubber seed meal (RSM).

A decreasing trend in body weight gain was noticed with increasing level of RSM from 5% to 20% inclusion. Fish exhibited high survival rate in all treatments during the 90days feeding trial of Rubber seed meal (RSM) supplementation (Table 1). The water quality parameters were within the acceptable range for the culture of African Catfish. Dissolved Oxygen (DO) ranged from 8.98 to 9.45 mg/l. the water temperature from 29.7 to 38.3^{0}C and pH from 8.3-8.4. Data in Table 3 shows that African Catfish fed diet containing 5% RSM had a significantly higher p≤0.05 weight gain (33.67g) than all other fish except the fish fed control diet (0%). Specific Growth Rate (SGR=1.25% day^{-1}) was highest in control diet (0% RSM) but not significantly different (p≥0.05) in fish fed diet supplemented with 5% RSM (1.22% day^{-1}). It was least in fish fed 20% RSM (1.03% day^{-1}) values of Feed Conversion Ratio (FCR) were highest in fish fed 20% RSM Supplementation (2.73), least in control (2.13) while Protein Efficiency Ratio (PER) was highest in fish control diet (1.43) but least in fish fed 20% RSM (1.14).

Table 3:Growth Performance of *Clarias gariepinus* Juveniles fed Rubber Seed Meal (RSM) feed for 90 days (±SE)

Parameters	0%	5%	10%	15%	20%
Initial Body Weight (g)	10.01±0.01	10.04±0.04	10.03±0.04	10.33±0.003	10.50±0.29
Final Body Weight (g)	c	bc	ab	a	a
	45.73±3.11	43.67±1.45	39.33±0.33	37.89±1.19	36.67±0.33
Total Weight Gain (g)	c	bc	ab	a	a
	35.73±3.11	33.67±1.45	29.33±0.33	27.63±1.43	26.17±044
Protein Efficiency Ratio (PER)					
	c	bc	ab	a	a
	1.43±0.09	1.36±0.05	1.23±0.01	1.18±0.04	1.14±0.01
Body Weight Gain (%)	c	bc	ab	a	a
	356.94±3.01	335.36±2.09	292.43±1.91	266.51±1.36	249.24±1.31

Specific Growth Rate (SGR) (%/days)	1.25 ± 0.08^{b}	1.22 ± 0.03^{b}	1.13 ± 0.01^{ab}	1.07 ± 0.05^{a}	1.03 ± 0.02^{a}
Feed Conversion Ratio (FCR)	2.13 ± 0.19^{a}	2.24 ± 0.09^{ab}	2.56 ± 0.03^{bc}	2.65 ± 0.09^{c}	2.73 ± 0.06^{c}
Aggregate Growth Rate (AGR) (g/days)	0.29 ± 0.03^{c}	0.27 ± 0.01^{c}	0.24 ± 0.00^{ab}	0.22 ± 0.01^{a}	0.21 ± 0.00^{a}
Survival (%)	93.33±1.66	93.33±1.66	91.66±1.66	91.66±1.66	91.66±1.66

Mean in the square row sharing the same superscript are not significantly different (P≥0.05)

Discussion

Feed is one of the most important inputs in aquaculture industry. Davies *et. al*; (2006) has reported that over 30% of total operational cost of aquaculture enterprise represents diet cost.

It is hope that the blend of fish meal and Rubber seed meal in the formation of fish feed could result in the formation of efficient and cost-effective fish feed.

In this study, the survival rate of the fish in all the treatment was high. It shows that the RSM had no detrimental effect on fish and may be reason for general positive growth and fish performance across the treatments. However, a decreasing trend in growth performance was noticed with increasing level of Rubber seed meal from5% to 20% inclusion.

This indicated that dietary supplementation of RSM at a suitable inclusion level (5% in this study) could improve the growth performance and feed utilization in *Clarias gariepinus* juveniles. However the downward trend in weight gain with increased inclusion level of RSM might be attributed to the fact that most plant protein sources including RSM are high in anti-nutritional compound such as tannins (Abasiubong *et al*; 2018; De *et al*; 2010).

Highest body weight gain was recorded in the group of fish fed diet 0% level of inclusion of RSM. The specific growth rate was not significantly different ($p<0.05$) between the 0% and 5% level of inclusion of RSM. A lot of factors have been advanced to support the positive influence of some feed ingredient on nutrient utilization efficiency by fish. These include improved intestinal microbial balance, increased enzyme activity and hence improvement in digestibility and absorption of feed and its utilization (Bomba *et al*; 2002, Magi and Salik, 2003).

Similar results were observed in Rohu *labeo rohita* (Sharma *et al*, 2014); in hybrid Catfish (*Clarias gariepinus* X *Clarias macrocephalus*) Hung *et al*; 2005; Hotimah, 2013), were fish fed higher RSM base diet obtain significantly low value of protein efficiency ratio, suggesting that higher supplementation of RSM could alter the internal metabolism process in fish as well reduce nutrient digestibility (Abimorad *et al., 2009*).

Furthermore, the ability of an organism to convert nutrient especially protein positively influences its growth performance. This was justified by the growth performance in 0% and 5% RSM inclusion diets. Lower feed conversion ratio indicates better utilization of the feed by the fish. The least mean feed conversion ratio was observed in diet with 0% RSM and closely followed by diet with 5% RSM, indicating that fish in these diets had the best utilization of the feed.

Conclusion

The experiment concludes that fish meal could be supplemented with RSM (rubber seed meal) at 5% inclusion level and that ingredient of plant origin can be utilized to reduced the cost of fish feed. The present study reveals that 5% inclusion level of rubber seed meal (RSM) would be optimum for the growth of *Clarias gariepinus* juvenile.

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Impact of Different Mating Ratio on Fertility and Hatchability of Japanese Quails

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Abstract

Mating ratios are vital to optimizing the breeding efficiency of breeder flocks in poultry. The study was conducted to investigate the reproductive performance of Japanese quails flock maintained at different male: female ratios. 138, twelve week-old Japanese quails birds were randomly divided into four experimental groups with three replicates each and were assigned to one of the following male: female ratios, 1M: 4F, 1M: 3F, 1M: 2F and 1M: 1F. Eggs were collected daily and weekly egg production was calculated for each group. Hen day production, fertility as well as hatchability were not significantly affected by sex ratio. Increasing the sex ratio had little or no effect on average egg production, egg fertility and hatchability. However, group with male to female of ratio 1:2 recorded the highest hen day production (70.49%) and hatchability (70.28%) while group with ratio 1:1 recorded the highest (89.48%) egg fertility. Average of 1 male to 3 females quails was recommended for better performance in battery cage system while further studies should be conducted to see the interaction between housing system and sex ratio on the performance of breeding quails.

Key words: Sex ratio, Japanese quail, hatchability, fertility, production.

Introduction

The poultry sector is the largest among all the livestock industries in Nigeria. The poultry production is practiced at levels ranging from subsistence to large scale commercial operation. According to King'Ori (2011) the commercial operations depend on the hatcheries for the supply of day old chicks while the subsistence farmers hatch their chicks by natural incubation. The uninterrupted supply of quality day old chicks is mainly necessary for the success of poultry production chain, for these reasons, the quail breeder's needs to maintain the high fertility, high hatchability and also good quality of chicks. Reproduction trait such as fertility, hatchability and embryonic mortality are important factor affecting the number of chicks that can be obtained from a breeding flock.

Fertility is defined as the number of fertile eggs per chicken and determine by both the genetic and environmental factors such as mating ratio, parental age, rate of laying egg and climatic conditions. Since fertility is a low heritable trait and requires a complex genetic improvement programme. Therefore for small scale enterprises it is primarily of interest to perform remedial actions for the environmental effect that have an influence on the fertility. Too many or too few males in a unit may leads to higher proportion of infertilities of eggs. Male to female ratio for optimum fertility and hatchability varies from species to species i.e. chicken 8-9 males to 100 females (Hazary *et al*., 2004). In quails, 1 male to 2 females was reported (Shanaway, 1994).

Males to females ratio in a poultry flock is a major factor in clarifying the behavior in animals according to Haghighi *et al.* (2016) too few or too many males in a unit place may cause a higher percent of infertile eggs.

According to Tauson and Svensson (1990) there are many factors that contribute to poor fertility and hatchability of eggs and poor quality of chicks, some of them include improper temperature and humidity, poor sanitation, male to female ratio, longer storage period, improper settings of eggs and others.

Coturnix coturnix japonica is the smallest avian species being farmed and has been considered as a source of animal protein recently, quails are generally kept for egg production in far East and Asian countries, while they are reared primarily for meat and egg production in European and American countries. In Turkey, quails are kept as a dual purpose breed for meat and egg production also; quails are reared for production generally at family type small scale enterprise in villages. Quails raised for meat production and sold by being priced per animal (Navinc and Akson., 2012).

In captivity, breeding groups typically consist of 15 to 20 birds kept in battery cage with an area of 1.0m^3 to 0.5m^3 and a height of 16 to 20cm (Gerken and Mills 1993). Under these housing conditions, aggressive pecking mainly pecks directed to the head, may cause serious injuries (sometimes lethal) such as skin or eyelid lesions or eye loss, and it is one of the important welfare problem arriving in quail farming Gerken and Mills (1993) added. However, serious head injuries caused by aggressive pecking occurs not only under intensive housing conditions, but also when small groups of quails (8 to 9 birds per $19m^2$) are kept in semi-natural outdoor aviaries (Schmid and Wechsler 1997) variation in personality traits, so any changes in the ratio exhibits a marked effects on fertility and hatchability of eggs (Newcombe 1996). The ratio of male to female in a population is an important factor in determining behaviors in animals.

Japanese quail's eggs should be handled with great care as they are very susceptible to shell damage and colored egg shells of quail make candling difficult. One of the main problems has been to establish and maintain satisfactory reproduction of stock. The effect of some management methods on fertility in Japanese quails, such as stocking density, mating ratio rearing type have been investigated (Altinel., 2001). Investigation indicates that grouping a single male with two to five females in a wire cage reduces aggressive behavior while numerous male birds cause stress and aggressive pecking (Ophir and Galef, (2003). When quail are kept in individual cage, a single male with one to three females is sufficient and reduces fighting among birds; pair mating in individual cages also gives good fertility. Quail rearing in individual cage is applied rather in the genetic improvement studies. The producer that applies commercial production prefers wire type cages to individual cages. In the tropics, it is important to know the best sex ratio for most profitable hatchability in Japanese quail.

Materials and Methods

Experimental site

This research was carried out at the poultry unit of Agricultural Extension and Management Teaching and Research Farm of the Federal College of Forestry, Jericho, Ibadan, Oyo State, Nigeria. The area lies between latitude $7^0$26N and longitude $3^0$36E. With the climate typically dominated. Rainfall pattern ranges from between 1400mm-1500mm with an average temperature of 31.2^0C and relative humidity of 65%. The eco climatic of the area is rainfall with two distinct seasons which are dry season, usually commencing from November to March and raining season from April to October (FRIN Annual Metrological Report, 2006).

Experimental birds and design

The experimental birds were obtained from the Federal College of Forestry quail farm, Jericho, Ibadan. One hundred and thirty eight (138) day old Japanese quail were purchased, brooded and raised till 12 weeks of laying when the experimental treatments were introduced. During this period water and feed were supplied to the birds adlibitum. All other necessary management practices were carried out.

Experimental design

The experiment was set up in a complete randomized design (CRD) into four (4) treatments with three (3) replicates. The four treatments are the four sex ratios, 1M: 4F, 1M: 3F, 1M: 2F and 1M: 1F designated as T1, T2, T3 and T4 respectively. The trials lasted for 10 weeks while daily routine management such as sweeping of the pen house, sweeping of environment, picking of debris, washing of drinker, feeding of experimental birds (9hr and 17hr of the day) to avoid wastage. Picking of eggs is done daily and recorded before taking to hatchery.

Table 1: Composition of Experimental Diets for quails

Ingredients	% Inclusion
Yellow maize	47.2
Soya bean meal	46.0
Wheat offal	3.0
Lime stone	0.5
Di calcium phosphate	1.5
Lysine	0.1
Methionine	0.2
Premix*	0.25
Salt	0.25
Palm oil	1.0
Total	100.0

Data collection and analysis

Parameters assessed were on daily and weekly basis and they include;

Hen day production: This is the total number of egg laid in each experimental unit which are checked and picked for recording on daily basis and the calculation expresses as Total egg produced per unit divided by Total number of birds per unit multiplied by one hundred.

$$\frac{\text{Total egg produced per unit}}{\text{Total number of birds per unit}} \times 100$$

Egg fertility (%): Number of fertile eggs divided by number of eggs set multiplied by one hundred.

Egg hatchability (%): Number of hatched chicks divided by number eggs set multiplied by one hundred. All data collected were statistically analyzed using one way ANOVA using SPSS package.

Results and discussion

Table 2: Effect of sex ratio on egg production, fertility and hatchability of Japanese quails

Parameter	T1	T2	T3	T4	SEM
Hen day production (%)	65.88	63.00	70.49	51.03	0.085
Fertility (%)	86.76	83.33	86.76	89.48	0.288
Hatchability (%)	60.41	47.60	70.28	65.54	0.201

NB: T1, T2, T3 and T4 had 1M: 4F, 1M: 3F, 1M: 2F and 1M: 1F respectively.

SEM= Standard Error of Means

Table 2 shows the hen day production, fertility and hatchability of Japanese quail eggs.

From the result, it shows that treatments with 4 males and 8 females (1:2) had the highest (70.49%) hen day production followed by treatments with 2 males and 8 females (1:4) which recorded 65.88%. However, the result on hen day production shows no significant different among the treatments. The result agrees with the findings of Shanaway, (1994) who reported highest hen day production in treatment with 1 male to 2 females in Japanese quails. Treatment with 6 males to 6 females recording the lowest hen day production may not be unconnected with disturbance of the females by frequent sexual activities of males.

On egg fertility, the result revealed that T4 with the highest number of males (6) to females (6) that is (1:1) had the highest (89.48%) egg fertility percentage. However, the result of fertility was similar across the experimental treatments.

Moreover, the result also shows that T3 with 4 males and 8 females (ratio of (1:2) has the highest percent hatchability of 70.28% followed by T4 (65.54%). This is in agreement with the result of Laila *et al.* (2012) who used 1:4 male to female ratio to investigate egg quality, fertility and hatchability of quail eggs and reported similar results. Since the hatchability was not significant influenced by the sex ratios it implies that farmer can makes use of small galvanized wire cage to rear quail and maximized profit using the highest sex ratio. The varied hatchability may however result from egg handling before and during incubation and cases of hair cracked eggs.

Conclusion

The study concludes there is no significant difference among the treatments so studied. However treatments 4 and 3 had best results in terms of fertility and hatchability respectively. Hence male to female ratio of 1:2 to 1:4 will be adequate for the best quail chick production.

Recommendation

Since male to female of ratio 1:2 gave the very best result in quail chick production under battery cage system we will like to also recommend that this research be carried out on deep litter with larger flock size. Further research should also be conducted to see the interaction between housing system and sex ratio on the performance of breeding quails. Farmer who is aiming at maximizing profit will minimize cost of production and at the same time the aggressive characters among the birds by using an average of 1 male to 3 female quail in his breeding stock.

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A Study on the Impact of Brownish Red Colouration on Some Water Quality Parameters in the Production Ponds of the University of Agriculture, Makurdi Fish Farm

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Abstract

The study was carried out at the University of Agriculture, Makurdi Fish Farm to evaluate the water quality parameters of the production ponds of the fish farm which are very vital to the survival of the fish. The study was also to determine the impact of the brownish red colouration on the fish in some of the production ponds. It was observed that the brownish red colouration was found to be bloom caused by Ectocarpus, Batrachospermum, Spirogyra and Chlamydomonas which are brown, red and green algae respectively. These algae were found not to have any deleterious effect on the fish, because no fish kill was observed in the course of the study, but the bloom was found to have affected some physico-chemical parameters of water, particularly the concentration of Dissolved Oxygen and water transparency. The results obtained from Table 1, showed a mean Dissolved Oxygen concentration of 7.08±0.241mg/l for pond A. 5.00±0.277mg/l and 4.90±0.224mg/l, for ponds B and C respectively. The result also showed a significant difference in the concentration of Dissolved Oxygen between pond A, B and C ($p<0.05$).The water transparency results showed that the water in ponds B and C were turbid hence a low transparency of 32.00±6.70cm and 30.60±10.27cm respectively. The result also showed a significant difference between the water transparency of pond A (63.80±7.81cm), B (32.00±6.70cm) and C (30.60±10.27cm).

Keywords: Impact, Water Quality, Parameters, University, Agriculture, Fish Farm

Introduction

The quality of water plays an important role in fish culture, hence attempts must be made to control and manage water quality parameters effectively in order to yield optimum results, because good quality water will produce more and healthier fish than poor water quality (Boyd, 1990). This has informed our decision to investigate the impact of brownish red colouration on water quality parameters in the production ponds in the university. Meanwhile, pond waters usually contain planktonic algae of diverse types. These algae are critical to food chains as they provide food for the microscopic animals which are in turn eaten by fish and other aquatic organisms. Occasionally, planktonic algae can bloom to nuisance levels which may necessitate using control methods. Planktonic algae are least abundant in winter when cold water temperatures inhibit their reproduction and growth (Lynch, 2002). This is why most ponds are transparent during that period. As ponds warm at the beginning of summer, reproduction by algae increases greatly and the algae bloom occurs. (Okayi *et al*, 2011). The dense concentrations of planktonic forms which are responsible for these blooms are caused by some species of non-filamentous micro-organisms (Adefemi *et al.,* 2007).

Algae bloom can be defined as a sudden discoloration of water caused by the explosion of dino-flagellates producing a red colour. A bloom can also be defined as an aggregation of planktonic sufficiently visible. The colour of a bloom may be green, brown in rod, all depending species of algae dominating the water (Lynch, 2002). A bloom may occur at any time when conditions are favourable, but it is more common in spring and early summer when primary production increases ahead of the growth in consumer population (Boyd, 2001). Algae blooms cause the water to appear pea soup green or brown in colour, that is the turbidity is usually high hence this causes clogging of fish gills and consequently death. It also causes oxygen depletion in water as a result of retarding photosynthetic activities. Bloom die-off will also result to low dissolved oxygen as a result of decay or decomposition (Lynch, 2002, Basu, 2011,Buentello *et al.*, 2000). Water can be assessed to be of good or bad quality when the water parameters or variables are determined to be at optimum levels or not (Egwusi *et al.*, 2014). Some of these variables include: water temperature, turbidity, hydrogen ion concentration (pH), dissolved oxygen, biological oxygen demand, free carbon dioxide and total alkalinity.

Materials and Methods

Study Site

University of Agriculture, Makurdi Fish Farm is located at the South Core of the campus, about 200m away from the River Benue, which is its primary source of water supply. Three fish ponds were selected in the fish farm for the purpose of this study.

Pond A. This pond was not affected by the bloom. It served as the control for this research.

Pond B. This pond was affected by the bloom.

Pond C. This was also affected by the bloom.

Sampling

Algae Sampling

Algae sampling was done between June and August during the rainy season. Algae were sampled using a sampling bottle. The specimen in the samples were concentrated at the bottom of the bottle using formalin and identified immediately in the Biological Science Laboratory of the University. Sample was placed in the Petridish and identified using a light microscope with the aid of a taxonomic guide.

Water Sampling

The water sample were collected in triplicate from each location: two 250ml reagent bottles and one 1litre jerry can. One of the two reagent bottles from each station was fixed for dissolve oxygen on the fields. The samples in the jerry can were used for analysis of other physico-chemical parameters, while the other set of samples in the reagent bottle were incubated for BOD analysis. Samples were collected between June and August.

Water Analysis

The water samples collected from the field were subjected to analysis in the fisheries laboratory and food chemistry laboratory of the University.

***Temperature*:** This was determined for water temperature ex-situ using a mercury-in-glass thermometer (0-100^{0}C) which was immersed in water at above 10cm depth for 3 minutes to stabilize. The temperature was read on the stem according to the rise in mercury level.

***Turbidity*:** This was determined using the secchi disc. The secchi disc was slowly lowered into the water and keeping the line vertical, the depth at which it just disappeared was recorded as d1. The disc was lowered a little more and then raised, until it just reappeared and the depth was recorded as readings. (d1-d2)/ 2 cm.

***Dissolved Oxygen*:** This was determined titrimetrically using the Alterberg. Azide (Winkler's) method. The water sample collected in 250 ml reagent bottle was fixed with 2 ml alkaline Iodide and 2 ml Manganese sulphate at the field. This formed a white precipitate of manganous hydroxide in the laboratory, the precipitate was dissolved when 2ml of concentrated $H2S0_4$ acid was added. This yielded a yellowish solution 100 ml of the solution was transferred into a conical flask and 0.025 N sodium thiosulphate was titrated against it to a pale straw colour. 1ml of 1% starch solution was then added to form a dark blue colouration and the titration continued until a colourless solution was obtained. The volume of the sodium thiosulphate(v) was recorded and the value of dissolved oxygen determined from the relationship.

Do (mg/l) =volume of titrate (APHA 1985).

***Biological Oxygen Demand (BOD*).** This was determined in the same way Dissolved oxygen according to APHA, 1985 using Alterberg Azide method except that the raw water samples were incubated in bottle for 5 days in the dark. The BOD was then determined in the relationship BOD (mg/l) = Do (before incubation)-Do (after incubation).

Hydrogen Ion Concentration

This was determined using the pH meter (Model/Labtech digital 152R) values were displaced on the screen after the pH meter was conditioned or equilibrated the values displayed were recorded.

Free Carbondioxide: This was determined trimetrically using the sodium hydroxide method described by Saxena (1990). 100ml of water sample was placed into a conical flask 2-3 drops of phenolphthalein indicator was added and 0.002m. Sodium hydroxide solution was titrated until it turns to a pink colouration.

Free C02 mg/l = V1 = 100/Vs

V1 = Volume of titrant (sodium hydroxide)

Vs = volume of sample

***Total Alkalinity*:** This was determined by titration using $H2S0_4$ acid method described by Saxena (1990). To obtain total alkalinity, 2 indicators were used (phenolphthalein and methyl orange. 100ml of the sample was transferred into a conical flask. 2-3drops of phenolphthalein indicator was added and no colour change was observed. 2-3drops of methyl orange was also added then titred against 0.02N solution of $H2S0_4$ acid to a pink colouration. The value of total alkalinity was then determined in the relationship.

Total alkalinity as Ca C03 mg/l = TX100/V

T = Total Volume of $H_2S\ 0_4$ acid used

V = Volume of Sample

Results and Discussion

The results obtained from Table 1 showed that the mean values with the same superscript on the same row were not significantly difference from each other at 5% level of probability (p>0.05).

Three ponds on the fish farm were studied between June and August of the experimental year. The algae responsible for the brownish red colouration were identified, the physicochemical parameters of the water were assessed and the results are as shown below.

Identification of Algae

The species of algae identified in the course of study are as shown below:

Brown Algae, Red algae and Green Algae. The brown algae were more in number followed by the red Algae and green algae respectively that is 3:2:1.

Physico-chemical Parameters

Water Temperature

The water temperature of the various sample ponds are presented in Table 1. The results showed that water temperature was in the range of 28-29 °C in the three sample ponds. This reveals that there is no significant difference in the water sample ponds. The results also show that there is no significant difference in water temperature of the three ponds (p>0.05) at 5% level of probability.

Hydrogen Ion Concentration

The Variation in the pH between the three ponds are also presented in Table 1. The pH of the ponds varied from almost neutral to slightly alkaline. The results also show that there is no significant difference between the pH of the three ponds ($p>0.05$)

Dissolved Oxygen

The dissolved oxygen concentration of the three samples ponds are presented in Table 1. Pond C recorded the lowest mean value of 4.90 ± 0.224 mg/l while pond A recorded the highest value of (7.08 ± 0.241 mg/l). The results show that the concentration of dissolved oxygen in pond A differs significantly with pond B and C($p<0.05$) but pond B does not differ significantly with pond C($p<0.05$)

Free Carbondioxide

Variations in free carbondioxide are presented in Table 1. The results show that the concentration of free carbondioxide in pond A differs significantly with pond B and C ($p<0.05$)

Total Alkalinity

The results for the total alkalinity of the three ponds are presented in Table 1, and pond A recorded the highest concentration of 13.13 ± 1.288 mg/l. The variation between the three ponds shows that there is no significant difference in the total alkalinity between the ponds ($p>0.05$)

Biochemical Oxygen Demand (BOD)

The Biochemical Oxygen Demand content of the water at the various ponds is shown in table 1. The results show that BOD was in the range of 0.47-0.49 mg/l. The results also revealed that there is no significant difference between the three stations ($p>0.05$)

Water Transparency

The result for water transparency is also shown in table 1. The results revealed that water transparency decreased from pond A to pond B and C. Pond B and C have in high turbidity with water transparency of 32.00 ± 6.70cm and 30.6 ± 10.27cm respectively. Pond A has a water transparency of 63.80 ± 7.81cm. These results show that there is a significant difference between pond A and ponds B and c ($p<0.05$)

The algae identified were Ectocarpus, Batrachospermum, Spirogyra and Chlamydomonas, which are brown, red and green algae respectively. These divisions of algae were found to be the cause of the brownish colouration. This is in line with the work of Lynch (2002), that the colour of the water body may be greenish or brownish depending on the species of algae present in it.

Water Quality Parameters

The water temperature varied between 28-29^{0}c in the three ponds under investigation. Statistical analysis has shown that there is no significant difference in the water temperature of the ponds. This shows that the algae bloom does not have any effect on the water temperature. The range of the temperature also shows that it is normal for optimal growth of aquatic organisms (Boyd, 2001, Okomoda et al, 2016). The range of pH in the three ponds also reveals that it is within the optimal range suitable for fish production. Abowei (2010) described pH range of 6.5-9.0 as being the most suitable for fish production and also 5.0-9.5 as suitable for aquatic life (Bhatnaga et al, 2013, Akaahan et al 2015).

The high mean value of dissolved oxygen observed in pond A and low values in ponds B and C shows that the algae bloom has an effect on this water quality parameters.

Meanwhile, the algae compete with the fish over the oxygen for respiration. This is in line with the work of Boyd (2001) that almost all problems with dissolved oxygen fish culture are as a result of heavy plankton blooms. However, pond B and C whose range of dissolved oxygen is 4.80-5.20 mg/l is still above the critical concentration of 3 mg/l (Boyd, 2001).

The variation in the concentration of free carbon dioxide show that it is not interfering with the growth and the survival of the fish in the three ponds. The mean value are 2.05$\pm$0.236mg/l, 2.56$\pm$0.179mg/l and 2.53$\pm$0.136mg/l for pond A, B and C respectively. This means that carbon dioxide concentration less than 5mg/l is good for fish growth. Also the mean values of free carbon dioxide concentration in ponds B and C are higher, indicating that the high density of algae respire hence, increasing the concentration of carbon dioxide.

The Biochemical Oxygen Demand concentration in the three ponds shows that there is no significant difference between them The Biochemical Oxygen Demand concentration in the three ponds shows that there is no significant difference between them. However the concentration in ponds B and C may be as a result of the decomposition of algae after die-off (Lynch, 2002).

The Total Alkalinity in the three ponds falls within the range of 20-200mg/l which is suitable for fish production. The mean values of the concentration in three ponds also show that there is no significant difference between them.

The Transparency of Water in the two ponds affected by the bloom is very low compared to pond A. This is a natural consequence of heavy Plankton bloom.

Conclusion

At the end of this study, the water quality parameters of the university production ponds were evaluated and impact of brownish red colouration on water quality parameters was also assessed. Meanwhile, it was discovered that the algae bloom which was responsible for brownish red colouration in some of the ponds at the University Fish Farm was caused by Ectocarpus, Batrachospermum, Spirogyra and Chlamydomonas. Even though, the algae were found not to have any deleterious effect on the fish because no fish kill was observed in the course of the study but the bloom was found to have affected some physico-chemical parameters of water, hence may have stressful effect on fish. Consequently, we recommended that the alglae bloom identified in some of the ponds be controlled by the application of algaecides such as liquid chelated copper compounds like cutrine plus or algae-pro. We also recommended that the seasonal assessment of the algae bloom density and its impact on water quality parameters should be further investigated in all the experimental ponds of the university.

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Table 1. Mean Values of the Water Quality Parameters of the different Ponds at the University Fish Farm and their Standard Deviations

Parameters	Pond A	Pond B	Pond C
Water Temperature ^{0}C	28.87±0.197[a]	28.50±0.392[a]	28.87±0.229[a]
Hydrogen Ion Concentration	7.08±0.351[a]	6.89±0.275[a]	6.83±0.195[a]
Dissolved Oxygen(mg/l)	7.08±0.241[a]	5.00±0.277b[b]	4.90±0.224[b]
Free Carbondioxide(mg/l)	2.05±0.236[b]	2.56±0.179[a]	2.53±0.136[a]
Biochemical Oxygen Demand(mg/l**)**	0.47±0.018[a]	0.49±0.016[a]	0.48±0.015[a]

Total Alkalinity(mg/l)	33.13±1.288 [a]	31.88±1.775 [a]	31.18±1.545 [a]
Water Transparency(cm)	63.80±7.81 [b]	32.00±6.70 [a]	30.60±10.27 [a]

TABLE 2. Values Obtained for the Physico-chemical Parameters in ponds A,B AND C

Parameter Table	Pond	Water Temperature (^{0}c)	Hydrogen Ion Concentration	Dissolved Oxygen (mg/l)	Free Carbon dioxide (mg/l)	Biochemical Oxygen Demon (mg/l)	Total Alkalinity (mg/l)	Water Transparency (cm)
1	A	28.5	7.20	6.90	2.20	0.45	32.50	N.D
	B	28.0	7.26	5.20	2.60	0.40	30.80	N.D
	C	29.0	6.80	4.50	2.45	0.50	33.50	N.D
2S	A	29.0	6.57	6.70	1.70	0.48	33.40	60.00
	B	28.5	6.50	4.50	2.50	0.47	33.50	45.00
	C	28.7	6.50	4.80	2.60	0.49	32.60	50.00
3	A	29.0	7.50	7.20	1.90	0.47	31.20	65.00
	B	28.0	6.20	4.80	2.30	0.50	34.10	30.00
	C	29.0	7.70	4.90	2.47	0.46	29.30	30.00
4	A	29.0	7.50	7.70	2.40	0.45	33.60	68.00
	B	28.0	6.65	5.20	2.75	0.48	28.90	32.00
	C	29.2	6.90	5.10	2.30	0.48	30.55	20.00
5	A	28.7	6.80	7.00	1.90	0.46	33.70	64.00
	B	29.0	7.20	5.00	2.80	0.50	31.20	28.00

	C	28.5	7.05	5.20	2.70	0.47	31.60	25.00
6	A	29.0	6.90	7.30	2.20	0.50	35.40	62.00
	B	28.9	6.95	5.30	2.40	0.49	32.80	25.00
	C	28.8	7.05	4.90	2.65	0.30	29.50	28.00

NOTE: N.D Stands for Not Detected.

Poverty Reduction through Skill and Entrepreneurship Development in Aquaculture.The Case of Chikun–Kajuru Constituency Project, Kaduna State, Nigeria.

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Abstract

The exposure of the Nigerian economy to huge imports, fish inclusive poses serious threat to self-sufficiency in its basic needs and food sufficiency. The government through its back to farm programs intensifies aquaculture trainings for unemployed youths and women. The Nigeria fishing industry's performance (artisanal, industrial capture and aquaculture) is weak and requires government interventions. In Complementing and improving the fishing sector, the Federal Government focuses on aquaculture value chain to enhance fish supply. Chikun/Kajuru was one of the constituencies which received a boost through capacity building in fish farming as initial take off towards poverty reduction, food fish security and job creation. The program yielded important results and lessons particularly in the constituency, Kaduna State and Nigeria at large. The fisheries sector is important in prioritizing agricultural growth and effectiveness of overall economic growth leads to poverty reduction, market opportunities and price effect. The training is intended to stimulate aquaculture knowledge in the constituency,and to ensure a minimum presence of government by having some grass-root projects in every constituency during budgeting process.

Keywords: Poverty Reduction, Skill, Entrepreneurship, Aquaculture, Fishing Industry.

Introduction

Fisheries play important roles in the provision of food fish, employment and income generation but the Nigerian fishing industry's performance (artisanal, industrial capture and aquaculture) is weak as the rate of production has been constantly threatened by several factors which incapacitate capture fisheries (Alhaji, 2012). The Nigerian Fisheries Statistics (2016) reported that Nigeria's annual fish demand is estimated at 3.32 million metric tons while domestic production is estimated at about 1.12 million metric tons. This leaves the country with huge shortfalls which is complemented by fish imports, resulting in heavy foreign exchange expenditures annually. Also, Alhaji (2012) opined that the aggregate trend of demand pull suggests that the fisheries sector needs urgent attention in reducing disequilibria by injecting new techniques. Apart from its importance as a source of protein, fishing provides income to majority of Nigerians especially in the coastal areas. Its wide value-chain potentials (fish processing, recreation, tourism, sports, medicine, marketing, fisheries research, etcetera) places fishery in vintage position in improving standard of living and contributing substantially to national economic development. To further buttress the importance of fishery, the Federal Department of Fisheries (2015) asserted that fisheries provide employment for about 8.632 million people in the primary sector and 19.55 million people in the secondary sector and it estimated its contribution to Nigeria's agricultural GDP at 0.88%.

However, the Nigerian capture fisheries have been characterized by perennial problems which have been responsible for drastic drops in both industrial and artisanal fishery productions. This, undoubtedly, has been largely responsible for the redirection of emphasis on aquaculture production which has received wide support from government and it has since becoming an essential part of the national fish supply as well as increasingly contributing to global food fish supplies. Nigeria's soil, water, human resources and weather conditions are adequate for aquaculture practices but require injection of required funds at the appropriate time to encourage investment in the sub-sector so as to solve the many problems associated with unemployment, shortage of animal protein, heavy reliance on imports, amongst others.

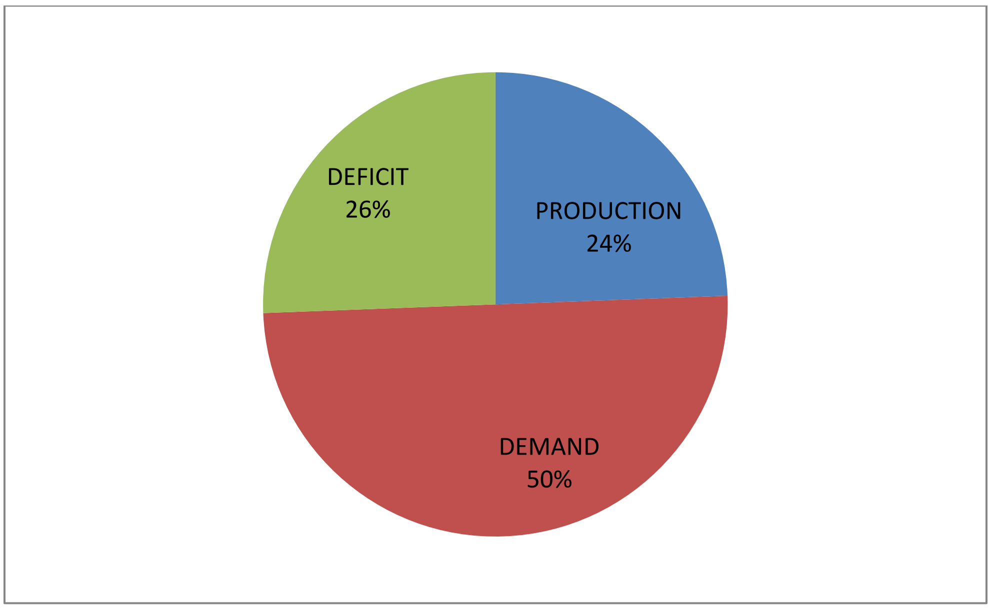
The representative Chikun/Kajuru constituency at the Nigeria's House of Representative, Honourable Umara, adopted and obtained funds for aquaculture as his constituency project for the benefit of "his people". Being government electoral district project, "constituency projects" is defined as developmental projects proposed and implemented in the constituency of members of National Assemblies (Dogara, 2016). But these, according to Orimuguje (2015), are nothing more than the usurpation of executive functions. This study assessed one hundred and twenty (120) participants drawn from within the Chikun/Kajuru constituency to undergo a-five-day aquaculture training designed for Promoting Knowledge Support Systems through Research and Development. To aid participants to easily grasp with the knowledge of fish culture, the training adopted the use of teaching manuals (made easy) and on-hand practical. Findings from the exercise were based on careful analysis and aggregation of information gathered during the training which is intended to inform and stimulate policy dialogue and formulation.

Materials and Methods

The training was carried out in Chikun LGA Zone B, Kaduna State, Nigeria. One hundred andtwenty (120) people (male and female) of different age groups were purposively selected from the constituency. Focus group discussion, direct feedback mechanism was adopted during the training for further confirmation of some issues raised during the training as well as confirming expected value addition after the training exercise. Physical observations of group tutorial and class discussion by a member of each group as nominated were scored. Further, areas that required corrections were identified and addressed by team of resource persons before end of the training. In addition, types of fish ponds and culture systems were made easier through pictorial presentations.

This work is presented using descriptive, table, narrative and pictorial formats and results discussed.

Results and Discussions Figure 1: Status of Nigeria fish consumption



Source: Alhaji T.A

Figure 1 indicated that Nigeria fish demand is at 50% while production is 24% and a huge deficit of 26%, bridging the gap requires an alternative means of supply to support domestic fish production. Fish culture has been on a positive trend growing at about 25 – 33 % per year since 2003 due to increase in public awareness in fish farming through individual and corporate investments. The Federal, State and Local Government as well as Private Sector have contributed to the development of this sector by training of Farmers, provision of inputs through

Growth Enhancement Scheme (GES) and the government policy on backward integration to encourage all fish importers to invest in aquaculture (FDF 2015).

Table 1: Recommended water quality requirements for African Catfish (Clariasgariepinus)

Water Quality Parameter	Water Quality Test	Recommended Level
Dissolved Oxygen (DO)	Test kit/DO Meter	4mg/1
PH	Test kit/pH Meter	6.5 – 8.5
Temperature	Thermometer/Meter	25^{o}C - 32^{o}C
Ammonia	Test kit	<0.02ppm
Nitrite	Test kit	<0.1ppm
Iron	Test kit	<0.5ppm
Water hardness	Test kit	50 – 250ppm calcium carbonate
Alkalinity	Test kit	50 – 250ppm
Turbidity	Test kit /Turbidimeter	40 – 80cm
Carbon dioxide	Test kit	<10ppm
Salinity	Test kit/Salinometer	<0.5ppt for fresh water fish

Source: Teaching Manual

Table 1 shows recommended items require for African Catfish *(Clariasgarapinues)* production. The trainees were introduced to water quality management, monitor by observation, test to detect, predict and problems that may arise at each time. Participants were encouraged to observe parameters that will lead to Good Aquaculture Practices (GAP) such that include Temperature, Dissolved Oxygen, pH, Ammonia, Nitrite, Alkalinity, Hardness and Turbidity/Transparency.


Plate: 1 Milt/Sperm **Plate:2 Milt Male gamete**

The instructors introduced participants on steps required for fish production.Fish sex identification, ponds (earthen, plastic, concrete, water recirculation system, etc.), selection of females from broodstock ponds,Streptozocin, Sterile normal saline (pH 7.4, phenoxyethanol, plastic containers for anesthetic and recovery water, paper towel, fish net, ½ cc syringe with 28.5 gauge needle. Petri dish lid, Scale, Plastic spoon, and other required inputs for fish production. In addition, trainees were thought fish hormone injection, proper dosage and where and how to condition the fish for better production (plate 1, and 2).

Conclusion and Recommendation

Fish production in Nigeria is significantly important to the nation's economy. The variance between production and consumption implies high market potentials in the fishing industry. Presently, Nigeria's demand for fish is yet to be met through domestic fish production. In order to intensify the fishery production in Nigeria, priority attention should be given to the aquaculture such that the projected level of out would be sustained. Aquacultureis favoured due to increased efforts towards developments,several government policies and machineries have been put in place to sustain aquaculture growth in the country.

Improved technology will ensure resource use intensification, The Federal government's "Anchor" programme for fish farmers which encourages farmers to be organized into cooperative groups should be sustained and extended to all aquaculture farmers across the nation. Furthermore, Honourable members should encourage aquaculture in their constituency to bridge up the gap between fish demand and supply.

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Effect of *Ocimum gratissimum* (Scent Leaf) on Nutrition and Haematology of African catfish

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Abstract

The plant *Ocimum gratissimum* (Scent leaf) is a widely known plant, used for medicinal and nutritional purposes. The main objective of this study is to determine the effect of *Ocimum gratissmum* (Scent leaf) on the growth performance and blood profiles of African Catfish (*Clarias gariepinu* .Six isonitrogenous diets were formulated to contain graded levels of scent leaf meal (SLM). D1 has (0%) while D2, D3, D4, D5 and D6 has 0.3%, 0.6%, 0.9%, 1.2%, 1.5% respectively. A total of eighty-four (84) juveniles C*larias gariepinus* were randomly distributed into plastic tanks at stocking rate of seven (7) fish per tank and replicated thrice. The fish were fed 3% of their body weight twice daily at 8.00am and 4.00pm for the period of 70days.All the Growth parameters values recorded were significantly different ($p<0.05$) and highest FMW (247.64g),WG (1160.87g) ,FW (1733.50g) and SGR (0.57) were observed in Treatment 4 (0.9%SLM) and the least FW(1218.50g),WG(645.85g), FMW(174.07g) and SGR(0.39) were recorded in treatment 1(control). The PI was significantly ($P>0.05$) highest (82.80g) in fish fed 1.5%SLMI (Treatment 6) and the least PI (71.96g) was found with fish fed 1.2%SLM (Treatment 5). The haemotological results revealed a significant difference ($p>0.05$) across the treatments. The highest PCV (53.50%) was recorded in Treatment 3 while the least value (49.00%) was obtained in Treatment 2. Highest WBC was found in Treatment 5 (12.45) while the least value was obtained in Treatment1 (8.85). In conclusion, it was observed from the results obtained that small quantity of scent leaf meal enhances growth without detrimental effect on the health of the fish

Keyword: *Ocimum gratissimum*, *Clarias gariepinus*, growth performance and haematological parameters.

Introduction

Globally, aquaculture industry has been rated as the fastest growing food producing industry (FAO, 2010) and has continued to show strong growth rate of 6.8 to 50.3 million metric tonnes between 2002 and 2007(FAO, 2010) This great achievement has brought many farmers into this sector, more than 10 million people in 2005 (FAO, 2010). The fish known as African catfish (*Clarias gariepinus)* belongs to the family Clariidea and genus Claris, has become a very popular aquaculture species in a number of African countries (Nlewadim *et al.*,2004). In Nigeria *Clarias gariepinus* has gained popularity and attracted the interest of the aqua culturists because of its high resistance to disease, fast growth rate, high fecundity, palatability, high stocking densities and ability to tolerate a wide range of environmental conditions and diets (Olaniyi *et al.*, 2013).

However, in Nigeria recently, many livestock farms, including fish farms were folding up due to sudden hike in prices of conventional protein sources such as fishmeal, soybean and groundnut cake etc which are very scarce and highly competitive because of their usage by other livestock farmers and human consumption. This situation has resulted to low level of animal protein production and only few can attain the minimum daily protein intake of 35grams as recommended by Food and Agriculture Organization (FAO, 2010). Therefore, to solve this ongoing problem, many researchers and fish farmers have embarked on searching and evaluating alternatives lesser known, locally and readily available, inexpensive, unconventional plant protein sources to replace the conventional ones.

Nigeria favorable weather condition has allowed the growth of many varieties of medicinal herbs spread over the country. One of such is *Ocimum bascilium* known as basil leaf is an aromatic, herbaceous and perennial plant. It is called nchanwu, daidoya and effirin in Igbo, Hausa and Yoruba languages respectively in Nigeria (Ephraim *et al.*, 2000). The plant possess antimicrobial properties (Orifidiya *et al.*, 2000) and a number of chemical substances that facilitate their utilization by man and in the treatments of poultry disease as well as helping in reduction of cost in poultry nutrition (Nworgu *et al.*, 2013) and in fish(Adewole, 2015). This study therefore, investigates the effect of *Ocimum bascilium* on the nutrition and haematology of African catfish (*Clarias gariepinus*).

Materials and Methods

Experimental Site :The experiment was carried out at the fishery unit, teaching and Research farm of LadokeAkintola University of Technology, Ogbomoso Oyo State.

Experimental Fish: A total of two hundred and fifty (250) juvenile African catfish (*clarias gariepinus*) was obtained from a reputable fish farm in Ogbomoso, Oyo State. The fish were stocked in plastic tanks containing aerated water and acclimatized for two weeks during which the fish were fed floating feeds in order to empty their gut and maintain uniform stomach condition to prepare their appetites in readiness for administration of experimental diets.

Collection and Processing of the Test ingredient (Scent leaf):Matured scent leaves were plucked from its plants at teaching and research farm in Lautech, ogbomoso. It was then processed using abrasion method and air dried under normal temperature until constant weight was achieved. The scent leaves were grinded to powder form with a grinding machine and store in air tight nylon prior the feeding trial.

Experimental Diets: Feed ingredients such as fishmeal, groundnut cake, soybean, oyster shell, wheat offal, bone meal, yellow maize, lysine, and mineral premix were purchased from a reputable feed mill in Ogbomoso. Six (6) isonitrogenous experimental diets (35%CP) containing varying levels (0%, 10%, 20%, 30%, 40%and 50%) of scent leaf meal were formulated and pelletized (2mm) and sundried for few hours to reduce the moisture and prevent mould formation, the feed were packed into the airtight containers.

Experimental Procedure: After acclimatization period, eighty- four (84) African catfish juveniles were selected and divided into six groups of treatments, fish were stocked at the rate of seven (7) juveniles in a plastic tank (70L) and the experiment was replicated twice. The fish were fed 3% of their body weight twice daily, morning and evening (8.00hrs and 17.00 hrs.) and were weighed fortnightly using electric weighing scale for the period of twelve weeks.

Data Collection: Data collected were weight gain (WG) and feed intake and other parameters such as mean weight gain (MWG),percentage mean weight gain(PMWG), average daily weight gain (ADWG), specific growth rate (SGR), average feed intake (AFI),feed conversion ratio (FCR) and protein efficiency ratio (PER) were calculated as follows:

Weight gain (WG) WG= $W_2 - W_1$ Where: W_2 = final weight gain; W_1= initial weight gain

Mean weight gain (MWG): MWG = $W_2 - W_1$ / by no of fishes

Percentage mean weight gain (PMWG): PMWG= MWG X 100/ initial weight

Average daily weight gain (ADWG): MWG/ no of days

Specific growth rate (SGR): SGR= log final body weight – log initial body weight/no of days X 100

Average Feed Intake (AFI): AFI= feed intake / no of days

Feed Conversion Ratio (FCR): FCR= Average Feed Intake (g)/ Mean weight gain (g)

Protein Efficiency Ratio (PER) =

Table1: Gross Composition of Experimental Diet

Ingredients	D1 (0%)	D2 (0.3%SLM)	D3 (0.6%SLM)	D4 (0.9%SLM)	D5 (1.2%SLM)	D6 (1.5%SLM)
Maize	20.60	20.60	20.60	20.60	20.60	20.60
Wheat Offal	10.30	10.27	10.24	10.21	10.18	10.15
Scent Leaf	-	0.03	0.06	0.09	0.12	0.15
Fish Meal	11.10	11.10	11.10	11.10	11.10	11.10
Soya Bean	33.30	33.30	33.30	33.30	33.30	33.30
Groundnut Cake	22.20	22.20	22.20	22.20	22.20	22.20
Oyster Shell	0.5	0.5	0.5	0.5	0.5	0.5
Bone Meal	0.5	0.5	0.5	0.5	0.5	0.5
Mineral	0.5	0.5	0.5	0.5	0.5	0.5

Premix						
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Veg. Oil	0.25	0.25	0.25	0.25	0.25	0.25
TOTAL	100	100	100	100	100	100

Blood Collection and Analysis: The blood samples were collected from the caudal peduncle of the fish samples selected randomly from all the treatments at the end of feeding trials. The blood samples for hematological analysis were dispensed into an ethylene diamine tetra acetatic acid (EDTA) bottle to prevent coagulation, after which the samples were taken to a reputable laboratory for analysis to determine parameters such as: packed cell value (PCV), Hemoglobin (Hb) and Red Blood Cell and White Blood Cell (RBC and WBC).The procedure is as reported in page 13 and 14.

Chemical Analysis: Proximate composition of the fish samples, experimental diets and text ingredients were determined on dry matter bases. The parameters determined were as follows: moisture content, crude protein, either extract, crude tube, ash and nitrogen free extract according to the method of A.O.A.C, (2000).

Statistical Analysis :The data collected during experimental period were subjected to one way analysis of variance (ANOVA) using completely randomized design (CRD) in accordance with SAS (2000) and Duncan's multiple range tests was employed to reveal significant difference among the treatments.

Results

The proximate composition of the processed scent leaf meal (SLM) used for the experiment revealed that it contained 16.58% crude protein, 32.01% crude fibre, 4.81% ether extract,7.60% moisture and 13.60% ash.

The result obtained for growth performance and nutrient utilization of juvenile catfish is as shown in table 2. All parameters were significantly different across all dietary levels ($p<0.05$). 100% Survival rate were observed in all the treatments. It was observed that fish fed 0.9% SLM

(Treatment 4) recorded the highest FMW (247.64g), ADWG (1.97g), PWG (202.74%), SGR (0.57%), AFI (236.50g) while the fish fed diet without SLM (control) had the least FMW(174.07g), ADWG (1.1g), PWG (112.80%), SGR(0.39g), AFI(118.96g). However, highest FCR (1.66) was recorded in fish fed 0.6%SLM (treatment 3) while least the FCR (1.43) was obtained in fish fed 0.9%SLM. Highest AFI (g) and PI (g) (236.50g and 82.68) were also observed in fish fed 0.9%SLM (Treatment 4) while least AFI (g)and PI(g) (118.96g and 66.14) respectively were recorded by the fish fed control diet. Highest PER (14.49) was obtained in fish fed 1.2% SLM (treatment 5) while the least PER (9.77) was obtained in fish fed control diet.

The haematological results of African catfish fed scent leaf meal is as shown in table 3.There were significant difference ($p<0.05$) among treated groups. Highest PCV (53.50%) was obtained in treatment 3 while least PCV (42.50%) was obtained in Treatment 2.Highest WBC (12.45cmm) and RBC(3.68) were observed in treatment 6 while least WBC (8.85cmm) and RBC(3.25) was obtained in the control .Highest MCH (53.10pg) was observed in treatment 3 while the least MCH(36.85pg) was observed in treatment6.

Table2. Growth Performance and Nutrient Utilization of Juvenile African Catfish Fed Scent Leaf Meal

Parameter	T1 (0%)	T2 (0.3%SLM)	T3 (0.6%SLM)	T4 (0.9%SLM)	T5 (1.2%SLM)	T6 (1.5%SM)	SEM
IMW(g)	81.80	81.80	81.80	81.80	81.80	81.80	0.01
FMW(g)	174.07^{f}	209.64^{e}	246.79^{b}	247.64^{a}	230.79^{c}	229.64^{d}	4.28
MWG(g)	92.27^{e}	127.84^{d}	164.99^{b}	165.84^{a}	148.99^{c}	147.84^{d}	4.28
ADWG (g)	1.10^{d}	1.52^{c}	1.96^{a}	1.97^{a}	1.77^{b}	1.76^{b}	0.05

PWG (%)	112.80^{f}	156.28^{e}	201.70^{b}	202.74^{a}	182.14^{c}	180.73^{d}	5.24
AFI (g)	118.96^{e}	212.40^{c}	229.14^{b}	236.50^{a}	205.60^{d}	236.56^{a}	2.96
FCR	2.05^{a}	1.66^{b}	1.39^{c}	1.43^{c}	1.38^{c}	1.60^{b}	0.40
SGR	0.39^{c}	0.49^{b}	0.57^{a}	0.57^{a}	0.54^{ab}	0.54^{ab}	0.14
PI	66.14^{e}	74.34^{c}	80.20^{b}	82.68^{a}	71.96^{d}	82.80^{a}	1.03
PER	9.77^{f}	12.04^{e}	14.40^{b}	14.02^{c}	14.49^{a}	12.50^{d}	0.28
Survl rate(%)	100	100	100	100	100	100	

a,b,c,d- superscripts.Means in the same row with the same superscripts are not significantly different (p>0.05).

IW: Initial Weight , FW: Final Weight, IMW: Initial Mean Weight, FMW: Final Mean Weight ;TFT: Total Feed Intake, AFI: Average Feed Intake, WG: Weight Gain, FCR: Feed Conversion Ratio, PWG: Percentage Weight Gain, ADVG: Average Daily Weight Gain, SGR: Specific Growth Rate, PI: Protein Ratio, Per: Protein Efficiency Ratio T :Treatment

Table 3 . Haematology of Juvenile African Catfish Fed Scent Leaf Meal

PARAMETER	T1 (0%SLM)	T2 (0.3%SLM)	T3 (0.6%SLM)	T4 (0.9%SLM)	T5 (1.2%SLM)	T6 (1.5%SLM)	SEM
PCV(%)	49.00^{bc}	42.50^{d}	53.50^{a}	45.50^{cd}	46.50^{bc}	50.00^{ab}	0.67
WBC(cmm)	8.85^{b}	9.95^{b}	9.00^{b}	9.55^{b}	12.05^{a}	12.45^{a}	0.29

HETERO	22.00^{b}	21.17^{b}	32.00^{a}	26.50^{ab}	24.00^{b}	31.50^{a}	0.97
LYMPH(%)	43.50^{ab}	48.50^{a}	43.50^{ab}	47.00^{ab}	51.50^{a}	38.50^{b}	1.22
NEUT(%)	1.00^{c}	2.00^{ab}	1.50^{bc}	1.50^{bc}	2.50^{a}	2.50^{a}	0.11
BASO(%)	8.00^{b}	5.50^{b}	2.50^{c}	7.00^{b}	7.00^{b}	11.50^{a}	0.46
BLAST	25.00^{a}	22.00^{ab}	20.50^{ab}	18.00^{bc}	15.00^{c}	16.00^{c}	0.84
HGB	15.70^{b}	14.03^{cd}	17.90^{a}	15.20^{bc}	15.19^{bc}	13.60^{d}	0.25
RBC	3.25^{c}	3.64^{a}	3.38^{bc}	3.36^{bc}	3.55^{ab}	3.68^{a}	0.03
MCV(fl)	151.00^{b}	502.00^{a}	158.50^{b}	135.50^{b}	134.00^{b}	139.00^{b}	23.14
MCH(pg)	48.75^{ab}	39.85^{de}	53.10^{a}	45.25^{bc}	43.10^{cd}	36.85^{e}	0.91
MCHC(g/dl)	31.98^{a}	33.05^{a}	33.45^{a}	33.40^{a}	32.85^{a}	27.55^{b}	0.37

a,b,c,d- superscripts.Means in the same row with the same superscripts are not significantly different (p>0.05). PCV; Packed Cell Volume, WBC; White Blood Cell, HETERO; Heterophil, LYMPH; Lymphocytes , NEUT; Neutrophils, BASO; Basophils, BLAST; Blast Cell, HGB;Haemoglobin RBC; Red Blood Cell, MCV; Mean Corpuscular Volume, MCH; Mean Corpuscular Haemoglobin, MCHC; Mean Corpuscular Haemoglobin Concentration

Discussion

Medicinal plants have been reported to be growth promoters and immune booters in livestock and fish nutrition (Levic *et al*, 2008; kumar *et al*, 2014 ; Reverter *et al* 2014; Iheanacho *et al*, 2017a).The findings of this present study on growth performance of *C.gariepinus* juvenile fed scent leaf meal revealed that there were increase in treated groups as compared to the control, which means higher inclusion of Scent leaf meal in the nutrition of African cat fish enhances growth. Heamatological parameters are important health indicators whose study reveals the health of fish regarding diseases and immune system condition before and after an experiment (Iheanacho *et al*, 2017; Olaniyi *et al.*, 2016). In the feeding of juvenile African catfish with scent leaf meal, it was revealed that there were significant differences (p<0.05) among treated groups. Blood could be used as a means through which general condition of the animal could be assessed. The PVC value in this study contradict 36.0% reported by Adeyemo (2007). The PVC values obtained in this experiment ranges from (42.50-53.50). The result of PCV obtained from this study showed that African catfish fed scent leaf meal at (0.9%) level does not result into anemia and thus could support its use in aquaculture; however, Sotolu and faturoti (2011) reported lower PCV values which can result into anemia from shrunken red blood cells, a situation that probably resulted into fish asphyxiation and death as confirmed by Adeyemo (2005). The WBC values ranges between 8.85-12.45cmm, Ajani (2006)and Kor-siakpere *et al.*, (2009) stated that high WBC count means a release of more cells to maintain homeostasis while low WBC count is a common stress response. Therefore, increasing or decreasing numbers of WBC are normal physiological reactions to toxicant and this showed the response of the immune system under toxic condition. The RBC values were greater than 2.11E+12ml to 2.93E+12ml reported Ajiboye (2009) and higher in works of Ayoola (2011). The increased RBC count might be due to increase of new RBC's from erythropoietic tissue to improve the oxygen-carrying capacity of fish blood with resultant higher values of erythrocyte count as observed by Rattmann *et al* (1992) and Alhakem *et al* (1998). The MCV values obtained in this study were higher than 113.07-138.07fl for juvenile intergenetic hybrid catfishes (Diyawae *et al*, 2013) and 96.62fl for *C. gariepinus* fingerlings (Ochang *et al*,2007). MCV has an estimate of the volume of RBC's indicated the status or size of the RBC and reflects normal or abnormal cell division during RBC production. Larsson *et al* (1985) attributed increase in MCV to swelling of the RBC due to hypoxic condition (low oxygen condition), impaired water quality, somatic stress or macrocytic anaemia (swelling of RBC) in fish exposed to metal pollution, While reduced MCV could be linked with shrinkage of RBC either due to hypoxia or microcytic aneamia (shrinkage of RBC) as reported by Bhagwant and Bhikajee (2000). Adesina (2008) and Alwan *et al* (2009), the statistical variation between MCH values suggested that MCH was affected by dietary treatments. Higher MCH indicates a good volume of heamoglobin which indicates effective oxygen transportation in the bloodstream for healthy well being of the fish (Diyawae *et al*, 2013). MCH values were within the range recommended by Bhaskev and Rao (1989) for healthy fish.

Conclusion

It was observed from the results of this study that, as high as 0.9% SLM (Scent leaf meal) included in the diet of African catfish enhanced growth. Also, fish fed 0.9%SLM recorded the PCV value within the recommended value though a little lower than the PCV(53.50%) of fish fed 0.6%SLM which was found to be above the required PCV level for African catfish. In conclusion, ***Ocimum gratissimum*** can be included in the diet of African catfish up to 0.9% to enhance growth and promote good health status.

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Case Report: Fatty Liver Haemorrhagic Syndrome in Poultry Production

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Abstract

Fatty liver haemorrhagic syndrome is a disease in chickens and other birds. It affects only hens. Birds with this disease have large amounts of fat deposited in their liver and abdomen. This often results in an enlarged liver that is easily damaged and prone to bleeding. In some cases the disease is fatal, usually as a result of blood loss from an internal haemorrhage in the liver. The haemorrhage often occurs when a hen is straining to lay her egg. Excessive dietary energy intake is believed to be the cause of the syndrome. Birds housed in cages will more likely be affected because they are unable to exercise to burn off the extra dietary energy. The disease is observed most often in birds that appear to be healthy and in a state of high egg production. As a result, this death occurred quite unexpectedly. This case presented a total of six dead birds of 36 weeks old, from a flock of 2000 Isa Brown Layers housed in battery cage which were reported dead in the farm of NRCRI, Umudike over a three day period of time. The six birds presented differently had died over periods of three days. There had not been any serious reduction in egg production. The battery cage system had 3 birds per cage, and the feaces looked normal. Necropsy examination of the birds revealed; Pale pectoral muscles, Clotted blood seen beside the liver, Pale, enlarged and friable liver, Haemorrhages and blood clots on the surface of the liver, and Hematomas of different sizes on the liver. Fatty liver haemorrhagic syndrome was the diagnosis. Treatment with Aminototal® supplement was instituted and slight reduction in daily feed allowance. The birds recovered and no further mortality.

Keywords: Fatty liver, haemorrhagic, necropsy and diagnosis

Introduction

The shift from floor-reared layers to cage confinement was not without a creation of a new problems, some of which have yet to satisfactorily explained or controlled. These include fatty liver haemorrhagic syndrome characterized by fat deposits, fatty livers, and a drop in egg production, (Peckham,1978). The precise mechanism or chain of events leading to the development of this disease has not been clearly demonstrated. The disease is seen in different strains and breeds of chickens, and all major feed companies have faced the problem. (Peckham,1978). Fatty liver haemorrhagic syndrome is a disease in chickens and other birds, it affects only hens. Birds with this disease have large amounts of fat deposited in their liver and abdomen. This often results to an enlarged liver that is easily damaged and prone to bleeding. In some cases the disease is fatal, usually as a result of blood loss from an internal haemorrhage in the liver. The haemorrhage often occurs when a hen is straining to lay her egg. The disease is a major cause of mortality in laying hens. One theory is that the syndrome is the result of excessive caloric intake and/or decreased utilization. Heredity may also play a role, but it is not the entire cause for the disease. Birds housed in cages will more likely be affected because they are unable to exercise to burn off the extra dietary energy. Walking hens are less likely to develop this problem. The disease is observed most often in birds that appear to be healthy and in a state of high egg production. As a result, death can occur quite unexpectedly, (Peckham,1978).

Methodology (Case Management)

Total of six dead birds of 36 weeks old, from a flock of 2000 Isa Brown Layers were reported dead in the farm of NRCRI, Umudike. This birds died suddenly. On further investigation, it was observed that the birds appeared overweight compared to other birds; vaccination was up to date, and the birds were eating normally. The six birds presented differently had died over periods of three days. There had not been any serious reduction in egg production. When the farm was visited and live birds examined, observation was, the farm was well run, with routine foot-bath at the entrance, and the remaining birds appeared healthy and feeding normally. The battery cage system had 3 birds per cage, and the feaces looked normal. The birds examined were relatively heavy and some others had pale combs and wattles. The dead birds were submitted for recropsy examination and diagnosis was made followed by prescription and drug administration.

Results

Necropsy examination of the birds revealed; Pale pectoral muscles, Clotted blood seen beside the liver, Pale, enlarged and friable liver, Haemorrhages and blood clots on the surface of the liver, and Hematomas of different sizes on the liver.

Summary of findings; Sudden death in heavy caged birds, Pale combs and wattles and Enlarged, soft, haemorrhagic livers with hematomas. Clinical diagnosis was Fatty liver haemorrhagic syndrome which was confirmed by post mortem (necropsy) examination.

Treatment and outcome; Aminototal® supplement 5/7 per os according to manufacturers recommendation. Also there was slight reduction in their daily feed allowance. The birds recovered and no mortality was recorded again.

plate 1

plate 2

plate 3

plate 4

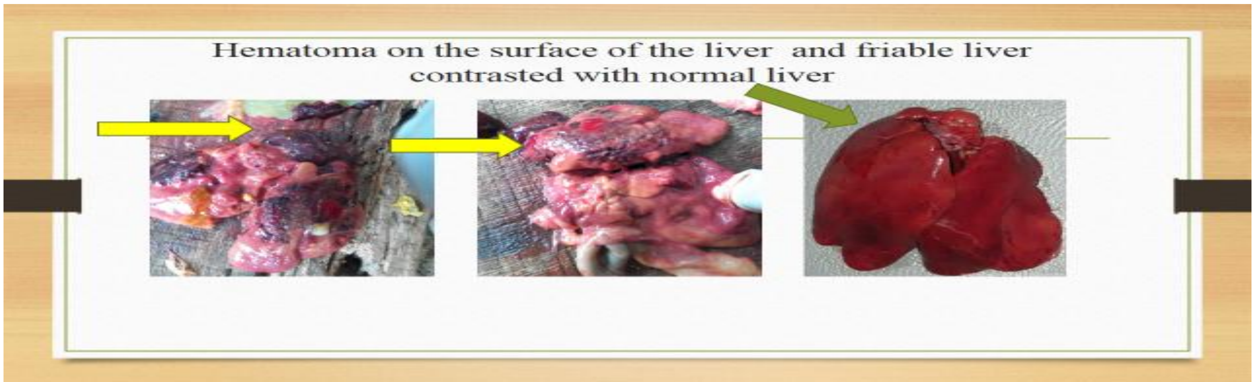
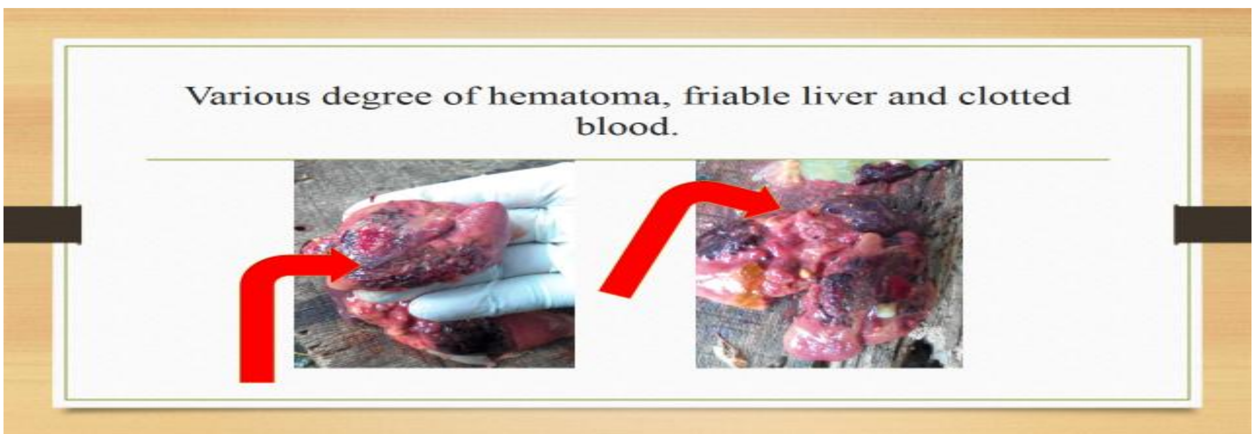


plate 5



Disscussion

Fatty liver haemorrhagic syndrome as seen in this case, is a metabolic condition that occurs in commercial layers and is frequently the major cause of death in high producing laying flocks. It is characterized by excessive fat in the liver and haemorrhage from a ruptured liver (plate 2 and 3). This syndrome occurs in laying birds, primarily in birds that are in positive balance (Polin and Wolford, 1977). The decrease in egg production and increase in mortality associated with fatty liver haemorrhagic syndrome have implications for the welfare of hens and cause considerable economic losses to egg producers. Since it was first observed in 1954 (Couch,1956) numerous studies have explored the causes of fatty liver haemorrhagic syndrome, however the aetiology of this syndrome is still poorly understood and the occurrence underappreciated. The main factors involved in the aetiology includes; Nutritional factors: Intake of high-energy diet that allows caged hens to consume energy in excess of the requirements for maintenance and egg production this results in a positive energy balance and increased hepatic fat deposition. Hormonal factors: Oestrogens influenced the lipid synthesis which is required for yolk deposition. It was indicated that the liver haemorrhage score was markedly increased when excess energy intake was combined with exogenous oestrogen treatment.(Pollin and Wolford 1977). Environmental factors: exposure to cold or heat induces stress and influences lipid metabolism in the fowl (Hermier, 1997). Housing condition; the factors responsible for this condition are stress and lack of exercise due to confinement and crowding seen in this case agrees with Squires and Leeson (1988). Genetic conditions: It has been suggested that some strains of laying hens are more susceptible to Fatty Liver Haemorrhagic Syndrome in heavy and high producing breeder hens. Toxicological factors: Dietary factors other than excessive caloric intake, such as toxins and rapeseed products may stimulate lipogenesis (Pearson and Butler, 1978). There was evidence that mycotoxins (aflatoxin in particular) which may contaminate cereals will induce liver lipid accumulation (Bryden et al., 1979).

Conclusion and Recommendation

Farmers are advised to monitor the factors that could contribute to the condition. It is necessary to avoid over-crowding and slightly reduce the daily quantity of feed given to layers kept in cages or avoid feeding high energy feeds. It is important to give room (provision) for exercise and to avoid overcrowding. When these are applied then the economic losses due to the disease will be checked.

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Genetic Diversity and Identification of Single Nucleotide Polymorphism of Insulin-like Growth Factor- 1 Gene in *Sarotherodon melanotheron*

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Abstract

Sarotherodon melanotheron is a dominant and relevant cichlid species in South-west Nigerian coastal waters with good economic and nutritional values. Having a better understanding of the genetic basis of variation in traits related to growth in *Sarotherodon melanotheron* will enhance genetic improvement and aquaculture production. Regions of the *Sarotherodon melanotheron* were investigated to identify single nucleotide polymorphism and genetic diversity among three populations of *S. melanotheron* in South- west Nigeria. In this study, a specific primer pair was designed to amplify a fragment of IGF-1 gene using polymerase chain reaction (PCR). The amplicons were sequenced while nucleotide sequences generated were edited, aligned and compared across populations. One hundred and seventy-one SNPs were detected across the studied populations. Only Badagry population revealed genetic diversity among the studied populations with the number of alleles, hetrozygosity and polymorphic sites. This finding revealed more information regarding the genetic variation of this fish species for breeding purpose.

Keywords: Single nucleotide polymorphisms, genetic variation, Igf-1, *Sarotherodon melanotheron*

Introduction

Sarotherodon melanotheron is a typical estuarine cichlid species dominating lagoons and estuaries of West African Coast (Amoussou *et al*., 2018). This fish is one of the most exploited due to its huge nutritional and economic importance with good aquaculture potential. Despite the nutritional and economic importance of *S. melanotheron* globally, the knowledge of the genetic basis of variation in traits related to growth in *S. melanotheron* is of great relevance for genetic improvement. There is therefore need to improve the production traits by using molecular markers associated with productive characteristics for sustainable aquaculture production.

The insulin like growth factor-1 gene (IGF-1) is a candidate gene for growth, body composition and metabolism in different species of fish (Thompson *et al*., 2010). The IGF-I is a mediator of the endocrine action of hormonal growth and is able to stimulate the synthesis of DNA and subsequent cell division in many cell types (Wood *et al*., 2005). It is also considered a highly conserved and crucial growth-regulating gene in tilapia species. SNP have been successfully used for the identification of candidate genes of traits and strains useful in aquaculture (Yáñez *et al*., 2015). Cuevas-Rodriguez *et al*. (2016) successfully identified genetic variation and single nucleotide polymorphism in candidate genes for growth in *Oreochromis niloticus*. However, information on the genetic variation and single nucleotide polymorphism identification in candidate gene for growth in *S. melanotheron* has not been well documented.

Materials and Methods

Thirty (30) broodstocks of *S. melanotheron* from three different populations (10 per location) were collected from three coastal rivers in South-west Nigeria, namely Pepe and Ugbonla (Ondo state), Badagry (Lagos state). The coordinates of the sampling locations are shown in Table 1. The fish samples were obtained from fishermen at the landing sites. Genomic DNA was extracted from the muscle tissue (1 cm^2) of the experimental fish using phenol-chloroform method according to Sambrook and Russel (2001). The quality of the extracted DNA was checked using a Nano-drop spectrometer. The specific primer (ALT-IGF-1 forward-CTTGGACGAGTAGGAGGCAAATG and ALT-IGF-1 reverse-GAAATACAAGCAAGCGATAAGAA) of 399bp was designed to amplify regions of the IGF-1gene. Purified PCR products were bidirectional-sequenced in an automatic sequencer (ABI 3500XL Genetic Analyser), at Inqaba biotechnology laboratory, South Africa. Sequence alignments and SNP identification was done using Arlequin v. 3.5.2 software. The primer sequences, annealing temperature and amplicon size of the amplified fragments are shown in Table. 2.

Table 1: Geographical Location of the Sampling Stations

Location	Latitude	Longitude	State
Pepe	N06 10^{1} 01.3^{1}	E02^{0} 52.988^{1}	Ondo
Ugbonla	N060 08^{1} 31.1^{1}	E004^{0} 47^{1} 39.8^{1}	Ondo
Badagry	N04^{0} 25.012^{1}	E02^{0} 52.988^{1}	Lagos

Results and Discussions

Candidate gene technique is a great tool to detect genetic polymorphisms existing in genes associated with economic important traits in farm animals (Rothschild and Soller, 1997). Several studies have confirmed this candidate gene approach a strong technique for the identification of polymorphisms in genes that associate with economic traits (Hemmer-Hansen *et al*., 2011). In the current study, ALT IGF-1 fragment revealed a total of 171 SNP loci in Badagry while no SNP loci were found in the other two (Pepe and Ugbonla) *S. melanotheron* populations studied. Badagry population had the highest number of alleles (1.512$\pm$0.56) while Pepe and Ugbonla had same and lowest number of alleles (1.0$\pm$0.0) respectively. In all populations, expected heterozygosity and number of polymorphic sites were observed highest in Badagry (0.104 and 171) and none were detected in Pepe and Ugbonla populations (Table 3). Based on the number of SNP loci in this gene fragment among the three *S. melanotheron* populations, the most diversity was observed in Badagry population, and the least diversity was observed in Pepe and Ugbonla respectively. Badagry population displayed the highest genetic diversity as demonstrated by the number of alleles, expected heterozygosity number of polymorphic sites and number of SNPs. This finding is in line with the report of Ukenye *et al*. (2016) on genetic diversity assessment of *T. guineensis* using microsatellite markers where Badagry population exhibited high genetic diversity. Xiao *et al*. (2007) stated that genetic heterozygosity indicates the proportion of the group with site heterozygotes at some loci. The average heterozygosity of loci reflects the level of variation in the genetic structure. Thus, Badagry population had the highest genetic variation and represents the best population of *S. melanotheron* connected with growth traits in the present study. The least diversity that was observed in Pepe and Ugbonla populations based on number of SNPs may be due to inbreeding or founder effect.

Table 2: Primer sequence, annealing temperature and amplicon size, used in Amplification of IGF-1 gene.

Primer	Sequence	Annealing temperature (°C)	Amplicon size (bp)
ALT-IGF-1	F-CTTAGGASGAGTAGGAGGCAAATG R-GTGAAATACAAGCAAGCGATAAG	55	399

Table 3: Genetic Diversity and Single nucleotide polymorphism of IGF-1 gene in S. *melanotheron* Populations

Population	A	He	SNP	Transitions	Transversions
Badagry	1.51±0.57	0.104±0.117	171	104	67
Pepe	1.0±0.0	0	0	0	0
Ugbonla	1.0±0.0	0	0	0	0

A: average number of alleles, He: expected heterozygosity, SNP: single nucleotide polymorphism

Conclusion

The polymorphism identified in the current study indicated a greater genetic diversity in Badagry population which may represent the best population of *S. melanotheron* associated with growth traits among the populations studied.

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ECONOMIC ANALYSIS OF CATTLE FATTENING IN SANDAMU LOCAL GOVERNMENT AREA, KATSINA STATE, NIGERIA

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Abstract

This study uses data on cattle fattening from 120 respondents in four areas in Sandamu local government area, Katsina state. The data was collected using a structured questionnaire. Data was analyzed using descriptive statistical tools (frequency, percentage, and mean) and inferential statistical tool (z-test). The findings indicate that cattle fattening is profitable and has a significant effect on the annual income of the farmers. Equally, the results show that cattle fattening had no effect on the rate of employment generation and that the major challenges facing cattle fattening in Sandamu local government were high cost of hired labour, inadequate fund, high interest rate on loan, lack of collateral security, insufficient veterinary services, high cost of medication, high cost of feeds, and poor infrastructural development. Based on the findings, the study recommends that government should provide maximum security to aid cattle fattening, proper road network should be constructed for easy access to the market. More so, the cattle farmers should be encouraged to form cooperative for easy access to loan. It also recommends that he Ministry of Agriculture and Natural Resources should recruit veterinary doctors to reduce the cost to medication checkmate pests and diseases.

Keywords: fattening, Sandamu, cattle, economic

Introduction

Livestock systems occupy about 30 percent of the planet's ice-free terrestrial surface area and are a significant global asset with a value of at least $1.4 trillion. (Steinfeld *et al*. 2006). The livestock sector is increasingly organized in long market chains that employ at least 1.3 billion people globally and directly support the livelihoods of 600 million poor smallholder farmers in the developing world (Thornton *et al*. 2006). It provides a means of livelihood for a significant proportion of the livestock rearing (pastoral) households in the sub-humid and semi-arid ecological zones of Nigeria (Okunmadewa, 1999; FAO, 2006). The Nigerian cattle sector is the highest component of the total livestock cash income and contributed an average of 12% of total Nigerian livestock cash income (NBS 2010). The livestock subsector of the economy has greatest impact on development of poor peasant farmers.

Cattle contribute about 10 percent of the Nigerian Livestock population in monetary terms while cattle production in monetary terms account for about 42 percent of livestock revenue in Nigeria (Mcintyere, 2012).

Cattle fattening as a component of livestock management is an important integral component of Agriculture. The livestock subsector contributes meaningfully to the Gross Domestic Product (GDP) of Nigeria. It represents a significant component of the agricultural sector with great economic, income, poverty alleviation and social implications (CBN 2011).

There is an increased investment in cattle fattening business because of its rate of return and shorter production cycle. Thus, cattle fattening has become an important business in the rural environment. It also provides investment opportunity, providing draught power and manure for sustainable agriculture and more so, it fulfills cultural roles in some areas (Maikasuwa et al, 2012).

Sandamu and its environs remains one of the centers of cattle rearing in northern Nigeria. Arising from the above, the area has over 12.00 million cattle consisting of 1.01 million milking cows and 2 million beef cattle (FAO, 2017). The cattle are managed traditionally under the extensive system. The economic viability of cattle then becomes an issue of public worry because of the cattle rustling problem in the country and stakeholders in the marketing chain.

Due to increasing practice of cattle fattening in Sandamu local government area, the demand and price of the inputs such as seed cotton cake used in fattening, the need for planning for optimal and efficient use of the inputs become a necessities in order to obtain optimum animal performance and profit.

Therefore, the study was to: describe the socio-economic characteristics of farmers involved in cattle fattening business, determine the income effect of cattle fattening among farmers in the business and identify the challenges involved in cattle fattening business in the area.

Materials and method

The Study Area

Sandamu is a Local Government Area in Katsina state, north-west geopolitical zone of Nigeria. Its headquarters are in the town of **Sandamu** on the area at12°57′37″N 8°21′44″E. It has an area of 1418 km² and Sandamu LGA has an estimated population of 251,898 inhabitants with the area mostly occupied by members of the Fulani ethnic group. The LGA is a part of the prestigious Daura Emirate and is made up of several towns and villages such as Dadin kowa, Jiba, Gazori, Rade, Yakawada, Ruma, Lemo, and Kwasarawa. The Fufulde language is commonly spoken in the LGA

Trade flourishes in Sandamu LGA with the area hosting several markets which include the Kwasarawa central market. Farming and raring of livestock are an important economic activity in Sandamu LGA with the area known for the cultivation of a variety of crops such as millet, sorghum, groundnut, and rice. Other important economic enterprises engaged in by the people of Sandamu LGA include pottery, leather works and hunting.

Sampling Technique

Sandamu has eleven wards out of which only four (4) were purposely selected due to their level of involvement in cattle production activities and proximity to daura and kwasarawa livestock market. The selected four wards are: karkarku, fago A, kwasarawa and katsayal. One hundered and twenty (120) cattle rarer were taken as sample size.

Data used

This study used primary data which includes; questionnaire. The questionnaire was divided into three sections: describes the respondent's socio-economic characteristics; income of cattle fattening: before and after the fattening and business growth (net-worth) of cattle fatteningana; as well challenges faced in the course of fattening.

Analytical technique

Descriptive and inferential statistics were adopted to analyze the data and test the hypotheses. In Socio-economic characteristics of members were analyse descriptive statistics such as frequency distribution, number, percentage and means were used. Thereafter, a threshold point of 2.50 was applied. Z-test statistics was employed to test the significance of the null hypothesis respectively for the independent variables (X) on the dependent variables (Y) at the alpha level of 5% (0.05), in order to decide whether to accept or reject the null hypotheses.

Result and Discussion

Socio-economic Characteristics of Cattle Farmers

The table below shows the socio-economic characteristics of the cattle farmers which includes their age, gender, marital status, level of education, type of occupation, household size and their percentage distribution.

Table 1 shows that the mean value of respondents age 40.49 years. This result indicates that most respondents are of middle age. This confirms the work of Suleiman M, Isiaka M, Ishaku A (2013).

Table 1: Age of the respondents

Age	Frequency(120)	Percentage (%)	Cumulative percentage	mean
20-29	21	17.50	17.50	
30-39	28	23.33	40.83	
40-49	37	30.83	71.66	
50-59	19	15.83	87.49	
60 –above	15	12.50	100	1.81

Field survey, 2019

Results from Table 2 below shows female respondents are less (7.50%). These indicate that male folks participate more in cattle farming in Sandamu. This finding support earlier findings by Sarma *et al*, (2014) that revealed that male folks were much more than female in cattle fattening business.

Table 2 Gender of the respondents

Gender	Frequency (120)	Percentage (%)	Cumulative percentage	Mean
Male	111	92.50	92.50	
Female	09	7.50	100	0.77

Field survey, 2019

Table 3, reveal 50.83% of the respondents are married, 30.83% of the respondents are single, while widow has 6.67%. This implies that most the respondents are married.

Table 3: Marital status

Marital	**Frequency(120)**	**Percentage (%)**	**Cumulative percentage**	**Mean**
Single	37	30.83	30.83	
Married	61	50.83	81.66	
Divorced	11	9.17	90.83	
Widow	08	6.67	97.50	
Widower	03	2.50	100	2.50

Field survey, 2019

Table 4 Majority with a cumulative percentage of 88.33% (tertiary, secondary and primary school attainment) of the cattle fatteners are educated. This shows that the literate people are more involved in cattle fattening business.

Table 4 level of Education

Level of education	Frequency (120)	Percentage (%)	Cumulative percentage	Mean
Tertiary institution	31	25.83	25.83	
Secondary institution	48	40.00	65.83	
Primary institution	27	22.50	88.33	
Non- formal	11	9.17	97.50	
Adult education	03	2.50	100	2.12

Field survey, 2019

In the case of type of occupation; civil servants that are involved in cattle fattening are 41 (34.17%) of the total respondent, followed by 23 (19 17% of cattle farmers are into trading of other goods. Those that are engaged in other business constitute are 56 (46.67% of the total respondent). While 27 (22.50%) focused on just cattle fattening. And the remaining 13 (10.83%) are into cattle fattening and crop farming.

Table 5: Occupation

Type of occupation	Freq.	Percentage	Cumm. percentage	Mean
				1.99
Cattle fattening/civil servants	41	34.17	34.17	
Cattle fattening/trading	23	19.17	53.34	
Cattle fattening/crop fatting	13	10.83	64.17	
Cattle fattening	27	22.50	86.67	
Cattle fattening/ other business	16	13.33	100	

Field survey, 2019

The result as shown in Table 6 shows that average household size of the respondents is twenty four (24). Household size determines the consumption needs of the households, family labour and to a certain extent the requirement for diversification in order to obtain more income for their livelihood.

Table 6: Household size

Household size	Frequency (120)	Percentage (%)	Cumulative percentage	mean
1-5	58	48.33	48.33	
6-10	24	20.00	68.33	
11-15	18	15.00	83.33	
16-20	13	10.83	94.16	
21-above	07	5.83	100	2.45

Field survey, 2019

Annual Income Effect of Cattle Farmers

Table 7 shows that the mean values of farmers annual income before and after joining cattle fattening business were 1.48 and 2.60 respectively. This indicates that respondents made huge income as a result of engaging in cattle fattening business. This is in agreement with the work of Smith *et al* (2011) that opined that cattle fattening is aimed at achieving economic benefits for those involved in it and the economy at large.

Table 7: Distribution of income according to annual income of cattle farmers involved in fattening.

	Range of Annual Income Growth (net-worth) N	Frequency (N 120)	Percentage (%)	Cumulative Percentage	Means (x)
1	BEFORE				
	100 – 500,000	13	10.83	10.83	
	500,100 – 1,000,000	19	15.83	26.66	
	1,000,100 – 1,500,000	39	32.50	59.16	
	1,500,100 – 2,000,000	26	21.67	80.83	
	2,000,100 - above	23	19.17	100	1.48
2	AFTER				
	100 – 500,000	59	49.17	49.17	
	500,100 – 1,000,000	31	25.83	75.53	
	1,000,100 – 1,500,000	19	15.83	90.70	
	1,500,100 – 2,000,000	11	9.17	99.97	
	2,000,100 - above	0	100	100	2.60

Field survey, 2019

Net-worth of Cattle Farmers

Table 8, shows that the mean values of the farmers' net- worth both before and after cattle fattening were 1.29 and 1.77 respectively. This indicates that respondents' net-worth increased tremendously as a result of engaging in cattle fattening business. This is also in agreement with the work of Smith et al (2011) and Suleiman M, Isiaka M and Ishaku A (2013).

Table 8: Net-worth of cattle farmers BEFORE and AFTER involvement in fattening

	Range of Annual Income Growth (net-worth) N	Frequency (N=120)	Percentage (%)	Cumulative Percentage	Means (x)
1	**BEFORE**				
	1 – 1,000,000	43	35.83	35.83	
	1,000,001 – 2,000,000	33	27.50	63.33	
	2,000,001 – 3,000,000	23	19.17	82.50	
	3,000,001 – 4,000,000	14	11.67	94.17	
	4,000,001 – above	07	5.83	100	1.29
2	**AFTER**				
	1 – 1,000,000	16	13.33	13.33	
	1,000,001 – 2,000,000	28	23.33	36.66	
	2,000,001 – 3,000,000	41	34.17	70.83	
	3,000,001 – 4,000,000	25	20.83	91.66	
	4,000,001 – above	10	8.33	100	1.77

Field survey, 2019

Employment Generation Effect of Cattle Fattening

Table 9, shows that the mean values of respondents' rate of employment generation BEFORE and AFTER involvement in cattle fattening were 1.86 and 1.97 respectively. This indicates that respondents were able to create a little employment opportunity as a result of engaging in cattle fattening business. This is in line with the work of Adamu (2011) that opined that cattle fattening is a major source of job creation, income generation, national growth and economy development. In the same vein, Suleiman M, Isiaka M and Ishiaku A (2013) in their study confirm that cattle fattening contributes to employment creation and income generation.

Table 9: Distribution of income on the ability of cattle fattening to generate employment opportunities.

	Range of Annual Income (N)	Frequency (N 120)	Percentage (%)
1	BEFORE		
	Less than 10	57	47.50
	11 – 20	38	31.67
	21 – 30	21	17.50
	31 – 40	02	1.67
	41 – above		
2	AFTER		
	Less than 10	66	55.00
	11 – 20	33	27.50
	21 – 30	19	15.83
	31—40	02	1.67
	41 above		

Field survey, 2019

Problems facing Cattle Fattening

Table 10, presents the challenges facing cattle farmers (respondents) on the challenges involved in cattle fattening business include Poor infrastructural facilities (16.10%) which is the most followed by high cost of medication (13.33%) and high cost of feeds (12.50).

Table 10: Distribution of respondent according to problems faced in cattle fattening

	Challenges	(N 120)	Frequency	Percentage
1.	Inadequate capital			07
2.	High interest rate on loan		14	5.83
3.	Lack of collateral security		13	11.67
4.	Insufficient veterinary doctors		05	10.83
5.	High cost of medication		16	4.17
6.	No access to medication		03	13.33
7.	High cost of feeds		15	2.50
8.	Poor infrastructural facilities	&	17	7.50

Field survey, 2019

Summary, Conclusion and Recommendation

Summary

The results revealed that cattle fattening is profitable to farmers in Sandamu local government area. The agrees with the finding of Smith et al (2011): cattle fattening is aimed at achieving economic benefits for those involved in it and the economy at large.

The result also indicated that business growth (net-worth) of the farmers increased as a result of engaging in cattle fattening business. Consequent upon that cattle fattening is a employment promoter, diversify souece of income generation, ensure economic development.

The study however identified the challenges facings cattle fattening in study area to include inadequate fund, insufficient veterinary doctors, high cost of medication and high cost of feeds

Conclusion

In conclusion, it is evident that cattle fattening is a very profitable and important enterprise that has gained prominence in the agribusiness sector. It provides source of diversifying income for the farmers since it can be done all year round. Cattle fattening could play a vital role in generating self-employment opportunities, source of additional income.

Recommendations

For an effective cattle fattening based on the finding of this study, the following recommendations are made;

i. Ministry of Health should deploy more veterinary doctors to Sandamu LGA to boost productivity

ii. Cattle farmers should form associations or cooperative that will enable them have access to loan and training easily to boost their fattening business. Cattle farmers should learn to depend on locally formulated feeds to reduce cost of cattle fattening and maximize profit.

iii. The existing state of extension services should be retrained and equipped with the necessary technology.

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SUB THEME H

SOIL CONSERVATION AND MANAGEMENT

Mitigation of climate change through soil (terrestrial) carbon sequestration and organic matter management on tropical soils

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Abstract

Climate change is a current global concern that impacts on earth's atmosphere and soil productivity in the tropical regions of the world and more especially in sub-Saharan Africa. There has been increase in average global carbon (iv) Oxide (CO_2) concentration in the atmosphere from 270ppm to 360ppm starting from the pre-industrial revolution period to the present era. This paper aimed at reviewing climate change and its mitigation through carbon sequestration and soil organic matter management practices in the tropics. It is predicted that in future, climate scenarios will lead to increase in global mean temperatures and further increase in the frequency of extreme climatic events. Other effects of climate change are variation in temperature regimes, rainfall pattern, drought, flooding, melting of glaciers, hurricanes, forest fire, etc. The driving force of the observed changing climate has been identified as global warming caused primarily by increased concentration of green house gases (GHGs) such as CO_2, CH_2 and N_2O in the atmosphere. Soil being a major carbon sink could have significant impacts on climate change mitigation through carbon sequestration and management of soil organic matter (SOM). Therefore, mitigation of GHGs is possible in agriculture with some management practices that encourage soil carbon sequestration and organic matter formation. Among these practices are agro-forestry, afforestation, conservation tillage, conservation practice, cover cropping and green manuring, organic agriculture, reforestation, grazing land management, sustainable forest management, etc. The above approach will certainly purify the atmosphere, improve soil productivity and encourage climate smart agriculture for sustainable ecosystem.

Key words: Carbon sequestration, Climate change, Greenhouse gases, Mitigation, Soil organic matter.

Introduction

Globally, the entire human race is under great threat due to climate change. Climate changes are resulting in erratic weather patterns and the impacts are already being felt in many parts of the world particularly the tropical regions (Bandyopadhyay, 2013). These adverse weather events propelled 28% rise in CO_2 and 25% loss in world's top soil and have resulted to the warming of continents by1.27^oF or 0.7^oC (Katyal, 2012). Research has shown that there has been increase in average air and ocean temperatures, leading to melting permafrost and increase in sea levels as a result of climate change (Olayinka, 2018). Since the inception of industrial revolution, CO_2 concentration increased from 270ppm to 360ppm (Olayinka, 2018). Correspondingly, there has been an increase of between 0.4 and 0.8^oC in the earth's global air temperature which was found to be hottest in 2016 globally (Olayinka, 2018). Global warming is attributed to increased concentrations in the atmosphere of greenhouse gases (GHGs) such as $CO_{2,}$ CH_4 and N_2O (IPCC,2007). Global weather patterns will be subject to change with increased frequency and extreme weather events like heat waves, droughts, storms, and floods (Millennium Project, 2008).

Nowadays, maximum attention has focused on the use of agricultural soils for the mitigation of elevated atmospheric carbon (iv) oxide (CO_2) levels through the sequestration of soil carbon. Mitigation in this regard is defined as activities that reduce green house gas (GHG) emissions or enhance the capacity of carbon sinks to absorb GHGs from the atmosphere. Climate change mitigation also includes acts capable of enhancing natural sinks, such as reforestation, afforestation, farming system and other appropriate agricultural management practices that could increase carbon sequestration (Auwal *et al.,* 2018). Tropical soils are characterized with inherent low fertility, low organic carbon, deforestation and high rate of soil physical degradation caused by extreme climatic conditions such as high rainfall intensity and rainfall (Are *et al.,* 2018). Soil carbon sequestration refers to a method of moving CO_2 from the atmosphere into the soil where it can no longer contribute to global warming (Schroth *et al.,* 2002). Plants pull CO_2 out of the atmosphere through photosynthesis, so as plants grow, carbon is captured in their roots (IPCC, 2000). Soil carbon sequestration otherwise known as soil carbon storage (SCS) has been considered as acceptable strategy with great potential for controlling the increase in the concentration of global warming gases in the atmosphere. When the plant dies, its root remains in the soil, serving as storage unit for Carbon (Birdsley, 1996). Soil organic matter (SOM) is approximately fifty percent carbon, as we increase soil carbon we build soil. Plant litter and other biomass accumulate as organic matter in soils and is degraded by chemical weathering and biological degradation. This paper aimed at reviewing climate change and its mitigation through soil/terrestrial carbon sequestration and soil organic matter management.

Climate Change: Causes and Sources.

The driving force of the observed changing climate has been identified as global warning (Olayinka, 2018). Since the early 20th century, the earth's mean surface temperature has increased by about 0.8^0C (1.4^0F) of which about two-third of the increase occurred since 1990 (US NRC, 2011; Auwal *et al*, 2018). Bandyopadhyay (2013) observed that global warming is the major cause of changes in the various climatic events of the global environment. According to Olayinka (2018), global warming can be defined as increase in the earth's global average temperature resulting from human activities such as burning of fossil duel, animal husbandry and changing land use. However, there are some gases in the atmosphere which acts a blanket preventing the escape of the infra-ray radiation by absorbing and emitting it back thereby warming the earth's surface and troposphere, such gases are called green house gases (GHGs) (Willey *et al.*, 2009). Below are some of the gases and their sources;

i. Carbon (iv) Oxide (CO_2): Carbon (iv) oxide (CO_2) commonly called carbon di oxide comes from the combustion of fossil fuels in cars, factories and electricity production and is most responsible for global warming. It is the green house gas responsible for the most (55%) of anthropogenic global warming (IPCC, 2007). Other anthropogenic sources of (**CO_2**) include solid wastes, wood and wood products, land clearing and cultivation (Crutzen *et al.*, 1979, Marland and Rotty, 1984, IPCC, 2007).

ii Methane (CH_4) : Methane the second major contributor to global warming apart from CO_2 is released from agricultural activities and from the digestive systems of grazing animals (ruminants). It's concentration in the atmosphere is about 26%. It is generated by methanogens through anaerobic fermentation in wetlands and rice paddies, in the bowels of the ruminating animals and guts of termites. More of it is generated during biomass burning, mining activities and from landfills (Sieler *et al.*, 1984).

iii Nitrogen (i) Oxide (N_2O): N_2O Commonly called nitrous oxide is obtained from fertilizers used in agricultural production. It is one of the gases released during anaerobic transformation of inorganic Nitrogen (N) by chemoheterotrophs like Acidothiobacillus denitrificans. Therefore, the N- fertilizers application in intensive agriculture is a major contributing factor to nitrous oxide emission (Isaksen, 1980, Smith *et al.*, 2007.)

iv Chlorofluoro carbons (CFCs): These are gases used for refrigerators. CFCs are another green house gas that encourages global warming. This gas is capable of degrading or depleting the ozone layer which led to its ban by many countries.

Soil Carbon and Climate Change

There is a growing body of evidence supporting the hypothesis that the earth's climate is rapidly changing in response to continued inputs of carbon (iv) oxide and other green house gases (GHGs) to the atmosphere resulting from human activities (IPCC, 2007). Among the green house gases (GHGs) that exist (e.g. N_2O, CH_4 NH_3), carbon (iv) oxide has the largest effect on global climate as a result of enormous increases from the preindustrial era to today. Approximately two-thirds of the total increase in atmospheric CO_2 is as a result of the burning of fossil fuels, with the remainder coming from soil organic carbon (SOC) loss due to land use change (Lal, 2008), such as the clearing of forests and the cultivation of land for food production.

Effect of Climate Change

The probable consequences of climate change include variation in temperature regimes, rainfall pattern, agricultural yields, sea level rise, regular occurrence of extreme weather events like heat waves, droughts, heavy intensity rainfall, cyclones, hurricanes, melting of glaciers or ice, forest fire, flooding change in ecosystem function, shifts in species distribution, species extinctions desert encroachment, rise in sea level etc (Jian *et al* ; 2007). Green house gases emissions are envisaged to grow up to 52 percent by 2050 (Millennium project 2008). Regional weather patterns will be subject to change with events such as heat waves, droughts, storms and floods (Millennium project, 2008). Climate change affects water availability, water is increasingly scarce. 90 percent of fresh water supplies will disappear by 2030 if the current trends continue without mitigation.

Climate change is also having an effect on the loss of biodiversity and renewable natural resources, reduces stability and resilience, and leads to fragmentation, species loss, and the loss of ecosystem quality. Many agricultural systems will be affected by higher temperatures as some plants are sensitive to high temperature during critical stages such as flowering and seed development (Auwal *et al.,* 2018). Many pests and disease of crops, animals and humans are sensitive to climate changes especially changes in temperature. Some diseases and pests may become prevalent in areas where they were previously unknown (Brandyopadhy, 2013)

Mitigation strategies for climate change: Soil (Terrestrial) Carbon Sequestration and Soil Organic matter Management.

Soil/Terrestrial Carbon Sequestration

Carbon sequestration is being viewed today as one of the most viable ways of returning normalcy to both the atmosphere and climate related activities by mitigating carbon accumulation in the atmosphere and storing it away in other natural and man-made reservoirs for either long or short term basis. Soils represent a short to long term carbon storage medium and contain more carbon than all the terrestrial vegetation and the atmosphere combined (Batjes, 1996). The United States Environmental protection Agency (2010) defined terrestrial carbon sequestration as the process through which CO_2 from the atmosphere is absorbed by trees, plants and crops through photosynthesis and store as carbon in biomass (tree trunks, branches, foliage and roots) and soils

Vegetation and soils have a large influence on atmospheric levels of CO_2 that is why they are largely recognized as carbon sinks. It is believed that the global biosphere absorbs roughly 2 billion tons of carbon annually (USDE, 2010) an amount equal to or roughly one third of all global emissions from anthropogenic activities. **Soil Organic Matter Management**

Soil organic matter (SOM) known to be of a crucial importance to soil quality and productivity is the component of soil derived from dead living matter that have been decomposed by soil organism. Tropical soils often contain between 1 and 3% of SOM being a characteristic constituent of soils. In terms of rates of turnover, SOM is subdivided into easily mineralizable component (labile fraction) and recalcitrant component (stable fraction). It is a source of nutrients for plants and energy for soil organisms, it enhances soil structural development and aggregation. It improves the soils CEC, buffering and water-holding capacities (Olayinka, 2018). According to EC (2002, 2006) soils are the largest repositories of carbon (1,500 Gt) and thus affect soil productivity and biodiversity. Soil organic matter is both a source and sink of carbon (Frey *et al.*, 2013)

Management Practices that encourage Carbon Sequestration and Formation of Soil Organic Matter (SOM).

Forested land and agricultural lands are the land types most commonly associated with carbon sequestration and soil organic matter formation. Below are the practices;

Afforestation and Agroforestry: Afforestation is the conversion of previously non-forested land into forested land. Afforestation can result in a large amount of carbon sequestered over a long period of time. In this management system, carbon is sequestered by the above and below ground biomass (living and non-living) consequently leading to increase in SOM content (Olayinka, 2018). Agro-forestry is essentially the combination of forestry and agriculture, whereby trees are grown alongside traditional crops

Reforestation: Reforestation is the restoration of previously forested land. Doing so can produce an increase in carbon uptake of around 2.1MMT per acre over a period of 90-120years (EPA, 2006). Trees absorb CO_2 and store it in living tissues which eventually takes that carbon out of circulation permanently when leaves and dead wood are decomposed into the soil. Deforestation is a significant source of global emissions, over the next five years emissions arising from deforestation will exceed those made from aviation emission (Chatellier, 2010).

Sustainable Forest Management: Sustainable forest management techniques include forest preservation, adoption of low-impact harvesting methods, lengthening of forest rotation cycles, agro-forestry, and the adoption of other methods aimed at increasing carbon uptake (Richards *et al.*, 2005). Forest preservation is the protection of current forest land from conversion into other land types. Doing so prevents the release of carbon from the current carbon stocks (EPA, 2006).

Conservation Practice:-Grasses or tress planted along streams and croplands to prevent soil erosion and nutrients run-off into water ways, this increases carbon storage through sequestration. An estimated 115.2MMT of carbon is removed from agricultural land via erosion every year, 20% of which is believed to return to the atmosphere (Nelson, 1999).

Conservation Tillage on Crop Lands: - Typically defined as any tillage and planting system in which 30% or more of the crop residue remains on the soil after planting. This disturbs the soil less and therefore allows soil carbon to accumulate. There are different kinds of conservation tillage systems, including no till, ridge till, minimum till and mulch till that are capable

Grazing Land Management:- Modification to grazing practices that produce beef and dairy products that lead to net green house gas reductions e.g rotational grazing. Overgrazing leads to removal of vegetation, soil compaction and accelerated soil erosion all leading to reduced SOM contents. Converting such overgrazed lands into improved pastures and practicing rotational grazing will help to restore soil fertility with increased SOM contents and improved soil physical properties.

Cover Cropping and Green Manuring: Most cover and green manure crops are nitrogen-fixing leguminous crops which improve the nitrogen contents of soils. There is a corresponding increase in C (humus) with increase in soil N content. Incorporated cover or green manure crops add organic C to the soil and thereby increase the SOM content (Mbah and Idike, 2011).

Organic Agriculture: This management practice deals with agricultural production devoid of use of inorganic amendments, pesticides and genetically modified organisms. It minimizes air, water and soil pollution. This according to Olayinka (2018) is an alternative to energy intensive agriculture, and is also termed regenerative farming. Organic agriculture devoid of inorganic fertilizers can mitigate GHG emissions by 20% while increasing C sequestration by 40-72%. Practices associated with organic farming include application of organic manures and composts, pasture and livestock keeping, crop rotation, biological pest control, etc. These practices encourage increase in SOM content which improves the soil physical, chemical and biological properties as well as its fertility.

Conclusion

The review work has shown that climate change has continued to be the source of global warming and fluctuations in temperature and rainfall patterns expressed as droughts and floods in the entire globe. Sequestration of organic carbon in soils is an effective strategy to mitigate global climate change. Carbon sequestration and proper management of soil organic matter could lead to an increase in carbon stocks in soil, thereby reducing green house gases (GHGs) while improving soil quality and productivity. It is certain that if the management practices that encourage carbon sequestration and organic matter formation are adopted globally, the effect of climate change will be practically mitigated.

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Antibacterial Effect of Bee Propolis On Some Soil-borne Bacteria

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Abstract

Bee propolis is a natural substance collected by honey bees and produced by mixing the saliva of honey bees with resins of flowers, leaves of plants and trees. It is waxy in nature, used by bees as protective barrier against external invaders and in folklore is used for the treatment of various diseases. This medicinal property of bee propolis can be explored for use in agriculture therefore, the present study, seeks to evaluate ethanol extract of bee propolis for antimicrobial activity against some bacteria strains isolated from soil; *Escherichia coli, Pseudomonas aeruginosa, klebsiella pneumoniae* (gram negative) and *Staphelococcus aureus* (gram positive). The Kirby-Bauer disc diffusion technique was employed for the determination of the sensitivity of the microorganisms to the extract. The obtained results suggest that the greatest antimicrobial activity exhibited by the bee propolis extract was against *E. coli* at a concentration of 12.5mg/ml, followed by 10.0mg/ml and 5mg/ml. Therefore, our findings suggest that bee propolis has antimicrobial activity and can be considered for its potency

Keywords: Bee Propolis, Compositions, Antimicrobial, Effect, microorganisms

Introduction

Bee propolis is a resinous mixture collected by honey bees and produced by the honey bee from mixture of bee saliva with resins and exudates from plants. Composition of propolis is varied mainly due to season of collection and the variability of plant species growing around the hive (Toreti *et al*., 2013) therefore, its chemical composition varies due to the geographic and plant origins of these resins, as well as the species of bee. In general, raw propolis is composed of about 50% resins, 30% waxes, 10% essential oils, 5% pollen, and 5% of various organic compounds (Park *et al*. 2002). Propolis is said to have some pharmacological potentials which include; antioxidant, antibacterial, antifungal, biological, anti-tumoral and anti-inflamatory activities etc. (Wagh, 2013). However, some studies have reported about the antimicrobial and antibiotic activities of bee propolis (Gebara *et al*. 2002; Nagai *et al*. 2003). Soil pathogens cause low agricultural yield, therefore effective pathogen control measure will increase food productivity. Hence, the present study was conducted to investigate the antimicrobial property of propolis on some pathogenic soil microorganisms.

Materials and Methods

This experimental study was performed in central laboratory of National Root Crops Research Institute (NRCRI) Umudike, Nigeria (longitude 07^0 33' E, latitude 05^0 29' N and altitude 122 M). Umudike is in the low-land humid tropics of south eastern Nigeria.

Extraction of propolis: Bee propolis was harvested from the bee hive of NRCRI Umudike. Ethanol extract of the propolis was prepared by dissolving 25g of crushed propolis in100ml of ethanol. The mixture was left to soak for 24hrs, then filtered with whattman filter paper No 1. The filtrate was allowed to completely evaporate at 40^oC in a water bath after which, it was stored in an air tight labelled container until when used.

Preparation of test organism: Soil solution was cultured, obtained bacterial colonies sub-cultured with a nutrient agar, incubated at 37^oC for 24hours and observed for the presence of growth. Discrete colonies were sub-cultured on slant sub-nutrient broth for further identification at 37^oC for 24 hours.

Preparation of nutrient agar: Nutrient agar was weighed (28grams) into 1litre of distilled water and allowed to soak for 10 minutes before swirling to mix and sterilized by autoclaving at 12^oC for 15 minutes then allow to cool. The required amount was dispensed aseptically into plates (Petri dish) and test tubes, these were allowed to solidify before usage.

Preparation of dilutions:

The dilution was from 12.5 mm/ml, 10 mm/ml, 5 mm/ml and 2.5 mm/ml. The dilution was in triplicate.

Evaluation of antimicrobial potential of extracts:

The antimicrobial potentials of the propolis extract was tested on the organism using the disc diffusion method. A perforator was used to cut a filter paper into discs of 6mm in size. The discs were sterilized in an oven at 140^0C for 1hr thereafter impregnated with 20µl of 2.5, 5.0, 10.0 and 12.5mg/ml concentrations of the extract respectively. Discs for the control were impregnated with Streptomycin and Ampiclox respectively while the disc for the negative control was soaked with the extracting solvent, ethanol. All the discs were left in an incubator at 50^oC to dry. The discs were placed on nutrient agar plates inoculated with 0.1 ml of bacterial suspension isolated from the soil. The plates were then incubated at $37^{o}C$ for 24 hours and the resulting zones of inhibition measured in millimeters using calibrated ruler.

Result and Discussion

Table 1 shows the antimicrobial effect of bee propolis ethanol extract on *E. coli,* as shown in plate 1 below showing the zones of inhibition for the propolis extract (A) and control (B) with streptomycin. The results obtained showed that the propolis extract was sensitive in all the evaluated concentration levels, with 12.5mg/ml concentration of the propolis giving the highest zone of inhibition. The zones of inhibition ranged from 13.0mm to 1.2mm with the highest concentration (12.5mg/ml) giving the highest zone of inhibition (13.0mm) which compared favourably with the control (20mm). Table 2 showed the antimicrobial effect of propolis on *staphylococcus aureus.* The concentration of 12.5mg/ml gave the highest zone of inhibition at 2.5mm followed by 10.0mg/ml which gave 1.0mm zone of inhibition. The *staphylococcus aureus* were resistance to the propolis extract and their zone of inhibition did not compare well with the control. Table 3 and 4 show the antimicrobial effect of *Klebsiella* and *Psuedomonas* respectively. The tested organisms were resistant to the bee propolis at all concentration levels with insignificant inhibitions. The present study was conducted to evaluate the antimicrobial property of propolis against some soil borne pathogenic microorganisms. Our findings showed that the extract of propolis obtained from the bee hive located at NRCRI, Umudike showed a higher activity against gram negative bacteria, *E. coli* than the gram positive bacteria, *staphylococcus aureus*. Przybylek and Karpiriski (2019) in a review report on ‘Antibacterial properties of propolis’ observed that most report on antimicrobial activity of propolis showed that antimicrobial activity of propolis is higher in relation to gram-positive than gram-negative bacterial. However, the antimicrobial activity of propolis depends on the chemical composition of the propolis which is closely related to the resins and balsam of the plant source used to produce the propolis (Przybylek and Karpiriski, 2019).

Conclusion

The result of our studies have shown that ethanol extract of propolis is effective against the control of some soil born microorganisms like *E. coli*. However, further studies should be carried out to test for the efficacy of propolis on other soil-borne microorganisms as well as evaluate potentials of propolis as a natural alternative to pesticides.

Table 1 Antimicrobial effect of Ethanol extracts of *propolis* on *Escherichia coli*

Organism	Test sample	Concentration Of The Extract (mg/ml)	Zone of inhibition (MM)	Comments
Escherichia coli	Ethanol extract	12.5	13.0	Activity was observed in all concentration.
		10.0	10.0	
		5.0	8.0	
		2.5	1.2	
Control	Streptomycin disc	0.005	20	The antibiotics is sensitive to the organism

Table 2: Antimicrobial effect of Ethanol extracts of propolis on *Staphylococcus aureus*

Organism	Test sample	Concentration of The Extract (mg/ml)	Zone of inhibition (MM)	Comments
Staphylococcus Aureas	Ethanol Extract	12.5	2.5	Activity was only in 12.5%, 10%, 5% and no activity at 2.5%
		10.0	1.0	
		5.0	0.1	
		2.5	NAD	
Control	Ampiclox disc	0.005	27.0	It is sensitive to the organism

NAD – No activity detected

Table 3: Antimicrobial effect of Ethanol extracts of propolis on *klebsiella*

Organism	Test sample	Concentration of The Extract (mg/ml)	Zone of inhibition (MM)	Comments
klebsiella	Ethanol Extract	12.5	0.43	All the concentration showed resistant
		10.0	0.37	
		5.0	0.35	
		2.5	0.2	
Control	Ampiclox (Apx) disc potency	-	13	It is sensitive to the organism

NAD – No activity detected

Table 4: Antimicrobial effect of Ethanol extracts of propolis on *pseudomonas aeruginosa*

Organism	Test sample	Concentration Of The Extract (mg/ml)	Zone of inhibition (MM)	Comments
Pseudomonas aeruginosa	Ethanol extract	12.5	5.0	All the concentration showed resistant
		10.0	3.0	
		5.0	0.27	
		2.5	0.22	
Control	Streptomycin(s) disc potency	-	9.0	The antibiotics is sensitive to the organism

NAD – No activity detected.

A  B 

Plate1. A: Active compound of ethanol extract of propolis against *Escherichia coli*; B: control - Streptomycin

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Effect of Atrazine Herbicide on Some Selected Soil Properties and Plant Biomass

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Abstract

A pot experiment was carried out to investigate the effect of herbicide on soil physical characteristic at the screen house of Department of Soil Science Technology, Faculty of Plant and Environmental Sciences, Oyo State College of Agriculture and Technology, Igboora. The experiment contains five treatments 0, 1.5, 2.0, 2.5 and 3.0 L/ha laid out in completely randomized block design (CRD) replicated four times making a total of twenty treatments. Each of the Experimental pot was filled with 5 kg of soil. The buckets were perforated at bottom for easy passage of air and water. Amaranth seeds was obtained from Oyo State Agricultural Development Shop (OYSADEP), broadcast into the pot with the help of table spoon. Paraquat was used as base herbicide. Atrazine was applied into the pot with help of old time household mosquito insect (150 cm^3 capacity) sprayer. Seedlings were thinned down to two after germination. Soil samples were taken weekly for soil pH, soil moisture, soil organic matter analysis starting from 3WAP to 6WAP. The biomass weight were taken at the end of experiment 6WAP with scale. Laboratory results were subjected to the Analysis of Variance (ANOVA) and means subjected to Duncan Multiple Range Test at 5 % probability. The results showed that herbicide application has significant effect and that it increases Soil moisture, Soil pH, Soil organic matter (SOM) and Biomass weight. At 6 weeks after planting, the treatment 3.0L/ha had *the highest moisture content (4.92%), soil pH (5.57), SOM (1.78%), and biomass weight 4.2 t/ha while control application had the least resultant effect.*

Keywords*:* Soil pH, Soil moisture, Soil Organic matter and biomass weight

Introduction

Farmers efforts in producing food in large quantities to meet ever increasing human population, necessitated the use of pesticide starting from seeds planting, weed management, up to harvesting of crops and storage of produce for human or industrial uses (Gill and Garg, 2014). Crop productions in large quantities depend on good soil rich in adequate nutrients to increase yield per hectare. Soil is a complex structure and contains mainly five major components: minerals, water, air, organic matter and living organisms. The quantity of these components in the soil does not remain the same but varies with the locality. Soil serve many vital functions in life particularly for food production (BaishyaKarishma and SarmaHari Prasad, 2014). Soil is a dynamic living system with a variety of micro-and macro-flora and fauna including bacterial, actinomycetes, fungi, nematodes, arthropods, crustaceans and earthworms (Doetsch and Cook,1974). They play a primary role in the degradation of plant and animal residues and their organic matter in the environment as well as in Nitrogen fixation, nitrification and the release of nutrients from soil minerals. Anything that affects these activities might affect the function of soils not only in production but also in the global carbon and nitrogen cycles and in the removal of a range of environmental pollutants.

Pesticides are used in controlling insect pest, diseases and weeds in agriculture. They increase agricultural production tremendously as these chemicals act on pest that destroy the crop yields. The behavior of a pesticide in the environment depends on its stability, physicochemical properties, on climatic conditions and the medium to which it was applied (Graham-Bryce, 1981).The negative effects of pesticides misuse include low crop yield, destruction of soil micro fauna and flora and undesirable accumulation in food crops (Edwards, 1986). Ionisable herbicide (phenoxy acids, triazines, imidazolinones) are particularly common and represent the largest major group of soil-applied herbicides (Harper 1994).

However, as good as the use of pesticide is, its aftermath cannot be underestimated. It has been confirmed that the use or continuous used of pesticide has affected soil characteristic (pH, cation exchange capacity (CEC) and anion exchange capacity (AEC) and the organic matter concentration) one way or the other. There is therefore a need to regulate its use on the farm to minimum or lowest quantity, if it cannot be totally eradicated especially during this period when everybody is clamoring for organic farming. The Objective of this research is to investigate the effect of using herbicides on some selected soil properties.

Materials and methods

A pot experiment was carried out at the Screen house of Department of Soil Science Technology,Oyo State College of Agriculture and Technology, Igboora to investigate the effect of herbicide (Atrazine) on selected soil properties such as soil reaction pH, soil organic matter, soil moisture and amaranth biomass weight. The treatments were 0, 1 .5, 2.0, 2.5 and 3.0 L/ha Atrazine was laid out in Complete Randomized Block Design (CRD), in four replicate making a total number twenty pots. The experimental bucket bought from a local market in Igboora. The buckets were perforated at bottom for air and excess water passage and each bucket was filled with 5kg soil with help of the scale. The test crop Amaranth were broadcasted into bucket with the help of spoon and the treatment (Atrazine) were applied immediately after planting with the help of old time mosquito (Raid /Mobil) sprayer as used for household insecticide. The seedlings were thinned down to two stands per pot after germination. Atrazine and Paraquat were obtained from Oyo State Agricultural Development Shop (OYSADEP) in Igboora. Soil sample were randomly taken from the bucket. The samples were air dried for two weeks, the soil composite were sieved through 2mm sieve and pack inside a labeled medium brown envelope, then taken to Laboratory for chemical analysis. Prior to the field work, an interview questionnaire were generated to cover the whole Ibarapa area to investigate the most commonly used herbicide in the area. The questionnaire were given to Extension officer (EO) covering Ibarapa East, Ibarapa central and Ibarapa North local Government area of Oyo State. From the results and analysis, it was discovered that most of the farmers in the areas especially maize farmer prefer Atrazine and Paraquat to other available herbicides. Paraquat was used as basal, since the experimental soil were newly ploughed soil with no green weeds. Cultural practices were done as at when necessary. The only data collected on amaranth was the biomass weight.

Results and discussion.

The results in Table 1 showed the chemical properties of the trial soil. The soil is found to be moderately acidic with pH 6.60. The textural class of the soil is sandyloam. The Nitrogen (N), Phosphorus (P) and Potassium (K) concentration were very low and therefore needs soil amendment for high yield production. The N content is below the critical (1.5-2.0g/g) level required for crops planting (Chude *et al*., 2012). Available P and exchangeable cations were very low when compared with recommendation made by (Agboola and Ayodele, 1985).

The results presented in Table 2 showed effect of Atrazine on soil moisture. The herbicide application increased moisture content of the soil from 3 to 6 weeks after planting (WAP). The moisture content increased with increase in treatment application. The highest moisture content was with treatment T4 (2.5L/ha), 4.88% at 6WAP, while T1 gave the lowest soil moisture content of 3.36% at 6WAP. This finding was in accordance with Khan *et al*. (1998) that herbicide application reduces population density of weeds thereby making soil moisture more available for the growing crops.

The results in Table 3 showed the effect of Atrazine application on soil pH. The result showed that application of herbicide had significant effect ($p<0.05$). The soil pH decreased with increases in the number of application of herbicide from 3WAP to 6WAP. Similar trend were observed as treatment rate increased; there was a reduction in soil pH across the table. At 3WAP, the soil pH reduced to 5.75 at 6WAP.

The results presented in Table 4 showed the effect of herbicide on soil organic matter (SOM). There is a positive response of soil organic matter to herbicide application with increase in number of week. As the treatment rate increased the organic matter quantity increased. The results showed the quantity of organic matter increased from control (0L/ha) to 3.0L/ha. At 6WAP treatment 3.0L/ha had 1.78 while the value in control was 1.36.This finding was in agreement with (Mewatankam and Sivasithamparan, 1987), that as the days of herbicide application increases, there is an increase in microbial population which enhances soil organic matter production.

The effect of herbicide on vegetable biomass weight is presented in Table 5. Herbicide application had significant ($P<0.05$) effect on vegetable biomass weight. The biomass weight increased as treatment rate increases. At 6WAP, 3.0L/ha had biomass weight of 4.2 t/ha followed by 2.5L/ha with biomass weight of 4.1t/ha which is statistically not different at 5 % level probability. Control gave the least biomass weight of 2.4 t/ha. This finding was in agreement with Malik *et al*.(2006 that found that application herbicide in the right proportion enhances plant yield

Conclusion

This work showed that herbicide application affect soil properties such as soil pH lower from 6.60 up to 5.75 with treatment (3.0L/ha) at 6WAP.The trial also revealed an increases in soil organic matter (1.78%) soil moisture (4.92%) and highest biomass weight 4.20 t/ha at 6WAP when the treatment rate is 3.0L/ha. The only limitation to this research is the analysis of Herbicide (Atrazine and Paraquat are yet to be determined

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Table 1: Chemical Analysis of the trial Soil

ELEMENTS	VALUE
pH	6.60
OC	17.6g/kg
N	1.20g/kg
P	12.40g/kg
K	0.47cmol/kg
Ca	2.41cmol/kg
Mg	0.53cmol/kg
Na	0.46cmol/kg
Fe	1.5mg/kg
Mn	86.90mg/kg
Cu	1.02mg/kg

Table 2: Effect of Atrazine herbicide on Soil moisture (%) of soil planted to Amaranth

Treatment(L/ha)	3WAP	4WAP	5WAP	6WAP
0	2.60c	2.90e	3.10d	3.36e
1.5	3.19d	3.24d	3.46c	3.53c
2.0	4.23c	4.53c	4.61b	4.63b
2.5	4.34b	4.78b	4.83a	4.88a
3.0	4.41a	4.86a	4.87a	4.92d

Means followed by the same letter in the columns and row are not significantly different at 5% probability by DMRT

Table 3: Effect of Atrazine herbicide on Soil pH on the soil planted to Amaranth.

Treatment(L/ha)	3WAP	4WAP	5WAP	6WAP
0	6.58a	6.57a	6.56a	6.56a
1.5	6.22b	6.30b	6.42b	6.53b
2.0	6.14c	6.21c	6.38c	6.43c
2.5	6.03d	6.08d	6.14d	6.18d
3.0	5.70e	5.60e	5.80e	5.75e

Means followed by the same letter in the columns and rows are not significantly different at 5% probability by DMRT

Table 4: Effect of Atrazine herbicide on organic matter (%) of soil planted to Amaranth.

Treatment(L/ha)	3WAP	4WAP	5WAP	6WAP
0	1.19e	1.30e	1.33e	1.36e
1.5	1.20d	1.32d	1.35d	1.37d
2.0	1.23c	1.38c	1.45c	1.53c
2.5	1.25b	1.40b	1.48b	0.68b
3.0	1.29a	1.42a	1.50a	1.78a

Means followed by the same letter in the columns and row are not significantly different at 5% probability by DMRT

Table 5: Effect of Atrazine herbicide on Amaranth Biomass (t/ha)

Treatment (L/ha)	Plant weight (t/ha)
0	2.4d
1.5	3.2c
2.0	3.4b
2.5	4.1a
3.0	4.2a

Means followed by the same letter in the columns and row are not significantly different at 5% probability by DMRT

Effect of Land Use on Available Micronutrients in Institute for Agricultural Research Farm, Samaru Zaria Nigeria

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Abstract

The farmland of Institute for Agricultural Research, Ahmadu Bello University, Zaria have been under cultivation for over 60 years. The study was therefore undertaken to determine the effect of land use on micronutrients (Cu, Fe, Mn and Zn) content of the soils. The micronutrients studied were adequate in the soils of the different land uses across the study area. Mean value of Cu in Maize and Legume intercrop was significantly higher than soils of other land uses. Land-use for Mango had the highest mean available Mn (65.72 $mgkg^{-1}$) and was significantly higher than other land uses. Soil depth varied in manganese distribution and was significantly higher in the sub soil compared to the surface soil. Relationship between soil properties and micronutrients were notable between copper and available phosphorus ($r = 0.4539^*$) and manganese and pH ($r = 0.4438^*$).

Keywords: Copper, Land use, Manganese, Micronutrients, Research farm, Zaria.

Introduction

Soil as a natural land resource plays an important role in serving man in numerous ways through food production and other non-agricultural practices. Land use pattern plays vital role in governing the nutrient dynamics and fertility of soils (Jiang *et al.*, 2002). Due to continuous cultivation, soils under particular land use system may affect physico-chemical properties which may modify content and availability to plants (Kabata-Pendias and Pendias, 2011). Several researches have been conducted on influence of land use types on soil properties (Oguike *et al.*, 2009; Chaudhari *et al*., 2012). They reported influence of several factors such as parent material, land use, physico-chemical properties and soil management on content of micronutrients in various soils. Micronutrient deficiencies have been reported across arable lands in Nigeria

(Oguike *et al.*, 2009) and many of these deficiencies were brought about by the continuous use of inorganic fertilizers (N P and K) by farmers, non-application of micronutrients, limited use of organic manures as well as non-recycling of crop residues. These may lead to exhaustion of micronutrients in soil output.

The farmland of the Institute for Agricultural Research (IAR) at Samaru Zaria have been under cultivation for over 60 years, and there is dirt of information on effect of land uses on micronutrients contents. Therefore, the present study is undertaken to determine the effect of different land uses on available micronutrients and their relation with some selected soil physico-chemical properties in the IAR farm.

Materials and Methods

Environmental Setting of the Study Area

The study was carried out at the IAR farm of Ahmadu Bello University Zaria, Nigeria. The area is within Sub-Humid Highplain agro-ecological zone (Ojanuga, 2006). The farm site is geographically located between latitude11^{o}10.647'N and 11^{o}11.393'N and longitude 070^{o}36.566'E and 007^{o}37.190'E). Climate of the area has mean annual rainfall of 1121.30mm, with mean temperature range between 15.03^{o}C and 36.55^{o}C.

Soil Sampling

Five plots under different land uses were selected namely Mango Orchard (MO), Virgin land (VL), Rosella intercrop (RI), Maize and Legume intercropped (ML) and Irrigation land (IL). Soil samples were taken randomly at 2 points on each of the land uses and at depths of 0 - 15cm and 15 - 30cm. The soils were air dried, crushed and sieved with 2 mm mesh sieve.

Laboratory Analyses

Particle size distribution, pH, electrical conductivity, organic carbon and available phosphorus (Av. P) were determined by method described in IITA (1979) laboratory manual. Exchangeable bases (Ca, Mg, K and Na) and exchange acidity were determined using ammonium acetate saturation method described by Thomas (1982), and summed to obtain effective cation exchange capacity (ECEC). Available Cu, Fe, Mn and Zn were extracted with 0.1M HCl solutionand determined on Atomic Absorption Spectrophotometer (Udo et al., 2009).

Statistical Analysis

Physico-chemical properties and micronutrients between the five land uses and between surface and subsurface horizons were analyzed using two ways analysis of variance (ANOVA), and their means compared. Their relationship was determined using correlation analysis (StatPoint, 2005).

Results and Discussion

Physico-chemical Properties and Effect of Land Use

The data of physico-chemical properties and nutrients of the soils are presented in Table 1. Particle size distribution generally varied with loam texture dominating the soils. Soil pH ranged between 5.86 and 7.94, and rated as moderately acid to moderately alkaline (Kparmwang et al., 2000). Calcium was generally high between 4.6 and 18.4 cmol(+)kg^{-1} and dominated the exchange sites, followed by either exchange Na and Mg and the least was K. The values of ECEC across the land-uses was rated as medium to high indicating adequate available sites for nutrients adsorption and retention.

Influence of land-use on particle size distribution was significant on clay fraction, with IL been significantly higher in clay compared to land-use area with RI, MO and VL, but at par with ML (Table 2). Mean soil pH was least in IL though at par with soils of VL and ML, but significantly lower than RI and MO. The least pH in soils of IL may be attributed to acidic irrigation water (Musa, 2017). Mango orchard significantly contributed to exchangeable K compared to other land-uses and might have been trapped as wind breakers. Comparison of horizon showed that OC and Av. P were significantly higher in the surface than sub-soil horizons. It may be attributed to reservoir effect of organic matter for Av. P (Maniyunda, 2012), and further buttressed by the significant correlation between OC and Av. P (r = 0.5122*).

Content of Soil Micronutrients and Effect of Land Use

Extractable Cu ranged between 3.16 and 5.14 mgkg^{-1} (Table 1) and rated high (Kparmwang et al., 2000). Mean values of available Cu significantly varied ($P \leq 0.01$) with ML significantly higher than other land-uses, followed by IL, VL and RI. The content of Fe ranged between 46.63 and 158.37 mgkg^{-1} and rated high. Copper correlated significantly with Av. P (r = 0.4539*) but negatively with Na (r = -0.4524*), thus similar factor may be influencing availability Av. P Cu. **A**vailable manganese was adequate and varied between 20.99 and 71.07 mgkg^{-1}, and rated high (Kparmwang et al., 2000). Mango orchard had the highest mean Mn (65.72 mgkg^{-1}) and was significantly higher than other land-uses. It was followed by RI and ML. However, only RI was significantly higher than VL and IL. Manganese significantly correlated with pH (r = 0.444*) and thus influences availability of Mn in these soils. Zinc was low to high and ranged between 0.91 and 16.77 $mgkg^{-1}$. Zinc significantly correlated with Mg (r = 0.4605*) and therefore similar properties and processes influenced their availability (Kabata-Pendias and Pendias, 2011).

Conclusion

The micronutrients studied were adequate across the land uses. Variation in land use significantly varied content of available Cu and Mn. The influence of land use on soil physico-chemical properties played an important role in the availability of micronutrients in the soils. Some of the significant relationships were notable between Cu and Av. P, and Mn and pH.

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Table 1: Soil Physico-Chemical Properties and Nutrient Status of the different Land-uses

Land Use	Soil Depth	Sand	Silt	Clay	Text. Class*	pH		Ca	Mg	K	Na	Exc. Acid	ECEC	OC	Avail. P	Cu	Fe	Mn	Zn
	cm	------(g/kg)------						-------------------(cmol/kg)------------------						(g/kg)	--------------------(mg/kg)-------------------				
Rosella Intercrop	0-15	490	420	90	L	7.70	7.04	8.8	2.83	0.72	2.09	0.8	15.24	1.805	14.88	4.02	71.93	52.90	16.77
	15-30	450	440	110	L	7.94	7.03	8.2	2.67	0.46	1.74	0.4	13.47	1.114	10.50	4.08	59.55	53.75	3.97
	0-15	730	200	70	SL	7.53	7.06	4.8	0.83	0.46	1.91	0.8	8.80	1.478	19.78	4.16	57.37	33.05	1.45
	15-30	790	160	50	LS	7.57	6.91	7.2	1.00	0.41	2.09	0.4	11.10	0.634	4.90	4.08	85.75	52.64	9.03
Mango Orchar	0-15	470	480	50	SL	7.58	6.94	5.6	2.08	0.51	4.18	0.8	13.17	1.805	8.40	3.45	122.5	67.53	4.69

d	15-30	490	440	70	L	7.55	7.04	5.0	1.08	0.66	3.82	0.4	10.96	1.152	4.73	3.16	46.63	71.07	2.96
	0-15	450	460	90	L	7.38	7.01	8.8	2.08	0.56	1.74	0.4	13.58	1.805	5.43	3.57	62.14	60.81	2.48
	15-30	470	460	70	L	7.16	6.82	5.8	1.83	1.02	2.09	0.2	10.94	0.941	3.33	3.82	170.0	63.46	2.35
Virgin Land	0-15	470	400	130	L	6.32	6.22	4.6	0.83	0.29	1.57	0.4	7.69	0.710	2.98	3.91	94.74	31.26	0.91
	15-30	530	360	110	SL	6.38	6.14	13.6	1.33	0.27	2.26	0.8	18.26	0.672	2.80	3.36	74.22	27.97	1.43
	0-15	530	360	110	SL	6.26	6.16	8.8	0.33	0.26	2.78	0.4	12.57	0.691	5.08	4.05	57.38	20.99	1.38
	15-30	510	380	110	L	6.44	6.24	4.6	0.58	0.21	2.09	0.4	7.88	0.403	2.98	4.43	112.8	45.62	2.44
Maize and	0-15	470	420	110	L	6.54	6.32	7.8	1.08	0.41	2.61	1.6	13.50	0.517	14.35	4.73	101.3	41.54	4.63

Legume intercrop	15-30	450	380	170	L	6.44	6.25	10.2	1.33	0.3	1.04	0.8	13.67	1.382	7.18	5.14	78.5	40.60	6.41
	0-15	470	400	130	L	6.59	6.51	13.4	0.83	0.41	2.61	0.8	18.05	1.805	42.88	4.93	158.4	37.50	4.25
	15-30	410	400	190	L	6.56	6.51	18.4	2.08	0.46	1.74	2.4	25.08	1.286	3.50	4.39	69.63	32.89	4.84
Irrigation Land	0-15	410	400	190	L	6.49	6.54	8.0	0.67	0.47	1.74	0.4	11.28	1.21	3.50	3.97	138.2	23.83	2.70
	15-30	490	400	110	L	6.53	6.44	6.6	0.42	0.4	2.09	1.2	10.71	0.71	2.80	4.16	103.2	38.08	6.32
	0-15	260	490	250	L	6.17	5.83	9.6	0.67	0.36	1.74	0.8	13.17	0.864	5.43	3.89	60.31	25.10	2.43
	15-30	150	500	350	SiCL	5.86	5.67	9.6	0.58	0.47	2.09	1.2	13.94	0.50	2.80	4.19	71.41	34.80	3.99

*L = Loam, SL = Sandy loam, SiCL = Silty clay loam

TABLE 2: Ranking of Means of Physico-chemical Properties and Nutrients of Land Use

Parameter	Rosella Intercrop	Mango Orchard	Virgin Land	Maize and legume intercrop	Irrigation Land	SE±	LOS
OC	1.258^{ab}	1.426^{a}	0.619^{c}	1.248^{ab}	0.821^{bc}	0.169	0.034^{*}
Avail. P	12.51	5.47	3.46	16.98	3.63	3.357	NS
Clay	8.00^{b}	7.00^{b}	11.50^{b}	15.50^{ab}	22.50^{a}	2.915	0.023^{*}
Silt	30.50	46.00	37.50	40.00	44.75	4.308	NS
Sand	61.50	47.00	51.00	45.00	32.75	6.302	NS
Ca	7.25	6.30	7.90	12.45	8.45	1.720	NS
Mg	1.83	1.77	7.77	1.33	0.59	0.332	NS
Na	1.96	2.96	2.18	2.00	1.92	0.372	NS
K	0.51^{ab}	0.69^{a}	0.26^{c}	0.40^{bc}	0.43^{bc}	0.056	0.004^{**}
Exch. A	0.60	0.45	0.50	1.40	0.90	0.216	NS
ECEC	12.15	12.15	11.60	17.57	12.28	2.073	NS
pH(H_2O)	7.69^{a}	7.42^{a}	6.35^{b}	6.53^{b}	6.26^{b}	0.108	0.000^{**}
pH($CaCl_2$)	7.01^{a}	6.95^{a}	6.19^{b}	6.40^{b}	6.12^{b}	0.127	0.001^{**}
Cu	4.09^{b}	3.50^{c}	3.94^{bc}	4.80^{a}	4.05^{b}	0.167	0.004^{**}
Zn	7.81	3.12	1.54	5.03	3.86	1.854	NS
Mn	36.18^{b}	65.72^{a}	31.46^{b}	38.13^{b}	30.45^{b}	4.153	0.001^{**}
Fe	68.65	100.33	84.79	101.95	93.28	20.334	NS

LOS = Level of significance, SE = Standard error, LOS (P) = NS>0.05,*≤0.05, **≤0.01

Potential Use of Soils in Kwadaro Sub-humid Environment for Sustainable Agriculture

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Abstract

The soils of the sub-humid environment are fragile with inherent moderate to low fertility status, ability to form hard crusts and low carbon and nitrogen levels which adversely affect cropping potential. To harness the soils in Kwadaro for sustainable agriculture without damaging the fragile sub-humid soils, there is need for better understanding of the soil resources and possible suggestions for sustainable soil management practices. Detailed soil survey of 42.8ha farm land was conducted in Kwadaro and five soil units identified. Soil samples were collected from the pedogenic horizons and samples analyzed for relevant physical and chemical properties. Results of the study showed that sand dominated particle size fractions (mean 528.75 g kg^{-1}) followed by silt (mean 331.67 g kg^{-1}) and clay was the least (mean 139.58 g kg^{-1}). The soil reaction had mean value of 5.8, and the soils were non saline with mean electrical conductivity value of 0.031 dS m^{-1} which is far less than the 4 dSm^{-1} critical limit needed to define saline soils. The soils were non sodic with low ESP and SAR mean values of 4.47 % and 0.195 and less than 15 % and 13 respectively used to define sodic soils. The mean values of exchangeable Ca, Mg and Na were 5.56, 1.49 and 0.35 cmol (+) kg^{-1} respectively, while mean Exchangeable K value was 0.29 cmol (+) kg^{-1}. The mean ECEC values of the soils were 8.12 cmol (+) kg^{-1}. The organic carbon and total nitrogen mean values of these soils were rated low, indicating deficiency 6.40 g kg^{-1} and 0.41 g kg^{-1}, while available phosphorous was rated moderate 14.5 mg kg^{-1}. Base saturation percentage had a mean value of 94.72% and was rated high which translates the characteristics of sub humid soils. Some of the soil units had shown susceptibility to erosion leading to surface crusting. For Kwadaro soils to be effectively utilized there is need for proper and sustainable soil management practices which should include; use of organic materials through; organic and green manuring and application of inorganic fertilizers. However, the right fertilizer should be applied to the right crop in the right quantity at the right time after soil testing.

Keywords: Fragile, Kwadaro, Potential use, Sub-humid, Sustainable agriculture.

Introduction

The Nigerian Sub-humid agro-ecological zone as defined by ILCA (1979), is bounded to the north by the limit of the 180-day crop growing season and to the south by the interface between the derived savanna and forest vegetation zones (Nord,1982).. Soils of the Sub-humid zone are characterized by high content of sand particle in the surface horizon overlying a weakly structured clay accumulation (Maniyunda et al., 2014). Odunze *et al*. (1996) and Odunze (2017) described the Alfisols soils of Sub-humid zone of Nigeria as fragile, with predominance of low-activity clays and inherent moderate to low fertility status. They have tendency to form hard crusts and carbon and nitrogen levels were low. They have a poor nutrient and water retention capacity, all of which adversely affect cropping potential. When subjected to continuous cultivation they became degraded soils. Dudal (1980), identified the limitations of the Sub-humid wooded savannah zone soils as mainly moisture stress and sensitivity to erosion particularly, under conditions of inadequate crop cover. Understanding characteristics of the soils through soil resource inventory will serve as a guide in selecting the most appropriate land uses and suggesting sustainable soil management options that will enhance sustainability and the efficiency of resource use. Therefore, the objective of this study is to assess the soil resource in Kwadaro and measure their characteristics for knowledge transfer and sustainable management.

Materials and Method

Environmental setting

The project site is located in Kwadaro, Soba Local Government Area of Kaduna State. The site is located on north east of Zaria city, along Zaria to Jos road, with an area of 42.8 ha. Geographically, the project area is bordered on the north by Kwadaro Tudu, N 10.94919^{o}, E 007.94530^{o} Elevation 667 m. The southern boundary covers Fadamar Kwadaro, N 10.94679^{o}, E 007.94604^{o} Elevation 656 m. The geology of area is within the undifferentiated basement complex (NGSA, 2004), which has an intricate pattern of rocks comprised of metamorphic and igneous origin which are essentially granites, gneisses, migmatites, schists and quartzites. The survey area is situated within the sub-humid tropical climate environment with distinct wet and dry seasons with a mean annual rainfall varying between 1016 and 1300mm (Ojanuga, 2006). The vegetation indicator is moist savanna (Northern Guinea Savanna) characterized by woodland vegetation with shrubs and grass under layer.

A total of five soil mapping units were delineated using rigid grid survey at 50m intervals, and designated as AAY1, AAY2, AAY3, AAY4a and AAY4b. A total of eight soil profile pits were dug with two profile pits for each of the soil mapping unit, and no profile pit was dug in mapping unit AAY3. Undisturbed soil samples were collected within the genetic horizons of penetrable soils for bulk density determination as described by Blake and Hartge (1986), and total porosity was calculated using a formula described by Danielson and Sutherland (1986). Disturbed soil samples were used for the determination of ; Particle size distribution (Gee and Or 2002), Soil pH (Thomas, 1996), Exchangeable bases (Ca, Mg, K and Na) (Thomas (1982), Total Exchangeable Acidity (H+Al) (Thomas,1982), Effective Cation Exchange Capacity (IITA, 1979) and (Rhoades, 1982), Base Saturation Percentage (BSP), Sodium Adsorption Ratio (SAR) and Exchangeable Sodium Percentage (ESP) were calculated using formulae. Electrical Conductivity (Udo *et al*., 2009), Organic carbon (Nelson and Sommers ,1996), Total nitrogen (Bremner ,1996) and Available phosphorus (IITA, 1979). Data generated were analyzed using descriptive statistics (Agbenin, 1995), where ranges and means were used.

Results and Discussion

Table 1 presents the physical and chemical properties of the soils. Sand dominated particle size fractions with values ranging from 300 to 780 g kg^{-1} and generally decreasing with an increase in soil with depth. This is followed by silt which varied between 100 and 580 g kg^{-1}. Clay content increased with depth from 40 g kg^{-1} in the surface horizon to a maximum of 320 g kg^{-1} in the subsoil. The increase in clay content with soil depth is attributed to illuviation process. Maniyunda et al. (2014) opined that, soils of the sub-humid zone were characterized by a sandy particle surface horizon overlying a weakly structured clay accumulation. The bulk density values ranged between 1.17 and 1.49 g cm^{-3} and rated low to medium. The total porosity of the soils is moderate with values ranging between 32.3 to 51.5 %. The present condition is conducive for root penetration and adequate aeration. Where the bulk density is higher in the surface horizon, this may be attributed to crusting of surface soils leading to compaction which reduces the total porosity. This was corroborated Dudal, (1980) and Odunze et al. (1996) in the sub-humid soils, especially where the soil surface was left bare. The particle size distribution influenced the texture to vary between sandy loam, loam and loamy sand.

The chemical and fertility properties presented in Table 1 indicate that the soil reaction ranged from 5.3 to 6.2 The mean values of the pH for Kwadaro indicate that, the soils were moderately acid and fall within the limit of (pH 5.5 to 6.5) set for optimum crop production in the tropics. The soils were non saline as the electrical conductivity of the saturation extract is between (0.013

– 0.075 dS m^{-1}) far less than the 4dS m^{-1} critical limit needed to define saline soils. The soils were non sodic with ESP values ranged between 0.88 – 8.9 %, less than 15% used to define sodic soils. Similarly, SAR values were too low, ranging between 0.036 and 0.421, confirming the soils are non-sodic. Therefore, the soil has no potential to develop salinity and sodicity at present. The mean values of exchangeable Ca, Mg and Na were 5.56, 1.49 and 0.35 cmol (+) kg^{-1}respecively and generally rated high, while the values trend ranged from 3.6 to 8.4, 0.9 to 2.27 and 0.07 to 1.13 cmol (+) kg^{-1} respectively (Table 1). Exchangeable K mean value was rated moderate 0.29 cmol (+) kg^{-1} with values that ranged from 0.08 to 0.77 cmol (+) kg^{-1}. The mean ECEC values of the soils were rated moderate (8.12 cmol (+) kg^{-1}), with values that ranged from 5.17 to 11.8 cmol (+) kg^{-1}. Soils of the sub humid environment were characterized by low cation exchange capacity, there by having poor buffering capacity affecting cropping potential negatively (Odunze et al., 1996). The organic carbon and Total nitrogen mean values of these soils were rated low, indicating deficiency between 6.40 g kg^{-1} and 0.41 g kg^{-1}, and decreased with increase in soil depth, while available phosphorus was rated moderate 14.5 mg kg^{-1}. Base saturation percentage ranged from 92.12 to 97.65 % with mean value of 94.72 % and rated as high. The low values of OC and TN, with moderate and high values of available phosphorus and BSP were in line with the findings of Odunze (1996) and FAO (1966), where they rated the soils of sub humid zone as of moderate to low fertility status.

Sustainable management

For sustainable soil management and crop production to take place at Kwadaro, the soils should be managed through the following appropriate practices: The use of organic materials as proposed by Liniger et al. (2011), which involves; (i) Green manuring through application of herbaceous plants on soil surface or sometimes incorporated into soil for the benefit of a food crop and (ii) Composting of materials in form of decomposed organic materials produced in combination with some additives like animal excreta or mineral fertilizers should be applied.. The use of conservation measures have also been suggested which includes; minimum tillage, permanent soil cover, and crop rotation (Lal, 1983). Although, minimum soil disturbance is beneficial, however, tillage is recommended sometimes because it disturbs the soils in order to break the surface crust so that infiltration can be improved and surface runoff reduced. Sub soiling can also be employed with equipment to break up compacted sub soils and improve rooting depth. The use crop residues and mulching were also recommended in the soils of the study area. This will help in stimulating termite activity which will break up the soil surface crust, there by leading to improved soil porosity and water infiltration (Zombre et al., 1999; Mando et al., 1999; Mando and Stroosnijder, 1999). Application of inorganic materials to supply essential nutrients to crops in sub-humid environments has been documented FAO (1989). The right fertilizer should be applied to the right crop in the right quantity at the right time after soil testing.

Conclusion

The detailed soil resource inventory of Kwadaro survey area in a sub-humid environment has provided base-line information of the soils in this area and its potential for sustainable agricultural production. Surface crusting has been identified in some of the soil units. The soils were generally high in exchangeable Ca, Mg and Na and moderate in K and ECEC and available P. Base saturation was rated high, while organic carbon and total nitrogen were rated low. Levels of salinity and sodicity were rated very low indicating no threat at present. Sustainable soil management options to be employed in order to protect the soil from degradation include; application of organic materials (organic and green manure), minimum tillage and application of mineral fertilizers at the right place, right quantity and at the right time.

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Table 1: soil physical and chemical properties of the survey area.

Horizon	Depth	Particle size distribution			Tex. class	BD	TP	PD	pH Ratio 1:2.5		ECe	OC	TN	Ap	Ca	Mg	K	Na	ECEC	ESP	BSP	SAR
		Clay	Silt	Sand					H_20	$CaCl_2$												
			g kg^{-1}			gcm^{-3}	%	gcm^{-3}			dSm^{1}	g kg^{-1}		mg kg^{-1}	←	→ cmol (+) kg^{-1}				%		
AAY1 P1																						
Ap	0-10	40	360	600	SL	1.49	32.3	2.2	5.7	5.2	0.06	7.34	0.39	20.35	3.6	0.9	0.19	0.21	5.17	4.06	96.13	0.139
Bt	10 -54	260	340	400	L	1.31	45.4	2.40	5.9	4.6	0.02	4.95	0.28	12.49	8.4	2.3	0.21	0.32	11.8	2.71	94.92	0.139
AAY1																						

P2																						
Ap	0-15	60	280	660	SL	1.48	41.7	2.54	5.8	5.0	0.03	5.42	0.22	17.58	4.2	1.1	0.77	0.49	6.99	7.01	94.28	0.300
Bt1	15-59	80	480	440	L	1.36	45.8	2.51	5.6	4.5	0.04	5.75	0.22	11.56	7.6	2.1	0.48	0.57	11.1	5.14	96.40	0.259
Bt2	59-116	200	340	460	L	1.17	51.5	2.41	5.4	4.7	0.05	1.76	0.11	16.65	5.8	1.6	0.41	0.42	8.60	4.88	95.35	0.219
BCv	116-140	120	200	680	SL				5.7	4.8	0.03	2.55	0.17	22.2	5.6	1.5	0.36	0.40	8.21	4.87	95.13	0.213
AAY2 P1																						
Ap	0-7	60	360	580	SL	1.35	45.8	2.41	5.6	4.7	0.06	10.5	0.45	15.26	5.0	1.4	0.36	0.30	7.61	3.94	92.12	0.168
Bt	7-20	250	350	400	L	1.35	47.5	2.51	5.7	4.7	0.03	3.03	1.32	12.03	3.6	0.9	0.45	0.43	5.58	7.71	96.42	0.287
AAY2 P2																						
Ap	0-6	180	32	500	L				6.	4.9	0.0	6.0	0.4	15.26	5.	1.5	0.2	0.3	8.0	3.7	92.	0.1

			0						1		4	6	8		4		5	0	1	5	51	62
Btv	6-20	220	400	380	L				5.8	4.7	0.02	7.34	0.25	12.03	5.2	1.4	0.26	0.37	7.63	4.85	94.76	0.204
AAY3	Very shallow soils to rock outcrops, no profile pit sunk																					
AAY4a p1																						
Ap	0-23	200	300	500	L	1.29	43.9	2.30	5.7	3.8	0.02	10.5	0.53	10.18	5.6	1.5	0.16	0.20	7.87	2.54	94.92	0.106
Btg1	23-50	120	320	560	SL	1.24	43.6	2.20	5.8	3.8	0.01	6.06	0.36	11.56	6.6	1.8	0.09	0.13	9.0	1.44	95.56	0.064
Btg2	50-98	200	180	620	SL	1.24	49.4	2.45	5.9	4.1	0.02	2.55	0.45	11.1	5.6	1.5	0.12	0.34	7.97	4.27	94.98	0.180
BCtg	98-130	140	560	300	SL	1.31	42.3	2.29	5.9	4.5	0.03	0.96	0.06	15.26	5.0	1.4	0.1	0.21	7.06	2.97	94.33	0.118
AAY4a P2																						
Apg	0-13	80	280	640	SL	1.40	44.2	2.51	5.7	4.9	0.08	15.5	0.84	26.36	6.4	1.8	0.25	0.38	9.22	4.12	95.66	0.188

Btg1	13-54	200	580	220	SiL	1.40	42.6	2.44	5.7	4.2	0.03	12.5	0.78	9.25	5.4	1.5	0.72	0.78	8.76	8.90	95.43	0.421
Btg2	54-134	160	400	440	L	1.41	42.4	2.45	5.9	3.9	0.01	4.79	0.31	17.11	7.4	2.0	0.13	0.43	10.2	4.22	97.65	0.198
AAY4b P1																						
Ap	0-23	80	320	600	SL	1.32	45.0	2.40	5.9	4.9	0.03	10.2	0.50	13.88	4.8	1.3	0.10	0.15	6.75	2.22	94.07	0.086
ACg	23-82	80	440	480	L	1.34	41.7	2.30	5.9	5.1	0.04	8.62	0.53	11.56	6.6	1.8	0.12	0.21	9.11	2.31	95.61	0.103
2ACg	82-142	60	170	770	LS	1.40	39.1	2.30	6.2	5.2	0.02	4.63	0.25	11.56	4.2	1.1	0.09	0.23	6.25	3.68	90.40	0.141
AAY4b P2																						
Apg	0-33	40	360	600	SL	1.31	44.3	2.33	5.9	4.8	0.02	3.99	0.25	15.73	4.4	1.2	1.07	1.13	8.19	13.8	95.12	0.67
2Ag	33-56	160	340	500	L	1.28	46.4	2.39	5.3	3.9	0.03	7.18	0.39	12.95	5.8	1.6	0.08	0.07	7.92	0.88	94.95	0.036

2ACg	56-96	320	100	580	SL	1.18	48.2	2.28	5.9	4.9	0.02	7.02	0.31	13.88	6.8	1.8	0.13	0.23	9.4	2.45	95.74	0.111
2Cg	96-160	40	180	780	LS	1.23	45.3	2.25	5.8	4.7	0.03	4.47	0.45	12.49	4.4	1.2	0.09	0.30	6.58	4.56	90.88	0.179

Key:Textural class; SL= sandy loam, LS= loamy sand, L= loam, SiL= Silty loam

IMPACT OF AGROFORESTRY ON SOIL CONSERVATION AND ENVIRONMENTAL SUSTAINABILITY: A REVIEW

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Abstract

It is globally known that agroforestry systems play significant roles in soil conservation and environmental sustainability and this is highly important to make the environment conducive, favourable and habitable for living.

Introduction

Soil conservation refers to the maintenance of soil fertility and erosion control. Soil fertility maintenance in Agroforestry system is achieved through the addition of organic matter, typically through litterfall and mulching, while erosion control is achieved through the mitigation of soil loses. Agroforestry has been proven to be efficient in soil conservation and sustainability of the environment (Barhier,1989). Agroforestry is a multiple land-use system in which agricultural crops and woody perennials are grown on the same land management unit (Owonubi and Otegbeye 2012). Agroforestry practices encompasses an entire spectrum of land use system in which woody perennial are deliberately combined with agricultural crops and /or in some spatial or temporal arrangement (Lundgren and Raintree, 1982) The presence of woody component in an agroforestry system plays a significant role both in soil conservation and environmental sustainability.

Agrofeorestry which is a land use system that has the potential of improving agricultural land use while providing lasting solution and alleviating adverse environmental effects at all level. Several agroforestry approaches are available for restructuring and increasing land productivity while also meeting the needs of low income farmers, and the presence of trees confers a number of advantages. For example, trees can protect fix nitrogen, stabilize the soil, and be used in terracing, contour cultivation and strip cropping to combat soil erosion and increase soil fertility. Trees planted as wind break and shelterbelt can protect soil against wind erosion. Trees can also be planted in an improved fallow and alley cropping with the branches pruned and applied as mulch to increase soil organic matter and nutrient status. In silvopastoral systems, tree canopies provide livestock with shade and wind protection and thus indirectly improve animal welfare, health and productivity. The presence of woody perennial in agroforestry system may affect several bio-physical and bio-chemical processes that determine the health of the soil substrate (Nair 1992). The less disputed effect of trees on soil include: amelioration of erosion primarily through continuous degeneration of roots and decomposition of liters, nitrogen fixation, enhancement of physical properties such as soil structure, porosity and moisture retention through the extensive root system and canopy cover can reduced the efficiency of the nutrient used because the tree used system can intercept, absorb and recycle nutrient in the soil that would otherwise be lost through leaching(Zanchez 1987) .Agroforestry which is the best biological remedy for soil degradation, erosion etc. It also promotes sustainable forest management as well as conservation and sustainability of the environment. It is therefore important to employ agroforestry as a land use which encourages increase in productivity as well as environmental sustainability (Sangotoyinbo et al.(2010c)

Agroforestry system can also provide wide range of environmental services including supporting services such as; pollination and carbon cycling..Regulatory services such as;protection against wind, increase water quality, biological pest control and nitrogen fixation. Also provisional services such as; timber, food, meat etc for home consumption and income generation. A well planned and designed agroforestry system can help restore, conserve and stabilized the environment hence, contributing to biodiversity conservation and climate change adaptation and mitigation. The three most important environmental services provided by the agroforestry systems include; erosion control, increased water availability and improved soil productivity.

Nigeria is blessed with a large area of land vegetation but the use of these important resources has been abused and bastardised, not sustainably used or managed. Ladipo (2010) stated that the forest has been treated in the past by rural dwellers as in exhaustible. Recently, everyone now realize that forest is at the verge of going to extinction.The soil that develops under natural forest and woodlot is fertile. It is well structured, has good water-holding capacity and has a store of nutrients bound up in the organic matter

Adverse effects of trees on soil

Allelopathy

Acidification

Removal of organic matter and nutrients in the tree harvest

What makes good soil-improving trees

• A high rate of production of leafy biomass.

• A dense network of fine roots, with a capacity for abundant mycorrhizal association

• The existence of deep roots

• A high rate of nitrogen fixation

• A high and balanced nutrient content in the foliage: litter of high quality (high in nitrogen, low in lignin and polyphenols).

• An appreciable nutrient content in the root system.

• Either rapid litter decay, where nutrient release is desired, or a moderate rate of litter decay, where maintenance of a soil cover is required

• Absence of toxic substances in the litter or root residues.

• For soil reclamation, a capacity to grow on poor soils.

• Absence of severe competitive effects with crops, particularly for water.

• Low invasiveness

Agroforestry and Soil Organic Matter

Agroforestry systems can maintain soil organic matter and biological activity at levels satisfactory for soil fertility. In agroforestry systems opportunities for soil organic matter management through the following means: increasing the supply of inputs as plant residues; reducing the proportion of plant material (tree and crop) removed from the system; reducing the rate of humus decomposition, through shading and mulching; reducing the loss of humus in eroded soils.

The supply of plant residues to the soil in agroforestry systems is determined by the biomass production (per unit area) of each plant component, tree and herbaceous system:

• The area occupied by each plant;

• Which part of each plant;

• Leaf, fruit, wood and root are added to the soil.

Agroforestry system can maintain more favorable soil physical properties than agriculture through organic matter maintenance and the effects of tree roots. Trees in agroforestry system can assist in maintenance of organic matter by

• increasing supply of biomass, as litter, prunings and root residues;

• reducing the rate of decomposition of soil organic matter;

• reducing the loss of organic matter through erosion

Role of Agroforestry in Climate Change Mitigation

Climate change is a global phenomenon that imposes economic, social, and ecological challenges to the global community. Research has shown that climate change is attributed to human activities, which bring about CO2 emissions, through the removal of forest cover (Owolabi, 2010). Deforestation, human induced conversion of forests to non forestland uses, is typically associated with large immediate reductions in forest carbon stock through land clearance. Poor forest management policies and illegal encroachment into forest reserves, urban development, road construction, fossil fuel combustion and excessive harvesting of fuel wood, contribute to the depletion of the ozone layer. Food and Agricultural Organisation of the United Nation FAO (2010), observed that deforestation account for approximately 18% of global carbon emissions. It was further reported by FAO (2001)that reduced deforestration, forest regeneratiuon, increased plantations development and agroforestry accounts for 12% to 15% of global sequestration of carbon emission from fossil fuels. Agroforestry has high potential to reduce atmospheric concentration of carbon dioxide (CO2) and mitigate climate change. It is an established fact that planting of more trees, to increase the amount of forested land or to increase the density of the existing forest in Nigeria would help mitigate climate change impacts in the country and at global level. Morgan et al (2001) also supported the fact that rising level of atmospheric carbon dioxide and associated global warming can only be addressed by adopting CO2 reduction strategies.

Environmental Benefits Of Agroforestry

The environmental benefits of agroforestry are:

Improving natural resource development: The total crop and wood production from an agro forestry plot is more than the separate production on the same piece of land. This is because the trees and crops complement each other's growth. Weeds in young forestry plantations are substituted by harvested pasture or crops. Maintenance is less expensive and environmental resources are used effectively.

Original open landscapes are created and are aesthetically pleasing and favor recreational activities. Agro forestry plots have landscaping potential and can enhance the public image of farmers in society.

The greenhouse effect is countered by the constitution of an efficient system for carbon sequestration, by integrating the stock maintenance of organic material in the soil and superimposing a net fixing wooded layer.

Enables the protection of soil and water especially in sensitive areas

Enhance biodiversity in the sense that crops are protected by their association with trees stimulating the hyper parasite (parasite of parasites) population of crops

Off-site benefits from water-table control - An agro forestry system helps decrease the water table and helps reduce the off-site impacts from dry land salinity and water logging.

Flood mitigation - The risk of flooding in large areas is increased by rising water tables. By lowering water tables, this can be reduced and downstream towns can benefit.

Soil erosion and runoff can be controlled by reducing water loss, soil material, nutrients and organic matter

Biological activity and soil organic matter can be maintained at satisfactory levels for soil fertility.

Through organic matter maintenance and the impact of tree roots, physical properties of soil can be maintained.

The development of soil toxicities can be checked or reduced – soil acidification and salination can be monitored and trees can be employed to reclaim polluted soils.

Solar energy is used more effectively than monocultural systems; a range of leaf shapes, alignments and plants of different heights all contribute to this.

Agro forestry may result in a reduction in insect pests and related diseases. It can also reclaim degraded or eroded land.

Trees and shrubs that aid in nitrogen fixing increase nitrogen inputs to agro forestry systems.

Agro forestry is capable of creating a diverse farm economy and stimulating the entire rural economy resulting in more stable communities and farms. When systems produce a number of products, economic risks are reduced.

When compared to conventional forestry systems, agro forestry offers a different land use option. Since trees and crops complement each other, this set up is ideal and available resources are effectively used.

Agro forestry has environmental benefits and also has a landscape benefit. Modern versions of agro forestry have adapted to the restrictions imposed from mechanization.

The agro forestry plot constantly generates revenue for the farmer, enabling the diversification of farm activity and a better use of environmental resources.

Agroforestry systems improve land protection in following areas:

Salinity and Water Table Control

Salinity is mainly caused by rising water tables. Trees help to lower water tables, acting as pumps to take up water from the soil and then evaporating it to the atmosphere.

Soil Erosion Control

Soil erosion or loss results from the action of wind and water on unprotected soils. The forest canopy, roots and leaf litter all have a role in controlling soil erosion.

Water Logging

Through water removal, established trees can substantially reduce water logging in their immediate area, which may result in improved land uses, e.g. pasture or crop.

Agroforestry can have immense benefits for the environment and the farmer.For farmers, the ability to maintain some sort of control over land and production in the face of climate change means agrofrestry could hold huge promise for the agricultural sector.

On an environmental level, agroforestry's ability to help prevent soil erosion while simultaneously aiding water retention and promoting soil fertility could help provide a solution for areas where rainfal is irregular or might become irregular due to climate change while dense plantations of trees would also help absorb CO2 and regulate local temperature

Conclusion and Recommendations

Greater recognition of agroforestry system as valuable option for soil conservation and environmental sustainability, this is highly needed to stabilized the environment.

It is essential to facilitate the development of local capacities for the collection, production and the distribution of crops and trees varieties and livestock breeds that can tolerate environmental extremes (e.g drought, heat stress and salinity) in order to support the local communities in adapting to climate change.

Access to information and training should be provided to rural advisors and farmers especially women and youth to stimulate the adoption of agroforestry, and taking advantages of both scientific and farmers knowledge.

Enabling environments need to be put in place for the development and scaling up of traditional and improved system in soil conservation and environmental stability projects .This means revising and reformulation unfavorable regulation and legal restriction on agroforestry, improving coordination among various sectors involved in agroforestry development; clarifying and securing land and tree tenure take into account the need of women for better access to land and associated resources and supporting agroforestry products value chains.

Incentive schemes; based on the role of trees in the supply of ecosystem services such as erosion control, enhance biodiversity, water quality and carbon sequestration should be put in place to motivate farmers and land owners to favour agroforestry as a valuable option for increasing the productivity and profitability of their lands. Combined with upfront finance or other support to cover the often significant start up cost such incentive would help farmers overcome investment barrier – especially delay in returns on investment in the period after- establishment in which tree yield little income but require resources for their upkeep.

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Evaluation of nutrient status of soils of NRCRI, Nyanya sub–station Abuja for increased cassava production

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Abstract

Soil managers recognize that soil degradation and nutrient depletion pose a serious threat to cassava production. Nutrient status of soils of National Root Crops Research Institute Nyanya sub-station Federal Capital Territory, Abuja Nigeria were evaluated to ascertain their present status and suggest management practices needed for an increased cassava yield. Soils were sampled at 0 – 15 cm depth and a total of 60 composite samples were collected from the research farm and analyzed in laboratory. The results revealed that the soils had a mean pH value of 6.0, exchangeable Ca (9.20cmol kg^{-1}), exchangeable Mg (5.40 cmol kg^{-1}), exchangeable Na (1.55 cmol kg^{-1}), exchangeable K (0.58 cmol kg^{-1}), organic carbon (8.13 gkg^{-}), total N (0.78 gkg^{-1}), available P (7.31 mg kg^{-1}). From the result of the study, increased cassava yield in the soils required some good management practices such as increasing the organic carbon status of the soils. Therefore, application of deficient nutrient elements were recommended.

Keywords: Cassava, Management, Soils**.**

Introduction

Cassava (*Manihot esculanta*) plays a major role in the economy of Nigeria, as it supplies more than half the calorie intake of the inhabitants (Abam *et a*l., 2006). Nigeria is the largest producer in the world, with an annual production rate of 59.6 million metric tons (FAO, 2017). It has diverse uses; it is principally used as human food, where it provides the major source of dietary energy for well over 200 million people in Africa. It can be processed into gari, fufu, farinhnade, mandioca, flour, chips and starch. Cassava chips, pellets and leaves are important in animal feed industry. Its starch is used in glucose, textiles and confectionery industries, as well as in food industry. It is a major source of cash income for households, as it generates cash income for a large number of them in comparison with other staple crops, thereby contributing to poverty alleviation (Onyekwere *et.al*, 2018).

The annual production rate of this important economic commodity crop by Nigeria as stated earlier is not as a result of its yield per unit area in farmers' field compared to yield obtained from countries like Brazil, China and Thailand. The production rate is due to large expanse of land subjected to its production. Presently, it has been observed that cassava yield in farmer's field in Nigeria is less than 9 t $ha^{-1.}$ This is as a result of some factors such as declining soil fertility, pests and diseases, use of unimproved cassava varieties and weed infestation. Among all factors the most important is declining soil fertility. To get a meaningful yield of cassava from farmers' fields, the soil fertility needs to be managed to improve the soil resource base. Soil fertility management has resulted to increase in cassava root yield in experimental fields (Chairoji et al.2017).

Declining soil fertility is a major problem militating against increase in cassava yield in Nigeria (Reinhardt 2017). For Nigeria to cope with the increase in the present demand and consumption of this commodity crop, soil fertility must be tackled to enhance productivity. Making sustainable research on effort towards improving soil fertility status for yield increase is therefore necessary.

Soil fertility decline could be alleviated through fertilizer application period. For fertilizer application to be effective the type and quality of fertilizer must depend on soil test result, otherwise soil abuse and low yield may be the result. The objectives of this to determine the nutrients status of soils of National Root Crops Research Institute Nyanya sub-station Federal Capital Territory Abuja, Nigeria and to determine management practices required for sustainable cassava production on these soils.

Materials and Methods

Study area

The study area was National Root Crops Research Institute Nyanya sub-station Federal Capital Territory Abuja, Nigeria. It is located within latitude 7'.62318^{o} N and longitude 9'.06733^{0} E. The mean annual rainfall of the location is 1,404 mm, with mean annual temperature of

26.74°C and the vegetation is typical of Southern Guinea Savanna zone. The soils are derived from basement parent material.

Sampling scheme

Soil samples were collected at 0-15 cm depth, using soil auger. A total of 60 composite samples were made, labeled and then transported to the soil science laboratory of the National Root Crops Research Institute (NRCRI), Umudike, Abia State for Soil physical and chemical analysis.

Laboratory Analysis.

All the soil samples were air dried, crushed and sieved through a 2 mm mesh and re-sieved through a 0.5 mm mesh for organic carbon and total nitrogen prior to physical and chemical analysis. The samples were then analyzed using standard laboratory methods as contained in the method of soil analysis by International Soil Reference and Information Center and Food and Agricultural Organization. **(**ISRIC and FAO, 2002).

Results and Discussion

Textural Classification

Percent sand, silt and clay content of the soils of the study area are as shown in Table 1

Particle size distribution.

Sand had the highest fraction with a mean value of 662 gkg^{-1} , followed by silt particle size fraction with a mean value of 225 gkg^{-1} and clay had the least fraction, with a mean value of 113 gkg^{-1}.The particle size distribution is an indication that the soils originated from coarse parent materials as reported by Onyekwere *et al* (2010).

Textural Classification

The texture of the soils is sandy loam. Generally, the textual classification of these soils agrees with optimum criterion of light medium loam sandy soil (Onyekwere *et al*., 2009) required for unhindered anchorage and bulking of roots and tubers (including cassava) and for easy harvest. This is an indication that the soil is good for cassava production.

Table 1: Mean values of the Physical properties of the soils studied.

Parameter	Mean value
Sand (gkg^{-1})	662
Silt (gkg^{-1})	225
Clay (gkg^{-1})	113
Textural class	Sandy Loam

Chemical Properties

The results of some chemical properties of the soils of the study area are shown in Table 2. N, P and K are the primary nutrients most commonly demanded by crops in plant nutrition. This explains why most compound fertilizers and fertilizer requirements for the crop (cassava) is based on N, P and K and their results are shown in Table 2.

Total N.

The results obtained showed that the total N of the soils studied was low with a mean value of 0.78 gkg^{-1} .The result of total N is a reflection of the organic carbon content of the soils (Onyekwere *et. al*., 2009). Positive response of cassava to applied nitrogen fertilizer is thus expected in these soils.

Available P.

Available phosphorous value of the soils was low, with a mean value of 7.13 $mgkg^{-1}$. This suggested that the soils will show substantial response to applied phosphorus fertilizer for cassava production.

Potassium.

The exchangeable potassium content of the soils studied was high, with a mean value of 0.58 cmol kg^{-1}. The soils had mean value that is above 0.20 cmol kg^{-1} value regarded to be the critical exchangeable K level in the soils (Onyekwere, *et al*, 2018). This is an indication that these soils are good for cassava production.

Soil Reaction. The soil reaction as expressed by pH (H_20) was moderately acidic with a mean value of 6.0. Agronomically, the mean pH value of the soils is good for cassava cultivation, as it can make room for the availability of both macro and micro nutrients as well enhance the activities of microorganisms in the soils.

Organic Carbon

The Organic carbon content of the soils is low, with a mean value of 8.13gkg^{-1} Maintenance of a satisfactory organic matter status in these soils is highly essential, Onyekwere and Ezenwa (2009) reported that incorporation of organic residues to the soil will enhance mineralization of most of the nitrogen and half of the phosphorous in the soils, if the cassava fields were unfertilized.

Calcium

The exchangeable calcium of the soils studied was high, with mean value of 9.20 cmol kg $^{-1}$. Soils of the study area had mean value above 4 cmol kg^{-1} regarded as lower limit for fertile soils (Onyekwere *et.al.* 2001)

Magnesium

The exchangeable magnesium content of the soils studied was high 5.40 cmol kg^{-1}., the soils were well endowed with exchangeable magnesium.

Sodium

The exchangeable sodium content of the soils was high, with a mean value of 1.59 cmolkg^{-1}. The soils had exchangeable Na above 0.2 cmolkg^{-1} regarded as the critical value needed in soils (Onyekwere, et al. 2018).

Table 2: Mean values of the chemical properties of the soils studied.

Parameter	Mean value
pH	6.0
Organic Carbon (gkg^{-1})	8.13
Total Nitrogen (gkg^{-1})	0.78

Exchangeable Ca (cmol kg^{-1}.)	9.20
Exchangeable Mg (cmol kg^{-1}.)	5.40
Exchangeable K (cmol kg^{-1}.)	0.58
Exchangeable Na (cmol kg^{-1}.)	1.55
Exchangeable Acidity (cmol kg^{-1}.)	0.14
Avaiable P (mgkg^{-1})	7.31

Conclusion

The findings in this study gave the following indications: That the textural classification and the soil reaction of the soils are ideal for cassava production, they can give room for the availability and uptake of both micro and macro nutrients.

That, the soils are further characterized by low organic carbon, high exchangeable Ca, Mg and Na and low primary nutrients apart from potassium. Based on these finding, incorporation of crop residue and other organic inputs and application of 90 kg N/ha and 20 Kg P_2O_5 /ha fertilizer are suggested for an increased cassava yield on the soils studied

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Effect of organic and inorganic soil amendments on cocoyam (NCe 011) yield at Umudike, southeastern Nigeria

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Abstract

A study was carried out to evaluate the growth and yield responses of cocoyam (taro) to NPK fertilizer and poultry manure. The experiment was laid out in a Randomized Complete Block Design (RCBD), with four treatments (Control (No amendment), 4 t/ha Poultry manure, 400 kg/ha NPK 15:15:15 and 200 kg/ha NPK !5:15:15 + 2 t/ha Poultry manure), replicated three times. Results obtained showed that application of 200 kg/ha NPK + 2 t/ha Poultry manure produced significantly taller plants with higher number of leaves and higher leaf area. Poultry manure, NPK fertilizer and their combinations increased yield significantly compared to the control. However, optimal yield was obtained at treatment combination of 200kg/ha NPK+2t/ha Poultry manure. This treatment also recorded highest; number of cormels per stand (8.0), cormel girth (7.0 cm), corm girth (7.9 cm),weight of cormels per hectare (3.40t/ha) and corms per hectare (11.63 t/ha). Results of correlation analyses revealed significant and positive correlations in most agronomic traits. Cormels yield (t/ha) significantly and positively influenced plant height (r = 0.73**), number of leaves (r = 0.81**) and leaf area (r = 0.80**) at 22 WAP. Weight of corms per hectare had positive correlation with yield attributes such as weight of cormels per hectare (r = 0.94**) and cormel length (r = 0.85**).Consequently, the application of 200kg/ha NPK+2t/ha Poultry manure had the greatest potential for cocoyam yield in the study area and is recommended for the cultivation of cocoyam (taro) in the agro-ecology.

Keywords: Cocoyam (taro) yield, Soil, Amendments.

Introduction

Cocoyam (Taro) belongs to the family Araceas and comprises many underground food crops grown in several tropical and sub-tropical countries. It is believed to be one of the vital world's oldest food crops, with a historical past of more than 2000 years in cultivation. FAOSTAT

(2010) ranked taro the fourteenth major vegetable crop, with about 12 million tons produced from about 2 million hectares with a yield of 6.5 t/ha. Nutritionally, taro is superior to cassava and yam with regards to higher protein, mineral and vitamins contents as well as easily digestible starch (FAO, 2012). Taro production in Nigeria rose from 0.93 to 3.89 million metric tons between 1990 and 2000 and further increased to 5.07 million metric tons in 2007 (FAO, 2007). In recent years, (2008-2012), production in Nigeria declined drastically due to the incidence of taro leaf blight (TLB) (FAO, 2013), decline in soil fertility levels and lack of soil management practices for continuous production (Agbede and Adekiya, 2016).

Cocoyam responds very well to organic and inorganic fertilizer inputs as reported by Ogbonna and Nweze, (2012). Complimentary application of organic and inorganic fertilizers is an important means of creating and sustaining optimal soil physico-chemical conditions for proper plant growth and development. A study was carried out in 2018 cropping season to evaluate the effect of organic and inorganic fertilization on the growth and yield of cocoyam (taro) in southeastern Nigeria.

Materials and Methods

A field study was carried out at National Root Crops Research Institute, Umudike Abia State (Latitude, 05^0 $29^'$ N longitude 07^0 $33^'$ E and altitude 122m above sea level) in 2018 cropping season. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Treatments comprised the following: Control (No treatment added) (T1); Poultry manure at 4t/ha alone (T2); NPK 15:15:15 at 400 kg/ha alone (T3); and Combined application of NPK 15:15:15 200kg/ha + Poultry manure 2t/ha (T4).The land was slashed, ploughed, harrowed and ridged before marking out into plots. Planting was done immediately after, on plots measuring 4 m x 5 m and at a spacing of 0.50 m within rows and 1 m between rows using one cultivar of cocoyam (taro) (NCe 011). Poultry manure was incorporated at planting in a grove at the crest of the ridge between plantings. Inorganic fertilizer treatment (NPK 15:15:15) was applied to relevant plots immediately after weeding at 6 WAP using side band method. Plots were manually kept weed-free. Data were collected on leaf number/plant, plant height (cm) and leaf area (cm^2) at 6, 14 and 22 WAP. Data were collected on corms and cormels weight (t/ha), total weight of corms + cormels (t/ha), corm and cormels length (cm), corms and cormels girth (cm) and number of stands at harvest. Harvesting was carried out in December. Data collected were subjected to analysis of variance for a randomised complete block design (RCBD) (Steel and Torrie, 1980). Significant treatment means were separated using F-LSD at 5% probability level (Obi, 1986). Spearman’s correlation matrix was constructed to measure relationships between measured growth (at 22 WAP) and yield parameters.

Analysis of physico-chemical properties of the study soil.

Particle size distribution was measured by the hydrometer method as described by Gee and Bauder (1986). Total N was determined by the macro-Kjeldahl digestion method (Bremner and Mulvaney, 1982). Organic carbon was determined by the dichromate oxidation method of Walkley and Black method (Nelson and Sommers, 1982). Organic matter (O.M) was determined by multiplying OC with the conventional Van Bernmeller factor of 1.724. Soil pH (H_2O) was measured (soil/water ratio of 1:2.5) with a digital pH meter (McLean, 1982). Available P was determined by the Bray 2 method according to Bray and Kurtz (1945). Cation exchange capacity (CEC) was determined by the NH_4OAc displacement method (Thomas, 1982) and exchangeable K in extract estimated by flame photometry. Exchangeable acidity was determined by the titrimetric method after extraction with1.0 M KCl (McLean, 1982). Effective cation exchange capacity (ECEC) was determined by the sum of the exchangeable bases and the exchangeable acidity.

Results and Discussion

Initial soil test results

Results of the initial physico-chemical properties of the study soil are as shown in Table 1. The study soil had a loamy sand texture, and a slightly acidic soil reaction (5.60). Percentage total nitrogen was very low (0.03%) with a moderate value of available phosphorus (34.0 mg/kg). Percentage soil organic matter was low (0.74%).

Effect of soil amendments on leaf number, plant height (cm) and leaf area (cm^2) at 6, 14 and 22 WAP.

Fertilizer amendment significantly ($P < 0.01$) influenced measured growth parameters across periods of observation, except at 6 WAP for leaf number/plant and leaf area (Table 2). Highest number of leaves were recorded from plots that received 2 t/ha PM + 200 kg/ha NPK fertilizer (T4) at 14 WAP (4.2) and at 22 WAP (5.9), which did not differ significantly from values obtained from the application of 400 kg/ha NPK alone at 14WAP (3.9) and at 22 WAP (5.7). Lowest numbers of leaves were recorded from the control plots that received no fertilizer treatment at 14 and 22 WAP (2.6 and 3.9, respectively). Similarly, application of 2 t/ha PM + 200 kg/ha NPK fertilizer (T4) recorded tallest plants that did not differ with values obtained from 400 kg/ha NPK fertilizer alone (T3) across the three periods of observations. Nevertheless, the Control, recorded consistently lowest plant heights of 24.2 cm, 26.8 cm and 27.3 cm at 6, 14 and

22 WAP, respectively. Application of T4 significantly ($P < 0.01$)recorded highest leaf area at 14 and 22 WAP (366.0 cm^2 and 528.7 cm^2, respectively). However, the Control (T1) recorded least values of leaf area at 14 WAP (234.0 cm^2) and at 22 WAP (338.0 cm^2).

Effect of soil amendments on yield and yield parameters of cocoyam (taro) (NCe 011).

Soil amendments very significantly ($P < 0.01$) affected significantly ($P < 0.05$)cormels, cormsand corms + cormels yields (t/ha). Complimentary application of 2 t/ha PM and 200 kg/ha NPK fertilizer recorded significantly highest total tuber yield of 15.03 t/ha. None application of soil amendments suppressed total tuber yield by 47.6% and recorded the least total tuber yield of 7.87 t/ha.Similarly, application of 2 t/ha PM + 200 kg/ha NPK fertilizer out-yielded other soil amendments in cormels weight (3.40 t/ha). No application of soil amendments suppressed corms yield by 44.3% and cormels yield by 59.1%. Application of 2 t/ha PM + 200 kg/ha NPK fertilizer yielded significantly highest corms (11.63 t/ha) which did not differ significantly with corms yield due to application of 400 kg/ha NPK fertilizer alone (9.51 t/ha).

Corms and cormels length and girth were significantly increased when complimentary application of 2 t/ha PM and 200 kg/ha NPK fertilizer were applied. Significantly highest values of corms length (10.3 cm), cormels length (8.4 cm), corms girth (7.9 cm) and cormels girth (7.0 cm) were obtained from complimentary use of 2 t/ha PM + 200 kg/ha NPK fertilizer treatments.

The results of this experiment showed clearly that the effects of 2 t/ha Poultry manure + 200 kg/ha NPK on cocoyam appeared more pronounced later in crop growth at 14 and 22 WAP. This might be attributed to the slow release of nutrients by poultry manure. This result is consistent with the findings of Miyasaka *et al*. (2001) who attributed the enhanced growth and yield response of the crop to organic amendment, to slow release of nutrients by the organic manure over the long duration of its growth. Fuchs *et al.* (2012) also reported that nutrients from inorganic fertilizers enhance the establishment of crops while those from mineralization of organic manure promoted yield related traits when both fertilizers were combined. On

Table 1. **Soil physico-chemical properties before treatment application**

Properties	Values
Sand (%)	78.20
Silt (%)	9.50

Clay (%)	12.30
Texture[a]	LS
pH(H_2O)	5.60
ECEC[b] (cmol/kg)	6.84
Organic carbon (%)	0.43
Organic matter (%)	0.74
Total N (%)	0.03
Available P (mg/kg)	34.0
Exchangeable K (cmol/kg)	0.05
C/N ratio	14.33

a.LS = Loamy sand; b. ECEC = Effective cation exchange capacity

Table 2: Effect of soil amendments on leaf number/plant, plant height (cm) and leaf area (cm^2) of cocoyam (taro) at 6, 14 and 22 WAP.

Treatment	Leaf number/plant			Plant height (cm)			Leaf area (cm^2)		
	6	**14**	**22**	**6**	**14**	**22**	**6**	**14**	**22**
		WAP			**WAP**			**WAP**	
T1	1.8	2.6	3.9	24.2	26.8	27.3	80.5	234.0	338.0
T2	2.2	3.4	4.9	29.8	33.1	33.7	85.9	300.0	433.3
T3	2.4	3.9	5.7	34.8	34.1	35.1	85.9	315.6	455.9
T4	2.3	4.2	5.9	31.0	34.4	39.4	67.9	366.0	528.7
$LSD_{(0.05)}$	**NS**	**0.6****	**0.7****	**4.7****	**5.2****	**5.3****	**NS**	**50.2****	**72.6****

** = Significant at 1% probability level; NS = Not significant at 5% probability level.

T1 = Control (No amendment); T2 = 4 t/ha PM; T3 = 400 kg/ha NPK fert. T4 = 2 t/ha PM + 200 kg/ha NPK fertilizer.

Table 3:Effect of soil amendments on yield and yield parameters of cocoyam (taro) at Umudike southeastern Nigeria

Treatment	No of stands at harvest	Corms weight (t/ha)	Cormels weight (t/ha)	Total tuber yield (t/ha)	Corms length (cm)	Corms girth (cm)	Cormels length (cm)	Cormels girth (cm)
T1	33.2	6.48	1.39	7.87	6.0	4.6	4.9	4.0
T2	32.0	7.41	1.85	9.26	7.3	5.6	5.7	4.7
T3	41.7	9.51	2.43	11.94	9.2	7.1	6.9	5.7
T4	33.3	11.63	3.40	15.03	10.3	7.9	8.4	7.0
LSD$_{(0.05)}$	**NS**	**2.87***	**0.56****	**.32****	**0.5****	**0.4****	**0.9***	**0.8****

** = Significant at 1% probability level; NS = Not significant at 5% probability level.

T1 = Control (No amendment); T2 = 4 t/ha PM; T3 = 400 kg/ha NPK fert. T4 = 2 t/ha PM + 200 kg/ha

NPK fertilizer.

the average, the combined application of NPK fertilizer and poultry manure appeared satisfactory for obtaining highest tuber characteristics and yield of cocoyam in the studied environment. Mokwunye, (1980) asserted that when organic manure is applied together with mineral fertilizers, the latter aids the decomposition of the former and subsequent release of plant available nutrients. Previous researchers had observed that the use of PM increased the efficiency of inorganic fertilizer probably by serving as a liming material and providing secondary and micronutrients not present in inorganic fertilizers (Lombin and Abdullahhi,(1978); Lombin *et al*, (1994); Ayoola and Adeniyan, (2000)). This may therefore explain the significant response of these yield attributes when both PM and inorganic fertilizer were applied together than separately. However, low response was obtained with the sole application of NPK fertilizer. This could be due to the fact that nutrient supplied by NPK fertilizer lasted for a short time because of leaching and luxury uptake by plants.

Correlation analyses of agronomic and yield characteristics (Table 4) revealed significant and positive correlations in most agronomic traits. Cormels yield (t/ha) significantly and positively influenced plant height at 22 WAP (r = 0.73**), number of leaves at 22 WAP (r = 0.81**) and leaf area at 22 WAP (r = 0.80**). Weight of corms per hectare had positive correlation with yield attributes such as weight of cormels per hectare (r = 0.94**) (revealing that bulking of corms did not negatively affect bulking of cormels, but was increasing with increase in cormels yield), and with cormel length (r = 0.85**). The result which we found on this research is in agreement with Gooding (1987) and Abd El-Latif *et al*. (2011).

Conclusion

Poultry manure, NPK fertilizer and their combinations significantly increased plant height, number of leaves , leaf area, corms and cormels weight, length and girth. However, optimum growth parameters at 14 and 22 WAP and total tuber yield were obtained at plots that received 200kg/ha NPK+2t/ha Poultry manure. Consequently, the application of 200kg/ha NPK+2t/ha Poultry manure had the greatest potential for cocoyam production in the study area. It is recommended that similar work be carried out in other agricultural zones in the State to confirm the findings

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Table 4: Spearman correlation matrix for some agronomic parameters in cocoyam production at Umudike.

Parameter	1	2	3	4	5	6	7	8	9	10	11	12
1). Plant height at 22WAP	-											
2). No. of leaves at 22WAP	0.833**	-										
3). Leaf area at 22WAP	0.862**	0.861**	-									
4). Cormel length	0.799**	0.782**	0.877**	-								
5). Corms length(cm)	0.831**	0.831**	0.877**	0.962**	-							
6). Cormel girth	0.799**	0.782**	0.877**	1.000**	0.962**	-						
7). Corm girth	0.831**	0.831**	0.877**	0.962**	1.000**	0.962**	-					
8). No. of Cormel per stand	0.850**	0.846**	0.888**	0.875**	0.846**	0.875**	0.846**	-				
9). Wt of cormels /stand	0.611*	0.767**	0.689*	0.791**	0.844**	0.791**	0.844**	0.688*	-			
10). Wt of corms per stand	0.680*	0.844**	0.752**	0.803**	0.875**	0.803**	0.875**	0.681*	0.803**	-		
11). WT of corms t/ha	0.611*	0.766**	0.721**	0.848**	0.868**	0.848**	0.868**	0.740**	0.981**	0.782**	-	
12). WT of cormel t/ha	0.729**	0.813**	0.804**	0.918**	0.889**	0.918**	0.889**	0.862**	0.897**	0.740**	0.942**	-

* Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).

Effect of different cropping systems and slope positions on carbon sequestration and carbon to nitrogen ratio in inland valleys of Southeastern Nigeria

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Abstract

A study was conducted using split-plot in a randomized complete block design in 2019, to evaluate the effect of different cropping systems and topo-sequences on carbon sequestration and carbon to nitrogen ratio in Ishiagu lowlands of Southeastern Nigeria. Eight cropping systems (sole okro, sole maize, sole rice, sole cassava, intercrop of maize and okro, intercrop of maize and cassava, mixed cropping of okro, yam, cassava, maize, cocoyam, castor oil bean) were sampled for this study and they constituted the sub-plots. The upper, middle and lower slopes served as the main-plots, while three points of soil collection stand as the blocks. In each of the cropping system site, soil samples were collected from three topsequences at 0-15 cm depth. Soil properties evaluated were soil total nitrogen, organic carbon and bulk density while soil carbon sequestration was determined by calculation. Data were subjected to statistical analysis using GENSTAT 37.2 Edition. Results revealed significant difference ($p < 0.05$) among the cropping systems in their effect on carbon sequestration. Maize intercropped with okro significantly produced the highest carbon sequestration of 92.60 mg/ha. The high soil carbon sequestration produced can improved soil quality and reduce agriculture's contribution to CO_2 emissions in the area. Maize/okro intercrop improved the C:N ratio. Soil and crop management practices as mixed and/ or inter cropping that are environmental friendly are recommended to increase the amount of carbon sequestration. Results indicated that lower slope improved the soil carbon sequestration higher with a value of 65.10 Mg/ha, than other slopes.

Keywords: Cropping systems, toposequence, carbon sequestration, intercropping, mixed cropping, sole cropping

1.0 Introduction

Ebonyi State, Southeastern Nigeria is drastically affected by climate change revenging the globe, with its original vegetation changed from forest zone to derived savanna presently (Nwite *et al.*, 2008); and there is anticipation that if nothing is done in the agricultural practices involved in the area in the nearest future, the vegetation may further degrade to a complete savanna area. Cropping systems in the State is characterized by sole cropping, intercropping and mixed cropping with improper selection of crops to feature in the cropping system.

Different cropping pattern have been observed to sequestrate organic carbon in different level depending on the type of crops selected for the pattern (Ma *et al.*, 2000; Liebig *et al.*, 2004;), this is due to differences in their size and depth of root biomass. Carbon sequestration can be defined as the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere(Lal, 2004). Soil carbon sequestration implies the removal of atmospheric CO_2 by plants and storage of the fixed carbon (C) through incorporation into soil organic matter (Lal, 2004). The strategy is to increase soil organic carbon (SOC), improve depth distribution of SOC and stabilize SOC by encapsulating it within stable micro-aggregates so that C is protected from microbial processes or as recalcitrant C with long turnover time.

There is an urgent need to adopt effective and proper agricultural practices for mitigating the threat of global climate change (Lal, 2004), which is due to the rapid increase in atmospheric carbon dioxide (CO_2) concentration associated with greenhouse gases (GHGs) emissions. The recent attention to global warming have motivated the search for efficient soil management and cropping systems to convert CO_2 from the air into soil organic carbon (SOC) (Lal, 2008). Cropping system has been credited to have influenced soil carbon sequestration in agricultural practicing areas. Pattern of crops taken up for a given piece of land have been reported to influence soil carbon to nitrogen (C:N) ratio greatly. Carbon to Nitrogen ratio (C:N) is a ratio of the mass of carbon to the mass of nitrogen in a substance. A cropping system of continuous no-till wheat as reported by Wortman *et al.* (2006) certainly provides good soil cover, as wheat produces a fair amount of residue with a relatively high C:N ratio (80:1) that decomposes relatively slowly. However, such a cropping system does not allow the crop nutrients in the wheat straw to become readily available to soil microorganisms or plants (Wortman *et al.*, 2006). Likewise, a cropping system of continuous no-till peas would result in very little soil cover as soil microbes would consume the pea residue (C:N of 29:1) relatively quick, as not much additional nitrogen would be necessary for decomposition of the residue to take place (Brady and Weil, 2002).

Cropping systems with high biomass input to maintain the soil permanently covered imitate the conditions found with natural vegetation as well as in fallow system and develop the stratification of the soil organic carbon (SOC) pools similar to the natural vegetation (Sá and Lal, 2008). They provide a continuous mass and an energy flow that release organic compounds to stimulate the soil biota biodiversity and the soil organic matter (SOM) changes (Uphoff *et al.*, 2006; Six *et al.*, 2006; Séguy *et al.*, 2006). This concept is based on the multifunctional action of each species in the cropping system interacting with the soil attributes and stimulating the biological activity in a systemic interdependence of the soil structure and the soil organic matter pools (Uphoff *et al.,* 2006; Six *et al.,* 2006; Séguy *et al.,* 2006).

The level of soil carbon sequestrated and nutrient distribution do depend on slope positions. AungZaw *et al.* (2013), in a study on effect of topo-sequence position on soil properties and crop yield of paddy rice, reported that slope position influence the quantity of soil organic carbon input in an area. They further submitted that total nitrogen and carbon contents were significantly higher in middle field than in other slope positions.

Gebyaw (2015) in a study to determine the effect of slope position on soil physico-chemical properties with different management practices in small holder cultivated farms, submitted that the lowest SOC of 0.650% was recorded in continuous and intensive lower slope cultivated fields, whereas the highest SOC of 1.88% was obtained from recently cultivated higher slope compared to other slopes, which might be due to addition of soil organic matter (SOM) foliage. The lowest SOC according to him in the lower slope cultivated land, on the other hand, could be due to reduced inputs of organic matter, reduced physical protection of SOC as a result of tillage and increased oxidation of soil organic matter (SOM).

This necessitates the need for this study. The study therefore aimed at evaluating the various cropping systems commonly practiced in the area on the soil carbon sequestration and carbon:nitrogen (C:N) ratio. It also aimed at determining which slope position within the cropping systems can sequestrate soil organic carbon most and lower soil C:N ratio.

2.0 Materials and Methods

2.1 Description of the study site

The study was conducted in eight different cropping systems in Ishiagu, Ivo Local Government Area of Ebonyi State, Southeastern Nigeria. Farmers in the study area, are notably okro growers and the lowlands soils of the area where this okro plant are grown, are under intensive cultivation. The okro plant is sometimes planted sole or intercropped with maize, cassava, yam, cocoyam, and sometimes mixed with many other crops with no regards on the principles guiding intercropping or mix cropping. Ishiagu is located between latitude 5° 55´ N and 6° 00´ N and longitudes 7° 30´ E and 7° 35´ E. The relief of the study area is lowland and undulating (Eze and Chukwu, 2011). The geology of the area comprises sequences of sandy shales, with fine grained micaceous sandstones and mudstones that is Albian in age and belongs to the Asu River Group. The dark coloured shales are believed to have formed in stagnant marine basins. (Eze and Chukwu, 2011).

The soil classification is Ultisol, which is hydromorphic, of shale parent material with underlying impervious layer at about 40 cm depth. It is characterized by rampant flooding and water logging which is a precipitate of poor drainage resulting from the impervious layer, high soil bulk density and crusting (FDALR 1985). The flooding is experienced at about the peaks of the rainy season (July and September) and covers the basins and floodplains around the middle and lower courses of the river and the streams (Nwite *et al.*, 2014).

2.2 Field study

Eight different cropping systems including fallow land was identified and selected in different lowlands of Ishiagu, Southeastern Nigeria for the study in 2019. The cropping systems include; Sole rice, Sole cassava, Sole maize, Sole okra, Intercrop of maize and yam, Intercrop of maize and cassava, Mixed cropping of yam/cassava/cocoyam/maize/okra/castor oil bean and Fallow land system

Random and systematic methods of sampling were used to collect soil samples from the eight (8) different cropping systems. In each study cropping system site, soil samples (Auger and Core) were collected at three different sampling points from three toposequences or slope positions (upper, middle and bottom slopes) at 0-30 cm depths. The experiment was built into a split-plot in a randomized complete block design where the three toposequences constituted the main plots, while the eight (8) cropping systems constituted the subplots (treatments). Three sampling points in each cropping system were used as the blocks/replicates. This gave rise to seventy-two (72) auger and core samples collection used for the study. The auger soil samples were stored in labeled soil bags.

They were air-dried, crushed, sieved with a 2.00 mm sieve and taken to the laboratory for the determination of the particle size distribution and some selected soil chemical properties.

Soil analysis

Soil fractions less than 2 mm from individual samples were then analyzed using the following methods; Soil pH was measured in a 1:2.5 soil:0.1 M KCl suspensions (McLean, 1982). The soil OC was determined by the Walkley and Black method as described by Nelson and Sommers (1982). Total nitrogen was determined by semi-micro kjeldahl digestion method using sulphuric acid and $CuSO_4$ and Na_2SO_4 catalyst mixture (Bremner and Mulvaney, 1982).

Core samples was allowed to drain freely for 24 hours before being oven dried for determination of bulk density. This was determined by calculation as:

BD = Mass of dry soil (g) / vol. of same (cm3) as described by the Blake and Hartge's method (1986).

Carbon sequestration: This was determined by calculation as:

Carbon stock = Carbon (%) X soil bulk density X area (10, 000 m^2, i.e. 1 ha) x soil depth.

100

Data Analysis

Data analysis was performed using GENSTAT 3 7.2 Edition. Treatment means were separated and compared using Least Significant Difference (LSD) and all inferences were made at 5% Level of probability.

3.0 Results and Discussion

3.1 Toposequences and Different Cropping Systems Impacts on Soil Carbon Sequestration and C:N Ratio

The results (Table 1) present the effects of different slope positions or toposequences and cropping systems in lowland areas on soil organic carbon sequestration. Table 1 shows that there was significant ($p < 0.05$) differences in the different slope positions studied. It was observed that highest significant increase on the soil carbon sequestration was recorded at the bottom/lower slopes of the studied different cropping systems with a value of 65.10 Mg/ha, while the least mean value (59.46 Mg/ha) of carbon sequestration was obtained from the middle slopes.

The results indicated that soil carbon sequestration was significantly ($p < 0.05$) varied among the different cropping systems studied. The results revealed that among the different cropping systems, the highest significant increase (92.09 mg/ha) on the soil carbon sequestration was obtained from intercrop of maize and okro, while the lowest value was recorded in areas with sole okro cropping pattern. The result explains the need for increased sensitization of farmers in the area known for large okro farming, to adopt intercropping of maize and okro in their cropping pattern as against their usual sole okro cropping pattern for improved soil quality and reduced carbon emissions.

The reduced soil C:N ratio obtained in the bottom slope (Table 2) agreed with Garten *et al.* (1994) in a study at the Walker Branch forest watershed (Tennessee, USA), where they submitted that valley floors had greater total N concentrations, lower soil C:N ratios, greater potential net nitrification, and greater microbial activity. The lowest C:N ratio (Table 5) recorded in the studied fallow land could be attributed to accumulation of litter-fall and plant roots decay in the area which might have improved the N- mineralization in the area. This conforms to the submission that C:N ratios in plant material should be fairly large where N limitations occur (Lloyd, 1999).

Table 1: **Effect of different slope positions or toposequences and cropping systems in lowland areas on soil organic carbon sequestration (Mg/ha)**

	Slope Positions			
Cropping Systems Studied	**Upper slope**	**Middle slope**	**Bottom slope**	**Mean**
Sole Okro	51.91	42.46	30.59	**41.65**
Sole Maize	47.62	57.81	55.00	**53.48**
Sole Rice	49.20	53.04	63.32	**55.19**
Sole cassava	30.79	46.11	59.01	**45.30**
Intercropping maize/cassava	76.59	77.43	58.80	**70.94**
Intercropping maize/okro	88.02	77.24	111.03	**92.09**
Mixed cropping y/c/cy/m/o/cob	78.20	58.65	82.19	**73.01**
Fallow land	94.07	62.95	60.85	**72.62**
Mean	**64.55**	**59.46**	**65.10**	**63.04**
LSD $_{0.05}$ (Slopes)		**1.279**	F- probability	**<.001**
LSD $_{0.05}$ (Cropping System)		**1.759**	F- probability	**<.001**
LSD $_{0.05}$ (Slopes x Cropping System)		**2.990**	F- probability	**<.001**

y/c/cy/m/o/cob = y = yam, c = cassava, cy = cocoyam, m = maize, o = okra, cob = castor oil bean; NS = non-significant

Table 2: **Effect of different slope positions or toposequences and cropping systems in lowland areas on soil carbon to nitrogen ratio (0-30cm) soil depth (g/kg)**

	Slope Positions

Cropping Systems Studied	Upper slope	Middle slope	Bottom slope	Mean
Sole Okro	6.04	1.36	0.68	**2.70**
Sole Maize	2.49	3.43	1.03	**2.32**
Sole Rice	7.92	9.48	8.98	**8.80**
Sole cassava	1.07	2.24	6.68	**3.33**
Intercropping maize/cassava	6.32	1.51	0.29	**2.71**
Intercropping maize/okro	9.49	9.07	1.04	**6.53**
Mixed cropping y/c/cy/m/o/cob	15.14	12.91	3.11	**10.39**
Fallow land	1.61	0.72	0.91	**1.08**
Mean	**6.26**	**5.09**	**2.84**	**4.73**
LSD $_{0.05}$ (Slopes)		**0.874**	F - probability	**0.001**
LSD $_{0.05}$ (Cropping System)		**0.905**	F - probability	**<.001**
LSD $_{0.05}$ (Slopes x Cropping System)		**1.596**	F - probability	**<.001**

y/c/cy/m/o/cob = y = yam, c = cassava, cy = cocoyam, m = maize, o = okra, cob = castor oil bean; NS = non-significant

4.0 Conclusion

The study has revealed the importance of intercropping and mixed cropping on soil fertility improvement and reduction of soil carbon emissions in the study area. Therefore, there is a need to protect fallow lands, adopt soil and crop management practices such as mixed and/ or inter cropping that are environmental friendly, to increase the level of carbon sequestration, control soil degradation, and environmental pollution. An awareness of crop C:N ratios is necessary to select crop types and keep a cropping sequence on the right path toward sustainability of the ultimate C:N ratio that supports soil microorganisms.

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Concentration of Heavy Metals in Agricultural Soils of Micheal Okpara University of Agriculture Umudike Host Communities

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Abstract

The study was conducted to investigate the concentration of some selected heavy metals (Fe,Cr,Cu and Cd) in the soils of agricultural lands of Michael Okpara University of Agriculture Umudike host communities (Umudike, Umuariaga, and Amoba). Soil samples were collected at 0-30cm depth from the 3 host communities- Umudike, Umuariaga, and Amoba) and control (soil from Agricultural land far from the 3 host communities), the samples were analyzed in the laboratory using standard methods, data obtained were analyzed using analysis of variance (ANOVA) as contained in the GENSAT 2015 version. Result obtained showed that the soil pH increased significantly ($p<0.05$) at the host communities when compared with control sample. Umudike recorded highest pH value of 6.5 while control had 5.1, Available Phosphorus were higher at Umudike (40.3 mg/kg) and lower at control with 17.4 mg/kg. Apart from exchangeable acidity that was higher at control with 1.03 cmol/kg, while the soil from Umudike had 0.48 cmol/kg as the lowest value. Chromium, Iron, Copper and Cadmium were all significantly ($p<0.05$) higher at the 3host communities than control.

Introduction

Heavy metal concentration in soil is associated with biological and geographical cycles and actions such as agricultural practices, industrial activities and waste disposal methods (Eja *et al.*, 2003). The knowledge of heavy metal accumulation in soils, the origin of these metals and their possible interactions with soil properties are priority in many environmental monitoring (Qishlaqi and Moore, 2007). The accumulation of heavy metals in agricultural soils is of increasing concern due to food safety issues and potential health risks, as well as it's detrimental effects on soil ecosystem (Alloway and Aynes 1997).

Most of the agricultural lands within the university (Michael Okpara University of Agriculture Umudike) host communities are becoming a dumping ground for technological waste, especially used electronics and other harmful material from the university computer village and student hostels within the school and its host communities. It is a known fact that some of these products/materials contain hazardous metals such as iron, lead, copper, cadmium, mercury, chromium, arsenic, zinc etc. Increase in human population, business activities and technological improvement in most Michael Okpara University of agriculture Umudike host communities have increased the quantity of wastes deposited on agricultural lands due to poor waste management. It has been a common practice in these host communities to burn those wastes to reduce it or get rid of the wastes before cultivating their land, thus generating heavy metal riche ashes. These ashes will be dissolved in rain water and leached into the soil, causing contamination of underground water or washed away by run-off water into streams and rivers, thereby contaminating the environment. The determination of levels of heavy metals in the soils around the host communities will go a long way in suggesting remedial measures to avoid the soil being used to grow crops, which when consumed will lead to transfer of heavy metals into animal and human body. Hence the objective of the study is to determine heavy metals concentration in agricultural soils of Michael Okpara University of agriculture Umudike host communities.

Materials and Method

The study was carried out at Michael Okpara University of Agriculture Umudike host communities, Umudike, Umuariaga and Amoba all in Ikwuano LGA of Abia State South Eastern Nigeria. Umudike is located at latitude 05˚ 27’N and longitude 07˚ 32’E, Umuariaga is located at latitude 05˚ 28’N and longitude07˚ 32’E while Amoba is located at latitude 05˚ 28 ’N and longitude 07˚ 33’E

Sample collection

Soil samples were collected from agricultural lands in Umudike, Umuariaga, Amoba and control sample was picked from farm land far from the university host communities. The samples were collected three (3) each from the university host communities and control at depth of 0-30cm with soil auger, making a total of 12 samples. The samples were labelled and transported to laboratory for chemical and heavy metal analysis.

Laboratory analysis

Soil pH was determined in H_20 using glass electrode pH meter at a soil liquid ratio of 1:2.5 as explained by Udo *et al.* (2009). Soil Organic Carbon was determined by Walkley and Black wet oxidation method and modified by Udo *et al.* (2009). Organic Matter was determined by calculation using the conventional Van Bellema factor of 1.724. Total Nitrogen, Available Phosphorus, Exchangeable Bases (Ca, Mg, K and Na) and Exchangeable acidity were determined according to Udo *et al*. (2009). Effective Cation Exchange Capacity (ECEC) and

Percentage Base Saturation (BS) were calculated by summation of TEB + EA and {(ECEC – EA) ÷ ECEC} × 100, respectively. Heavy metals (Fe, Cr, Cu and Cd) were determined with AAS as described by Udo *et al.,* (2009).

Data analysis

Data collected from the laboratory analysis were subjected to analysis of variance (ANOVA) using GENESTAT software package, and Fishers least significant difference (LSD) were used to compare the means at 5% probability level.

Results and Discussion

Concentration of some selected chemical properties of soil collected from Michael Okpara University of Agriculture host communities (Umudike, Umuariaga, and Amoba) and control (table 1) showed that pH value ranged from 6.5 to 5.1. The highest value of pH was recorded on sample collected from Umudike (6.5) followed by Umuariaga (6.2) and Amoba (5.8) while the lowest value was recorded from the control sample (5.1). Available Phosphorus (Av. P) ranged from 40.3 to 17.4 mg/kg. The highest value of available Phosphorus was recorded from Umudike community (40.3mg/kg) followed by Amoba (38.2 mg/kg) and 35.7 mg/kg from Umuariaga while the lowest value of phosphorus 17.4 mg/kg was recorded on sample from control soil. Total nitrogen (TN) ranged from 0.47 to 0.13 %. The result from University host communities showed that the nitrogen content were high. Umudike had 0.47 %, followed by Umuariaga (0.43 %) and Amoba 0.41 % while the lowest value of 0.13 % was obtained from control. Organic matter (OM) ranged from 5.1 to 1.8 %, with Umuariaga given the highest value of 5.1 % followed by Umudike 4.8 % the lowest value of 1.8 % was recorded from control soil. Calcium (Ca) and magnesium (Mg) followed same trend, where Umudike had the highest value of Ca (14.4cmol/kg) and Mg (6.0 cmol/kg) followed by Umuariaga Ca (12.8 cmol/kg) Mg (5.6 cmol/kg) while the lowest value of Ca and Mg were obtained from the control Ca (4.6 cmol/kg) Mg (1.0 cmol/kg). Potassium (K) value ranged from 0.580 to 0.170 cmol/kg. The highest value of (K) was obtained from Umuariaga sample (0.580 cmol/kg) followed by Umudike (0.550 cmol/kg) and Amoba (0.510 cmol/kg) while the lowest value was obtained from control (0.170 cmol/kg). Sodium (Na) was higher across the 3 host communities with Umuariaga given the highest value of 0.460 cmol/kg followed by Umudike with 0.440 cmol/kg while the lowest value recorded from control sample (0.110 cmol/kg). Exchangeable acidity ranged (EA) from 1.03 to 0.48 cmol/kg with highest value recorded from control (1.03 cmol/kg) followed by Amoba (0.52 cmol/kg), 0.48 cmol/kg from Umudike while the lowest values was obtained from Umuariaga (0.47 cmol/kg). Effective cation exchange capacity (ECEC) ranged from 21.9 to 6.9 cmol/kg with Umudike sample given the highest value of 21.9 cmol/kg followed by 19.9 cmol/kg from Umuariaga and 18.9

cmol/kg from Amoba while the lowest value was obtained from control 6.9 cmol/kg. Base saturation (BS) followed the same trend where Umudike had 97.8 % BS followed by Umuariaga with 97.7% while the lowest value was recorded from control site (85.1 %). The result showed that there is a significant ($p<0.05$) increase in most of the chemical properties of soil tested. The increase may be attributed to indiscriminate dumping of wastes on agricultural lands across these 3 host communities from students living there. The result obtained from this study is in accordance with the findings of Eja *et al*. (2003) where they observed a similar increase in most chemical properties of soil collected from industrial estate.

Heavy Metals

Concentration of some selected heavy metals of soil collected from Michael Okpara University of Agriculture host communities (Umudike, Umuariaga, and Amoba) and control (table 2) showed that Iron (Fe) value ranged from 295.4 to 19.9 mg/kg with the highest value recorded at Umudike (295.4mg/kg) followed by 293.3mg/kg from Umuariaga and 266.1mg/kg from Amoba, while the lowest value was recorded on control sample 19.9mg/kg. Chromium(Cr) ranged from 131.8 to 102.9mg/kg across the 3 host communities, with Umuariaga given the highest value of 131.8mg/kg followed by Umudike with 111.3 mg/kg and 102.9/kg from Amoba while control was not detectable (ND). Copper (Cu) ranged from 212.1 to 0.11 mg/kg with Umudike given the highest value of Cu (212,1mg/kg) followed by Umuariaga (205.3mg/kg) while the lowest value was obtained from control sample (0.11 mg/kg). Cadmium (Cd) followed the same trend as cooper where Umudike had the highest value of Cd (81mg/kg) followed by 72.3mg/kg from Umuariaga and 67.0mg/kg from Amoba while control was not detectable (ND). The result obtained from the study shows that all heavy metals tested were significantly ($p<0.05$) higher across the 3 university host communities (Umudike, Umuariaga, and Amoba) when compared with the control sample. The increase in heavy metal concentration maybe attributed to increase in indiscriminate way of disposing wastes from business centers and students living in these hosting communities. The result is in agreement with the findings of Eja *et al.* (2003)

Conclusion and Recommendation

The result of this study revealed that heavy metals (Fe, Cr, Cu and Cd) were found to be very high in the 3 University host communities than the control soil as a result of increase of increase in student population, business centers that uses materials that contains heavy metals and indiscriminate disposing of waste materials that contains heavy metals on agricultural lands within the host communities. It is therefore recommended that special space or land far from agricultural lands should be mapped out for disposing of wastes from business centers and private hostels located within the university host communities.

Table 1: Some selected chemical properties of the soil from university host communities and control

Location	Depth (cm)	pH	Av.P	TN	OM	Ca	Mg	K	Na	EA	ECEC	BS
			mg/kg	……%…..		…………		cmol/kg	……………..			%
Umudike	0-30	6.5	40.3	0.47	4.8	14.4	6.0	0.551	0.440	0.48	21.9	97.8
Umuariaga	0-30	6.2	35.7	0.43	5.1	12.8	5.6	0.580	0.461	0.46	19.9	97.7
Amoba	0-30	5.9	38.2	0.41	4.6	11.9	5.5	0.510	0.421	0.52	18.9	97.3
Control	0-30	5.1	17.4	0.13	1.8	4.6	1.0	0.171	0.110	1.03	6.9	85.1
CV (%)		1.3	4.8	3.2	1.4	0.5	1.4	1.00	3.2	2.6	0.6	0.2
LSD (0.05)		0.3	6.4	0.04	0.2	1.1	0.7	0.020	0.03	0.09	1.8	1.0

Table2: Some selected heavy metals from university host communities and control

Location	Depth(cm)	Fe	Cr	Cu	Cd
		………………… **mg/kg** ………………			

Umudike	0-30	295.4	111.3	212.1	81.0
Umuariaga	0-30	293.3	131.8	205.3	72.3
Amoba	0-30	266.1	92.9	194.1	67.0
Control	0-30	19.9	ND	0.11	ND
CV (%)		0.3	2.9	1.2	2.2
LSD (0.05)		19.7	8.8	5.1	7.9

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Effect of different levels of abattoir waste on soil properties and dry matter yield of cucumber (*Cucumis sativa*)

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Abstract

The modern day agriculture emphasizes more on organic agriculture and de-emphasizes the use of mineral fertilizers for sustainable crop production and environmental safety. Based on the above premise, effect of different levels of abattoir waste on soil properties and dry matter yield of cucumber was studied at Chukwuemeka Odumegwu Ojukwu University, Faculty of Agriculture the study was a complete randomized design (CRD) experiment with four (4) levels of abattoir waste and 3 replications. The result of the study showed that abattoir waste had a positive effect on the chemical properties of the soil and cucumber yield. The leaf area, number of leaves and plant height in most cases increased as the rate of the abattoir application increased, it also increased the pH, available P, N, OM, Ca, Mg, K, Na, EA and ECEC of the soil. The rates studied therefore recommended for cucumber production in the studied area.

Keywords: Abattoir, crop growth, chemical nutrients, soil properties

Introduction

The south eastern soils of Nigeria are poor in basic nutrients for optimum crop production. The problem can be traced to the genesis of the soil, high rainfall and temperature, overgrazing, deforestation, increase in population etc. Thus the fertility of the soils in the past are maintained through bush fallowing and shifting cultivation to allow for the fertility and structural restoration of the soil. Increases in population however have reduced the fallow periods and this had been found to have an adverse effect on the fertility restoration that result in crop yield failures. In order to solve the problem of crop failures farmers adopt the use of chemical fertilizers, which of course was found to increase crop yield but have been discovered to cause more harm than good to the soil which is the bedrock of life and health challenges to animals and man. Hence there is now a concerted effort by people through seminars, symposia, conferences etc to educate the populace and farmers on the need to end the use of chemical fertilizers especially in the south eastern soils of Nigeria that are so fragile. That more emphasis should be placed on the use of organic wastes, effluents, composts and any other organic materials that will be both soil and environmental healthy. Studies by Osemwonta (2010), Nsoanya and Nweke (2015) and Nweke (2017ab) have shown that the application of organic wastes improves the productivity of the soil, nutrient elements, plant growth and yield. Their works tend to substantiate and prove that waste supply virtually all the nutrients required by crops that improves soil physical, chemical and biological conditions for agricultural sustainability and environmental safety. Those wastes according to Nweke (2017a) can be added to the pool of organic matter content of tropical soils which have been reported to be a major problem militating against the yield of crop in the area.

Waste effluent can alter the physicochemical properties of the soil in which it is applied. And one of the wastes according to Ezeoha and Ungwuishiwu, (2011) that is of great concern to both urban and rural areas in Nigeria is the abattoir waste and effluent. Abattoir effluent is the residual materials obtained from the abattoir after the slaughter of animals such as cattle, goat, sheep, pig etc. The effluent comprises of materials like the blood, urine, faeces, water etc of such slaughtered animals. Abattoir waste have been noted to enhance the pH value and the chemical components of the soil as well as the organic matter content of the soil (Rabah et al., 2013, Neboh et al., 2013 and Nafamda et al., 2006). Improper management of abattoir waste especially with the dosage of application can portend serious environmental and health hazards to crops and human life. Thus Rabah et al., (2010) observed that continuous application of abattoir effluent into the soil fix complex plant nutrients, thereby making them unavailable for plant use thereby affecting the fertility status of the soil. This may lead to low productivity of the farm land. Hence it becomes paramount important that rates of abattoir waste need to be studied in order to find out the levels that will be compatible with the soil and will not portend dangers to the crop plants and environmental health. It was against this backdrop that the study was conceived to study levels of abattoir waste on soil properties and dry matter yield of cucumber.

Materials and methods

The pot experiment was set up in the green house in the Faculty of Agriculture Chukwuemeka Odumegwu Ojukwu University, Igbariam campus. The area is located within the latitude 05^{0} 40 and 06^{0}45 North and Longitude 06^{0} 40 and 07^{0} 20 East. The soil used for the study was collected by scrapping away 0-5cm of the surface soil from the Faculty of Agriculture farm land and the 15-20cm deep was collected in a plastic container. After collection of the soil, stones and hard clods were removed in order to ensure fine tilth before measuring the soil. 3kg of soil sample was weighed into each 16 plastic containers of dimension 19cm x 17cm and was thoroughly mixed with abattoir waste at the rates of 0g, 150g, 300g and 450g. The treatment was moistened and allowed 7 days before planting cucumber seeds in each of the 16 plastic pots. The pots were perforated and plugged with cotton wool at the bottom to prevent excessive drainage. The pots were watered to maintain moisture level at about field capacity throughout the growth periods of 8 weeks. Weeding was done by hand pulling where applicable till harvest. Agronomic parameters such as plant height, leaf area and number of leaves were measured every two (2) weeks. Fresh and dry matter weights were measured. At the end of the study soil samples were collected from each pot, these post samples and prior soil samples were sieved through 2mm sieve and subjected to chemical analysis as out lined in Black (1965). All the data collected were subjected to analysis of variance for a CRD experiment and treatment means were separated by least significance difference at 5% alpha level.

Results

The results in Table 1 present the chemical properties of soil samples used for the experiment. The result indicated that the soil is acidic in reaction and nutrient elements tested are below their critical level for crop production. Hence it is expected that the studied soil will benefit from the application of abattoir waste.

Table 1 Chemical properties of soil sample before experiment

Parameter	Value
pHH_2O	5.58
Avail. P	11mgkg^{-1}
N	0.042%
OC	0.53%
OM	0.91%
Ca	3.60cmolkg^{-1}
Mg	1.60cmolkg^{-1}
K	0.179cmolkg^{-1}
Na	0.165cmolkg^{-1}
EA	1.28cmolkg^{-1}

ECEC	6.82cmolkg^{-1}

Effect of abattoir waste on the yield component of cucumber

The result of 2, 4 and 6 weeks after planting (WAP) indicated significant differences among the treatments. The highest value in plant height 315.64cm and leaf area 32.67cm^2 (2 WAP), 53.14cm and 58.68cm^2 (4 WAP) and 70.52cm and 62.25cm^2 (6 WAP) were recorded in AB4 respectively (Table 2). It was also observed that the value recorded for the two parameters increased with attendant increase in the rates of abattoir waste application. The number of leaves result in the weeks under review did not follow any particular order, though in 2WAP, the value recorded was observed to be decreased with the increase in the rate of abattoir waste applied. The result of 8WAP indicated that AB3 recorded the highest value in plant height (70.31cm), leaf area (55.96cm^2) and the number of leaves (10.13). The control soil (ABO) recorded poor values relative to the amended soil in all the parameters tested.

Table 2 Effect of abattoir effluent on the yield component of cucumber

Treatment	2 weeks after planting			4 weeks after planting			6weeks after planting			8weeks after planting		
	Plant height cm	Leaf area cm^2	No. of leaves	Plant height cm	Leaf area cm^2	No of leaves	Plant height Cm	Leaf area cm^2	No of leaves	Plant height cm	Leaf area cm^2	No of leaves
ABO	10.22	10.55	3.81	10.03	10.50	2.63	25.73	17.98	3.08	26.54	18.16	4.50
AB1	113.90	14.63	3.73	23.70	19.57	4.63	43.49	24.21	6.56	57.03	28.72	7.11
AB3	313.64	31.97	3.56	34.89	48.12	5.88	52.84	56.51	8.88	70.31	55.96	10.13
AB4	315.64	32.67	3.50	53.14	58.68	6.56	70.52	62.25	7.15	59.98	30.77	6.50

LSD0.05	1.35	0.73	NS	8.96	10.57	1.45	17.25	18.79	1.06	12.09	9.45	2.13

AB1=150g Abattoir waste; AB3=300g Abattoir waste; AB4=450g Abattoir waste; ABO=control

Effect of abattoir waste on the yield of cucumber

The fresh and dry matter yield of cucumber presented in Table 3 showed non-significant difference (P < 0.05) among the rates of abattoir waste applied except for the result of fresh shoot weight. The result scenario for fresh shoot and root weight as well as dry shoot weight indicated AB3 >AB1 >AB4 >AB0 respectively. The dry root weight result indicated AB1 and AB3 to have recorded the same value, while highest recorded value for the parameter was obtained from AB4.

Table 3 Effect of abattoir waste on the fresh and dry matter yield of cucumber

Treatment	Fresh matter weight		Dry matter weight	
	Shoot gkg-1	Root gkg-1	Shoot gkg-1	Root gkg-1
ABO	5.75	1.75	1.75	0.5
AB1	12.25	3.25	4.0	1.0
AB3	36.25	4.0	5.0	1.0
AB4	17.75	3.5	3.75	1.25
LSD P < 0.05	14.06	NS	NS	NS

AB1=150g Abattoir waste; AB3=300g Abattoir waste; AB4=450g Abattoir waste; ABO = control

Effect of abattoir waste on soil chemical properties

Effect of abattoir waste on soil chemical properties in Table 4 showed non-significant (P < 0.05) difference among the rates of abattoir waste studied except for the results of available phosphorus, nitrogen, organic matter content and effective cation exchange capacity (ECEC). The recorded values for pH, available P, N, OM and Mg content were higher in AB4 compared to their values obtained from the other rates of abattoir waste. In most of the parameters recorded values increased with increase in the rates of application. The result of K and Na showed higher value in AB1 relative to other rates of abattoir waste studied.

Table 4 Effect of abattoir waste on soil chemical properties

Treatment	PH H_2O	P $Mgkg^{-1}$	N %	OM %	Ca $cmolkg^{-1}$	Mg $cmolkg^{-1}$	K $cmolkg^{-1}$	Na $cmolkg^{-1}$	EA $cmolkg^{-1}$	ECEC $cmolkg^{-1}$
ABO	6.11	15.73	0.06	1.18	3.1	1.5	0.12	0.23	1.0	5.42
AB1	6.08	18.83	0.09	1.36	3.6	1.7	0.12	0.23	0.86	6.51
AB3	6.22	15.80	0.08	1.24	3.2	1.6	0.13	0.48	0.83	6.24
AB4	6.58	22.55	0.11	1.78	3.2	1.8	0.12	0.23	0.76	6.11
LSD $P < 0.05$	NS	0.46	0.01	0.24	NS	NS	NS	NS	NS	0.63

AB1=150g Abattoir waste; AB3=300g Abattoir waste; AB4=450g Abattoir waste; ABO=control

Discussion

The rates of abattoir waste studied were found to have influenced positively the growth and yield parameters of cucumber as well as the soil parameters studied. This probably might have been due to the increased soil pH to the level where nutrients availability are made possible for the utilization of the cucumber plant that have resulted to enhanced yield and increased soil nutrients. The increased soil pH recorded in abattoir amended soils relative to non-amended (AB0) soil is an indication of positive effect of abattoir on the studied soil. This however was not in line with the report of Rabah et al. (2013), whose studies revealed lower pH on abattoir waste contaminated soil. The differences in the results might be on the rate of abattoir studied. The rate of abattoir studied is very important as improper management of abattoir wastes have been found to cause serious environmental and health hazards both to soil, human being and aquatic life (Osibanjo and Adie, 2007). The increased organic matter content observed in the study was in line with findings of Neboh et al. (2013), who found out high percentage organic carbon and organic matter value on abattoir waste of contaminated soil than on uncontaminated soil. This probably might be due to the fact that waste from abattoir waste typically contains compound that are characterized by high organic level (Coker et al., 2001; Nafarnda et al., 2006). Organic matter has equally been noted to be the primary source of nutrition for soil organisms and its incorporations in soil result in increased soil carbon.

Conclusion

The results of the study has shown that abattoir waste improves the soil properties which in turn resulted in higher output in terms of the growth and dry matter yield of cucumber . Farmers are therefore advised to make use of abattoir waste as their source of fertilizer as it improves soil life, fertility status and higher crop yield. However, they should be mindful of the rate to be applied as high rates might be dangerous to soil, crop and human life.

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Glyphosate effect on Soil Chemistry of Afikpo, Southeastern Nigeria

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Abstract

A pot experiment was carried out in the Green House of Akanu Ibiam Federal Polytechnic Unwana to investigate the effect of different concentrations of Glyphosate on selected soil fertility properties. Soil samples were collected with the soil anger from the Polytechnic multi-purpose farm at 0-20cm depth. This was air dried, sieved with 2mm sieve, after which sub-samples of 5kg each were weighed into 12L capacity plastic buckets perforated at the bottom to allow for air and water movement. Treatments comprised of three standard concentrations and one control (No glyphosate application) of glyphosates including the following: (1) 0 oz/gal of water which is equivalent to 0ml of glyphosate + 0 litre of water (Treatment A), (2)1 oz/gal of water which is equivalent to 29.5735ml of glyphosate + 1 litre of water (Treatment B), (3) 2 oz/gal of water which is equivalent to 59.1471ml of glyphosate + 1 litre of water (Treatment C), (3) 3 oz/gal of water which is equivalent to 88.7206ml of glyphosate + 1 litre of water (Treatment D). These were arranged in Complete Randomized Design (CRD) with three replications. These pots were adequately watered for the period of 8 weeks. Results showed that Glyphosate application affected the pH and concentrations of organic C, organic matter, total N, available P, Ca, Mg, K, Na, Exchangeable acidity, ECEC and Base saturation. Findings of this short-term study showed that with the exception of exchangeable acidity and available phosphorus, all the nutrient indices decreased as the concentration of glyphosate increased. Treatment B, generally gave the best in terms of soil fertility properties and is therefore recommended in the use of glyphosate for weed control.

Keywords: Glyphosate, Soil, Chemistry and Afikpo

Introduction

The need to produce enough food for the rapidly growing population of developing countries is more urgent than ever before, as food production has lagged far behind food need (FAO, 2007).Attempts have been made to increase food production by putting more land under cultivation and the use of improved seeds, more fertilizers and pesticides (FAO, 2007). However, if examined closely, some of the apparent gains in food production have not been actually realized due to the prevalence of pest especially weed (Gordon, 2006; Charls, 1985). Weed competes with human for food, host plant diseases and general reduction in crop yield (Gordon, 2006). It has been estimated that about 33 million tons of food is loss to weed (FAO, 2007). As far as possible, weed population should be control in order to ensure optimum crop production and thus food security.

Glyphosate use has over the years proved to be the quickest and the most effective chemical option for weed control. Glyphosate [N-(phosphonomethyl) glycine] is an active ingredient in a range of weed killer products, created for use in agriculture, horticulture and at amenity sites. Its use globally has risen almost 15-fold since 1996. Over the last decade, about 6.1 billion kilograms of the herbicide glyphosate have been applied Worldwide (FERA, 2016). According to (Newman *et al*, 2016) glyphosate is one of the most widely use herbicide in agriculture with prediction that 1.35 million metric tons will be used annually by 2020.

Despite being the most heavily applied herbicide in the world, there are reports of some negative effects associated with persistence glyphosate use in soils, plants and animals. Glyphosate changes soil microbiology in ways that can reduce plant nourishment and vitality, particularly nitrogen fixation; interferes with photosynthesis; reduces water use efficiency; lowers lignin content; damages and shortens root systems; causes plants to release important sugars; and changes soil pH—all of which can negatively affect crop health (Sihtmäe *et al.,* 2013). The glyphosate concentration in the soil builds up season after season with each subsequent application. It can also accumulate for 6-8 years in soils and its effects are reactivated by the application of P fertilizers (Mamy *et al*., 2016).

The Soil Association has reviewed the science on the impact of glyphosate on soils and soil life but surprisingly little research which has been done, shows contrasting results and significant uncertainty. Thus to further research findings, this study was designed to investigate the effect of different concentrations of glyphosate on soil chemical properties in Afikpo, southeastern Nigeria.

Materials And Methods

A pot experiment was carried out in the Green House of Akanu Ibiam Federal Polytechnic Unwana, tropical rain forest zone of Nigeria (coordinates: latitude $5^0$48’N and longitude $7^0$55’E). The two main soil types found in the study area are silty clayey hydromorphic soil and the grey sandy clay hydromorphic soil. The silty clayey hydromorphic soil has a brown loamy top horizon which overlies reddish brown silty clay subsoil (Obasi *et al*., 2015). The air temperature is generally high all year round and the current temperature range is 32^{o}C - 21^{o}C with total annual rainfall exceeding 3,500 mm (Njoku *et al*., 2006). Soil samples were collected with the soil anger from the Polytechnic multi-purpose farm at 0-20cm depth. This was air dried, sieved with 2mm sieve, after which sub-samples of 5kg each were weighed into 12L capacity plastic buckets perforated at the bottom to allow for air and water movement. **T**reatments comprised of three standard concentrations and one control (No glyphosate application) of glyphosates including the following:

1. 0 oz/gal of water which is equivalent to 0ml of glyphosate + 0 litre of water (Treatment A)
2. 1 oz/gal of water which is equivalent to 29.5735ml of glyphosate + 1 litre of water (Treatment B)
3. 2 oz/gal of water which is equivalent to 59.1471ml of glyphosate + 1 litre of water (Treatment C)
4. 3 oz/gal of water which is equivalent to 88.7206ml of glyphosate + 1 litre of water (Treatment D)

These were arranged in Complete Randomized Design (CRD) with three replications. These pots were adequately watered for the period of 8 weeks. Samples were collected after this period and were analyzed in the laboratory for the following chemical properties: Soil pH (Udo, et al.,2009), org. C (Pansu and Gautheyrous, 2006), total N (Simmone et al., 1994), Available P (Bray and Kurtz, 1945) ECEC (Udo, et al.,2009) and base saturation was obtained mathematically with:

$$B5(\%) = \frac{total\ cations}{ECEC} * \frac{100}{1}$$

Statistical Analysis Data generated from the study were subjected to analysis of variance (ANOVA) and the means separated using FlsD.0.05.

Results and Discussion

The physic-chemical properties of the soil used for the study are presented in the table 1. The textural class was a clayey loam with sand, silt and clay content of 38.41%, 26.77% and 34.82% respectively. The soil reaction indicated acidity with pH value of 4.20 and 3.92 in water and $Cacl_2$ respectively which is similar to pH values in ultisols of southeastern Nigeria (Onwuka *et al*., 2007).

Table 1: Physical and Chemical Properties of the Soil Used for the Study

Properties	Values
Sand (%)	38.41
Silt (%)	26.77
Clay (%)	34.82
Texture	Clayey-Loam
pH (H_2O)	4.20
pH ($Cacl_2$)	3.92
Org. C. (%)	1.4
Org. M (%)	2.47
Total N (%)	0.16
Av. P (mg/kg)	9.27
Ca (cmol./kg)	2.03
Mg (cmol./kg)	1.10
K (cmol./kg)	0.12
Na (cmol./kg)	0.02
Exc. Acidity	2.19
ECEC	5.46
B.S %	59.89

Organic matter were moderately low (1.40 and 2.47%) respectively) indicating a low soil fertility status (Woomer and Ingram, 1990). Total nitrogen was moderate (0.16%), which is greater than the critical level of 0.15% reported by Adoye and Agboola, (1984) for soils of humic tropical region. The soil was low in available phosphorus (9.20mg/kg) which is lower than the critical value of 15mg/kg for most tropical crops (Osodeke and Uba, 2005). The exchangeable bases and ECEC were moderately low indicating the ability of the soil to support crop growth if little application of fertilizer is carried out.

Effects of different Concentrations of Glyphosate on Soil Chemical Properties.

The effect of the different concentrations of glyphosate on soil chemical properties is presented in Table 2. The results of this study showed subtle alterations to soil chemical properties following the application of the herbicide glyphosate. The concentration rate of the glyphosate was statistically significant (P<.0.05) in influencing the soil chemical properties. This finding corroborates the results of other studies who report changes in soil chemical properties due to glyphosate application (Mamy *et al*., 2016; Newman *et al*., 2016). A consistent reduction in pH due to increased concentration of glyphosate was observed. This may probably be attributed to the reduced microbial population and activities due to glyphosate application, thus mineralization of organic matter and release of basic cations is impeded (Sihtmäe 2013). Therefore heavy use of glyphosate can lead to soil acidity. This result agrees with the report of Bronstad and Freste, (1985), but however contradicts the finding of Seralini (2015), who report non effect of glyphosate on soil pH. With the exception of exchangeable acidity and available phosphorus, all the nutrient indices decreased as the concentration of glyphosates increased. The control treatment (Treatment A) had the most appreciable results in almost all soil fertility properties examined. This also could be attributed to decline in soil microbial activities which have led to decrease in the release of nutrient from organic materials in the soil (Brady and Well, 2008). Other researchers have reported a decrease of soil chemical and nutrient indices as a result of glyphosate use (Bronstad and Friedstad, 1985, Benbrook, 2016).

Table 2: Mean effects of different Concentrations of Glyphosate on Soil Chemical Properties

Concentration	pH		OC.	OM	TN	Av P	Ca	Mg	K	Na	TEA	ECEC
Mg/l	H_2O	$Cacl_2$	%			mg/kg					Cmol/kg	
(Treatment A)	4.61	4.00	2.55	4.57	0.17	9.19	2.00	1.10	0.13	0.02	2.23	5.48
(Treatment B)	4.33	3.90	2.14	3.84	0.17	9.00	1.73	1.00	0.13	0.05	2.27	5.18
(Treatment C)	4.26	3.74	1.80	3.22	0.13	10.12	1.12	0.85	0.09	0.02	2.88	4.95

(Treatment D)	4.00	3.39	1.00	1.79	0.09	11.11	1.06	0.06	0.06	0.02	2.95	4.69
LSD(0.05)	1.11	0.89	0.24	1.00	0.07	3.25	0.19	0.04	0.01	0.01	0.77	2.09

OM= Organic matter; TEA = Total exchange acidity.

However, a consistent increase in available P and exchangeable acidity due to increased glyphosate concentration was observed. This gradual increase of soil phosphorus consequent of increased glyphosate concentration could be attributed to the fact that glyphosate is equally adsorbed by soil particles and therefore competes with phosphorus on the exchange complex. This reduces the available surfaces for phosphorus adsorption, thus making more phosphorus available in soil solution (Shelas *et al.*, 2002). Relative to other concentrations, dilution rate of 1L of water to 29.5735ml of glyphosate gave the least negative effect on the soil fertility indices. Therefore if glyphosate must be used in weed control in Afikpo, dilution rate of 1L of water to 29.5735ml of glyphosate should be used.

Conclusion

Glyphosate herbicides have achieved greater level of acceptance in comparison with other herbicides in Afikpo, Ebonyi State. Reasons for this success include a broad weed control spectrum and environmental safety. Despite the remarkable successes in weed control using glyphosate, however, there is growing concern on the negative soil and environmental impact of consistent glyphosate use. This study examined the effect of the standard dilution concentrations of glyphosate on soil chemical properties. Results showed that Glyphosate application affected the pH and concentrations of organic C, organic matter, total N, available P, Ca, Mg, K, Na, Exchangeable acidity, ECEC and Base saturation. Findings of this short-term study showed that crop management practices including herbicide program with glyphosate could affect soil chemical properties by reducing soil surface fertility and thus crop production. With the exception of exchangeable acidity and available phosphorus, all the nutrient indices decreased as the concentration of glyphosate increased. Dilution rate of 1L of water to 29.5735ml of glyphosate (Treatment B) gave the least negative effect on soil fertility properties and is therefore recommended in the use of glyphosate for weed control.

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SUB THEME I

VALUE CHAIN AND AGRIBUSINESS

Perceived Constraints Affecting Honey Marketing In Kano Metropolis, Kano State, Nigeria

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Abstract

The research analyzed the constraints of honey marketing in Kano metropolis. Three markets were purposively selected (kurmi, wambai and hajj camp markets) and a proportion of 50% of marketers were chosen from a sample size of 60, the sample size comprises of 15 wholesalers and 45 retailers. Structured questioners were used to collect data from the marketers. Descriptive statistics was used to analyze the data. The result of the analysis revealed that 33.4% and 33.7% of the wholesalers and retailers were within the age bracket of 33-41 and 29-35 respectively. Both marketers had experience of 1-8 years, for wholesaler (53.4%) and retailer (51.1%). 33.4% of wholesalers and 42.2% of retailers had household size of 1-4 and 1-3 respectively. The results however show that all the respondents were males for both wholesalers and retailers while 93.3% of wholesalers and 82.2% of retailers were married. The educational level of the respondents shows that 33.3% of wholesalers and 42.2% of retailer had secondary education as their highest level of education. The analysis revealed that educational status and years of experience were found to be significant among wholesalers and retailers. The result shows that 86.7% of wholesalers had problem of insecurity, majority of honey wholesale and retail marketers had problem of adulteration with about 40% and 38.5% respectively ranking 2nd among the list of problems. The result also shows that 33.3% of honey wholesalers in the study area had problem of inadequate storage facilities. However, the retailers were only 17.8% of the total respondents. This problem is the third in ranking among all problems. Also, 13.3% of the wholesalers had high cost of transportation as part of the constraints affecting honey marketing in the study area. On the other hand, the retailers with this problem were only 4.4% % of the entire sample. It was concluded that Honey marketing could be effectively used as a vehicle for eradicating poverty and improve the standard of living of people in the area of study, it is therefore recommended that honey marketers should be educated on honey marketing strategy for effective marketing.

Keywords: Perceived, Constraints, Honey, Marketing and Kano State

Introduction

Beekeeping for honey production has been identified as one of the most lucrative enterprises in many parts of the world. In 2005, China, Argentina, Turkey and the United States were the top producers of natural honey (FAO, 2009). Ethiopia is the ninth highest honey producing country in the world, with a total production estimated at 44,000 tons valued at US$76.6 (€57.6) million and is the largest producer and exporter of honey and beeswax in Africa. (FAO, 2009). This means that bee products are very important as a source of foreign exchange (Canadian Statistics, 2003). Presently in Nigeria, honey production is still at its developmental stage, though its awareness was created far back as early 1950s. This could be attributed to inefficient and inadequate information on the enterprise and the belief that swarms of bees are a taboo and signifies that a terrible mayhem is about to befall the individual whom it visits (Onyekuru, 2004). The recently estimated annual honey production in the world is over 2000 tones, the price of honey in Nigeria range from N100, 000 to N200, 000 per tonne . Although honey is produced in Nigeria but there is no fact and figure that can indicate the quantities of honey produced in Nigeria like the above mentioned countries (Oluwaseun, 2009).

The recently estimated annual honey production was over 2000 tones, yet Nigeria's productions and marketing to be insignificant as it was not recognized by the Food and Agricultural Organization (FAO, 2009). Inefficient processing of honey and its products for sale constitute the problem faced by marketing. Poor packaging and harvesting of honey products result in rapid deterioration of the products there by reducing the marketing performance. Adulteration of honey is also another major problem experienced in its marketing (Ojeleye, 1999). In this study area, some marketers in order to offer large quantities of the product for sale add sugar, water and saccharine to honey which eventually alters its quality, nutrient composition and moisture contents. This is the reason why some individual desist from the purchase of the product as the unadulterated product is so scarce. The objectives of the study were to describe the socio-economic characteristics of honey marketers and describe the constraints associated with honey marketing in the study area.

Methodology

Study area

The study area was Kano metropolis of Kano State. Kano metropolis comprised of eight local governments, they include; Dala, Ungogo, Kumbotso, Nasarawa, Gwale, Kano municipal, Tarauni and Fagge local governments. The markets used for the study were Kurmi market in Kano municipal Local government, Wambai and Hajj camp markets in Fagge Local Government. Kurmi market is one of Africa's oldest local markets. It is found within Kano municipal local government. It is located at latitude 11.9519°N and Longitude 8.54^{0} 3"E. It is made up of narrow alleys where you can find shop for everything from carvings, calabashes, to jewelries, brass works, leather goods and pottery. Other commodity sold there include; honey, hides and skin, simple farm tools like hoe, cutlass etc, firewood and so on. Economically, the city emerged as a centre of trade with the Maghreb countries of North Africa (Kano ADP, 2007). Wambai market is found within Fagge local government area of Kano state. majority of the products marketed in the market are agricultural in nature. Hajj camp market just like the Wambai market is found in Fagge local government. Agricultural products sold in the market include; honey, herbs and firewood.

Sampling Techniques

Three markets within Kano metropolis were selected for the study. The markets were Kurmi, Wambai and Hajj camp markets. These markets were selected purposively because they were notable for honey marketing in the study area. An estimate of 80 marketers was found at the Kurmi market (10 wholesalers and 70 retailers), 25 at the Hajj camp market (4 wholesalers and 21 retailers) and 15 at the Wambai market all wholesalers. 50% of the marketers from each market were randomly selected out of which 15 wholesalers and 45 were being retailers which gave a total of sixty (60) respondents for the study.

Table 1: Sample frame and sample size for the marketers

Markets	Estimated no. of wholesalers	Estimated no. of retailers	No. of samples for wholesalers (50%)	No. of samples for Retailers (50%)	Overall No. of samples to be taken (50%)
Kurmi	10	70	5	35	40
Wambai	15	-	8	-	8
Hajj camp	4	21	2	10	12
Total	**29**	**91**	**15**	**45**	**60**

Source: field survey, 2018

Method of Data Collection and Analysis

The data for the study was obtained using primary sources. It was collected using a well-structured questionnaire which was administered to the marketers. The questionnaire elicit information on socio economic characteristics of the honey marketers and further information was collected on problems encountered and other relevant information on the marketing of honeys in Kano metropolis. Data were analyzed using descriptive statistics.

Result and Discussion

Socioeconomic Characteristics of Honey Marketers

The result from table 2 shows that 100% (all) of the respondents were males for both wholesalers and retailers. The reason behind this could be attributed to the culture and religion of the people in the study area and the nature and role of female in the society. Majority of people in the study area are Muslims and as such, Islamic religion and the culture of the people does not allow women to participate businesses that require their outing and exposure to the male sex. It agrees with Onyekuru. (2010)) who posited that most of those involved in honey enterprise are of male folks. This is also in line with the findings of (ewa and Agu, 1998) who said “the economic status and contribution of female is less in developing countries due to their continuous dependence on their male counterparts and the social arrangement of their society. The result from table 2 revealed that among the wholesalers, majority 93.3% were married while only 6.7% (minority) of the population was unmarried. While among the retailers, majority (82.2%) were married while only 17.8% were unmarried. The above result shows that high importance is attached to marriage in the study area. This is in line with the findings of Abere and Lameed (2012) having 96% of their respondents married. The result in table 2 revealed that among the wholesalers, majority (33.3%) had secondary education, 26.7% had only Islamic education, 20% each had primary education and tertiary education. While among the retailers, majority 42.2% had secondary education, 28.9% had tertiary education, 17.8% had Islamic education, however, only11.1% (minority had primary education). Majority of the respondents (wholesalers and retailers) having secondary education as their highest level of education indicates that they had average level of education. This implies that they will have better marketing strategies (e.g promotion and advert) that will boost their sales of the product.

Table 2: Socioeconomic Characteristics of Honey Marketers

Wholesalers		Retailers		
Variables	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Gender				
Male	15.00	100	45.00	100.00
Female	0	0	0	0
Total	15.00	100.00	45.00	100.00
Marital Status				
Married	14.00	93.30	37.00	82.20
Single	1.00	6.70	8.00	17.80
Total	15.00	100.00	45.00	100.0
Educational status				
Islamic education	4.00	26.7	8.00	17.80
Primary	3.00	20.0	5.00	11.10
Secondary	5.00	33.3	19.00	42.20
Tertiary	3.00	20.0	13.00	28.90
Total	15.00	?????	45.00	100.00
Primary occupation	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Honey marketing	15.00	100.00	28.00	62.22
Others	0.00	0.00	17.00	37.78
Total	15.00	100.00	45.00	100.00
Other occupation beside honey	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Islamic medicine	4.00	26.70	42.00	93.40
Traditional medicine	1.00	6.60	2.00	4.40
None	10.00	66.70	1.00	2.20
Total	15.00	100.00	45.00	100.00

Source: field survey, 2018

Constraints to effective marketing of honey

Marketing of agricultural products in developing countries like Nigeria is associated with numerous constraints (Olukosi *et.al.* 2005). Nevertheless, it is a major determinant of general development especially agricultural (Abba, 2009). However, marketing of agricultural products has been variously charged with hoarding and exploitation of innocent farmers and powerless consumers, numerous constraints has been blocking the trajectory to achieving effective, efficient and improved performance of honey marketing. Therefore, the various constraints were investigated in the study area and the result is hereby presented in this section.

Table 3: Problems of honey marketing

Wholesalers				Retailers			
Problem Type	**Freq.**	**%**	**Rank**	**Problem Type**	**Freq.**	**%**	**Rank**
Insecurity	13.00	86.70	1st	Insecurity	24.00	53.30	1st
Adulteration	5.00	33.30	2nd	Adulteration	18.00	40.00	2nd
Inadequate Credit Facilities	5.00	33.30	3th	Inadequate Credit Facilities	8.00	17.80	3rd
High Cost of Transportation	2.00	13.30	4th	Inadequate Storage Facilities	4.00	8.90	4th
Inadequate Storage Facilities	2.00	13.30	5th	High Cost of Transportation	2.00	4.40	5th

Source: field survey, 2018 Multiple responses, there is no total among the variables

Table 3 shows that 86.7% of wholesalers had problem of insecurity. It is ranked the 1st among all the problems and this may be probably because of the existing insecurity challenges in the country. Furthermore, Majority of honey wholesale and retail marketers had problem of adulteration with about 40% and 38.5% respectively ranking 2nd among the list of problems. This is in conformity with the (Adeola, *et.al.* 2011) that had 37.76% in a research of economic analysis of honey marketing in Ibadan metropolis Oyo state, Nigeria. The table also shows that 33.3% of honey wholesalers in the study area had problem of inadequate storage facilities. However, the retailers were only 17.8% of the total respondents. This problem is the third in ranking among all problems. Also, 13.3% of the wholesalers had high cost of transportation as part of the constraints affecting honey marketing in the study area. On the other hand, the retailers with this problem were only 4.4% % of the entire sample. Finally, 13.3% of the wholesaler ranking 5th had problem of inadequate or poor storage facilities. However, among the retailers this problem ranked 4th with about 8.90% of the respondents.

Conclusion

The honey marketing analysis in the study area revealed that young men aged 29-41 constituted the majority of the marketers. They had medium education level in both Islamic and conventional educations. All the respondents were male and majority of them are married with household size ranged 3 in the study area. A constraint which militates against profitability of honey marketing includes insecurity, adulteration, and high cost of transportation, inadequate credit facilities and poor storage facilities. Honey marketing could be effectively used as a vehicle for eradicating poverty and improve the standard of living of people in the area of study.

Recommendations

The following recommendations will improve honey marketing in the study area;

- Honey marketers should be educated on the marketing strategies that will enhance honey marketing.
- There is need to sensitize the public on the importance of honey to healthy living while the association of honey marketers should put in place strategies for detecting fake adulterated honey with defaulters being prosecuted
- There is need for honey marketers to use modern storage and packaging facilities in order to reduce waste and also create more value addition to their products.
- Women participation in honey marketing is encouraged in order to see their potentials and boost production.

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ECONOMIC ANALYSIS OF KOLANUT MARKETING IN OSUN AND OGUN STATES OF NIGERIA

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Abstract

The study investigated the economics of kolanut marketing in the study area. Multi-stage sampling technique was used to select 160 respondents for the study. Structured questionnaire was used to elicit information from the respondents and the data from the information collected were analyzed with the use of descriptive statistics, gross margin analysis as well as multi-variate regression analysis. The result of the analysis shows that 72.5% of the respondents are above 60 years of age while 100% of the respondents are females. Gross margin analysis shows that the proportion of the net income to the total cost is 7.76%. The result further revealed that the income generated from kolanut marketing is influenced by the age and the educational level of the marketers as well as the costs incurred in the course of the marketing operations. The study recommended that youths should be encouraged into the business and adult education programme should be introduced among the marketers.

Keywords: Kolanut, marketers, profitability level, net income, economics

Introduction

Kola is a member of the tropical family sterculiaceae and it grows as a tree form. There are over fifty species of kola. Of these, seven have edible nuts, but only two have been widely exploited, these are *cola nitida* and *cola acuminate.* The most important is *cola nitida* because of its wide economic value. Kola is mostly produced in Africa and is cultivated to a large degree in Nigeria but also in Ghana, Ivory Coast, Brazil and the West Indian Islands (Opeke, 1982). Annual production from these countries alone is in excess of 250,000 tons while the world production is about 300,000 tons (American Horticultural Society, 2002). Oluokun and Oladokun (1999) claimed that Nigeria produces two million metric tons of kolanut annually which represented 70% of the world's kolanut production. In Nigeria, there is a common saying that "kola is produced in the West by Yorubas, consumed in the North by Hausas and worshiped in the East by Ibos". The South Easterners are more interested in *C. acuminata*, which features prominently in most traditional ceremonies and social functions such as marriages, weddings, coronation, installation of high chiefs and traditional rulers (Asogwa *et al*, 2011). Kolanut, apart from the fact that it is widely consumed by virtually all categories of income groups, the commodity has been found to be useful in the production of beverages, flavoring material alkaloids, caffeine, theobromine, laxatives, heart stimulants and sedatives.

The local market for kolanut is quite developed to the extent that specialised kolanut markets such as Shagamu, Ibadan, Okuku, Ikoro-Ekiti, Olode, Ikare-Akoko, Kano etc were well known far and wide. The inter-regional trade is said to be by far the most important arm of the Nigerian kolanut market (in terms of organisation) as it accounts for 80% of traded kola produce. Wealthy Northern States-based businessmen invest capital in kolanut trade through master agents of proven integrity who live in the main cities and towns of the kola producing areas of the Southern States. The master agents in turn employ the services of sub-agents who normally carry out the actual purchase and collection of the produce from farmers or itinerant collectors.

However, despite the fact that kolanut trading business activities are going on normally in all these areas, it could be observed that there's no record that actually shows the profitability level of kolanut trading in Nigeria. This study therefore intends to determine the profitability level of kolanut trading in the study area.

Methodology

The study was carried out in two States of Nigeria. These are Ogun and Osun States. From each of the States, one kolanut marketing Local Government Area (LGA) was purposively selected from each of the States. To this end, Sagamu LGA was selected from Ogun State while Ife South LGA was chosen from Osun State. From Sagamu LGA, Sagamu kolanut market was selected while in Ife South LGA, Olode kolanut market was chosen. A total of 160 kolanut marketers were randomly selected from the two markets. A well-structured questionnaire was used to elicit information from the respondents and the data collected from the information collected were analysed using gross margin analysis and multiple regression analysis.

(i) Gross Margin Analysis (GMA) - this was used to estimate the cost as well as the revenue generated from kolanut marketing.

Total Cost (TC) = Total Fixed Cost (TFC) + Total Variable Cost (TVC)……..... (i)

Gross Revenue (GR) = Total Output X unit price ……………………………… (ii)

Gross Margin (GM) = GR – Total Variable Cost (TVC) …………………......... (iii)

Net Income (NI) = GR – Total Fixed Cost (TFC) …………………………….. (iv)

(ii) Multiple Regression Analysis – Here, Ordinary Least Square regression analysis (OLS) was used to estimate the determinants of income from kolanut marketing.

The implicit model is

$$Q = \alpha_o + \alpha_i X_i + e_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(v)}$$

Where:

Q = Vector of dependent variable (Income (₦));

X = Vector of independent variables;

α = vector of parameter estimates to be estimated;

e = Random error term;

i = 1…n (n = number of exogenous variables investigated).

Results and Discussion

Table 1 shows the summary of the cost and returns on kolanut marketing. The result shows that the average variable cost per kolanut marketer is ₦19,079.70. The average fixed cost and the average gross revenue are ₦2,189.69 and ₦22,918.75 respectively. The gross margin and the net income per marketer are ₦3,839.05 and ₦1,649.36 respectively. The average total cost per marketer and the average gross revenue per marketer are ₦21,268.39 and ₦22,918.75 respectively. The proportion of the net income to the total cost therefore is 7.76%. Hence, 7.76% of the total cost expended on kolanut marketing is generated as profit. Therefore kolanut marketing in the study area is profitable, though the level of profitability is low. The lowness in the profitability level might be due to the low educational status of the respondents as well as their old age. This finding is in line with Oluyole *et al*, 2009 which showed that the profitability level of farmers is influenced by the educational level of the farmers.

Table 1. Cost and Returns Analysis for Kolanut Marketing

S/N	Item	Amount (₦)
1	Total Variable Cost (TVC)	3,052,752.00
2	Average Variable Cost (AVC)	19,079.70
3	Total Fixed Cost (TFC)	350,350.40
4	Average Fixed Cost (AFC)	2,189.69
5	Total Cost (TC)	3,403,102.40
6	Average Total Cost (ATC)	21,268.39
7	Gross Revenue (GR)	3,667,000.00
8	Average Gross Revenue (AGR)	22,918.75
9	Gross Margin (GM)	614,248.00
10	Average Gross Margin (AGM)	3,839.05
11	Net Income (NI)	263,897.60
12	Average Net Income (ANI)	1,649.36

Source: Field survey, 2019

Table 2 shows the determinants of income in kolanut marketing. The table shows that out of a total of 13 variables investigated, 12 variables were found to have significantly affected the income of kolanut marketers. The significant variables are age ($p<0.01$), marital status ($p<0.01$), educational status ($p<0.01$), years of marketing experience ($p<0.01$), cost of fetching water ($p<0.01$), cost of peeling/washing ($p<0.01$), cost of packaging/preservation ($p<0.01$), cost of transportation ($p<0.01$), cost of reservoir ($p<0.01$), cost of basket ($p<0.01$), cost of preservatives/chemical ($p<0.01$) and cost of nylon ($p<0.01$). Age is significant and negatively related to the income because the older the marketer, the lower the efficiency and this consequently results to lower income. As for marital status, the more the married respondents, the higher the availability of family labour for the marketing operations which ultimately results into more income. Educational level is significant and positively related showing that the more the respondents with formal educational, the higher the income derivable from kolanut marketing. This is because with the high level of education of the marketers, the marketers will be able to apply the new innovations to their marketing operations. Years of experience is significant and positively related to income, hence, the higher the number of years of experience, the higher the income derivable from kolanut marketing. However, the cost of fetching water, cost of peeling/washing, cost of packaging/preservation, cost of reservoir, cost of basin, cost of basket, cost of preservatives/chemical and cost of nylon are all significant and positively related to the income derivable from kolanut marketing. The increase in all these costs might be due to the fact that a higher quantity of kolanut is being marketed. Hence, more cost will be used to process a higher quantity of kolanut for marketing and a higher quantity of kolanut for marketing would result into a higher income. Therefore, an increase in all these costs would result into a higher income derivable from kolanut marketing, thus, the two of them are positively related. Meanwhile, the cost of transportation is significant and negatively related to the income. This means that as the cost of transportation is increasing, the income from kolanut marketing is decreasing and vice versa.

Table 2. Determinants of Income in Kolanut Marketing

Variable	Coefficient	t	Prob.
Constant	-6961.333	-17.86	0.000
Age	-98.11238	-13.14	0.000***
Marital status	246.5739	5.20	0.000***
Educational status	1283.257	21.90	0.000***
Years of experience	180.0388	12.49	0.000***
Cost of fetching of water	-1.576555	-11.27	0.000***
Cost of peeling/washing	3.688165	18.74	0.000***
Cost of packaging/preservation	8.080185	46.15	0.000***
Cost of transportation	-2.631101	-9.22	0.000***
Cost of reservoir	4.206554	26.63	0.000***
Cost of basin	1.389671	1.37	0.171
Cost of basket	8.486258	8.03	0.000***
Cost of preservatives/chemical	25.59375	11.76	0.000***
Cost of nylon	0.207622	35.35	0.000***
R-Squared	0.9956		
Adjusted R-Squared	0.9952		

Source: Field survey, 2019

*** Significant at 1% level.

Conclusion and recommendation

Though kolanut marketing in the study area is profitable, however, the profitability level is low. The income generated from kolanut marketing is influenced by the age and the educational level of the marketers as well as the costs incurred in the course of the marketing operations. However, based on the result from the study, the following recommendations are made.

1. Youths should be encouraged into kola marketing. This can be done by way of giving them soft loans to start the business.

2. Adult education programme should be introduced among the marketers as this will assist them to be able to read and apply the new technologies into their marketing business.

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VALUE CHAIN ANALYSIS OF FISH MARKETING IN LOKOJA LOCAL GOVERNMENT AREA, KOGI STATE, NIGERIA

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Abstract

The study assess the socioeconomic characteristics of the value chain actors; determine activities performed that affect prices of processed fish and challenges faced in Borgu LGA, Niger State Nigeria. A total of two markets: (Borgu and Wawa) were purposively selected of which 25% each of producers and retailers was taken 40% wholesalers and 10% processors. Majority of the respondents were male (62%) and were between 31-40 years of age (54%). The regression analysis of factors determining fish price showed that education, value addition, preservation methods, positively influence fish price while the cost of inputs negatively influence the fish price. All the variables are responsible in the variation (87%) observed in the price: education 46.216 value addition 2.150, marketing hours 2.400, preservation methods 3.0 and cost of input -3.067. the parameter estimate of each of the sign carries positive sign: confirm the a priori expectations at a significance level of 5% (*). It was recommended that processing facilities be made available and at cheap price through input liberalization.

Keyword: value chain actors, price, processed fish, challenge

Introduction

In Nigeria, fish production is practiced mainly in two environments namely fresh and salt waters. The fresh water fish production is classified into three major subsectors: Artisanal captured fishery, industrial captured fishery and aquaculture. In Artisanal captured fishery, production is achieved by an individual or by small groups of people with the use of labour intensive gears. The Artisanal Fishery subsector is the most important subsector as it represents between 85-90% of domestic production and providing means of economic support and livelihood for millions of rural dwellers (Federal Office of Statistics, 1996).

The artisanal fish farming supplies the highest volume of fish with an average 356.2mt yearly (CBN 2008) and there has been a steady increase in the number of full and part time fishermen since 2016 (FAO 2017).

Artisanal fisheries in Nigeria provided more than 82% of the domestic fish supply, giving livelihood to 1 million fishermen and up to 5.8 million fisher folks in the secondary sector while current needs put at a minimum of 2 million metric tons of fish to feed the population of over 140 million (Dawang *et al.*, 2011).

Despite the abundant fisheries resources and the relatively high consumption of fish in Nigeria (FDF, 2008), its domestic output of 0.85 million metric tonnes in 2010 still falls short of demand of 3.02 million metric tonnes (CBN, 2007; FDF, 2008; FDF, 2010). However a deficit of 2.17 million metric tonnes is required to meet the ever increasing demand for fish in Nigeria. This large deficit between the demand and supply of fish is augmented by massive importation of frozen fish which is a rigorous drain on the exchange earnings of the nation (Federal Department of Fisheries FDF, 2008). Availability of fish to the consumers at the right time, form, place and at the lowest possible cost requires an effective marketing system (Shamsuddin, 2007). Marketing of fish passes through various market participants and exchange points before they reach the final consumers (Ali et al., 2008).

Fish is major source of readily available protein in Nigeria and the most common in the coastal areas of Kogi State. According to FAO (2007), fish contributes more than 60% of the world supply of protein, especially in the developing countries. With an annual fish demand in the country of about 2.66 million tonnes, and a paltry domestic production of about 780,000 tonnes, the demand-supply gap stands at a staggering 1.8 million tonnes.

Parinde and Ojo (2014) had observed that fish is an important source of protein which is highly needed for human beings to experience necessary growth and development. Adeleke (2013) noted that the acceptability of fist in most communities of the world is due to fish tenderness and high digestibility compared to beef, mutton, chicken and bush meat.

Hence, there is a need to critically look into the activities of producers, processors and preservators of the fish products and marketers in order to bridge the gap between demand and supply. This is made possible by studying the factors that determine price and inherent challenges

It is therefore pertinent to raise the following questions; what are the socio-economic characteristics of fish value chain actors? what are the factors that determined fish price in the study area? And what are the challenges peculiar to fish value chain actors in the study areas?

Material and methods

The description of the study area

The study was carried out in Lokoja local government area of Niger state, Nigeria. The state lies between latitude 7°30′N 6°42′E and longitudes 7.500°N 6.700°E . Kogi, is a state in the central region (Middle-Belt) of Nigeria. It is popularly called the Confluence State because of the confluence of River Niger and River Benue at its capital, Lokoja, which is the first administrative capital of modern-day Nigeria.

Agriculture is the main part of the state economy with fishing in the riverine areas.

Adjacent States are as follows: Federal Capital Territory (Nigeria) to the north; Nasarawa State to the north east; Benue State to the east; Enugu State to the south east; Anambra State to the south; Edo State to the south west; Ondo State to the west; Ekiti State to the west; Kwara State to the west; Niger State to the north; Kogi state is the only state in Nigeria which shares a boundary with ten other states.

Data collection

Data collected for the purpose of this study were got from primary source through the use of well-structured questionnaires. The use of multimedia devices (ODK) greatly employed in the snapshots and stages of processing and preservation of fish in the study area. Tell us the information you will collect

Sampling Technique

A multi-stage sampling technique was used to select the sample for this study. The first stage involved the purposive selection of Lokoja local government area of Kogi State. The justification for the selection of this Local Government was because of proximity to river Niger and River Benue, and produces the largest fishing activities in the State in terms catch volume, species diversities of fish catches and fish production.

Analytical Techniques

The analytical techniques that were employed included descriptive statistics and regression analysis.

Descriptive Statistics

The socio-economic characteristics of the fisher folks as well as middle men involved in the value chain of the study area were described descriptively. The descriptive statistics employed included tables, bars, pie charts, frequency and percentage and measure of central tendency which include means and standard deviation.

Multiple Regression Analysis

This is to investigate the factors that influenced the price of fish in the study area and a regression model was used. The model was specified as follows:

$Y_i = X\beta + \tilde{e}$

Where:

Y_i = price of fish in Naira,

X = the matrix of independent/explanatory variables,

β = the regression coefficients,

ẽ = the error term.

Y_i = is the market price of fish in Naira which is dependent on the explanatory variables X1, X2, X3,…Xn, ẽ i.e. how much price is accounted for by each of the explanatory variables and how much is unexplained as measured by the error term ẽ. The regression model was implicitly specified as: Y = f(X1, X2, X3, X4… Xn,ẽ).

Where:

Y_i = fish price (in Naira)

X_1 = Age of respondent in years

X_2 = Sex of respondent (either male-1 or female-2).

X_3 = Household size.

X_4 = Educational level in years of formal schooling

X_5 = fishing experience

X_6 = Fish caught

X_7= Time spent in the fish production (in dayshours)

X_8= Time (hoe often)

X_9 = Cost of Gears

ẽ = the error term.

Three functional forms were tried on the data in order to get the one that best fits the model. These functional forms included linear, semi-logarithmic and double-logarithmic functions. The general forms of this function are specified as follows:

(i) Linear function:

$Y = a + b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+ e$…………………………………………….**i**

(ii) Semi-log production function

This is found useful in aggregate production function analysis. It is given by:

$Y = a + b_1\log X_1 + b_2logX_2 + b_3logX_3 + b_4logX_4 + b_5logX_5 + e$…………… ***ii***

Y = total output (kilogramme / kilogreamme grain equivalent)

b_1-b_5= the regression coefficients

X_1-X_5 = as specified in the linear model

$e = error\ term$

(iii) Cob Douglas Production Function

The model is given by:

$Y = aX_1^{b1}X_2^{b2}X_3^{b3}\ X_4^{b4}$……………………………………………………….………***iii***

When linearised it is expressed as:

$$\log Y = \log a + b_1logX_1 + b_2logX_2 + b_3 \log X_3 + b_4logX_4 + b_5logX_5 + e$$

Results and Discussion

Socio-Economic Characteristics of Respondents

Distribution of respondent according to value chain Actor

The table 1 shows distribution of respondent according to the activities performed in fish production value chain. 25% of the respondents are retailers, 25% are producers, 30% are Wholesalers and 20 of the respondents which represent 20% of the entire sample size are processors.

Table 1 Distribution of respondent according to value chain Actor

Value Chain Actors	Frequency	Percentage (%)	Valid percentage (%)	Cumulative Percent (%)
Retailer	25	25.0	25.0	25.0
Producers	**25**	**25.0**	**25.0**	**50.0**
Wholesalers	30	30.0	30.0	80.0
Processors	20	20.0	20.00	100.0
Total	**100**	**100.0**	**100.0**	

Source: computed field survey 2019

Distribution of Respondent according to Age

Table 2 shows the age distribution of the respondents. Fifty four percent (54%) of the respondents were less than or equal to 40 years of age. These were the age bracket that constitute the youth in the study area and were in their active age. Also 25% of the respondents were between the age bracket of 41 and 50 while the percentage of those respondents who were aged between 51 and 60 was just 20. Respondents who were older than 60 years were just 1%. This is good for fish procession in the study area and explains the reason behind the continuous fishing activity in the study area. These findings were consistent with that of (Odebiyi *et al*, 2013) and (Oparinde and Ojo, 2012).

Table 2: Age Distribution of Respondents

Age range of respondents (in years)	Retailer	Producer	Wholesaler	Processors	Total Frequency (%)	Total Percentage (%)
Less than 40 or equal	15	10	16	12	54	54
41 to 50	5	9	7	4	25	25
51 to 60	5	5	6	4	20	20
greater than 60	0	1	0	0	1	1
Total	**25**	**25**	**30**	**20**	**100**	**100**

Distribution of Respondent according to Sex

Table 3 reflects the distribution of the respondents according to their gender. Majority of the respondents were male and this represented 62% of the total sample size while the remaining 38% were female.

Table 3: Distribution of Respondent according to Sex

Sex	Retailer	Producer	Wholesaler	Processor	Total frequency	Total percentage (%)
Male	15	12	25	10	62	62
Female	10	8	10	10	38	38
Total	**25**	**25**	**30**	**20**	**100**	**100**

Source: Computed from Field Survey, 2019

Distribution of Respondents based on Marital Status

Table 4: shows the distribution of the respondents according to their marital status in the study area. It revealed that majority of the respondents (68%) were married, while 31% were single, only 1% of the respondents were divorced. The distribution revealed that the highest percentage of the respondents were married which indicated strong desire to cater for the families by the respondents.

Table 4: Marital distribution of respondents

Marital Status	Retailer	Producer	Wholesaler	Processor	Total frequency	Total percentage (%)
Married	15	16	18	15	64	64
Single	10	9	12	4	35	35
Divorced	0	0	0	1	1	1
Total	**25**	**25**	**30**	**20**	**100**	**100**

Source: Computed from Field Survey, 2019

Distribution of Respondents based on Household Size

Table 5: reveals that the about majority of the respondents have family size ranging between 6 and 10 persons and this represented 33% of the total respondents. About 21% have family size between 1 and 5 persons while those whose family size ranged between 11 and 15 persons represented 26%. However, 20% of the respondents family size greater than 15 persons. The family size of respondents in study area is relatively large and is of great important as large family provide the much needed labour.

Table 5: Household size distribution of Respondents

Household size	Retailer	Producer	Wholesaler	Processor	Frequency	Percentage
less than or equal to 5	6	7	7	1	21	26
6 to 10	7	5	12	9	33	31
11 to 15	7	6	8	5	26	26
greater 15	5	7	3	5	20	20
Total	**25**	**25**	**30**	**20**	**100**	**100**

Min: 1, Max: 16, Mode: 1, Mean: 6

Table 6: Educational level distribution of respondents

Level Of Education	Retailer	Producer	Wholesaler	Processor	Total frequency	Total percentage (%)
Primary	10	10	10	11	41	41
Secondary	6	5	7	6	36	36
Tertiary	1	0	2	1	4	4
Others	2	2	0	0	4	4
No formal education	6	5	0	3	15	15
Total	**25**	**25**	**30**	**20**	**100**	**100**

Distribution of Respondents based on Level of Education

Table 6: shows the educational attainment of the respondents in the study area. The result shows that 15% of the respondents had no formal education, 41% had primary education, 36% had secondary education, only 4% had tertiary education while another 4% had other forms of education and this included qurannic education, trade and vocational studies. These findings is in accordance with (PIND, 2011) and (Odebiyi *et al*, 2013) who both observed high percentage of education among fisher actors in Nigeria.

Distribution of Respondents According to Years of Fish Procession Experience

Respondents who had experience lees than or equal to 10 years accounted for 25% of the sample while those who fishing experience ranged from 11 years to 20 years accounted 52% (Table 7). Only 3% of the respondents had fishing experience ranging between 21 and 30 years while 15% of the respondents had years of experience in fishing between 31 and 40 years. Meanwhile, 5% had fishing experience more than 40 years.

Table 7: Distribution of Respondents according to years of Fishery Experience

Experience in years	Retailer	Producer	Wholesaler	Processor	Frequency	Total percentage (%)	Cumulative percentage (%)
less than or equal to 10	5	5	5	2	17	17	17
11 to 20	9	10	13	10	42	42	59
21 to 30	2	2	3	4	11	11	70
31 to 40	5	4	4	2	16	16	86
greater than 40	4	4	5	1	14	14	100
Total	**25**	**25**	**30**	**20**	**100**	**100**	

Min: 1, Max: 45, Mode: 15, Mean: 18.8,

Distribution of Respondents According to Sources of Funds and Inputs

Table8 reveals the sources of funds and inputs available to the respondents in the study area included personal savings, friends, family, cooperatives, and others. The majority of the respondents however got their funds and their own personal savings. Those who got their funds and inputs through personal savings accounted for 52%. About 28% got from friends and relatives. Cooperative societies which included fishing and non-fishing cooperatives accounted for 15%and others only represented 5%.

Table 8: Distribution of respondents according to sources of funds and inputs

Sources of funding	Frequency	Percentage (%)
Personal savings	52	52
Friends and relatives	28	28
Cooperatives	15	15
Others	5	5
Total	**100**	**100**

Distribution of Respondents According To Method of Preservation Used

Table 9: Showed that 36% of respondent smoked their fish as a both a means of preservation and value addition, 35% froze, and 29% salted which is also both a means of preservation and value addition.

Table 9: Distribution of Respondents According To Method of Preservation Used

Method of Preservation	Retailer	Producer	Wholesaler	Processor	Total Frequency	Percentage (%)
Freezing	15	5	10	5	35	35
Salting	5	9	10	5	29	29
Sun Drying	5	11	10	10	36	36
Total	**25**	**25**	**30**	**20**	**100**	**100**

Cost of Inputs

Table 10: shows the cost of inputs of the various respondents. This includes the total of cost of transportation, energy cost (electricity and generator), cost fishing gears for the fishermen, cost of fish feed, cost of land, cost of firewood and coal per month. Forty three per cent (43%) of the respondents spend between ₦20,000 and ₦30,000 on inputs monthly, closely followed by 30% of respondents who spent ₦30,000 to ₦40,000 monthly on inputs. Twenty seven per cent (27%) of the total respondents spend between ₦1,000 to ₦10,000 on inputs. With more than 50% of respondents spending so much amount of money on inputs, it can negatively affect fish business in case of unforeseen conditions such as spoilage or losses, or losses through accident during transit.

Table 10: Cost of inputs

Price of Fish per Basket Before and After Value Addition

Costs ofinputs(₦)	Retailer	Producer	Wholesaler	Processor	Frequency	Percentage (%)
1-10000	8	5	6	8	27	27
20-30000	10	12	15	6	43	43
30-40000	7	8	9	6	30	30
Total	**25**	**25**	**30**	**20**	**100**	**100**

From Table 12: it shows the differences of fish prices per basket being sold without value addition and sold with value addition. It can be seen that the prices after value additions were more than the price of fish before value addition. This is because inputs prices have been put into the value addition, hence increasing the out put price.

This is because the highest level of value addition is done by the processors. Fifteen per cent (15%) out of the entire 20% of processors sold their first between the range of ₦5,000 to ₦10,000 if no value was added and ₦10,000 to ₦15000 if value was added.

Half of the wholesalers (15%) sold their fish ₦3,000 to ₦6,000 without any value addition and ₦6,000 to ₦12,000 after value addition. Of the producers, 15% of the entire 25% of the sample size sold their fish without value addition between the range ₦1,000 and ₦3,000 per basket and ₦4,000 to ₦8,000 per basket after value addition.

Table 12: Price of fish per basket before and after value addition

Price Before Value addition (₦)	Price After Value addition (₦)	Retailer	Producer	Wholesaler	Processor	Frequency	Percentage (%)
1-3000	**4-8000**	4	15	10	2	31	31
3-6000	**6-12000**	15	6	15	3	38	38
5-10000	**10-15000**	6	4	5	15	31	31
Total		**25**	**25**	**30**	**20**	**100**	**100**

Source: Computed from Field Survey, 2019

Regression Analysis of factors determining Fish price in the value chain in the Study Area

From Table 13: talked about the results of the regression analysis to determine the factors that influence fish price in the fish value chain in the study area. The double-log functional form provided the best fit: (education (46.216), Value addition (2.150), preservation methods (3.0) and cost of inputs (-3.067)). The parameter estimates of each of these variables also carried signs, which conformed to the a priori expectations. The results indicate that education, value addition, preservation methods, positively influenced fish price while the cost of inputs negatively influenced the fish price in the study area. Thus, the major determinants of fish price were these three factors. All the explanatory variables together explained about 87% of the variations observed in value chain fish price.

Table 14: Regression Analysis of Factors Determining Fish Price the Study Area

Variables	**Simple Linear**		**Double log**	
	Coefficient	T-Value	Coefficient	T-Value
Constant	1491(984.23	1.514	5.274(0.110)	47.772
Age	-7.886(10.2)	-0.776	-0.006(0.01)	-1.352
Sex	239.6(33.3.1	-0.776	0.002(005)	0.499
Household size	-2.1(28.88)	-0.72	0.003(0.004)	0.807
Education	-1.377(23.9)	-0.58	1.023(0.022)	46.216*
Experience	13.891(6)	2.352*	0.006(0.003)	1.650
Value addition	0.0795(35)	0.023	0.007(0.003)	2.150*
Marketing hours	9.660(23.24)	0.404	0.012(0.005)	2.400*

Preservation methods	-89.402(75)	-1.196	0.015(0.005)	3.000*
Cost of inputs	0.001(0.01)		-0.004(0.013)	-3.067*
	R2=0.072 *SE=912.487 F Value=0.691		R2=0.87 SE=0.01135 F value=17428.7	

Note: *means significant at 5%, Values in parenthesis are t ratios

Challenges Associated with Fish Value Chain Fishing in the Study Area

An investigation into the challenges associated with fish value chain in Lokoja Kogi states reflected in Table 15 reveals that there were thirteen major challenges to fish production and value chain development. From the value chain actors' responses to the challenges, the challenges are ranked the three most responded to challenges are high perishability association with fish shelf life, ranked first (1st) and represents 88%, high costs of fishing gears (2nd) which represents 74% and poor technology for fish catch, procession and preservation which represent 70 %. These were followed by por cooperative (68%) and inadequate credit facilities (67). These challenges formed the core of the constraints and problems to fish value chain development in the lokoja, Kogi State, Nigeria. The findings above are consistent with (PIND, 2011) and (Oparinde and Ojo 2013).

Table 15: challenges of fish value chain and marketing in the study area

Challenges	Yes (%)	No (%)	Rank
Pollution of water bodies	51	49	8th
inadequate insurance for the chain actors	33	67	10th
High cost of fishing gears inputs	74	26	2nd
High perishability of fish	88	18	1st
Seasonality of fish harvest	56	46	6th
Inadequate credit facilities	67	33	5th
poor technology for fish catch, processing and preservation	70	30	3rd
Effect of Climate change	53	47	7th
Poor cooperative association	68	32	4th
Fluctuation in fish market demand	61	49	8th

Summary of the Findings

The study assessed the value chain in fishery Production in Lokoja Kogi State, Nigeria. Data were collected using a well-structured questionnaire using purposive sampling technique. Data were analyzed using descriptive statistics, and multiple regression models.

Results of the socio-economic analysis revealed that respondents who were older than 60 years were 1%. Cumulatively, respondents who could be classified as being economically able to effectively carry out productive fishing activities i.e. those less than or equal to 60 years were 99%. The implication of this is that almost all the respondents were still in their actively fishing years. In the same vein, majority of the respondents were male and this represented 62% of the total sample size while the remaning 38% were female which implied that fishing business is male-dominated in the study area.

The study further showed that the major challenges of fish value chain in the study area were high perishability associated with fish shelf life, ranked first (1st) and represents 88%, high costs of fishing gears (2nd) which represents 74% and poor technology for fish catch, procession and preservation (3rd), which represent 70 %. These three challenges and some others were the most challenging.

The double-log functional form provided the best fit: education (46.216), Value addition (2.150), preservation methods (3.0) and cost of inputs (-3.067). The parameter estimates of each of these variables also carried signs, which conformed to the a priori expectations. The results indicate that education, value addition, preservation methods, positively influenced fish price while the cost of inputs negatively influenced the fish price in the study area.

Recommendations

The following recommendations are made based on the findings from this study

i. Provision of adequate processing and storage facilities as well as other technology needed to enhance adequate processing, preservation and value addition to fish is paramount. This is occasioned by high level of fish perishability. Actors in the value chains should improve on their business by using modern processing, preservation and other new technology.

ii. Provision of subsidized inputs especially credit facilities, fishing gears and other inputs to the value chain actors by the Government of Kogi state will reduce the burden of high cost of production.

iii. Creation of a strong fisheries extension service between the government and the fisherfolks in order to adequately identify with the plights of the fisher actors.

Conclusion

Fish value chain in lokoja, Kogi State is still very traditional involving the use of indigenous production and marketing resources. The chain although conventional, still provides economic opportunities for the coastal areas of Kogi state. Most households depend on this for their survival. Major threats to the chains include high perishability. poor value addition to fish and high cost of fishing gears, poor technology for fish catch, processing.

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Determinants of total factor productivity in Oil palm production systems in Edo and Kogi States, Nigeria

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Abstract

The study examined the determinants of total factor productivity in oil palm production systems in Edo and Kogi States of Nigeria. A three-stage sampling procedure was used to select 180 farmers (large scale; 17, medium scale; 25 and small scale; 138). Data were collected with the aid of a structured questionnaire using the interview schedule method. Data were analysed using Tornqvist index and multiple regressions at $\alpha_{0.05}$. The result showed that Total Factor Productivity (TFP) of the large, medium and small scale Oil Palm Production Systems (OPPS) were 1.04, 0.99 and 0.82, respectively. Overall TFP was 0.92. The regression result showed that farm size (0.92), capital (0.23), extension contact (0.46), large OPPS (0.49) and medium OPPS (0.30) were the major determinants of TFP while returns to scale (0.88), was decreasing. Land and capital should be made available at affordable prices as farm size and capital were found to be major determinants of TFP. Promotion of extension contact, large and medium scale systems with improvement of small scale system to medium scale system is imperative for development of the industry.

Introduction

Palm oil is presently the vegetable oil produced in largest quantity globally having pushed soybean oil into second position. The low price of palm oil compared to other vegetable oils makes it an important component of the increasing intake of oils and fats in the developing world (AOCS, 2012). Nigeria is the largest producer of palm oil in Africa and the fifth largest in the world (FAO, 2019). The industry supplies palm oil and palm kernel oil for household consumption and raw materials to other expanding sectors of the economy (Okiy *et al.*, 2006). It is used for household cooking, food industry, bio-fuel production, oleo-chemicals, personal care and animal feed but its utilization for bio-fuels is still very low in the country. The industry provides direct employment to about four million Nigerians across twenty-four oil palm growing states in the country and indirectly to other numerous people involved in processing and marketing (Ahmed, 2001). However, there is demand - supply gap (supply deficit) of palm oil in the country, which has led to annual domestic palm oil price inflation and loss of premier position of being the world largest producer of palm oil prior 1965.

Productivity growth in agriculture is both a necessary and sufficient condition for its development and has remained a serious concern for intensive research over the past six decades (Kumar, Mittal, & Hossain, 2008). Total Factor Productivity (TFP) growth is the major source of long term economic growth (Ball, Wang, & Nehring, 2015). It is useful for performance measurement across firms and within firm over time. Comin (2006) posits that TFP is the portion of output not explained by the amount of input used in production. Long-run growth in income per capita in any economy is mostly driven by growth in total factor productivity. The unattractive situation of the Nigerian oil palm industry and steady decline in World palm oil production informed the decision for this study. In addition, there is inadequate documentation on productivity of Oil Palm Production Systems (OPPS) in Nigeria. Therefore, the objective of the study is to determine the factors influencing TFP in Oil palm production systems in Edo and Kogi States.

Methodology

The study was carried out in Edo and Kogi States to capture the areas of high and low oil palm production respectively in Nigeria. Both primary and secondary data were used for data collection. A three-stage sampling procedure was used to select 180 respondents for the study. In the first stage, two oil palm producing Local Government Areas (LGAs) were randomly selected out of 18 and 21 LGAs of Edo and Kogi States respectively while 5 villages from each LGA were selected in the second stage. In the last stage, 180 farmers (large scale 17, medium 25 and small 138) were randomly selected from the villages using the Agricultural Development Programme structure of each state. The selection of OPPS was based on small (≤10 hectare (ha), medium (11 – 50 ha) and large (≥51 ha). Data were collected on quantities of inputs, outputs and their prices. Data were analyzed using Tornqvist index and multiple regressions. The Tornqvist index was used for estimation of the dependent variable for the regression model. Equation 1 presents the regression function, while the log-linearized is shown in equation 2.

$$Q^* = \alpha_o Z_i^{\beta_i} e^u \quad (1)$$

$$\ln Q^* = \alpha_o + \beta_i lnZ_i + u$$
(2)

Where, Q* = Total Factor Productivity (TFP) per ha per year (obtained with Tornqvist index)

Ln = Natural logarithm, β_{is} = Parameters to be estimated, u = error term, *Z*= Explanatory variables

i = 1, 2, 3…10

Z_1 = Farm size in hectare

Z_2 = Educational status (number of years spent in school)

Z_3 = Capital input (N), it includes depreciation of asset for the production season under study and the amount paid as interest on borrowed fund (Nto, & Mbanasor, 2011)

Z_4 = Farming experience in years

Z_5 = Scale of operation (dummy;1 = medium scale or 0 otherwise)

Z_6 = Scale of operation (dummy; I =large scale or 0 otherwise)

Z_7 = Age of oil palm trees in years

Z_8 = Number of extension contact received by each farmer

Z_9 = Membership of social group (dummy; 1 = member or 0 otherwise)

Three functional forms, the linear, semi-log and double-log were experimented with. Lead equation was selected by use of significant variables, as well as the appropriateness of the variable signs and other diagnostic statistics such as mean square error and returns to scale following Ahmed (2012) and Ukoha *et. al.* (2010). Returns to scale was obtained by summing all the regression coefficients of the explanatory variables for Cobb-Douglas production function and summation of the elasticity values for linear and semi-log production models. The returns to scale model for Cobb-Douglas production function is shown in equation 3.

$$RTS = \sum_{i=1}^{n} \beta_i \qquad (3)$$

Where RTS is returns to scale, $n_{(S)}$ are number of explanatory variables, $\beta_{i(S)}$ are regression coefficients.

RTS > 1 indicates increasing returns to scale

RTS = 1 implies constant returns to scale

RTS < 1 means decreasing returns to scale (adapted from Omotesho *et al.*, 2010).

Results and discussion

The Tornqvist index model was used to estimate the TFP for the three oil palm production systems (small, medium and large scale). This was obtained by dividing the monetary value of Fresh Fruit Bunches (FFB) output by the cost of variable inputs (Seeds, labour, fertilizer, herbicides, and pesticides) using Total Factor Productivity Index Program (TFPIP) software. The TFP result was used as the dependent variable for the regression analysis. The factors influencing TFP were investigated by multiple regression analysis with OLS estimation techniques as presented in Table 1. Three functional forms; linear, semi-log and double-log were used to enable the selection of best model. The double-log model was chosen because it had the best fit specified by number of significant variables that were correctly signed in line with a priori expectation, adjusted R^2, mean square error and returns to scale.

The regression results revealed an adjusted R^2 of 0.7050 implying that 70% of the variation in the dependent variable (TFP/ha) was explained by the explanatory variables; farm size, educational status, capital, farming experience, scale of operations, frequency of extension contact, membership of social group and age of oil palm trees. The coefficient of farm size, 0.9155 was positive and statistically significant at 1% level, implying that if all other variables are kept constant, an increase of farm size by 1% will increase TFP by 0.91%. The positive sign of farm size follows a priori expectation that increase in farm size is expected to increase total factor productivity. This is in agreement with studies by Yaro (1999), who found that availability of land is an important predictor of productivity. The elasticity of farm size to TFP was 0.9155, implying that increase in TFP likely to be brought about by a unit increase in farm size is slightly inelastic. The coefficient of education was negative and statistically significant at 1% level inferring that the education of household member has negative impact on farm output. The elasticity of education to TFP was also negative and elastic, which confirms the inverse relationship between education and total factor productivity. This is similar to the findings of Miller and Upadhyay (2002), which report that at low-income levels with crude farm tools, education is negatively associated with TFP growth, while for middle and high-income countries with new technologies the effect is positive.

Table 1. Regression results of the determinants of total factor productivity

Variable/Selection Criteria	Linear	Marginal effects	Elasticity	Semi-log	Marginal effects	Elasticity	Double log
Farm size	-0.00096	-0.00079	-0.0131	0.4940	0..0073	0.2329	0.9155***
	(0.0021)			(0.3606)			(0.1998)
Educat. Status (yrs)	0.0081	0.00665	0.0690	-0.6811	-0.0100	-0.0674	-1.5765***
	(0.0051)			(0.7072)			(0.3576)
Capital	-2.83e-06	-2.33e-06	-0.0093	-0.0128	-0.0002	-0.0051	0.2266*
	(8.04e-06)			(0.5132)			(0.0878)
Farming Exp. (yrs)	-0.00071	0.000577	-0.0264	-0.3575	-0.0053	0.0639	-0.0167
	(0.0010)			(0.6464)			(0.0372)
Scale of operation (Dummy) 2 (Med.)	0.1370***	0.09297	0.0208	2.4205	0.0356	0.5036	0.2967***
	(0.0489)			(1.5370)			(0.0603)
Scale of operation	0.4057***	0.16997	0.0337	8.0894***	0.1188	0.9977	0.49490***
(Dummy) 3 (large)	(0.1990)			(2.5578)			(0.1054)
Freq. of Extension contact	-0.0044	-0.00366	-0.0072	-0.3701	-0.0054	-0.0591	0.4575***
	(0.0081)			(0.4269)			(0.0933)

Membership of Social grp (Dum)	0.0284	0.02334	0.0158	0.9475*	0.0139	0.9303	0.0511*
	(0.0155)			(0.5113)			(0.0279)
AgePtree	0.00086	0.00071	0.0360	0.6081	0.0089	0.1107	0.0288
	(0.00068)			(0.4800)			(0.0262)
Constant (C)	0.7290			-4.2577			0.1332
	(0.0558)			(3.3842)			(0.0951)
R^2	0.6445			0.5968			0.7300
Adj. R^2	0.6332			0.5753			0.7050
F stat. (9, 169)	27.75			27.79			21.18
Prob. F. stat.	0.0000			0.0000			0.0000
Root MSE	0.9022			0. 9418			0.0511
Returns to scale	0.1193			2.7075			0.8779

Figures in parenthesis are standard error. *** = 1% significant, ** = 5% significant, * = 10% Significant. Source: Field survey data, 2013

The coefficient of capital, 0.2266 was positive and statistically significant at 1% level implying that an increase in capital by 1% will increase TFP by 0.23%. The positive coefficient of capital follows a priori expectation that capital has dynamic relationship with total factor productivity. This result is consistent with the findings of Ahmed (2012), that agricultural growth is attributed to factor input including capital. Each of the coefficients of large and medium scale production systems was positive and statistically significant at 1% level. Thus, a 1% increase in the promotion/intensification of large and medium scale systems will lead to 0.49% and 0.30% increase in total factor productivity respectively. This result is akin to the finding of Nto and Mbanasor (2011) that scale of operation is among the determinants of agribusiness firms in Abia State. The coefficient/elasticity of extension contact (0.4575) was positive, inelastic and statistically significant at 1% level, which infers that increase in TFP that could be brought about by a unit increase in the promotion of extension services is extremely inelastic. The computed elasticity of each of the regressors with respect to TFP is less than unity except education, which indicates that absolute change in TFP with respect to relative change in each of the independent variables except education is inelastic, exhibiting decreasing returns to scale (RTS) economies confirmed by the computed RTS of 0.8779.

Conclusion

In summary, the study revealed that major determinants of TFP were farm size, capital, frequency of extension contact, large and medium scale systems. However, large scale, medium scale and farm size were more attractive in respect of individual contribution to total factor productivity. Though educational status was statistically significant, it was negatively signed implying inverse relationship with total factor productivity which is an indicator that Nigerian agriculture largely depends on traditional inputs. The effect of education on TFP is positive when the market and political environment are changing or new technologies are regularly being introduced but negative in a static environment. The implication is that there is need to provide modern inputs for oil palm production, processing and marketing for growth and development of the industry. The positive farm size and capital necessitate that land and capital for oil palm production, processing and marketing be made available at affordable costs. Promotion of extension contact, large and medium scale systems with improvement of small scale system to medium scale system is imperative for development of the industry.

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Analysis of total savings and livestock gross domestic product in Nigeria, 1981 – 2016.

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Abstract

*The study evaluated causality between total savings (TS) and livestock gross domestic product (LGDP) in Nigeria from 1981 to 2016. Time series data for the study were obtained from the Statistical Bulletin of the Central Bank of Nigeria. Descriptive statistics, Augmented Dickey-Fuller (ADF) unit root test and pairwise Granger causality test were used for data analysis on EStata14. The ADF results showed both variables were stationary at level [I(0)]. In addition, there was bidirectional causality between TS and LGDP as indicated by the statistical significance ($p < 0.01$) of the F-statistic for both models I (F-stat =*19.773) *and II (F-stat =* 10.126) *for Granger causality test. It was concluded that both TS and LGDP are complementary macroeconomic variables. The study recommended that policy makers should note the critical interdependency between TS and LGDP.*

Introduction

The livestock sector, an integral part of the agricultural economy, is vital to the socio-economic development of the country. The sector contributed around 1.7 percent to the national GDP and around 9 percent to the agriculture value added (FMARD, 2017 in Ahmed *et al*., 2017; Food and Agriculture Organisation, 2019). The majority of animals in Nigeria are raised in extensive production systems comprising smallholders and nomadic herders. Total production of milk, meat and eggs amounts to 0.5 billion litres, 1.4 and 0.6 million tonnes per year, respectively. Importation of food amounts up to 3-5 billion USD per year, out of which milk accounts for 1.3 billion USD (NLTP, 2019 in (Food and Agriculture Organisation, 2019).

Livestock production is a major component of the agricultural economy of developing countries and goes well beyond direct food production. The addition of milk and meat provides protein, calcium, vitamins, and other nutrients that are often deficient in diets (Eke and Effiong, 2016). In many African countries as well as in South Africa, many rural households earn a living from livestock farming and consider keeping livestock as a store of wealth. Livestock provides insurance for people who have no other financial markets available to them (Mandleni, 2011). Pursuant to the need to attain food security, Nigeria policy makers had pursued a structural adjustment programme which shifted emphasis from the public sectors to the private sector. The value of total livestock produced in an economy in a given year is reflected as livestock gross domestic product. This policy, according to Ogbanje *et al*. (2012), supports the assertion that economic growth relies on savings at both household and national levels, which in turn, enhances investment that directly facilitates growth.

The financial sector in Nigeria plays a vital role in savings mobilization and financial intermediation (Ahmed *et al*., 2017). It has been noted that high level of domestic savings would accelerate the rate of investment, enhance productivity and, hence, economic growth. Also, a country's level of savings in relation to other countries could be used as basis for comparing its growth potentials (Adam and Agba, 2006). In addition, saving in a country shows the capacity of an economy to withstand cyclical downturn or the capacity (Ahmed *et al*., 2017). In the first half of the twentieth century neoclassical economics identified three factors of economic growth: land, capital and labour. This explained economic growth in capitalist countries (Pietak, 2014). At the turn of the century, it became obvious that savings was required to generate investment capital, acquire land and pay for labour.

It is important to stress that saving does not necessarily imply deposit with the bank or any financial institutions. This is why Adam and Agba (2006) held that one's cash holding can be increased through conscious reduction in consumption. This view was derived from the direct relationship between savings and consumption as enunciated by classical economists. Furthermore, saving and savings are not synonymous. Saving is a flow, savings is a stock. This implies that saving is the rate of change in savings per unit time. On the other hand, savings is the cumulative amount set aside over a period of time (Adam & Agba, 2006). Saving is the portion of disposable income not spent on consumption of consumer goods but accumulated or invested directly in capital equipment (Ahmed *et al*., 2017). Gross savings includes net savings and depreciation allowances for replacement of real assets in the future (Najarzadeh *et al*., 2014).

The sub-activities of agriculture are, as classified by the Central Bank of Nigeria are crop, livestock, forestry and fishing (CBN, 2016). This paper focuses on the livestock sub-activity sector. Low productivity has been reported. In order to meet the rising demand for livestock products, and to harness the potential of this sector, there is a need to understand the macroeconomic factor (saving) that affects the growth of livestock output, invariably, its GDP (Chand and Raju, 2008). Livestock stocks or assets can be mobilized at any time. This asset could be seen as bank account and an important source of risk reduction and security increase (Maria *et al*., 2015). Consequently, empirical studies have been conducted in this area but with conflicting results.

Nwachukwu and Odigie (2011) contended that causation is imperative for understanding the process and policy design. They emphasized that saving is an important determinant of economic growth stability.The causal relationship between national savings and livestock gross domestic product in Nigeria is, thus, important to investigate. As noted by Eke and Effiong (2016), inadequate funding of the agricultural sector has been cited as the bane of increased agricultural output and, invariably, the value of livestock output. In developing countries, including Nigeria, where national income is generally low, investment and savings are also low (Adam & Agba, 2006; Ogbanje *et al*., 2012). It is important to stress that there are conflicting reports on the relationship between savings and the livestock subsector or the agricultural sector itself (Elias & Worku, 2015; Jagadeesh, 2015; Najarzadeh *et al*., 2014).

Studies have been conducted on causality between credit to agriculture and ginger production in Nigeria (1991 – 2015) (Ogbanje and Igboko, 2019) and Agricultural Credit Guarantee Scheme Fund and Agricultural Gross Domestic Product in Nigeria: A Granger Causality Approach (1980 – 2013) (Ogbanje *et al*., 2016). Kossele *et al*. (2016)analysed gross domestic savings, agriculture production and Cameroonian economic performance. Furthermore, Elias and Worku (2015) evaluated the casual relationship between gross domestic savings and economic growth in East African countries of Ethiopia, Uganda and Kenya. However, no study has investigated the causality between total savings and livestock gross domestic product in Nigeria. This is essentially the void which this study seeks to fill. Consequently, the specific objectives of the study were to assess total savings in Nigeria and analyse livestock gross domestic product in Nigeria. It was hypothesized that there is no causality between total savings and livestock gross domestic product in Nigeria.

This study was hinged on the theory of economic growth that was propounded by Solow (1956). According to him, savings influence the growth rate of an economy because higher savings result in higher capital accumulation which in turn improves the rate of economic growth. This presupposes that increased savings contributes directly to economic growth. Accordingly, the linkages between economic growth and other macroeconomic factors are very significant in determining the policies which steer economic growth.

Methodology

The study area is Nigeria. Time series data on total savings and livestock gross domestic product from 1981 to 2016 were used for this study. The data were obtained from the Statistical Bulletin of the Central Bank of Nigeria. All computations (descriptive analysis, stationarity test and Granger causality test were done on EStata14 software. The stationarity test employed was the Augmented Dickey–Fuller (ADF) test which was developed by Dickey and Fuller. If parameter α is equal to zero, it means the variable contains unit root which means the data are non-stationary.

The ADF test equation is stated as:

$$\Delta X_t = \alpha_0 + \sigma X_{t-1} + \sum \beta \Delta X_{t-1} + e_t$$

where:

X_t = total savings, livestock gross domestic product;

X_{t-1} = immediate past values of total savings, livestock gross domestic product;

Δ = difference operator

α, σ, and β = parameters to be estimated

e = error term

The Granger Causality model is stated as:

$$TS_t = \beta_0 + \sum_{i=1}^{p} \beta_1 LGDP_{t-1} + \sum_{j=1}^{p} \beta_2 TS_{t-1} + u_{1t} \qquad (Model\ I)$$

$$LGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_3 TS_{t-1} + \sum_{j=1}^{p} \beta_3 LGDP_{t-1} + u_{2t} \qquad (Model\ II)$$

where,

TS = total savings (Nb); LGDP = livestock gross domestic product (Nb)

Two null hypotheses were set for the Granger causality tests as follows:

H_1: TS does not cause LGDP; H_2: LGDP does not cause TS

Results and Discussion

Summary Statistics of TS and LGDP

The summary statistics of TS and LGDP were presented in Table 1. The result showed that total average total savings (N2, 357.94) was about 5.5 times higher than average livestock GDP (N429.56). However, the standard of deviation results indicated that total savings (635.82) had larger variation over the period of the study than the livestock GDP (92.92). These dissimilarities in movement between these variables were reflected in Figure 1 as TS has much higher rise than the LGDP.

Table 1: Summary Statistics of TS and LGDP (1981 – 2016)

Variables	Mean	Standard deviation
TS (Nb)	2,357.94	635.82
LGDP (Nb)	429.56	92.92

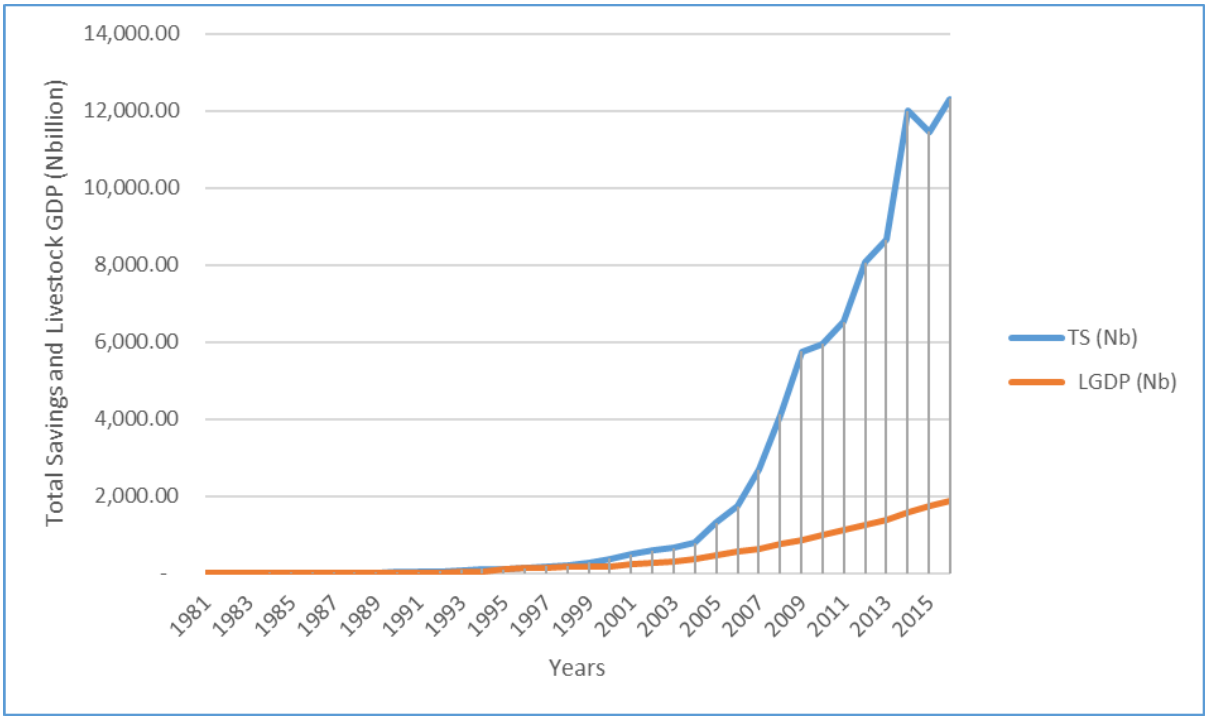

Figure 3: Total Savings and Livestock GDP in Nigeria, 1981-2016

Summary of Augmented Dickey Fuller Test

The summary of Augmented Dickey Fuller Test is presented in Table 2. The model used had no intercept and trend. For both variables, TS and LGDP, the test statistics were greater than the critical values, respectively, at level. Hence, the null hypotheses that both TS and LGDP had unit root could not be accepted but the alternative hypotheses were accepted. The implication was that both TS and LGDP had no unit root and hence suitable for Granger causality test.

Table 2: Summary of Augmented Dickey Fuller Test

Model	Variable	Excluded	Test statistic	Critical value	P-value	Conclusion
I	TS	LGDP	3.088	-2.972	0.004	I(0)
II	LGDP	TS	14.277	-2.972	0.000	I(0)

Granger causality test

The result of Granger causality test between TS and LGDP is presented in Table 3. In Model I, where TS is the dependent variable and LGDP is the independent variable, the F-statistic (19.773) was statistically significant ($p < 0.05$). Thus, the null hypothesis that LGDP does not Granger cause TS could not be accepted. Rather, the alternative hypothesis was accepted, implying that LGDP Granger caused TS. In other words, causality runs from LGDP to TS. This means that LGDP accelerated and augmented TS. This means that TS accelerates and augments LGDP in Nigeria. The result complemented (Ciftcioglu & Begovic, 2010) that domestic saving rate exerted a statistically significant effect on growth rate of GDP in Central and East European countries. The result, however, contradicted (Eke & Effiong, 2016) that domestic savings had positive but statistically insignificant impact on livestock production output in Nigeria.

In Model 2, where LGDP is the dependent variable and TS is the independent variable, the F-statistic (10.126) is statistically significant ($p < 0.05$). Thus, the null hypothesis that TS does not Granger cause LGDP could not be accepted. Rather, the alternative hypothesis was accepted, implying that TS Granger causes LGDP. In other words, causality runs from TS to LGDP. This result is in conformity with Najarzadeh *et al*., (2014) that there was a long-run causality running from savings to economic growth in Iran. The result, however, contradicts Verma (2007)that savings did not contribute to economic growth in India.

The result of both models indicate that there was bidirectional causality between TS and LGDP. In other words, causality runs from TS to LGDP with feedback. This result implies complementary relationship between the selected macroeconomic variables in Nigeria. This is contrary to (Rasmidatta & Lin, 2011) that causality runs from economic growth to domestic saving without feedback. The result is also contrary to the presence of unidirectional causality between economic growth and gross domestic savings in the case of Ethiopia and Uganda(Elias & Worku, 2015).

Table 3: Granger causality test

Model	Equation (Dependent variable)	Excluded (Independent variable	F-statistic	P-value	Decision
1	TS	LGDP	19.773	0.0001	Reject Ho
2	LGDP	TS	10.126	0.0032	Reject Ho

Conclusion and Recommendations

The study concluded that there is dual causality between total savings and livestock gross domestic product in Nigeria. In other words, these macroeconomic variables complement or support each other. The dual causality observed in the study illustrates sectoral interdependencies that are inherent in agroindustries. It was recommended that policy makers on economic growth should note that adjustment in either of the variables would resultant effect on the other. This would guard against unintended consequences of public economic policies.

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Attitude of Fadama III Beneficiaries towards Provision of Agricultural Extension Services in Makoda Local Government Area of Kano State, Nigeria

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Abstract

The study was carried out to assess the attitude of Fadama III beneficiaries towards provision of agricultural extension service in Makoda Local Government Area of Kano State, Nigeria. Multi stage sampling technique was used to select 80 beneficiaries and interviewed using questionnaire. The data collected were analyzed using descriptive statistics. likert scale was used to generate mean score. The result revealed an average age of farmers to be 48 years, with an average of ten (10) household members, having average of 24 years of experience in farming activities. Result further revealed that beneficiaries cultivated an average of 2.8ha of land. Group method of extension service delivery was found to be the most effective method used by the project in disseminating extension messages as reported by (27.5%) of the beneficiaries. The benefits derived by farmers were knowledge on good agronomic practice for raising different crops reported by (30%) of the beneficiaries, improved crop varieties, chemical fertilizer was reported by (27.2%), water pump and agrochemicals by (18.9%). In line with these, the result further showed that majority (54.4%) of the beneficiaries have favorable attitude toward the extension services delivered by the project. Nevertheless, late input disbursements (28.2%) as well as inadequate credit facilities (28.2%) were among the constraints affecting agricultural production in the area. In conclusion, Fadama III beneficiaries have favorable attitude toward extension services delivered by the project. It is therefore recommend that provision of access to credit and credit facilities without or with low collateral should be established through cooperative groups.

Key words: Attitude, Fadama III, Agricultural Extension services, Beneficiaries

Introduction

In an attempt to alleviate poverty among rural Nigerians and also to increase the incomes and productivity of the rural inhabitants as an approach of meeting up with the millennium development goals (MDGs) of food sufficiency and poverty eradication, the Federal Government of Nigeria through the pooled World Bank loan came up with Fadama project, to finance the development of Fadama lands by introducing small-scale irrigation in states with Fadama development potentials (KNARDA, 2011). The National Fadama Development Program (NFDP) is widely being implemented in all the 36 states of the federation and the Federal Capital Territory (FCT), (Baba and Singh, 1998). The project aimed at ensuring that Fadama facilities in Fadama areas are fully utilized to ensure all year round production of crops (Ingawa, 1998)

The First National Fadama Development Project (Fadama I) was designed in the early 1990s to promote simple and low-cost improved irrigation technology under World Bank financing. The widespread adoption of the technologies enabled farmers to increase production, by more than 30% in some cases (Simonyan, and Omolehin 2012). Fadama II is designed with a focus on community-driven development with maximum participation of stakeholders at every stage of the project cycle in the development of technology. To support the government of Nigeria in increasing rural income and reducing poverty in rural areas, the World Bank approved the third National Fadama Development Project (Fadama III) as a specific investment loan (SIL) in June 2008 (NFDP, 2016) With the success of the completed Fadama III, the Nigeria government wanted to expand the success to the agricultural transformation agenda, which led to the additional financing. These FADAMA phases centered on the capacity building, local governance, communications and information support, advisory service and input support development and small-scale community owned infrastructures.

Statement of the Problem

Despite efforts made by government (Ministries of agriculture and ADPs), research institutions, academic centers of learning, private partners and nongovernmental organization (NGOs) in the development of and dissemination of innovations for improvement of agricultural production, still farmers complained that those innovations were not appropriate to some extent and support need to be provided to compliment the adoption of such innovations. In line with these, the FADAMA project come with demand driven approach for innovations development and strategized ways for capacity building that will support the development and adoption of the innovations through communication and information support, small-scale community owned infrastructure, advisory services and input support development.

Objectives of the Study

The broad objective of the study is to determine the attitude of the Fadama III beneficiaries towards provision of agricultural extension services in the study area while the specific objectives are to:

I. describe the socio economics characteristics of the respondents in the study area,

II. describe the effectiveness of the methods of information dissemination used by Fadama III,

III. describe the benefit derived from Fadama III project,

IV. determine the attitude of Fadama III beneficiaries towards provision of agricultural extension service,

V. describe the problems faced by Fadama III beneficiaries in the study area.

Methodology

Description of the Area

The study area is within latitude 12^0 25`0" North and longitude $8^0$ 25`0" East.It has a total land area of 441km2 with population of 222,399 as at 2006 census (NPC, 2006). It is located in Sudan savannah region of the northern Nigeria, The area received an average annual rain of about 597mm with an average temperature of 28^oc and relative humidity ranging from 30% and 60%. The soil type is sandy loam which promotes the growth of different crops (KNARDA, 2011)

Sampling Techniques

Multistage sampling technique was used. The first stage involved purposive selection of four (4) wards out of eleven (11) due to concentration of Fadama III beneficiaries The second stage involved generating a list of registered Fadama users group (FUG) where eight (8) groups were found in each ward and each group consist of 25 members. The third stage involve systematic selection by random of 50% of the FUGs. In the fourth stage, 20% of the total number of members per group was systematically selected by random making a total of 80 respondents used in this study.

Table 1: Sampling Frame

Wards	No. of FUG per ward	No. of farmers per FUG	No. of FUG selected	Total No. of farmers	No. of farmers selected (20%)
Satame	8	25	4	100	20
Ganji	8	25	4	100	20
Wailare	8	25	4	100	20
Galori	8	15	6	90	20
Total	**32**	**90**	**18**	**390**	**80**

Source: KNARDA, 2019.

Data Collection and Analytical Techniques

Data were collected with the aid of structured questionnaires. Descriptive statistics was used to address the entire objectives in addition to likert scale of five points to determine the attitude of Fadama III beneficiaries towards provision of agricultural extension service. Averages score was calculated by summing the values of responses to all questions and divided by the total number of questions respectively. Scores equal to or above the mean indicated a positive attitude and those below shows a negative attitude.

Results and Discussion

Socio economic Characteristics of the Respondents

Table 2: Socio- Economic Characteristics of Respondent

Variables	Statistics	Minimum	Maximum	Mean	Std error
Age	80	20.00	78.00	48	1.4
Household size	80	1.00	21.00	10	0.5
Farming experience (yrs)	80	3.00	60.00	24.1	1.7
Farm size	80	0.50	8.00	2.80	0.2

Source: field survey, 2019

It was found from the result in table 2 that the average age of Fadama iii beneficiaries was 48 years with average household members of nine (9) peoples. The average years of farming experience was found to be 24 years and average farm size of 2.8 hectare of land. This implies that majority of the farmers fall within the active and productive age. Simonyan and Obiakor (2012) reported that large household size has larger expenses, but on the order hand might provide enough labor to increase productivity. Farming experiences determine the ability of farmer to make effectively farm management decision and manage risk better. In addition Awoyemi (1999) reported that rural farmers in Nigeria are predominantly smallholders. This agreed with the findings of this study.

Effectiveness of Methods Used for Extension Service delivered by Fadama III Project

Table 3: Effectiveness of methods used for extension service delivered by Fadama III project

Methods	Highly effective	Effective	Undecided	Ineffective	Highly ineffective
Individual	1(1.3%)	2(2.5%)	77(96.2%)	00(00%)	00(00%)
Group	22(27.5%)	38(47.5%)	6(7.5%)	4(5.0%)	00(00%)
Mass media	1(1.2%)	1(1.2%)	77(96.2%)	00(00%)	1(1.2%)
Field days	9(11.2%)	17(21.2%)	2(2.5%)	2(2.5%)	00(00%)
Workshop	1(1.2%)	3(3.8%)	75(93.8)	00(00%)	1(1.2%)
Method demonstration	10(12.5%)	20(25.0%)	1(1.2%)	2(2.5%)	00(00%)

Source: field survey, 2019

The result in the table 3 above revealed that different methods were used by fadama III project in the delivery of extension messages to the beneficiaries, but the most highly effective as reported by the beneficiaries was group method of extension service delivery as reported by (27.5%) of them. This is because participants have the chance to brain storm between them and seek for clarification from the extension agent. They preferred to work as a team rather than individual.

Benefits derived from Fadama III project by Beneficiaries

Table 4: Benefits derived from Fadama III project by Beneficiaries

Benefits	No. of beneficiaries	% of beneficiaries	Responses	% of Responses
Good agronomic practice	54	67.5%	54	30%
Improved seed varieties	49	61.3%	49	27.2%
Inorganic Fertilizer	13	16.3%	13	7.2%
Water pump	34	42.5%	34	18.9%
Agrochemicals	30	37.5%	30	16.7%
Total	**80**	**100%**	**180**	**100%**

Source: field survey, 2019 *multiple responses

Findings of the study in table 6 shows that participants of the project were provided with agronomic practices recommended for growth of different crops. Similarly improved seed of different crop varieties were also provided to participant in order to boost output. Other benefits derived were fertilizers, agrochemicals to protect crops from insect and pest attack and water pumps for dry season farming**.**

Attitude of Fadama III Beneficiaries towards Provision of Agricultural Extension Services of the Project

Table 5: Attitude of Fadama III beneficiaries towards provision of agricultural extension services

Attitude Statements	SA	A	U	D	SD
Fadama iii helped improved crop yield	43(53.8%)	21(26.2%)	1(1.2%)	14(1.5%)	1(1.2%)

Fadama iii has improved household income	36(45.0%)	30(37.5%)	5(6.2%)	9(11.2%)	00(00%)
Fadama iii has improve farming skills	49(61.2%)	17(21.2%)	4(5.0%)	9(11.2%)	1(1.2%)
Fadama iii helped improve livelihood	17(21.2%)	17(21.2%)	11(13.8%)	32(40%)	3(3.8%)
Fadama iii did not use the right methods in disseminating knowledge	00(00%)	7(8.8%)	4(5.0%)	26(32.5%)	43(53.8%)
The methods of extension service delivery used by Fadama iii was not effective	00(00%)	4(5.0%)	6(7.5%)	33(41.2%)	37(46.2%)
I will not participate in Fadama iii project again	00(00%)	5(6.2%)	7(8.8%)	15(18.8%)	53(66.2%)
Fadama iii has provided job opportunity	15(18.8%)	23(28.8%)	11(13.8%)	31(38.8%)	00(00%)

Source: field survey, 2019 *SA=(Strongly agreed), A= (Agreed), U= (Undecided), D= (Disagreed), SD= (Strongly disagreed)

It was found from the result that, majority of farmers have positive attitude toward extension services delivered by Fadama iii project. This clearly shown from the statements used in table 5 in measuring the attitude of farmers toward the favorable or unfavorable extension services delivered by Fadama iii project where majority are inconformity with the positive statements and disagreed with the negative statements. This shows that farmers agreed that extension services delivered by Fadama iii project positively influence their farming activities and improve their livelihood.

Constraints faced by Fadama III Beneficiaries in their Farming Activities

Table 6: Constraints faced by Fadama III beneficiaries in their farming activities

Constraints	**No. of Beneficiaries**	**% of Beneficiaries**	**Responses**	**% of responses**
Poor input facilities delivery at the right time	49	61%	49	34.3%
Inadequate storage facilities	49	61%	49	34.3%
Inadequate access to farm land	16	20%	16	11.2%
Inadequate credit facilities	19	23.8%	19	13.3%
Poor processing equipments	10	12.5%	10	6.9%
Total	**80**	**100%**	**143**	**100%**

Source: field survey, 2019 *multiple responses

Result in table 6 revealed the constraints faced by fadama iii beneficiaries in farming activities. Some of these constraints were poor input supply at the right time, inadequate storage facilities after harvest, and inadequate credit facilities to access credit for improvement of farming activities. In addition, inadequate access to farm land for expansion of agricultural production and poor processing equipments that will motivate intensification of agricultural production negatively influence agricultural production in the study area.

CONCLUSION

In conclusion, Fadama III beneficiaries have favorable attitude toward the extension services delivered by Fadama III project due to benefit derived as a result of the services delivered in the area.

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The Role, Relevance and Impact of Natural Rubber in the Nigeria Economy

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Abstract

The study is an overview of the role, relevance and impact of natural rubber in the Nigeria economy. From the study, it was discovered that natural rubber plays a great role in the Nigeria economy. Despite this contribution, the nation has not maximized it full potentials. It was therefore recommended that, to ensure that Nigeria return to its leading role in natural rubber production globally, there is urgent need to make rubber production become economically, socially and environmentally sustainable. The government/ policy maker should as a matter of urgency pay more attention to natural rubber production in order to benefit from the enormous gains and contribution of the said crop. This in-turn will be of great benefit to Nigeria as a country and the world at large.

Introduction

The oil boom of the 1970s led Nigeria to neglect its strong agricultural and light manufacturing bases in favour of an unhealthy dependence on crude oil. In 2002 Oil and gas exports accounted for more than 98 percent of export earnings and about 83 percent of Federal Government revenue (Adeloye, 2012). In Nigeria, agricultural exports have played a prominent role in economic diversification by providing the needed foreign exchange earnings for other capital development projects (Abolagba et al., 2018). Agricultural export was the engine of growth prior to 1973, providing much of the revenue that the government used in developing basic infrastructure system. Agricultural export also financed the import substitution industrialization programme. Olayide and Essang, (1976) observed that Nigeria's export earnings from major agricultural crops such as cocoa, natural rubber and oil palm contributed significantly to the Gross Domestic Product (GDP). At present Nigeria has lost its role as one of the world's leading exporters of agricultural commodities. In addition, the country is currently suffering from a declining as well as fluctuating income from its heavy dependence on oil exports. This study therefore aims to examine the role, relevance and impact of natural rubber in the Nigeria economy.

Roles: Contribution of Natural Rubber to Agricultural Exports

The introduction of petroleum in the mid –1960s into the nation's export scene changed the composition and structure of the export trade. In 1960, oil contributed just 2.6% to the foreign exchange earnings. Revenue generated from oil increased from N4, 565.1 million in 1975 to N6, 621,758.1 billion 2005 (Abolagba et al., 2003). On the other hand, the relative share of the agricultural sector in foreign earnings steadily declined from an average of 9.11% in the 1970-1975 periods to 1.76% between 1995 and 1997. This dramatic decline in agricultural exports is worrisome. Yusuf (2000), attributed this decline in Nigeria's agricultural export earnings to the discovery of crude oil and rural-urban migration. NBS (2012) examined the contributions of natural rubber to total agricultural exports in Nigeria from 1970 to 2013. It was categorized into 4 periods: namely, the pre 1970 era, pre-SAP, SAP and post-SAP. The contribution of rubber to total agricultural export in the pre-1970 era was 9.4%, pre-SAP era was 5.8%. The value of contribution of rubber to total agricultural exports increased to 22.7% in the SAP era. A slight reduction was observed in the contribution of rubber to the total agricultural exports in the post-SAP era with 12.7%. Obviously the impact of SAP could have been responsible for the increased contribution of natural rubber to the total agricultural exports in the SAP era (NBS, 2012).

Natural Rubber and Employment Opportunities

Ogbebor, (2013) posited that natural rubber helps the country's economy because it is a source of income. This is especially important in a country such as Nigeria where the agricultural sector, which should be generating a huge amount of income for the government, is in a state of neglect. Rubber is one major crop found in abundance in Nigeria that could help achieve a much-needed alternative source of funding and employment opportunities (Abolagba et al., 2018).

Natural Rubber and Agro-based industries

Natural rubber serve as raw materials for the local industries for the production of tyres, surgical gloves, balloons, condoms, erasers, pharmaceutical products, the rubber wood is used for industrial purposes and manufacture of furniture, paper among others and foreign exchange earner for the country (Abolagba *et al.*, 2003). According to Giroh *et al*. (2006), natural rubber is cultivated primarily for the production of latex or coagula, which is of economic importance especially in the provision of raw materials for agro-based industries for the production of rubber-based products. It serves as foreign exchange for Nigeria as a country and offers employment for it teeming population. The properties of natural rubber have enabled it to fight off competition from synthetic rubber made from petrochemicals. In spite of gloomy predictions during the 1980s, latex has held to 40% of global output against its synthetic rival which accounts for an average of 60%. The increase demand for natural rubber, 75% of which is used for making tyres, is as a result of the rapid growth of the Chinese automobile industry. Hence, the price of latex in the world markets rose by 58% between 2004 and 2006 (Spore, 2007).The economic importance of natural rubber is derived from its contribution to the gross domestic product, national income, raw material base for local industries, foreign exchange earnings, employment generation and afforestation. Abolagba *et al*. (2003) stated that rubber trees can be sold for timber once they have passed their productive life. The wood is a semi-hard, light-coloured timber. It has a pleasant grain and can be used in wooden utensils, furniture, flooring, and clipboard making. In another development (Lalabe *et al.*, 2007) found that rubber oil, which is yellowish in colour at normal temperature, contains a high percentage of such unsaturated fatty acids as oleic, linoleic and linolenic and these make it semi-drying oil. This oil is useful in the industrial manufacture of some commodities such as putty, soap, shampoo, cosmetics and paint

Relevance of Natural Rubber

Rubber has the potential to be a major source of finance to Nigeria. Rubber is an important plant not only for world economic strategies but also for the use of mankind. Social development enhances more demand for rubber-based products for human existence. Natural latex is one of the important raw materials available for making various kinds of products in heavy industries such as automobile industry, kitchen wares and house wares (Ekpo and Egwaikhide, 19194). About 70% of latex produced from rubber trees is consumed in the manufacture of tyres, tubes, and other materials associated with the automobile industry; about 6% is utilized for footwear and nearly 4% for wire and cable insulation. Other miscellaneous products include rubberized fabric, raincoats, household and hospital supplies (such as sheets, hot wear bags, surgery's gloves), shock absorbers, washers, gaskets, belts, hoses, sport goods, toys, erasers, adhesives, rubber bands and a host of other auxiliary products. (Ambaliah and momoh, 2012)

Potentials of Natural Rubber in Sustaining the Economic Development of Nigeria

The potentials of rubber sustainability to agricultural sector and overall economic development are immense and enormous (Rural Sector Enhancement Program, 2002). These include: Guaranteed supply of rubber products to the firms may stimulate expansion in farm production activities (Garba, 2000). Improved postharvest system with strong linkages between crop producer and end users not only generate added value but also create employment opportunities in rural areas, thereby contributing to economic growth and poverty reduction. Providing employment opportunities also in the production marketing chain. The indirect advantage of reward able employment in farming activities is the reduction in rural-urban migration. (Ambaliah and Momoh, 2012).

Impacts: Natural Rubber and Environment: Concept and Effects of Climate Change

Climate change is any change in the average daily weather pattern over an extended period of time (typically decades or longer) whether due to natural variability or as a result of human activity (IPCC 2007). The Inter-governmental Panel on Climate Change (IPCC) declared in its Fourth Assessment Report (AR4) that climate change is unequivocal (IPCC, 2007), evidenced by observed changes in several global and regional climatic indicators. The Food and Agriculture Organization (FAO) expects that considerable efforts would be required to prepare developing countries to deal with climate-related impacts; particularly in agriculture (Obinne, 2010).Climate change has resulted in loss of natural forests, thus requiring replanting of trees. This can be a breakthrough for rubber tree (Omokhafe, 2020). It is therefore necessary to restore the forest ecosystem, enhance the productivity of the forest dwellers, provide means of economic empowerment of forest communities under a sustainable farm practice. In this regard, the rubber tree is an outstanding tree crop to meet these multiple requirements of climate change effects. To promote tree planting and tree population in the humid savannah, the Tropical grassland world-wide is often between the Rain Forest and the arid zone, some times the desert. In this case, there is the humid savannah to the region of Rain Forest and arid savannah to the area of the desert. The natural humid savannah is rich in tree population, but this is threatened by increased aridity from the desert leading to loss of trees. This can be checked through conscious planting of trees, such as restoration or tree farming, natural rubber can be applied in this case (Omokhafe, 2020).

Conclusion and Recommendations

The information obtained from this research has x-rayed the role, relevance and impact of natural rubber in the Nigeria economy. As articulate and logical as these contributions are, the expected targets of agricultural sustainability reforms have not been met, hence there is a gross decline in natural rubber production. To ensure that Nigeria return to its leading role in natural rubber production globally, there is urgent need to make rubber production become economically, socially and environmentally sustainable. Also, the government/ policy maker should as a matter of urgency pay more attention to natural rubber in other to benefit from this enormous gains and contribution of the said crop. This in-turn will be of great benefit to Nigeria as a country and the world at large.

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Boosting farmers' income through value addition: a review

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Abstract

In Nigeria, most of the food crops are sold in the raw form at the farm gate, which has expectedly resulted to low revenue for the farmers. There is no gain saying therefore that value addition to agricultural outputs including food crops will increase the income of farmers. This has been empirically documented with back-up literatures. However, organization of the literature at different value chain levels of the marketing functions was the task of this paper. Thus the paper reviews existing literature on three key areas of value addition: processing (form utility), marketing (place utility) and storage (time utility). The findings showed that processing of food crops has the capability of increasing farmer's income, though human capital factor tend to reduce farmers participation in value addition through processing. Also, market participation yielded higher revenue for farmers, however some socioeconomic characteristics such as level of education, age, distance to market, off-farm source of income, membership of an association, years of experience, access to market information, and transportation costs were seen to affect farmer's market participation. Lastly, a good storage should not only add time value and increase farmer's income, but can also help in boosting food security. Though, value addition can help boost farmer's income and food security, still some farmers are unaware of the potentials of value addition to food crops. Hence there is need for increased awareness and promotion of value addition among farmers in Nigeria by government and policy makers.

Key words: value addition, market participation, processing, direct marketing, storage

Introduction

In Nigeria, most of the food crops are sold in the raw form at the farm gate, which has resulted to low revenue for the farmers (Abu, Issahaku, & Nkegbe, 2016 ;Coulibaly, Arinloye, Faye, & Abdoulaye, 2014). The Nigerian agricultural sector is not commercialized as most of it is subsistence and located in rural areas. There is need for improvement through value addition. Apart from increasing the income of farmers, value addition can also open markets and develop the rural communities (Born & Bachmann, 2006). Like Value addition, Agribusiness development helps to transform the livelihood of the rural farmer and also create wealth for the community.

According to Coltrain, Barton and Boland (2000) and Amanor –Boadu (2003), value addition in agriculture in general terms has been seen as processing of raw food crops (Lu and Dudensing, 2015). In recent studies value added agriculture have gone beyond food processing and gearing towards changing the form, place and time utility in the form that the consumer would prefer (Kuma, Getnet, Baker, Kassa, 2011). Coltrain, Barton and Boland (2000) defined adding value as the " process to economically add value to a product by changing its current place, time and form characteristics to characteristics more preferred in the marketplace". Alonso, (2011)**,** stated that value addition in agriculture enables farmers to maximize the returns from their produce in quantitative and qualitative terms and at the same time receive a bigger share of the final retail price.

The purpose of this review is to focus on value addition as a form utility (product transformation or processing), time utility (storage of food crops and food products) and place utility (Direct marketing by farmers) as stated by Coltrain, et al., 2000, because most researches are geared towards the traditional way of value addition through processing. When farmers adopt one or two of the opportunities of value addition, more farm income will be generated for the rural household and create employment for the community.

Value addition through processing

Form utility with regards to food crop transformation through processing. Processing of products by farmers is essential in value added agriculture as it preserves definite intrinsic uniqueness of their products (Lu and Dudensing, 2015), and also increases the total value of the food crops (Srivastava, Bishnoi, & Sarkar, 2017). Coulibaly, et al., (2014) noted that value added activities such as processing of raw food crops into other food products are a profitable big business that can raise revenue of producers. It is a common knowledge that processing increases the shelf life and improves the biological stability of food crops, reduces bulkiness, makes transportation easier and delivery of food products in the desired form acceptable to the consumers (Ogunsina, Aregbesola, Adebayo, & Odunlami, 2016).

Few related articles were reviewed on value addition through processing; In a study promoting value addition among farmers in the cassava food value chain in Nigeria. The findings indicated that human capital factors including farmer age and location tend to reduce farmers participation in value addition through processing while experience and record keeping promote farmer participation in cassava processing (Donkor, Onakuse, Bogue, & Carmenado, 2018).

According to a study carried out in Oyo State, Nigeria on value addition on cassava wastes among processors, the study assessed percieved benefits of cassava wastes value addition. The result showed that increased income was the major benefit of value addition on cassava waste (Oyewole & Eforuoku, 2019). Waste value additon can be converted to other value added products for livestock and organic manure. The increase in income for farmers that are into livestock production could be as a result of savings from the purchase of livestock feed.

Furthermore, a research on analysis of maize value addition among entrepreneurs in Taraba State, Nigeria, showed that out of five food products of maize being processed annually, that boiled corn is more profitable (Ater, Aye, & Daniel, 2018). Also, another Study on cassava value addition chain analysis in Ughelli North Local Government Area of Delta State, Nigeria determined the profitability of garri and edible starch processing.The result showed that garri and edible starch were profitable with benefit-cost ratio of 2.12 (Ndubueze-Ogaraku & Edema, 2015).

On a different note, a research on the awareness of value addition of sweet potato in Osun state indicated that there is low level of awareness of sweet potato value addition and the major constraint hindering farmers from engaging in value addition is inadequate finance followed by lack of knowledge on sweet potato value addition and too much focus on other roots and tubers (Omoare, Fakoya, Fapojuwa, & Oyediran, 2014).

Value addition through marketing

Place utility which involves the farmers selling their products directly to the consumer in other for them to claim the income been made by the middlemen (Lu and Dudensing, 2015). The marketing activities will enable farmers capture a larger share of the income. Direct marketing of food crops involves retail or wholesale marketing by the farmers. Few articles were reviewed on processing and marketing of food crops by farmers while some articles were on smallholder market participation mostly laying emphasis on the constraints that prevent farmers from participating in marketing of their food crops. In other to alleviate the poverty of rural farmers, market participation is emphasized (Abu et.al, 2016).

In a study on market participation and food security of cassava farmers in rural South West Nigeria, level of education, off-farm source of income, membership of an association, years of experience, access to market information. Age and transportation costs significantly influenced the extent of market participation (Obisesan, 2017). Similarly, a study conducted in Northern part of Taraba State, Nigeria on the Analysis of market participation and rural poverty among farmers, showed that distance to the market, belonging to a cooperative, family size, high output commercialization ratio, education and institutional variables have been found to be important variables affecting market participation (Gani & Adeoti, 2011). Also, a study on the determinants of market participation among maize farmers in Ogbomosho zone, Oyo State, Nigeria, 58% of the maize producers sold their product in the urban market. The result also showed that age, gender, marital status, household size, farming experience, educational level and membership of association are the major determinants influencing market participation (Egbetokun, Shittu, & Ayoade, 2017). It can be seen that belonging to an association somehow deprives the farmers from generating extra revenue if they have sold the food crops direct to consumers. High transaction cost can be as a result of distance to the market and poor road network, so the onus lies on the government to repair the roads in the country. Level of education and marketing information can be addressed by trainings from extension agents to enlighten the farmers on the importance of direct marketing and how to handle communication on market prices among themselves.

However, some studies emphasized farmers processing and marketing their products as it yields higher revenue. Studies like value addition and productivity differentials in Nigerian cassava system found out that cost and revenue outlays increased with value addition especially with farmers that produce-process-market their food products themselves. However, higher value addition farmers had better efficiency and non-reducing productivity (Adeyemo & Okoruwa, 2018). According to a study in Abia State, Nigeria on Market participation and value chain of cassava farrmers, it was seen that net margin and profitability analysis showed that the Net return on Investment (ROI) of fresh cassava roots and processed garri marketing were 1.68 and 2.36 respectivity (Onya, Oriala, Ejiba, & Okoronkwo, 2016). This showed farmers processing and marketing their food products yields higher revenue therefore they should be encouraged.

A study on profitability and marketing efficiency analysis of women cassava processors in Oyo State, Nigeria. The result showed that the benefit-cost ration of 1.5 revealed that cassava processing is a profitable entreprise. And marketing efficiency value of above 100 percent indicates that the processors were able to cover the costs of value addition plus marketing cost and made a profit margin (Oladejo, 2017). This implies that farmers should process and market their produce themselves in other to increase their farm income.

Value addition through storage

Time utility can be seen in the aspect of storage especially during bumper harvest to avoid selling off their products at a very low price and selling the products when they are off season. Srivastava et al (2017) are of the opinion that food preservation is very important in the storing up and enhances use of products to evade glut and make good use of the surplus during the offseason. It can also be seen as when food supplies are low and prices are high and this is referred to as preferred time characteristics as stated by Lu and Dudensing, (2015). Few studies were reviewed on storage techniques of food crops as there was no evident study on the effect of storage on the income of the farmers at the time of this review. In a study on assessment of use of indigenous maize storage practices among farmers in Anambra State, Nigeria it was seen that the farmers were making use of indigenous technologies such as baskets, over fire storage in the kitchen, bare floors among others in maize storage (Ajani & Onwubuya, 2012). Also, a study on effect of yam storage techniques usage on farm income in Kwara State, Nigeria, revealed that yam barn storage technique was ranked first in terms level of usage by the farmers (Falola, Salami, Bello, & Olaoye, 2017). From these studies it could be seen that farmers still practice the use of indigenous storage techniques but the income generated from value addition through storage of these food crops was not taken into cognisance. There is need for an improvement in the storage techniques to reduce postharvest food losses and increase the income of the farmers.

Conclusion

In conclusion, value addition will lead to agribusiness development in Nigeria and with value addition, the farmers should be seen as entreprenuers. They should take farming as a business that will help them put into practice value added agriculture as it will help increase profitability. They should also utilize the waste from processsing and transform them into other products. Farmers should also practice direct marketing so as to retain the profits that were made by middlemen as well as adopt to modern storage techniques available to them to help reduce postharvest losses. In view of these, researchers in Nigeria should shift their research on value addition to other indigenous crops in other to solve the problem of food security and low income by farmers. And the researches should gear towards investment oportunities in value addition and the impact of value addition on farm income, employment generated, community development in other to attract more farmers to add value to their food crops rather than sell them off at the farm gate. To the extension agents that train farmers on value addition, they should include pricing in the training package so that the farmers could capture the cost of processing, transaction costs and storage cost in the sale of their farm products.

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Sweet Potato Production, Processing and Marketing in Nigeria: Potentials for Food Security and Poverty Alleviation

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Abstract

The role of sweet potato production, processing and marketing in ensuring food security and poverty alleviation among the citizens in Nigeria cannot be underestimated. It relied on information from secondary sources such as documented relevant review literature on sweet potato and field experience of Researchers. The crop sweet potato occupies a prominent position in generating income for households. This implies that sweet potato has an important role in reducing poverty and food insecurity which have become a common phenomenon in most developing countries particularly Nigeria. Productivity, total output, diverse uses and various value added products of sweet potato in Nigeria has proven significant generating household income and assuring food security of the nation. Research efforts have resulted in the development of many improved varieties of the sweet potatoes with high genetic potential and farmer preferred qualities; the orange fleshed and are rich in vitamin A which is important particularly for the nutritional and health benefits. Though sweet potato farmers and processors in Nigeria have outlined major constraints of the crop production and processing, but high-quality, accessible processing technologies and product diversification are potential machineries for bolstering Nigeria's sweet potato market. This paper therefore recommends an increase in sweet potato productivity to strengthen diversified market opportunities for both women and men in Nigeria.

Keywords: Sweet potato, Production, Food security and Poverty alleviation

Introduction

Sweet potatoes (*Ipomoea batata (L) Lam*) is an important tropical root crop that offer a particularly significant potential for increasing food production and income thereby reducing poverty and improving food security level in Nigeria (Ekwe and Onunka, 2006). Sweet potatoes are consumed without much processing in most parts of the tropics (Ahmad *et al*, 2014). It presents diverse industrial uses, some of which are potentially highly profitable, such as sweet potato snacks. (Adewumi, *et al*., 2008). Sweet potatoes are extremely adaptable to adverse environmental conditions; they can help increase food security in times of drought and famine, particularly in post-conflict areas for displaced persons (NRCRI, 2009) and (Mbanaso *et al*., 2011). Sweet potatoes are used to restore access to food for resetting populations and alleviate future agro-climatic or political shocks. The challenge with using sweet potatoes in emergency response situations is the crop's low multiplication rate. Vine material needs to be ready to go and mechanisms in place to distribute vine materials to needy farmers. (Andrade *et al*., 2009). A number of initiatives in Nigeria encourage consumption of orange-fleshed sweet potatoes, which contain beta-carotene and help fight vitamin A deficiency, which can result in blindness for pregnant women and children and even death for 250,000-500,000 children per year. (Anyaegbunam, *et al*.,2011). In Nigeria, estimates suggest 29.5% of all children under the age of five are vitamin-A deficient. (HarvestPlus, 2016). The adoption and consumption of sweet potato products is very essential especially among the rural poor households. This can help to achieve the focus on eradicating vitamin A deficiency (VAD), address the adverse health effects of vitamin A deficiency and other nutrient required for maintaining immune function through a cheaper cost effective sustainable means accessible to even the rural poorer households in Nigeria. When foods are deficient in essential micronutrient such as vitamin A, Fe & Zn etc) some body cells remain hungry and fail to grow to full capacity and this is refer as hidden hunger (HarvestPlus, 2016). Recent field survey study in south-east Nigeria have shown that consumption of sweet potato products is medicinal with good nutrition, reduces weight, good for diabetic patients, good for sound sight and boost fertility"(Amadi et al, 2019).

Nigeria is the third largest producer of sweet potatoes in the world in terms of quantity, after China and Uganda. In 2010, Nigeria produced 2.5% of the world's production of sweet potatoes. However, sweet potatoes are still considered a minor crop in the country. In 2010, sweet potatoes had the tenth highest production level of any single food crop in Nigeria (after cassava, yam, oil palm fruit, maize, sorghum, millet, paddy rice, and plantains). In 2010, the gross agricultural production value for sweet potatoes was $954 million USD and accounted for 1.73% of total agricultural production value for all crops. Although a sweet potato is a crop that is consumed in all parts of the country, its level of production still remains low. However, the world sweet potatoes sector is undergoing major changes. Worldwide, sweet potato's production and consumption is huge and people eat and use this super food. Nigeria has become the highest sweet potato producer in Africa and the second largest producer in the world, behind China, which produced 85.21 million metric tones (FAO, 2009; Amadi et al, 2019). This review is therefore aimed at taking a close look into the potentials of sweet potato production, processing and marketing with a view of identifying its potentials for food security and poverty alleviation in Nigeria.

Sweet Potato Production in Nigeria

Sweet potato enjoys high productivity per unit land area and labor even on more marginal lands (4–6 MT/ha). Its short growing cycle either allows for flexible planting and harvesting times in high rainfall regions or, in drier areas or areas prone to droughts or floods, permits quick production within a 4- to 5-month window. The production process includes the following: Collection of sweet potato vines (select healthy and matured sweet potato vines of 4 to 8 weeks from the farm). Preparation and production of 2 nodes vines (cut selected sweet potato vines into 2 node vines with sharp objects). Treatment of 2 node vines with fungicide (Treat with available fungicide at the rate of 10g/20L of water and allow vines to stay for 10 minutes in the solution before removing them. Protect your hands by wearing hand groves). Planting (Plant the 2 node vines directly into a well prepared (ridge or mound) field at a depth of 2.3cm and at a spacing of 1m x 30cm or 60cm x 30cm. cover the same vine with soil. Plant when rain have been established, May/June). Field Maintenance (Weed the farm at 4 -6 weeks after planting or as weeds appears). Fertilizer (apply fertilizer at 5 -6 weeks after planting. Use NPK 20:10:10 at 300kg per hectare. Inorganic fertilizer can be used). Harvesting, (harvest at 12 to 15 weeks after planting using garden fork, digging rod or cutlass). (NRCRI, 2009) and Aniedu and Oti, (2007).

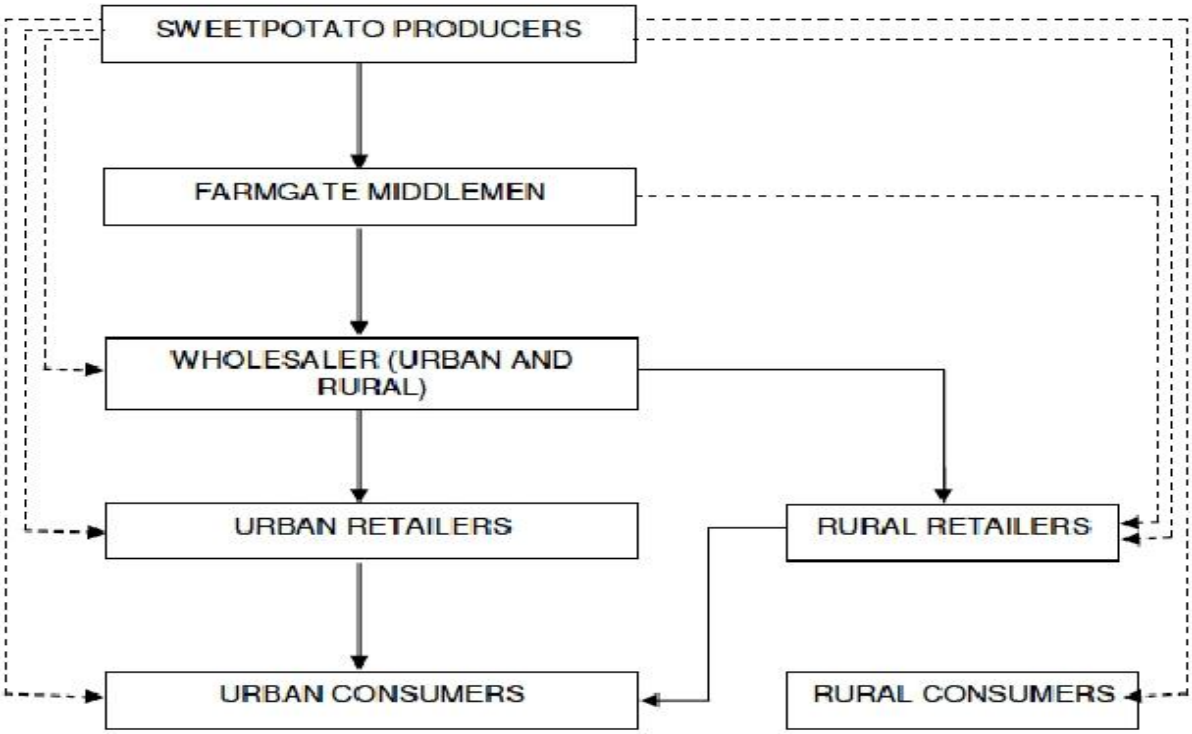
Sweet potato Processed Products

Potential mechanisms for bolstering Nigeria's sweet potato market has been attributed to high-quality and accessible processing technologies and product diversification (Tewe *et al.*, 2003). Processing is advantageous because it reduces the risk of post-harvest losses and diminishes the bulky weight of the product that typically increases transportation costs and space (Andrade *et al.*, 2009). A summary of sweet potato utilization potentials for the Nigerian food industry, adapted from Egeonu (2004) and Amadi *et al*., (2019), is given below as: Flour: It could be used for baking on its own or as a supplement to cereal flour. Sparri: It could be made into sparri (coined from sweet potato gari). Confectionaries: It can be made into various confectionaries including buns, cakes, rolls and puff-puff by using dough made from the parboiled and grated tubers. Crisps: It could be easily processed into crisps in much the same way as potato. Canned Sweet potato: This is commonly used in USA where the yellow-fleshed varieties are commonly preferred. Animal feed: The roots and tops apart from being used fresh, and could be made into a dried meal and fermented silage and fed to livestock, including pigs, cattle and poultry. Sweet potato Beer: The Koedo Brewery Kawagoe, of Kawagoe in Japan has been producing sweet potato beer from roast local sweet potatoes since 1996. It contains 7% alcohol and tastes like something between beer and wine, with a faint sweetness.

Sweet potato Beverage: Sweet-potato beverages and yoghurt marketing started in 1997 in Japan and these products are now quite popular. (Odebode, 2008). Other sweet potato added value products include: Sweet potato Jam, Sweet Potato Catsup, Sweet potato Hotcake, Sweet potato Drinks, Sweet potato Donuts, Sweet potato Bread among others (Amadi et al, 2019).

Marketing Systems

Sweet potato is a lucrative business crop that has diverse economic and health importance and highly valued at the national and international market, at the same time promoting entrepreneurship (Afuape et al, 2011). Sweet potato products are consumed in different forms in all the ecological zones of Nigeria. Previous studies had indicated that there is some degree of concentration in sweet potato markets but there is a greater degree of concentration in the retail than in wholesale sub sectors of the market in Nigeria (Mbanaso *et al.*, 2012). The differences in the degree of sellers' concentration between the wholesaler and retailers may be due to differences in the degree of risk taking, capital base and bargaining position. The level of sellers' concentration indicates some degree of inefficiency in the sweet potato marketing system probably due to the nature of market conduct in buying and selling, capital base of market participants and access to marketing facilities. Nigeria's sweet potato value chain typically involves many participants, some acting multiple roles. The sweet potato marketing system functions through many middlemen working in both rural and urban markets. Below shows the various alternate paths that sweet potatoes take from the producer to the final consumer.



Marketing Channels for Sweet Potato

Figure Fig.1: Marketing Channels for Sweet Potatoes in Nigeria Source: Anyaegbunam and Nto, (2011)

Sweet Potato Potentials for Food Security and Poverty Alleviation

There is food security when all people at all times have sufficient physical and economic access to safe and nutritious food to meet their dietary needs including food preferences, in order to live a healthy and active life" (Barret, 2002). Based on the FAO, (2009), the definition of food security focuses on three distinct but interrelated elements, all three of which are essential to achieving food security; food availability meaning having sufficient quantities of food from household production, other domestic output, commercial imports or food assistance. Food access having adequate resource to obtain appropriate foods for a nutritious diet, this depends on available income, distribution of income in the household, food prices\and market access (Harvestplus, 2016). Food utilization meaning proper biological use of food, requiring a diet with sufficient energy and essential nutrients, potable water and adequate sanitation, as well as knowledge of food storage, processing, basic nutrition and child care and illness management. The consumption of sweet potato and its role in the nutritional status of the average Nigerian has increased. The crop sweet potato occupies a prominent position in generating income for households. This implies that sweetpotato has an important role in reducing poverty and food insecurity which have become a common phenomenon in most developing countries particularly Nigeria. Productivity, total output, diverse uses and various value added products of sweet potato in Nigeria has proven significant generating household income and assuring food security of the nation. Research efforts have resulted in the development of many improved varieties of the sweet potatoes with high genetic potential and farmer preferred qualities; the orange fleshed and are rich in vitamin A which is important particularly for the nutritional and health benefits.

Sweet Potato Yields in Nigeria Face Diverse Constraints

Sweet potato farmers' had identified constraints to the production of sweet potato. These include: high labor costs, limited access to credit, inadequate government aid, limited access to improved technologies, and high incidence of pests and diseases (Egeonu, 2004). Others include the need to sustain sweet potato vines through the dry season since they serve as planting materials in the next crop cycle and consumption preferences of other crops over sweet potatoes (cassava, yams, plantain, rice, and cowpeas in the south and cassava, yam, sorghum, rice, millet, and cowpeas in the north).

Conclusion

In order to realize the full potential as a source of good nutrition, reliable food security, source of alleviating poverty and income for women and men in Nigeria, it is essential to increase sweet potato productivity and strengthen diversified market opportunities for both women and men. The crop sweet potato has an important role in reducing poverty and food insecurity which have become a common phenomenon in most developing countries particularly Nigeria.

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Evaluation of market structure of frozen fish marketing in Sabon Gari local government area Kaduna state

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Abstract

The study evaluated the market structure of frozen fish marketing in Sabon Gari local government area of Kaduna State. The specific objectives were to determine the market structure of frozen fish marketers, and determine the relationship between socio-economic variables and sales output in frozen fish marketing. A two- way sampling technique was used to select the respondents. Data were collected through the use of questionnaire and personal interview. Data were analyzed using gini coefficient, and multiple regression models. The results showed that frozen fish market structure was oligopolistic competition with a Gini coefficient of 0.709. The result of the regression showed that marital status (2126.553), education (8161.512), capital (5251.315) and age (54370.311) significantly influenced the sales output of frozen fish marketers at 1% and 10% level of probability. The R^2 value was 0.874 and the F-ratio (47.012) was significant at 1% level of probability. However, it is recommended that the frozen fish marketers should form cooperative in order to pool their resources together and expand their businesses.

Key words: Frozen fish marketing, gini coefficient, market structure

Introduction

The country has seven maritime states; however, the fishery industry has not attained the desired level of self-sufficiency in local fish production (Oyinbo and Rekwot, 2013). In Nigeria, total domestic fish production is far less than the total domestic demand. Fish importation makes up the balance of 400,000 tonnes (Rahji *et al* 2001). Nigeria requires about 1.5 million tonnes of fish annually (Ovia and Raji, 2006). This is what is needed to meet FAO's recommended minimum fish consumption rate of 12.5 kilograms per head yearly to satisfy basic protein needs (Amao *et al*, 2006). There are various species of frozen fish being imported into Nigeria such as heriing, Horse, Mackerel, Croaker, sardinella, and Blue whiting. The massive importation of frozen fish in the country has ranked Nigeria the largest importer of frozen fish in Africa (Atanda, 2012). Frozen fish importation in Nigeria may still continue for some time because supply from captured fisheries in Nigeria has been erratic and on the decline in recent years and the growth rate in aquaculture in not yet sufficient for the ever increasing demand (FDF, 2007).

Despite the abundance of human and natural resources, Nigeria depends largely on importation to meet its fish consumption needs (Esiobu and Onubuogu, 2014). Fish which contributes 36.6 grams per day of net protein utilization in Nigerian homes is still below the recommend requirement by the World Health Organization (WHO) (Ohen and Abang 2009). Nine (9) out of thirty six (36) states of the federation are located on the coast with access to the Atlantic Ocean (Oluwarore, 2018). With this scenario, the natural expectation is that Nigeria should not only be self – sufficient in fish production but should be an exporter of aquatic foods. Sadly, however, Nigeria imports between 700.000 and 900.000 metric tons of fish annually and is yet to partially meet a shortfall of 1,800,000 metric tons (Agbo, 2015). A good marketing organization directs production along the most suitable needs of the consumers (Onubuogu, 2005; Esiobu *et al*, 2014).

Empirical evidence remains largely scanty, isolated and devoid of in- depth analysis of frozen fish market structure. The specific objectives of the study were to determine the market structure, and determine the relationship between socio-economic variable and sales output in the study area.

Methodology

The study was carried out in Sabon gari local government area of Kaduna state. It is situated on latitude $11^0\,7^!$ N and longitude $7^0\,44^!$ E

Sampling procedure and sample size

Two- way sampling procedure was used for the study. First, purposive sampling was used to select Sabon Gari Local Government area based on the volume of frozen fish marketing and availability of large cold ware houses and was also used to select PZ, Sabon Gari main market, Muchia and Samaru. Secondly, random sampling technique was used to select 61% of the 242 frozen fish marketers. A total of 147 frozen fish marketers were sampled for the study.

Data source and collection

Primary data was used for the study. It was obtained through the administration of questionnaire and personal interview. Information obtained includes socio economic characteristics, sales outputs, prices and constraints to frozen fish marketing.

Data analysis

Data was analyzed using descriptive statistics and regression model.

Gini Coefficient is given by

$G = 1-\sum xy$

Where;

G= value of Gini coefficient

X= percentage of marketers

Y= cumulative percentage of sales

$\sum$= summation sign

Gini coefficient value range from zero to one and expresses the extent to which the market is concentrated. Gini coefficient is equal to zero when there is perfect equality in the size distribution by buyers and sellers as the case may be and equal to one where there is perfect monopoly in the market. Linear, semi-log, Double-log and Exponential functional forms were employed, filled and tried and on the basis of economic theory, statistical and econometric criteria; linear function form was chosen as the lead equation the explicit form of the model is presented below:-

$Y= b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_6X_6+b_nX_n+e_i$

Where:

Y = Sales output (₦)

X_1= Age (years)

$X_{2=}$ Gender (male= 1, female= 0)

X_3= Marital status (1=Married 0=others)

X_4 = Educational level (Years)

X_5 = Years of experience (years)

X_6 = Household size (number of persons)

X_7 = Capital input (₦)

e_i = error term

b_0 = Constant term

b_i - b_8 = Coefficient to be estimated

Results

Market structure

Table 1 shows the Gini coefficient computation for frozen fish marketers in Sabon Gari. The result shows that 23.9% of frozen fish marketers had sales between ₦330,000 – ₦459,000 and contributed ₦394,500 which represents 10%7% of total average sales. And 23.1% had sales between ₦460,000-₦589,000 and contributes ₦524,500 which represents 14.3% of the total average sales. The result shows a Gini coefficient of 0.709, indicating a concentration of level of 70.9% and implying tendencies towards an oligopolistic competition. This is contrary to the findings of Agom, *et al.*, (2012) who reported that frozen fish market structure in Calabar metropolis of Cross River State was perfectly competitive. However it is in agreement with the findings of Irhivben *et al*.(2015) who reported that a Gini coefficient of 0.7 in catfish market in Ibadan metropolis, Oyo state.

Relationship between socio economic variables and sales output

Table 2 shows the result of the influence of marketers' socio-economic characteristics on their sales output. A multiple regression analysis was carried out in four functional forms (semi-log, double log, linear and exponential forms). Based on the statistical, the linear function was chosen as the lead equation. The value of $R^{2,}$ and F-Ratio value, conformity of the signs with *a priori* expectations of the model and highest number of sign. The coefficient of multiple determinations R^2 was found to be 0.874 (87.4%). This is an indication that 87.4% of the variation in the sales output of frozen fish marketers was explained by the explanatory variables. The F-Ratio value was 47.012 and was significant at 1% level of probability indicating that the model fitted was correct.

Age: Age was found to be positively related to the sales output of frozen fish marketers. This implies that younger marketers made more sales than the older ones. This may be due to the fact that fish marketing requires much strength and the younger marketers have the potential to withstand stress and face tedious task associated with frozen fish marketing. The relationship was significant at 10% level of probability.

Gender: Gender has a positive relationship with the sales output of frozen fish marketers but not significant. This implies that whether male or female are involved in the marketing of frozen fish it does not influence the sales output significantly. This agrees with the findings of Coster and Otufale, (2012) who reported that sales output was not determined by any gender but hard work and marketing strategies.

Marital status: Marital status has a positive with the sales output of frozen fish marketers. This implies that married people made more sales than the singles. This could be that the married had access to capital and labour needed to improve their marketing activities. The relationship is significant at 1% level of probability.

Table 1: Gini coefficient computation

Sales (₦)	Freq	% of Frequency	commulative % Marketers	Average sale	% sales	commulative % sales	∑xy
70,000-199,000	14	9.52	9.52	134,500	3.66	3.66	0.00348432
200,000-329,000	33	22.45	31.97	264,500	7.20	10.86	0.024388070
330,000-459,000	35	23.89	55.77	394.500	10.74	21.60	0.05140800
460,000-589,000	34	23.13	78.90	524,500	14.28	35.88	0.08299044
590,000- 719,000	23	15.65	94.55	654,500	17.82	53.70	0.08404050
720,000-849,000	6	4.08	98.63	784,500	21.36	75.06	0.03062448
850,000-979,000	2	1.36	99.99	914,500	24.90	99.96	0.013594560
Total	147	100		3,671,500	100		0.2905230

Source: Field survey, 2018

G = 1-∑xy = 1- 0.2905230= 0.709

Education: Education had a positive coefficient with the sales output of the frozen fish marketers hence it is statistically significant at 1% level of probability. Marketers with formal education have greater ability to adopt new innovations, ideas, information and marketing strategies to increase volume of sales. It is expected that the level of education will significantly influence decision making of marketers. Esiobu *et al*., (2014) opined that exposure to high level of education is an added advantage in terms of achieving higher volume of sales, huge profit and efficient marketing.

Household size: Household size had a negative relationship with sales output. Decrease in household size makes for decrease in labour thus hampering expansion of market outlets which will not ensure proper coverage of the market and increase the cost of labour.

Marketing experience: Marketing experience had a negative coefficient with sales output. This is against a priori expectation, marketers with higher years of experience would be more efficient, have better knowledge of marketing techniques and thus expected to run a more efficient and profitable enterprise.

Capital input: Capital input had a positive coefficient with sales output and significant at 1% level of probability. This implies that increase in capital will invariably increase the purchasing power of the frozen fish marketers and hence take advantage of the economics of scale to purchase frozen fish in larger quantities at a reduced price.

Table 2: Result of Multiple Regression

Variables	Coefficient	T-value
Constant	52563.141	15.310***
Age (X_1)	54370.311	1.551*
Gender (X_2)	3916.632	0.453
Marital status (X_3)	2126.553	2.521***
Education (X_4)	8161.512	5.157***
Household size (X_5)	-7571.969	-0.531
Marketing Experience (X_6)	-3691.528	-0.152
Capital (X_7)	5251.315	3.457***
R^2	0.874	
F-Ratio	47.012***	

Source: Field survey, 2018 *** significant at 1%, * significant at 10%

Conclusion

The study examined the structure of frozen fish marketing in Sabon gari local government area of Kaduna state. The Gini coefficient of 0.709 showed that frozen fish market in the study area is an imperfect market. Marital Status, education, capital and age significantly influenced the sales output of frozen fish marketing in the study area. It is recommended that frozen fish marketers should form cooperatives in order to pool their resources together and improve access to credits and to use other forms of cooperative to increase patronage.

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EVALUATION OF THE EFFECTIVENESS OF THE DECENTRALIZED VINE MULTIPLIERS MODEL FOR SUSTAINABLE FORMAL SEED SYSTEM OF SWEET POTATO IN ABIA STATE, NIGERIA

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Abstract

The study evaluated the effectiveness of the decentralized vine multipliers model for sustainable formal seed system of sweet potato in Abia state. Multi stage random technique was used to elicit data from the farmers. The three agricultural zones were involved. Two blocks; two circles from each block making it twelve (12) circles. Ten (10) Sweet potato farmers were randomly selected from each circle, making a total of 120 farmers for the study. Data were analyzed using descriptive statistics. The result revealed that majority of the farmers sourced their sweet potato vine from NRCRI Umudike, followed by the cooperative. The findings revealed that no training on business management practices have been extended to these farmers. Grand mean score of 1.7 in the effectiveness of sweet potato vine multipliers model in Abia State showed that it is not effective. Also, grand mean score of 2.1 showed that farmers are not yet satisfied with sweet potato vine business in the state. Although Sweet potato seed business is lucrative in Abia State, the business model is not yet effective. Therefore, it is recommended that farmers should make effort to form clusters of sweet potato vine multipliers to enable them facilitate certification of their seeds for sustainable formal seed system.

Keywords: Effectiveness, Sweet potato, Decentralized Vine Multipliers and Abia State

Introduction

The Decentralized Vine Multipliers Model was introduced as a means of scaling out clean sweet potato vines through the relevant stakeholders to the farmers to ensure high yield and productivity by farmers. This is implemented through the activities of farmers' associations, out-growers, Non-governmental organizations (NGOs), cooperative societies and other seed producers with strong interest in sweet potato vine production in many sweet potato growing ecologies in Nigeria. This is an outcome of the collaboration between CIP and NRCRI during the Sweet potato Action for Security and Health in Africa (SASHA) Project. The decentralized vine multipliers model has greatly improved in capacity and output since its introduction in sweet potato seed production in Abia State, Nigeria. Therefore, there is need to evaluate the effectiveness of this model for sustainable formal seed system of sweet potato in the State. Specifically, the study examined access to quality seeds among the sweet potato farmers in Abia State; ascertained the quality of certified sweet potato vines produced in the state; determined whether the vine multipliers have been trained on appropriate improved agronomic and business management practices and evaluated effectiveness of sweet potato vine multipliers model in Abia State.

Methodology

The study was carried out in Abia State. Abia State lies between longitude 7^0 $00^0$and $8^0 10^1$ east and latitude 4^0 45^1 and 60^0 10^1north. It occupies a land mass of 5,833.77 square kilometers (ABSEEDS, 2006). Multi stage random technique was used to elicit data from the farmers. The three agricultural zones were involved. Two blocks from each zones were randomly selected; two circles were also randomly selected making it twelve (12) circles. Ten (10) Sweet potato farmers were randomlyselectedfrom each circle, making a total of 120farmers for the study. Data were analyzed using descriptive statistics such as percentages, mean and were presented in tables and charts.

Results and Discussion

Socio Economic of Sweet potato vine multipliers in Abia State

The result of the socio-economic indices of the sweet potato vine multipliers indicated that majority (68.15%) of the farmers were males, with average age of 52 years. It revealed that they vine multipliers were within the active and productive working class. This is in agreement with Adekunmi, *et al*. (2010), age affects mental attitude of individuals to new idea.Majority (85%) of them were married andhad household size of 7 persons. Emaziye (2015) opines that most farmers were married with large household size. The result showed that the farmers had secondary education level. According to Tokula and Nwachukwu (2004), level of education of farmers has positive and direct relationship with technology adoption. The farmers are subsistence farmers with 0.4ha of sweet potato vine farms.This showed that they are small scale farmers. Okoye, *et al.* (2004) opines that more than two third of the rural population live on small farms less than two hectares. The result also revealed that the farmers have been on sweet potato seed production for average of 2 years. The farmers had average annual income of N209,487.5from sweet potato seed production. This result indicated that they are resource poor farmers.

Table 1: Socioeconomic indices of Sweet Potato Seed Farmers in the study area

Description	Result
Sex	Males = 68. 15%, Females = 31.85%
Mean Age	52yrs
Marital status	Married = 85%, Single = 15%
Level of education	12years in school
Family Size	7 persons
General Farming experience	17 years
Experience in sweet potato seed (vine) production	2 years
Sweet potato seed farm size	0.4ha
Average annual income from sweet potato seed	₦209,487.5

Source: Field Survey, 2019

Sources of Supply of Sweet Potato Seeds

Figure 1 shows that the Sweet potato farmers' source seeds majorly from research (NRCRI) and cooperative society. The National Root Crops Research Institute Umudike produces healthy sweet potato seeds for farmers at reduced price.

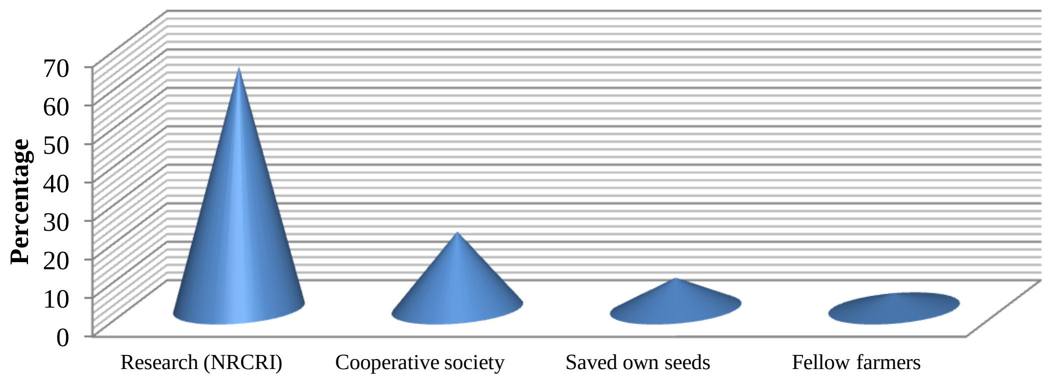

Fig. 1. Sources of Sweet potato seed

Source: Field Survey, 2019

Supply and Demand of Sweet Potato Seed

Figure 2 shows that the demand for sweet potato seeds is higher than the supply in the study area. This means that there is need for farmers to go into more sweet potato seed production to meet up with the demand. Taking sweet potato seed production as a business is a worthwhile venture in Abia State.

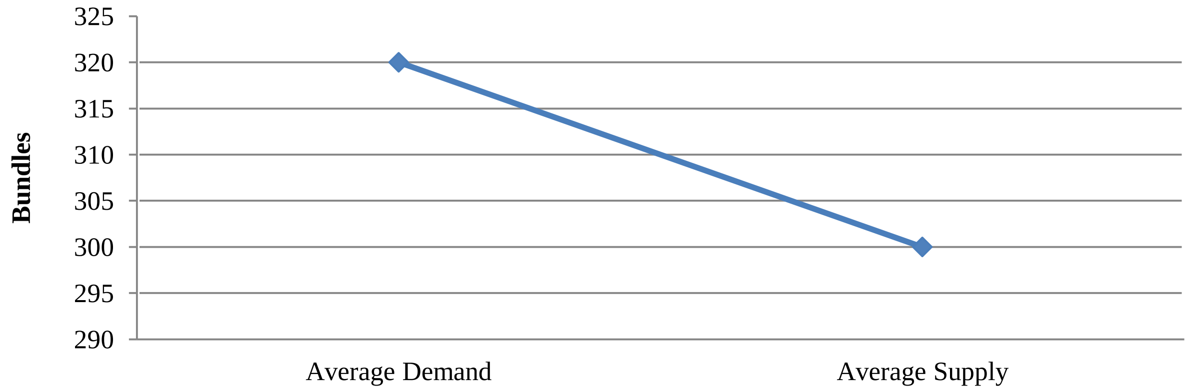

Fig 2. Demand and Supply of Sweet Potato Seed

Source: Field Survey, 2019

Sweet Potato Seed use in Abia State

From the chart below the major sweet potato seed use in Abia State were:

- UMUSPO 3
- UMUSPO 4
- TIS 87/0087
- Ex-Igbariam
- UMUSPO 1
- TIS 8164

These are improved varieties of sweet potato, high yielding and resistant to pest and diseases.

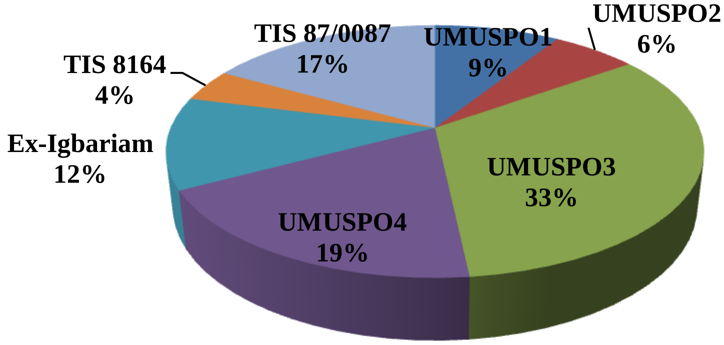

Fig 3**. Sweet Potato Seed use in Abia State**

Source: Field Survey, 2019

Quality of Sweet Potato Seed Produced by Sweet potato vine multipliers

- The sweet potato seeds produced by the Decentralized vine multipliers were not certified.
- The vines were healthy, free from pest and diseases.

Training on Improved Agronomic and Business Management Practices

The Decentralized vine multipliers have been trained on improved agronomic practices such as site selection, land clearing, ridging and bed making, vine planting, fertilizer application, weed management and harvesting of vines. This training enabled them to acquire the necessary skill for sweet potato seed production. The findings revealed that no training on business management practices have been extended to these farmers. Training on business management practices will empower the vine multipliers to take sweet potato seed production as a business.

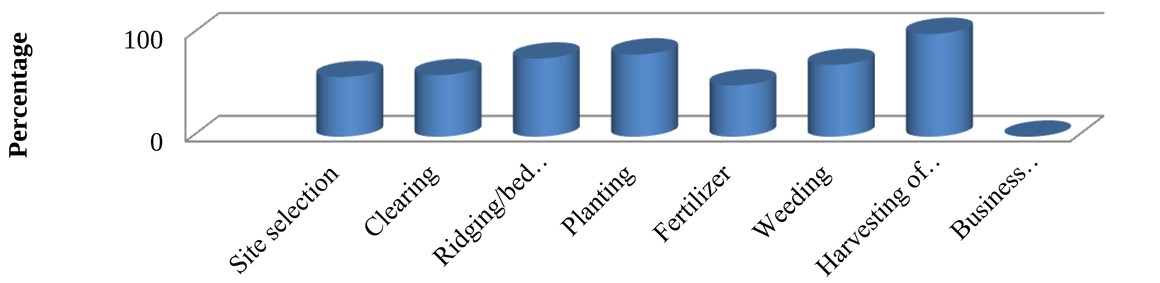

Fig 4.

Source: Field Survey, 2019

Effectiveness of Sweet Potato Vine Multipliers Model

From the result in Table 2, grand mean score of 1.7 shows that sweet potato vine multipliers model in Abia State is not effective. It was observed that National Agricultural Seed Council (NASC) has not visited the sweet potato farms for certification; also there is no sweet potato seed market in the State.

Table 2. Effectiveness of Sweet Potato Vine Multipliers Model

Options	Mean Score
There is appropriate follow up of the farmers that gets sweet potato seeds from me	1.0
I keep farm record of seeds I produced	1.6
I ensure that there are close monitoring of the sweet potato farms	1.5
I belong to a cooperative society	3.0
There is no sweet potato seed market in my area	3.0
NASC has visited my sweet potato farms	0.0
Grand mean	**1.7**

Source: Field Survey, 2019. **Note: Effectiveness > 3.0, Not effective < 3.0**

Farmers Satisfaction on Sweet Potato Seed Business

From the result of Table 3, grand mean score of 2.1 shows that farmers are not yet satisfied with sweet potato vine business in the state. This is however as a result of various issues confronting the business such as low price of sweet potato seeds, transportation, poor quality of farmers saved seeds, etc.

Table 3. Mean Rating of End User Satisfaction on sweet potato seed business

Options	Mean Satisfaction Score
Quality of NRCRI Sweet potato seeds	3.0
Price of NRCRI sweet potato seeds	1.4
Transportation of sweet potato seed	2.5
Quality of cooperatives sweet potato seeds	2.2
Price of cooperatives sweet potato seeds	2.6
Quality of farmers sweet potato seeds	2.5
Price of farmers sweet potato seeds	2.6
Quality of saved own seeds	1.3
Price of saved own seeds	1.2
Grand mean	**2.1**

Source: Field Survey, 2019 **Note: Satisfaction > 2.5, Non satisfaction < 2.5**

Conclusion

Although Sweet potato seed business is lucrative in Abia State, the business model is not yet effective. Therefore, it is recommended that farmers should make effort to form clusters of sweet potato vine multipliers to enable them facilitate certification of their seeds for sustainable formal seed system.

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Assessment of Formal Seed Yam System in Abia state: A Value Chain Thinking Approach

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Abstract

The development of a formal seed yam system is a panacea to improving yam productivity in Nigeria, which has remained underdeveloped due to several factors like farmers lack of knowledge of the benefits of purchasing improved seeds, a lack of communication and information flow among the breeder, processors and consumers. Hence, this study assessed the formal seed yam system in Abia State using value chain thinking approach. Through consumer intercept and key informant interviews data were collected from respondents identified along the chain and were analysed using value chain thinking approach. From the study, it was identified that disease resistance and early sprouting of seed yam were among the consumer preferred traits. The result further identified strengths of formal seed yam system in Abia State to include high ratio of propagation of seed yam produced in formal system and production of high seed quality from the system. The weaknesses include poor market infrastructures, low level of use of improve seed among others. The study shows that opportunities exists along formal seed yam value chain. It was recommended that all the actors along the chain have the potential to grow their size of the profit if they focus on consumer preferred attributes.

Keywords: seed yam, value chain and formal system**.**

Introduction

Yam tuber supplies substantial quantity of calories which comes from its carbohydrate content. The active ingredients in yam tuber includes dioscorine, saponin and sapogenin (Shehu et al 2010). Discorine has been identified as the major alkaloid in yam which can serve as a heart stimulant. Yam also has been reported as a good source of industrial starch although quality varies with species. Despite these importance, its production and productivity has been hindered by availability of and access to better quality planting materials (Maroya *et al* 2014). Nigerian Early Generation seed study reported that the formal seed system for yam is very small, with a less than 2 percent contribution of the total area planted with yam (Context Network and Sahel Capital, 2016). According to Mignouna *et al*., (2013) less than 10 percent of the yam growing households use certified seeds in yam belts of West Africa. In view of these, it is worthy to note that yam value chains in Nigeria is underdeveloped, with the informal seed system contributing about 98 % of total yam planted area in Nigeria (Context Network and Sahel Capital, 2016). This has resulted into low yield, largely because the quality of seed yams sourced from the informal sector is poor.

Louwaars (1994) defined a formal seed system as a purposely designed and bounded system, which involves chain of activities leading to a specific commodity which is a certified seed of confirmed varieties. The formal seed scheme is driven by the concept of preserving varietal identity and purity; and to generate seed of optimal physical, physiological and sanitary quality. The development of a formal yam seed system will act as a panacea to improving yam yield in Nigeria, which has been slowed down by several factors among others are lack of knowledge of the benefits of purchasing improved seeds, a lack of communication and information flow among the breeder, processors and consumers. Hence, this results into value chain that is unattractive to the chain members. Porter (1985) and Collins et al (2015) opined that a chain represents a linked set of value- added activities which cannot achieve competitive advantage by being examined in isolation, rather many discrete activities in designing, producing, marketing, delivering and supporting product and services are involved. It is an established fact that final consumers have exclusive rights to the definition of what constitutes value in a product or service (Soosay, *et al* 2012). In other to protect consumer interest, enterprises can only create successful value proposals by understanding what it is that consumers value in the products and services they create and then adapt to suit specific target segments. Value chain approach highlights how effective partners can effectively align their skills, resources and behaviour to better deliver products and services to different market segments and to reduce waste, with the resultant financial returns being distributed equitably so as to sustain partnership within the chain. Therefore, in order to improve competitiveness and help chain members to understand their interdependence, and the consequent benefits of solving problems mutually in a formal seed yam system, this study becomes germane. Studies focusing on improving seed systems have long been an important component of agricultural development strategies.

Previous studies on formal seed system rarely focused on yam. This study therefore aims at assessing the formal seed yam system through value chain thinking approach. Specifically, to map actors along the chain, determine consumer insight and identify where value is created along the chain, identify the strengths, weaknesses, opportunities and threats in the formal seed yam system and make recommendations for further improvement of the system.

Methodology

This study was carried out in Abia State Nigeria. The study adopted consumer research approach. The Yam Improvement for Income and Food Security in West Africa (YIIFSWA) conducted a training on improved seed yam multiplication techniques in Abia State. The respondents were purposively selected from the farmers who participated in the training. The first stage involved the identification of value chain actors. Through semi structured and key informant interviews data were collected from respondents identified along the chain. Ten participants comprising of 5 males and 5 females were purposively selected for a consumer interview because they are among the lead farmers. Personal interviews were carried out with plant breeders, input dealers, out growers and consumers. The data collected were analysed qualitatively.

.Result and Discussions

Chain actors in formal seed yam system

Actors along the formal seed yam system include breeders, seed parastatals, commercial seed companies, agro-input companies, regulatory bodies, and credit and insurance service providers. The principal actors identified from the study were breeders, seed entrepreneurs and commercial seed companies. The breeder breeds/develops the foundation seed while the seed companies, entrepreneurs and out growers receives the certified seed.

Breeder → seed Entrepreneur → commercial seed → consumer (Farmers)

Seed stage

(Foundation seed) (Certified seed) (Certified seed) (Commercial seed)

Figure 1: Mapping of actors along formal seed yam system value chain

Breeder

Plant breeders work with the genetic resources of various plant in the development of new varieties. Their functions include but not limited to improving the genetic purity, physiological quality and seed quality maintenance. These activities performed by breeders are vital for the sustainable intensification of yam production in Nigeria and subsequent improvement of the livelihood of numerous farmers who depend on yam production. It was observed that most of the functions carried out by the breeder are needed in other to create value in the chain.

Seed Entrepreneur

A seed yam entrepreneur is one of the actors identified along the formal seed system value chain. These are selected group of farmers that are trained with the view of seed yam multiplication. They receive the foundation seeds and ensures that seed quality is being maintained along the value chain. One of the respondents who owns more than 2 ha of seed yam farm, said “I was rarely using this latest technique in seed yam production before attending the training program, but now I can produce high quality seed and sell them to other farmers”.

Commercial seed Enterprise

The seed company identified within the location of study was Nwabugo Agro Enterprise who uses some of trained participants as out growers.

Activities along formal seed yam system

Table1: Activities performed by each actor along formal seed yam value chain

Breeder	seed entrepreneur	Commercial seed enterprises/marketer	Consumer
Improve genetic purity	Seed quality maintenance	Assemble	Disease free
Improve physiological quality	Seed multiplication	Transport	Disease resistant
Varietal development		sale	Seed size
Seed quality maintenance			Variety
			Early sprouting

Consumer Insight

The result on seed yam farmers' preferred attributes is shown in table 2. It was observed that the farmers are interested on seed yam that is free from disease and germinates early. The stage along the chain were these attributes are created is at foundation level which is the function of the breeders. The seed entrepreneurs (producers) also participate in seed quality maintenance to keep seeds free from disease.

Table 2: Consumer preferred attributes and chain actors responsiblee

Attributes	Critical activities	Chain actors responsible
Disease free	Genetic purity Seed quality maintenance	Breeder, seed producer
Disease resistant	Varietal development Seed quality maintenance	Breeder
Seed size	Improve physiological quality Varietal development	Breeder
Variety	Varietal development	Breeder
Early sprouting	Varietal development	Breeder

SWOT ANALYSIS FOR SEED VALUE CHAIN

Strength

High ratio of propagation

High seed quality

Large and viable market

Comparative price advantage

National Root Crops Research Institute presence (and other research centres experience and knowledge)

Weaknesses

Poor market infrastructures

Low level of use of improved seed

Informal seed sourcing still dominates

Low level of commercialization among small holder farmers

Opportunities

High demand for seed yam

Growing urbanization, new distribution channels

Changing consumers' food habits and demand for convenience foods

Threats

Scarcity of clean seed

Irregular power supply

Inadequate market

Recommendation and conclusion

This study analysed the actors along formal seed yam value chain in Abia state. The principal actors identified include the yam breeder, seed companies /entrepreneurs, out growers and consumers. The findings show that all the actors along the chain have the potential to grow their size of profit if they focus on consumer preferred attributes.

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Formation of Yellow Pepper Marketing in Enugu State, Nigeria

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Abstract

This study aimed to analyze the marketing formation of yellow pepper in Enugu State, Nigeria. The study was based on primary data collected using questionnaires administered to ninety nine(99) respondents using a purposive and simple random sampling technique. The analytical tools for the analysis were descriptive statistics to describe marketing channels and inferential statistics (Gini coefficient) to examine market formation. The study found that the marketing channels were much shorter with the marketing of yellow pepper and that retailers generally play a key role in marketing related agricultural activities in the study area. The concentration of market sales among yellow pepper traders was high, with the value of the Gini coefficient being0.72433, indicating that yellow pepper distributors have control over the market price. The study concludes that there is a reflection of a high level of inequality in income from sales among marketers in the study area. The study therefore, recommended that it is necessary to reduce the formation of oligopolistic market in the study area.

Keyword: marketing, pepper, channel, formation

Introduction

Agricultural marketing deals with the performance of all business activities that direct the forward flow of agricultural products and services to customers in order to achieve the goals of the producer (Usman ,Omoanyena ,Ishaya, (2008). A good marketing system reduces marketing costs, ensures a high level of income for producers, provides good quality agricultural products at an affordable price for consumers and minimizes the number of middlemen (Raj, *et al.*, 2007).In Nigeria, pepper ranks third among cultivated vegetables (Uzo, 2018). However, yellow peppers are an important commercial fruit vegetable(Madu *et al.*, 2005). Nigeria is known to be one of the major pepper producers in the world, accounting for about 50% of African production and the main production area is northern Nigeria (Business Day, 2007; Erinle, 1989). Pepper is used as a spice to flavor stews, soups and sauces. It is a rich source of vitamins A and C (Bosland and Votava, 2000). They are usually grown in rain-fed form and are evergreen when ripe, but a dark yellow or orange variety has also evolved (Uguru,2005). Indeed, yellow pepper is very aromatic and this attribute makes it expensive in the market (Nwankiti, 1981; Abu and Uguru, 2005). It is an important cash crop today, as its export to Nigeria has already been reported as business (Idowu-agida *et al.*, 2010). In Nigeria, the market and industry need pepper all year round, but production supply is severely limited by post-harvest losses (Uguru, 2005). Therefore, to benefit growers and other marketers involved in the production and marketing of yellow pepper, it is necessary to have a well-developed infrastructure to conserve the product until it reaches the end consumer. . Producers face many interrelated issues such as poor market information and infrastructure issues (storage, transport and processing) (NSPRI, 2000). In addition, the yellow pepper marketing channels and their characteristics have not yet been studied and analyzed for different zones of the country, in particular Enugu State, which specializes in the production and marketing of yellow pepper. Therefore, the specific objectives of the study were to study the commercialization of yellow pepper and to reduce the lack of information on the subject and contribute to a better understanding of improved strategies to reorient the marketing system for the benefit of traders and small holder farmer'sdevelopment.

Methodology

Description of the study area

The study was carried out in Enugu State, Nigeria. Enugu State has a humid and dry tropical climate. The dry season lasts at least five months (November-March) while the rainy season lasts from April to October. Average annual precipitation in the state ranges from 900 mm in the northwest to 1600 mm in the extreme south of the state (Onwubuya*et al*., 2009). The ecological condition of the state allows the cultivation of root crops, cereals, vegetables and animal husbandry in large numbers as well as trade.

Data collection methods, Sample size and sampling technique

Primary data was used for the study. It was obtained through the administration of a well-structured questionnaire to pepper traders in the study area. Ninety nine (99) yellow pepper traders were selected from the three agricultural zones in the study area using simple and purposive random sampling procedure. Six (6) local governments were purposively selected from the three zones because of their importance in the marketing of yellow pepper; Six (6) main markets from each of the selected local government areas (LGAs) were also purposely selected based on the entry of yellow pepper into the market. Respondents from each market were selected proportionately selected using Cocran's formula as follows (Cocran, 1997).

$$nh = \frac{Nh \ X \ n}{N}$$

Where: nh = number of respondents from the sampled market, Nh = number of marketers in each of the sampled markets, N = total number of marketers in all of the sampled markets, n = total number of questionnaires to be distributed and a procedure for Simple random sampling was used for the selection of respondents in each market. Thus, the total of 99 yellow pepper traders was observed and used as the sample size for the study.

Analytical tools / techniques

The analytical tools for the analysis were descriptive statistics such as frequencies and percentages to describe marketing channels and inferential statistics (Gini coefficient) to examine market formation. The Gini coefficient refers to a number or an index varying between zero and one; zero means perfect equality and perfect inequality.

Mathematically, the Gini coefficient is shown below:

$$G = 1 - \sum_{k=o}^{k=n-1} \left(\partial Y_{k-1} + Y_k\right)\left(\partial X_{k-1} - X_k\right)$$

Where;

G = Gini coefficient; X = number of red pepper dispensers; Y = volume of trade or total sales; ∂X = cumulative percentage or proportion of marketers; ∂Y = Cumulative percentage or proportion of total sales or trade

Channels of Yellow Pepper Marketing Channels

A marketing channel is a business structure of interdependent organizations that reach from the point of product origin to the consumer with the purpose of moving product to their final consumption destination (RehimaMussema, 2006). The analysis of marketing channels revealed the alternative routes followed by the product from the point of origin to the final destination. The study analysis identified four (4) marketing formation. This study is in agreement with that of (Aparna and Hanumanthaiah, 2012, Kotler and Armstrong, 2003). who identified 3 marketing channels for yellow pepper. Based on the results of this research, the main marketing channels were found to be much shorter (Channel 1: Producer Retailer Consumers) with yellow pepper sold in the markets. It is also, in line with the study by Rehima (2006) who reported that, the main marketing channels of the pepper markets in terms of the flow of pepper quantity in 2004/05 are short (i.e. from producer to consumer). Retailers are key actors in marketing related activities in the study area. In this case, producers sell the products to consumers and retailers as well as market-based wholesalers. The identified channels from the point of production until the product reaches the end consumer via different intermediaries were:

Channel-1: Producer Retailer Consumers

Channel-2: Producer wholesalers Retailer Consumers

Channel-3: Producer Rural Assemblers Retailers Consumers

Channel-4: Producers collectors Wholesalers Retailers Consumers

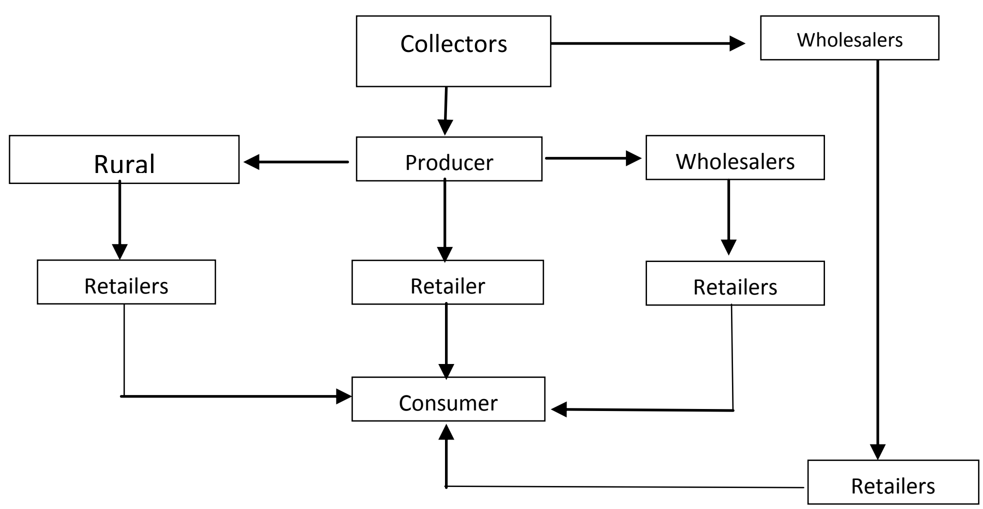

Fig. 1: Yellow Pepper Marketing Channels

Source, field survey 2020

Yellow pepper marketing formation

This section aimed to analyze the formation of yellow pepper marketing. The distribution of respondents according to their income or sales and the volume of sales in bags were also presented. Sales volume, on the other hand, refers to the value of the yellow pepper sold by traders at each level of the chain. Table 1 shows the value of the Gini coefficient of 0.72433, implying that the concentration of market sales among yellow pepper traders was high due to the small number of wholesalers competing with each other. This is an indication that the yellow pepper distributor exercises control over the market price. In other words, there is a reflection of a high level of inequality in income from sales among marketers in the study area. This study disagrees with that of Mekdes *et al.* (2017) who reported that the concentration ratio (CR4) of the four largest traders of yellow pepper was found to be low (weak). The result indicates that no single trader or a group of a few traders have a significant impact on the marketing of yellow pepper (Kohls and Uhl, 1985).

Table 1: **Gini Coefficient for yellow Pepper Marketers in Enugu State**

Income	Population freq	Cumulative population	Cum % of population	Cumulative income	Cum.% of income
<4,000	0	0	0	4000	0
4,000 – 20,000	65	65	65.7	22000	5.0
21,000 – 40,000	18	81	81.8	82000	18.6
41,000 – 60,000	9	90	90.9	142000	32.1
61,000 – 80,000	4	93	93.9	222000	50.2
81,000 – 100,000	1	94	94.9	322000	72.9
101,000 – 120,000	2	99	100	442000	100

*Ginin coefficient = 1 - ΣXY =1 - 0.29364 = 0.72433; XY = % of marketers multiplied by cumulative % of total sales **Source**: Field Survey, 2020

Conclusion and Recommendation

The study concludes that the yellow pepper marketing channel is short and that the concentration of market sales among yellow pepper traders was high, indicating that the yellow pepper distributor exercises control over the market price. This implies that there is potential for improving yellow pepper marketing systems to improve customer satisfaction and for traders to make more profit. Research efforts should be intensified to develop marketing channels that can improve customer satisfaction and increase the revenue-generating capacity of yellow pepper distributors.

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Agribusiness Risk Sources and Management Strategies Among Smallholder Farmers in Ebonyi State, Nigeria

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Abstract

This study explored agribusiness risk sources and management strategies among smallholder farmers in Ebonyi state, Nigeria. A sample size of two hundred and sixty respondents was drawn through simple random sampling technique. Data were collected by personal interview schedules using a structured questionnaire. The obtained data were analysed using descriptive and inferential statistical tools: frequency, percentage, mean and a three point-likert scale ranking. It was observed that *variability in farm input prices, economic/political situations, farm produce prices, rainfall patterns as well as occurrence of drought/flooding, changes in technology and pests/diseases outbreak were the major sources of agribusiness risks. Research outcome also revealed that use of improved crop varieties, access to market information, proper timing of farm operations, use of improved livestock breeds, involvement in off-farm activities, diversification of production, adoption of farm innovations, and proper farm record keeping had mean scores of above 2.0 respectively and were ranked the most important agribusiness risk management strategies in the study area. Thus, there is need for the agribusiness sector to become more resilient to the ever increasing production and financial risks. Use of improved crop varieties/livestock breeds, access to market information, proper timing of farm operations and proper record keeping should be encouraged among smallholder agribusiness farmers in Ebonyi state, Nigeria.* ***Key words:*** *Agribusiness, Risk Sources, Management Strategies, Smallholder Farmers.*

Introduction

Agribusiness simply means agriculture as a business. It is a combination of the words: agriculture and business and as well refers to any business related to agricultural production. Agribusiness is an aspect of agriculture comprising of production, manufacture and distribution of farm inputs, equipment and supplies at one hand and the processing, storage and distribution of farm commodities on the other hand. Agribusiness is the business sector encompassing farming and farming-related commercial activities: production, processing and distribution (Igbokwuwe & Essien, 2015). As a field of study, agribusiness is both an art and a science of managing an agricultural business enterprise. As an Art: agribusiness puts together the various skills of an individual or organization, in running a profitable venture. As a Science: risk-taking is backed up by an objective gathering and analysis of data and information. Agribusiness consists of a body of knowledge, which is borrowed from various disciplines. Agribusiness as a system consists of five sub-systems: the inputs subsystem, the production subsystem, the processing subsystem, the marketing subsystem, and the support subsystem. All the subsystems are strongly interrelated, and the coordination among them is a necessity for success of agribusiness.

Risk is an important aspect of the farming business. Five general types of risk are described here: production risk, price or market risk, financial risk, institutional risk, and human or personal risk. Risk, uncertainty and perfect knowledge constitute the three degrees of knowledge that are logically possible in agribusiness. The ability to predict exactly the future outcome of present actions does not usually exist for the agribusiness manager. Farmers are exposed to a wide range of risks arising from weather variability, natural hazards, and pests and diseases because agribusiness relies heavily on the natural resource base and climate conditions. Risk is defined as a situation which exists when the future can be predicted with a specified degree of probability. Thus, when a risk situation prevails, one can state that the chances are 50:50 or 75:25 that an event will occur. According to Nmadu, Shehu and Sallawu (2014), risk is a probability of threat, damage, injury, liability, loss or any negative occurance that is caused by internal and external vulnerabilities and may be avoided through pre-emptive actions. Risk is a major concern in agribusiness because farmers have imperfect information to forecast things such as farm input prices, product prices, and weather conditions, that might impact the farms in the future. Thus, farmers plan with uncertainty as all agribusiness decisions are subject to risk. Thus, smallholder agribusiness operators more often than not try to avoid risky situations no matter how profitable. Total risk avoidance is not possible in agribusiness because life itself is faced with daily risk. In agribusiness, higher risks are associated with higher profits. So, farmers cannot avoid risks but they often scout for ways to manage risky but potentially profitable agribusiness opportunities. Risks if not properly managed reduce social and economic security among agribusiness managers.

Risk management involves choosing among alternatives that reduce financial effects that can result from such uncertainties. Agribusiness risk management involves anticipating that an unfavourable event will occur and acting to reduce the probability of its occurrence and taking actions which will reduce the adverse consequences should the unfavourable event occurs (Nmadu, Shehu & Sallawu, 2014). A smallholder farmer is defined as a farmer who has a farming area of less than 30 rai (4.8 ha). This group of farmers operates mainly within the limits of their capacity and capability to employ most recommended risk management technologies. This diminishes their ability to optimize agribusiness productivity thereby affecting the food security prospects of Ebonyi state and Nigeria at large. This necessitated the study to explore the agribusiness risk sources and management strategies among smallholder farmers in Ebonyi state, Nigeria. This will close the information gap in agribusiness risk sources and management strategies in the study area and contribute maximally to effective agribusiness policy formulation. The central objective of this study is to examine agribusiness risk sources and management strategies among smallholder farmers in Ebonyi state, Nigeria. It also described the socio-economic characteristics of the smallholder farmers, identified agribusiness risk sources and described agribusiness risk management strategies among smallholder farmers in the study area.

Methodology

This study was carried out in Ebonyi state of Nigeria. Ebonyi State is located in south-east geopolitical zone of Nigeria. Ebonyi State has an estimated population of 4,339,136 based on the 2005 population census and the inhabitants are spread across 5,935 square kilometres (NPC, 2006). The people of the state are predominantly farmers and traders. With a land area of about 5,935 sq. km, It has a land area of 5,935 km2 with a projected population of 2,253,140 persons (NPC, 2006). Data for the study were collected from both primary and secondary sources. Structured questionnaire was used for data collection. Ten registered farmers were randomly selected from the Agricultural Departments of each of the thirteen local government areas giving a total of two hundred and sixty respondents for the study. Three point likert-type scale and descriptive statistics were used for data analysis. The socio-economic features of the respondents were analysed using descriptive tools: mean, percentage and frequency distribution while three point likert-type scale was used to analyse agribusiness risk sources, and risk management strategies among smallholder agribusiness farmers in the study area.

Results and Discussion

The household characteristics of the smallholder agribusiness farmers in Ebonyi state are presented in table 1. The results reveal that majority of the respondents (46.2%) fell within the age range of 31-40 years while 66.9% were married. About (45.4%) of them attended primary school while (32.3%) of them had no formal education. This shows that the agribusiness smallholder farmers in the study area had low level of education. Satit, Gan and Nartea (2012) argued that the educational level of farmers affected their decision making capacity. A higher educated farmer was expected to perform better than an uneducated farmer in terms of management skills and farm resource allocation to maximize farm profitability. The results obtained from data analysis further showed that majority of the farmers (47.3%) had household size of between 21-40 persons while greater number of them (56.9%) operated farm size of between 2-3 hectares. This result indicates that the agribusiness smallholder farmers in Ebonyi state operate average farm sizes of 2.5 hectares. This is consistent with Esiobu and Munonye (2017) who reported that the smallholder farmers in the rural areas of the South East Nigeria usually had an average farm size of between 2 t0 3 hectares. Besides, they generally maintained large family size as a means of adequate supply of cheap farm labour.

Table 1: Socio-economic attributes of the respondents

Age group (years):	**Frequency**	**Percentage**
Below 30	**2**	**7.7**
31-40	**120**	**46.2**
41-50	**90**	**34.6**
Above 50	**30**	**11.5**
Educational background:		
No formal education	84	32.3
Attended primary school	118	45.4
Attended secondary school	46	17.7
Attended tertiary school	12	4.6
Marital Status:		
Single	23	8.9
Married	174	66.9
Divorced	16	6.2
Widowed	47	18.0
Household size (Persons):		

Below 10	13	5.0
11-20	56	21.5
21-30	123	47.3
31-40	44	16.9
Above 40	24	5.0
Farm size (Hectares)		
Below 2	63	24.2
2-3	148	56.9
3-4	37	14.2
4-5	12	4.6
Above 5	0	0

Agribusiness Risk Sources

Table 2 shows the distribution of respondents according to sources of risks associated with agribusiness. This table shows that variability in farm input prices, variability in economic/political situations and variability in farm produce prices had the first second and third highest mean scores for sources of risks, respectively as rated by the respondents. Occurrence of drought, changes in technology, variability in rainfall patterns, occurrence of flooding and pests/diseases outbreak were ranked fourth, fifth, sixth, seventh and eighth, among the agribusiness smallholder farmers in the area, respectively. This finding is consistent with that of Igbokwuwe, Essien, and Agunnanah (2015) who argued that risks associated with the variability of product and input prices were the most important sources of risk considered by the farmers in their respective study areas.

Table 2: Distribution of Respondents by Sources of Risks

Variable:	1	2	3	Mean	Rank
Variability in rainfall pattern	0	84	176	2.68	6th

Farm pests/diseases outbreak	21	73	166	2.56	8th
Occurrence of accident/accident	6	104	150	2.55	9th
Occurrence of flooding	8	96	156	2.57	7th
Occurrence of drought	0	61	199	2.77	4th
Variability in farm produce prices	0	12	284	2.95	3rd
Variability in farm input prices	0	0	260	3.00	1st
Variability in farm labour cost	32	79	149	2.45	10th
Variability in economic/political situations	0	5	255	2.98	2nd
Fire outbreak	32	102	126	2.36	11th
Changes in technology/innovation	0	66	194	2.75	5th
Changes in debt status	93	113	54	2.08	12th
Variability in interest rate	132	87	41	1.65	14th
Occurrence of stealing/armed robbery	101	95	64	1.86	13th
Variability in government policy	126	134	0	1.52	15th

1 = Disagree, 2 = Agree, 3 = Strongly agree

Agribusiness Risk Management Strategies

Agribusiness risk management strategies adopted in both production and financial risk management are presented in table 3. From the perceptions of risk management strategies elicited from the agribusiness smallholder farmers in Ebonyi state, use of improved crop varieties, access to market information and proper timing of farm operations were considered more important managerial responses to risk by the farmers. This finding supports Nmadu, Shehu and Sallawu (2014) who argued that the use of improved crop varieties and proper timing of farm operations were most important farm risk management strategies in Nigeria. Use of improved livestock breeds, involvement in off-farm activities, diversification of production, proper asset management, adequate savings, adoption of farm innovations, access to storage facilities, cash holding, and proper farm record keeping were also ranked high by the respondents.

Table 3: Distribution of Respondents by Risk Management Strategies

Variable:	1	2	3	Mean	Rank
Diversification of production	0	98	162	2.62	6th
Proper asset management	18	85	103	2.53	7th
Agribusiness insurance	153	96	11	1.45	16th
Membership of cooperative societies	91	107	62	1.89	14th
Speculative produce storage	24	163	73	2.19	10th
Proper timing of farm operations	0	37	223	2.86	3rd
Adequate savings	11	158	91	2.31	8th
Involvement in off-farm activities	0	72	188	2.72	5th
Access to market information	0	15	245	2.94	2nd
Adoption of farm innovations	71	52	137	2.25	9th
Access to extension services	178	82	0	1.32	17th
Avoiding traditional farming methods	187	73	0	1.28	18th
Use of improved crop varieties	0	0	260	3.00	1st
Use of improved livestock breeds	0	52	208	2.80	4th
Holding cash	33	177	50	2.07	12th
Reducing debt level	81	136	43	1.85	15th
Access to storage facilities	55	116	89	2.13	11th
Proper farm record keeping	64	124	216	2.03	13th

1 = Disagree, 2 = Agree, 3 = Strongly agree

Conclusion and Recommendations

Agribusiness is the catalyst that activated traditional agriculture into modern and commercial agriculture in Nigeria. but it is vulnerable to both production and financial risks and uncertainties. World Bank (2013) in a report titled "Growing Africa: Unlocking the potential of agribusiness" shows poor infrastructure, high transportation including difficulties for smallholders and small firms to access technologies, information, skills and finance as critical bottlenecks bedeviling the growth of agribusiness. This paper examined agribusiness risk sources and management strategies among smallholder farmers in Ebonyi state, Nigeria. Simple descriptive statistical analytical tools and a three point likert-like scale were used to analyse and interpret data. The results of this study identified variability in farm input prices, variability in economic/political situations, variability in farm produce prices , occurrence of drought, changes in technology, variability in rainfall patterns, occurrence of flooding and pests/diseases outbreak as the major sources of agribusiness risks in the study area. According to the results obtained in table 3, use of improved crop varieties, access to market information proper timing of farm operations, use of improved livestock breeds, involvement in off-farm activities, diversification of production, proper asset management, adequate savings, adoption of farm innovations, access to storage facilities, cash holding, and proper farm record keeping were ranked the most important agribusiness risk management strategies among the smallholder agribusiness operators in Ebonyi state, Nigeria. I therefore recommend that government should ensure adequate and timely provision of farm inputs such as improved crop varieties, livestock strains, agrochemicals as well as rural infrastructure to the smallholder agribusiness farmers. The smallholder agribusiness farmers on their own part should pursue adequate access to market information and maintain proper timing of their agribusiness operations.

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Assessing the Consumer Preference and Acceptability of Pro Vitamin A Cassava Products in South-East and South-South Nigeria

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Abstract

The study assessed the consumer preference and acceptability of pro vitamin A cassava products among rural households in south-east and south-south Nigeria. Purposive and multistage random sampling was adopted in the selection of the sample size of 480 respondents from Imo, Anambra, Delta and AkwaIbom states. This is because pro vitamin A cassava has been massively disseminated in those areas. Focus Group Discussion and well-structured questionnaire were used to elicit information from the respondents while descriptive was used to analyze the data collected. Result emerging from analysis showed a grand mean of ($\bar{x}$=1.96), implying a general low frequency of consumption and usage of pro vitamin A cassava products across the states as below the bench mark of 3.0. The result also showed a grand mean of $\overline{(x}$=2.61), implying that consumers extremely like consuming pro vitamin A cassava products for its colour, texture, taste, aroma among others as above the bench mark of 2.0. The paper concluded that despite that respondent extremely like consuming the products for its colour, texture, taste and aroma the consumption frequency is still low in the study area. It was therefore recommended that promotional activity such as more awareness campaigns and nutritional information showcasing the potentials of pro vitamin A cassava to households in order to encourage massive consumption of vitamin A cassava in Nigeria. This is necessary to reduce the level of vitamin A deficiency among rural households in Nigeria.

Keywords: Consumption, Pro vitamin A cassava, Products, Rural, Households.

Introduction

Millions of Nigerians, irrespective of age, sex or geographic location consume less vitamin A than the body needs while women and children remain the most vulnerable (Egesi*et al*, 2014). In developing countries, vitamin A deficiency remains a major bottleneck to improved nutrition with approximately 250,000 to 500,000 malnourished children going blind each year, half of whom die within a year of becoming blind (Abdoulaye*et al*, 2015; McNulty and Oparinde, 2015). A sustainable way of mitigating vitamin A deficiency is by breeding food staples such as cassava to produce vitamin A by itself, a process known as biofortification (Ilona, 2012).Progressively, International Institute for Tropical Agriculture, Ibadan in partnership with the National Root Crops Research Institute, Umudike, Nigeria, developed and released the first and second pro vitamin A cassava varieties in 2011 and 2014 using traditional breeding methods in a Harvest-Plus-funded project. These pro vitamin A cassava varieties have been distributed to about 100,000 households in Nigeria as at October 2013 namely; Anambra, Abia, Ebonyi, Enugu, AkwaIbom, Cross River, Imo, Delta among others through the Extension Services Programme of the National Root Crops Research Institute, Umudike (Egesi*et al.* 2014) and other partners. According to Ilona (2017), as at the end of 2013, a cumulative total of 106,000 farm households in Nigeria had been reached with vitamin A cassava. It is estimated that by 2018 more than 2 million farming households will be planting vitamin A cassava and at least 17 million rural and urban consumers will be eating vitamin A *gari*and *fufu*in their regular diets (Ilona, 2012). The consumption of pro-vitamin A cassava could help Nigeria reduce economic losses in gross domestic product estimated at about $1.5 billion (Ilona, 2012). Most importantly, it improves nutrition, especially of women and children who are the most vulnerable (Njoku *etal*., 2014).

Expectedly, rural households should take a lead in consumption of the pro vitamin A cassava as these efforts will ultimately satisfy the increasing need for more healthy and nutritious food produced in environmentally sustainable ways. However, the rate of consumption of pro vitamin A cassava in south-east and south-south Nigeria is subject to its profitability in terms of nutritional value, health benefits, marketability, high yield, form and quality of the products. In view of the above, the need to assess the consumers' preferenceand acceptability of pro vitamin A cassava products in Nigeria becomes imperative. The objectives of this study were to: assess the frequency levels of consumption of pro vitamin A cassava products among rural households and assess the consumer preference and acceptability of pro vitamin A cassava products determine among rural households across the states.

Materials and Methods

This research adopted the descriptive survey design.The population of the study consisted of rural household farmers in the study area purposively selected from Imo and Anambra states representing south-east;AkwaIbom and Delta states representing south-south Nigeria. This is because pro vitamin A cassava has been massively disseminated in those areas. Multi-stage sampling procedure was used in selecting the sample size of 480 respondents cumulatively chosen from the four states. The first and second stages involve purposive selection of eight (8) agricultural zones and twenty-four (24) blocks from the four states. In the third stage, forty-eight (48) circles were randomly selected from the blocks. Finally, ten (10) farmers were randomly selected from the circles, giving one hundred and twenty (120) respondents from each state and a total of 480 respondents across the states. The study made use of well-structured questionnaire and focus group discussion to obtain data for the study. Data were analyzed and presented using descriptive statistics.

Results and Discussion

Frequency of consumption and usage of pro vitamin A cassava

The result (Table 1) showed a grand mean of $\bar{x}$=1.96, implying a general low frequency of consumption and usage of pro vitamin A cassava products across the states. However, there were high frequencies of consumption of gari ($\bar{x}$=3.95) and fufu($\bar{x}$=3.47) across the states. Specifically, there were high frequency of consumption of gari($\bar{x}$=3.63) and fufu ($\bar{x}$=3.35) in Imo state, gari($\bar{x}$=4.54) and fufu ($\bar{x}$=3.00) in Anambra state, gari ($\bar{x}$=4.13) and tapioca ($\bar{x}$=3.13) in Delta state and gari($\bar{x}$=3.50),fufu($\bar{x}$=4.74) and Abacha ($\bar{x}$=3.06)in AkwaIbom state. This result implied that consumers frequently consume pro vitamin A cassava products as gari and fufu across the states.However, it important to note that processing pro vitamin A cassava into value added products is likely to boost frequency of consumption in Nigeria. In the view of Atser and Oliver (2012) it was expected that after the mid-2014 harvest, more than 150,000 household members would be eating vitamin A-rich cassava in various forms steady.

Table 1: Mean responses of respondents based on their frequency of consumption form and usage of pro vitamin A cassava

Pro vitamin A Products	**Imo**		**Anambara**		**Delta**		**AkwIbom**		**Pooled**	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Consume in garri form	3.63	1.419	4.54	1.129	4.13	1.243	3.50	1.536	3.95	1.331
Consume in fufu form			3.00	1.094	2.80	1.268	4.74	1.260	3.47	1.419

	3.35	1.587								
Dispose as fresh root	1.04	.3007	1.03	.3004	1.01	.6116	1.15	.5891	1.06	.3008
Dispose as stem	1.02	.2017 .	1.12	.2764	1.02	.5351	1.12	.5586	1.07	.2836
Use as flour	1.12	.4335	1.37	.5009	1.08	.3326	2.36	1.297	1.48	.5584
Consume in flakes (abacha)	2.07	.5142	2.83	.5759	1.39	.4972	3.06	1.468	2.34	.7913
Use as cassava chips	1.03	.2800	1.04	.3007	1.07	.2645	1.65	.7970	1.19	.8567
Consume in value added	1.17	.4908	1.34	.4763	1.15	.4027	2.68	1.241	1.59	.4626
Tapioca	1.01	.2002	1.01	.2101	3.13	.8246	1.03	.2722	1.55	1.045
Grand mean	**1.72**		**1.92**		**1.86**		**2.37**		**1.96**	

Source: Field Survey, 2018

**Decision: > 3.0 indicates high frequency of consumption; < 3.0 indicates low frequency of consumption.*

Consumers' preference and acceptability of pro vitamin A cassava products

The result (Table 2) showed a grand mean of $\bar{x}$=2.61, implying that consumers extremely like consuming pro vitamin A cassava products for its colour, texture, taste, aroma among others across the states. The result further shows that majority of consumers in Imo, Anambra, Delta and AkwaIbom states prefer the colour, mouldability, texture, taste, mouth feel, elasticity and aroma of the garri, fufu, abacha and value added products like cake, bread, chin-chin, etc. It was only in Delta state that tapioca was extremely liked ($\bar{x}$ =2.98). The mean score was ($\bar{x}$=2.59) in Imo, ($\bar{x}$ =2.60) in Anambra, ($\bar{x}$=2.56) in Delta and ($\bar{x}$=2.66) in A kwaIbom. This implies that pro vitamin A garri and fufu are extremely liked and consumed at different frequency by rural households in the study area. Also, increase in value added products of pro vitamin A cassava such as cake, bread, boons, etc, would boost the consumption and general acceptance of pro vitamin A cassava products across the states. This study conforms to the findings of Oparinde*et al*, (2017) and Bouis and Saltzman (2017), who said that the yellow color of the root and its processed products is seen as evidence of the presence of vitamin A and is liked by consumers and yellow fufu has become a preference for fufu consumers in AkwaIbom, while yellow gari (biofortified) is a growing preference for consumers in regions that traditionally consume white gari. Birol et al, (2015) reported that to aid in acceptance, public relations tools need to be implemented to increase consumer demand and inspire positive attitudes surrounding new products made from yellow cassava varieties. According to Ilona*et al* (2017) available data from vitamin A cassava investors suggest that gari is the most traded vitamin A cassava product, accounting for 58% of total sales in 2015. Fufu accounted for 30% of the total sales, followed by flour (12%), resulting from the high demand for vitamin A cassava-based snacks and confectioneries like queen cake, combo-bits, and combo-strips.

Table 2: Mean score responses of respondents based on their consumption preference and acceptability of pro vitamin A cassava products

Products Preference	**Imo(n=120)**		**Anambra(n=120)**		**Delta(n=120)**		**AkIbom(n=120)**		**Pooled(n=480)**	
	$\bar{\bar{x}}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD

Garri:										
Colour	2.98	.1825	3.05	.1825	3.00	.3743	3.06	.2034	3.02	.1574
Mould ability	2.90	.2278	2.98	.0000	2.98	.1285	2.90	.3279	2.94	.1959
Taste	2.98	.1825	2.98	.1825	2.95	.2188	2.90	.3279	2.95	.2589
Elasticity	2.98	.1825	2.98	.1825	2.92	.3218	2.68	.5018	2.89	.3454
Texture	2 98	.1825	2.98	.1825	3.00	.3743	2.93	.3104	2.97	.1922
Fufu:										
Colour	3.00	. 3784	2.94	.2353	3.00	.3784	3.08	.2820	3.00	.1858
Mould ability	2.95	.2006	2.96	.1802	3.00	.3784	3.05	.3793	2.99	.2365
Taste	2.98	.1285	2.98	.1285	3.00	. 3784	3.05	.3619	3.00	.2064
Elasticity	2.97	.1567	2.98	.1285	3.00	. 3784	3.10	.4762	3.01	.2791
Texture	3.05	. 3794	2.98	.1285	3.00	3784	3.11	.3326	3.03	.1811
Flakes(abacha)										
Mouth feel	2.84	.3666	2.98	.1285	2.27	.5179	2.80	.4901	2.72	.4862
Colour	2.95	.2189	2.98	.1285	2.51	.5342	3.07	.4364	2.82	.4101
Taste	2.55	.4988	2.98	.1285	2.59	.5869	2.77	.4756	2.72	.4862
Flour										
Texture	2.07	.26450	2.21	.4137	2.26	.4440	2.61	.5374	2.29	.4694
Colour	2.22	.41933	2.15	.3665	2.14	.3501	2.64	.5313	2.29	.4685
Value added products(ca										

ke)										
Taste	2.20	.4016	2.20	.4078	2.05	.2687	2.15	.3813	2.15	.3728
Crispness	2.19	.3952	2.10	.3121	2.05	.2687	2.19	.4159	2.13	.3566
Aroma	2.30	.4601	2.07	.2645	2.05	.2687	2.10	.3379	2.13	.3545
Colour	2.15	.3665	2.10	.3121	2.05	.2687	2.14	.3734	2.11	.3341
Mouth feel	2.33	.4734	2.10	.3121	2.05	.2687	2.19	.4159	2.17	.3894
Tapioca	1.00	.1800	1.03	.1802	2.98	.1285	1.31	.3671	1.58	.4812
Grand mean	**2.59**		**2.60**		**2.56**		**2.66**		**2.61**	

Source: Field Survey, 2018*Decision: > 2.0 indicates extremely like; < 2.0 indicates extremely dislike

Conclusion

The study concluded that there was low frequency of consumption and usage of pro vitamin A cassava products generally, though, but with high frequencies of consumption of gari and fufu across the states. The study also concluded that consumers extremely like consuming pro vitamin A cassava products for its colour, texture, taste, aroma, elasticity, mouldability and crispiness across the states. It was therefore recommended that promotional activities, such as more awareness campaigns and nutritional information showcasing the potentials of pro vitamin A cassava to households in order to encourage massive consumption of vitamin A cassava in Nigeria. This is necessary to reduce the level of vitamin A deficiency among rural households in Nigeria.

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An Analysis of Cocoyam Profitability Among Small Holder Farmers In South Eastern Nigeria.

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Abstract

The present study was designed to examine cocoyam profitability among small holder farmers in South East of Nigeria. Primary data was collected from 196 cocoyam farmers that were selected for detailed study. Data collected were analyzed using percentages, multiple regression and Net farm income analysis. Results of the data analysis showed that most cocoyam farmers were young, educated and had access to market information. Finally, cocoyam farming was profitable with total cost of N502,608, total revenue of N300,000, gross margin of N199,408 and net farm income of N202,608. It was recommended that appropriate policies that would encourage cocoyam farmers" access to credit, educational programme and membership of organization should be encouraged.

Keywords: Cocoyam, Small holder, Farmers, Profitability

Introduction

Cocoyam varieties (*Xanthosoma sagittifolium*) called tannia and (*Colocasia esculenta*) called taro are important staple food crop grown extensively in south-eastern Nigeria. Cocoyam is an important crop in many parts of the world, mainly for smallholder farmers. The crop plays a major role in the lives of many as a food security crop and has rich economic and socio-cultural implications. It is a cash crop and foreign exchange earner, as well as an important component in the rural development of many areas and individuals (Acheapong, 2014). Cocoyam production is almost exclusively used for human consumption and an important food security crop in times of failure or shortage of other crops.

In Nigeria, like in most developing countries, root and tuber crops such as cassava, sweet potato, yam and cocoyam act as principal sources of food, nutrition and income especially to most food insecure households (Ezeano *et al*, 2017). These crops have a greater ability to produce more edible energy per hectare per day compared to other commodities and produce satisfactory under difficult conditions where other crops may fail (Ekwe *et al.*, 2007). This suggests that the potential of such crops like cocoyam, for food security, income generation and nutritional enhancement in the households are grossly underutilized.

According to Obasi *et al*. (2013) productivity improvements are only possible when there is a gap between actual and potential productivity. Therefore, the specific objectives are to describe the socioeconomic characteristics of the farmers, determine the effects of the factors on the farmers" productivity and estimate the profitability of cocoyam production in the study which is among the cocoyam production zone of the nation.

Methodology

The study was based in Abia and Enugu States of Nigeria. The states are located in a tropical rain forest zone with humid climate. Multistage random and purposive sampling techniques were adopted in the selection of respondents. Two states (Abia and Enugu State) out of five states in the South-East Geo-Political zone were purposively selected for the study. In the second stage two agricultural zones per state were randomly selected, giving a total of four agricultural zones. In the third stage, four Local Governments Areas (LGAs) were selected randomly from each zone. In the fourth stage, one community was randomly selected from each Local Government Area giving a total of eight communities. One village was selected from each community making it a total of eight villages. Finally, twenty-four root and tuber crop farmers were randomly selected from the villages. This gave a total of 192 respondents for the study. The study employed a survey research design. It involved the collection of data on socio-economic characteristics and market variables of cocoyam producing households in the study area. This was with the aid of structured questionnaire and data collected which were analyzed and used to achieve the set objectives.

Results and Discussion

Table 1. Average Socio-Economic Characteristics of Cocoyam among Small holder Farmers

Variable Description	**Abia**	**Enugu**	**Pooled**
No of Observation	**96**	**96**	**192**
Age	44.71	47.36	46.04
	(14.1)	(15.25)	(14.75)
Household size	5.51	6.08	5.79
	(2.50)	(3.09)	(2.82)
Educational Level (Years)	12.24	12.33	12.78
	(2.76)	(3.68)	(3.28)
Transportation Cost	0.80	4.15	3.09
	(0.50)	(3.06)	(2.59)
Non-farm income	41,873	50,670	62,659.69
	(51079.88)	(74063.24)	(65055.56)
Dummy (%)			
Credit Availability	72.92	95.83	55.21
Access to Market Information	61.46	85.42	69.79
Extension contact	67.71	77.08	58.85
Gender	51.04(m)	62.50(f)	64.06(m)
Marital Status	81.25	88.54	88.54

Source; Field Survey, 2019

*, ** and *** implies significance at 10 %, 5 % and 1 % respectively

Table 2: Multiple Regression Result

Abia State			Enugu State	Pooled
Variables	**Parameters**	**Semi log+ Cocoyam**	**Double log+ Cocoyam**	**Semi log+**
Age	X_1	-0.019	-0.344	0.07
		(-2.136)*	(-2.963)**	(1.308)
Educational Level	X_2	0.107	0.065	0.045
		(1.097)	(0.846)	(1.670)*
Gender	X_3	-1.110	-0.123	-0.073
		(-3.509)***	(-2.432)**	(-0.670)
Household size	X_4	0.001	-0.092	-0.039
		(0.011)	(-0.948)	(-0.889)
Income	X_7	6.860E005	0.962	3.403E006
		(5.845)***	(15.226)***	(0.758)
Market information	X_8	-0.265	0.052	1.173
		(-0.994)	(0.551)	(5.966)***
Extension contact	X_{10}	2.611	0.366	-0.439
		(3.687)***	(3.922)***	(-2.309)**
Credit availability	X_{11}	2.169	0.039	0.094
		(3.263)**	(0.793)	(0.475)
Non-Farm Income	X_{12}	-0.321	0.013	-0.035
		(-2.052)*	(0.199)*	(-0.510)
Capital Invested	X_{13}	-0.182	0.071	0.101
		(-0.607)	(3.662)***	(0.550)
Constant	β0	16.167	-3.562	5.831
		(4.409)***	(-4.423)***	(4.738)***
R^2		0.972	0.875	0.543
Adjusted R^2		0.8991	0.851	0.396
F ratio		13.284***	36.529***	6.276***

Source: Field Survey data, 2019

Note: ***, ** and * implies statistically significant at 1%, 5% and 10% levels respectively.

Values in parentheses represent the t-values.

Table 3: Costs and Return on Cocoyam Production Per Hectare

Item	Unit (Kg)	Quantity	Cost(N)	Value (N)
Revenue				
Yield		1000	300	300,000
Cost of Inputs				
Cocoyam sett		400	600	240,000
Fertilizer		350	6,500	45,000
Manure		900	1000	18,000
Transportation				40,000
Total				**343,000**
Labour	**Man-day**	**Family/Hired**		
Land Preparation		(20)H	2,500	50,000
Planting		(4)F(2)H	800	4,800
Fertilizer application		(6) F	800	4,800
Weeding		(15)F	1000	15,000
Harvesting		(6)F	1000	6000
Total Labour cost (TLC)				**80,600**
Opportunity cost of capital at bank lending rate of 23%				75,808
Total variable cost				**499,408**
Gross margin (GM) (TR – TVC)				199,408
Depreciation of fixed assets excluding land				3,200
Total cost (TVC + TFC)				502,608
Farm income (TR – TC)				202,608
Benefit cost ratio				1:2.01

Source: Field Survey, 2019

Conclusion and Recommendation

From the result, most cocoyam farmers were young, educated and had access to market information . Ordinary Least Square (OLS) Method of the multiple regression was used to estimate the determinants of Market Orientation among root and tuber crop producing households,However, cocoyam farming was profitable in the study area. Based on the study the following recommendations were proffered; there is need to ensure farmers" access to credit through micro finance and other financial institutions. Also, farmers should be encouraged to form themselves into groups such as co-operative societies to enable them strengthen their bargaining ability, especially during credit negotiation and production input procurement at lower price. Furthermore, adult education, workshops and seminars should be organized by the concerned government agencies in other to improve farmers‟ efficiency and effectiveness.

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ABSTRACTS

Sweet Potato: Crop for Enhanced Nutrition, Health and Income Generation

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Abstract

This paper on sweet potato: crop for enhanced nutrition, health and income generation in Nigeria reviewed the benefits of the crop for human consumption in Nigeria. The paper depended on information from secondary sources such as documented relevant review literature on sweet potato and field experience of researchers. The crop sweet potato occupies a prominent position in enhancing nutrition, health and income generation for people. Ignorance of recipes using sweet potato limits utilization of these root crops. Value addition and its awareness of the root crops, apart from increasing the utilization, will encourage production, improve food security, generate more employment opportunities, help fight malnutrition and support healthier population. The production process of these products also help to identify value chain which provides potential benefits for both local and international producers and consumers. paper therefore reviews the potentials of sweet potato in enhancing nutrition, health and generating income for households in Nigeria.

Yield response of Sweet Potato (*Ipomea Batatas* (L.) Lam) to different tillage practices in Ishiagu, Southeastern Nigeria

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Abstract

A field experiment was conducted at the research site of Federal College of Agriculture, Ishiagu during the 2019 rain fed cropping season on the 'agronomic response of sweet potato (Ipomea batatas (L) Lam) to different tillage practices in Ishiagu, Southeast Nigeria.' A randomized complete block design (RCBD) was used with four (4) treatment and three (3) replications. The treatments are: T1- Bed, T2- Ridge, T3 - Mound and T4 - zero tillage. Agronomic parameters were taken and statistically analyzed. The results of the experiment showed that there were significant different between treatments on the agronomic parameters. Specifically, the Bed and Mounds (Heap) tillage practices showed the best performance on the yield variables than the other tillage practices. Based on the results of the experiment, it was recommended that Bed and Mounds (Heap) tillage practices should be adopted by farmers in the production of sweet potato.

Propagation and socio economic importance of selected non timber forest products

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Abstract

Forest provides a wide range of benefits at the local, national and global level. The contribution of Non-Timber Forest Products (NTFPs) therefore, to forestry sector in particular rural household generally in most countries is significant, though it had been undervalued in the past. Non-Timber Forest Products (NTFPs) contribute in many ways to improving diets and combating hunger in local communities and rural households thereby alleviating poverty. This paper therefore looked into propagation and socio economic potentials of Chrysophyllum albidum, Caesalpinia bonduc, Irvingia wombulu and Dacryodes edulis as important NTFPs.

Biomass accumulated by *Entandrophragma angolense* (Welw.) C.DC. seedlings under different organic fertilizer

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Abstract

This study reveals that Stem Dry Weight (SDW) after 24 weeks, the seedlings grown on 20g of poultry manure had the highest mean value 2.71g while seedlings grown without application of fertilizer (control) gave the lowest mean value of SDW with the value of 0.49g. The mean Root Dry weight (RDW) of Entandrophragma angolense ranges from 0.57g – 2.46g with the highest value recorded in the seedlings grown with10g of cow dung and the least value in seedlings grown without the application of fertilizer (control). Mean Leaf Dry Weight (LDW) of seedlings grown with 20g of poultry manure had the highest mean value of 3.31g while the control without fertilizer had the lowest mean value of 0.67g. The result of the Total Dry Weight (TDW) was obtained from seedlings grown using 20g of poultry manure with the value of 8.28g while the lowest TDW with the value of 1.73g recorded with seedling without fertilizer control. This study implies that different fertilizer did not significantly enhance the biomass accumulated of Entandrophragma angolense seedlings.

Effect of Weed Control and Intra-Row Spacing on Growth and Yield of Soybeans (*Glycine max*), During Wet Season at Afaka, Kaduna

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Abstract

The research was conducted during the rainy season of 2017 at the research farm of Federal College of Forestry Mechanization, Afaka, Kaduna (Latitude $10^0$03N and Longitude $07^0 47^0$E),to determine the effect of weed control treatments and intra-row spacing on growth and yield of soybean (Glycine max).The experiment consisted of factorial combination of four weed control treatments pendimethalin at 1.5 and 3.0 kga.i./ha, hoe weeded control at 3,6 and 9 WAS and weedy check) and three intra- row spacing of 5cm,10cm and 20cm respectively. The experiment was laid out in a randomized complete block design (RCBD) replicated three times. The result of the study indicated that prominent weed species were Cyperus rotundus Linn, Dactylocterium aegyptium Linn and Euphobia heterophylla Linn. The result also showed that the hoe weeded control recorded the least weed cover score, and this was at par with the application of pendimethalin at 3.0kga.i./ha. The highest weed cover score was produced by the weedy check. The weed control treatments had no significant effect on weed dry weight and crop vigour score of soybean. The hoe weeded control produced significantly higher number of branches per plant, and this was at par with pendimethalin at 3.0kga.i./ha.The highest grain yield was recorded by the hoe weeded control, and this was at par with that of pendimethalin at 1.5kga.i./ha and pendimethalin at 3.0kga.i./ha.The least grain yield was produced by the weedy check. Intra- row spacing of 5cm recorded the highest weed dry weight. The least weed dry weight was recorded by the 20cm intra – row spacing . The most vigorous crops were produced by the 20cm intra - row spacing and this was at par with the 10cm intra – row spacing . The 5cm intra –row spacing recorded the least vigorous crops. Intra – row spacing of 20cm produced significantly higher number of branches. The least number of branches was produced by the 5cm intra – row spacing .The highest grain yield was recorded by the 10cm intra – row spacing. The 20 cm intra – row spacing recorded the least grain yield. Yield loss due to weed infestation was 51.41%.For cultivation of soybean during the raining season in the Northern Guinea Savannah ecological zone, application of pendimethalin at 1.5kga.i./ha with intra - row spacing of 10cm will be appropriate for recommendation to the farmers.

Factors Influencing The Production Of Millet In Zango Kataf Local Government Area Of Kaduna State

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Abstract

The study analyzed factors influencing the production of millet in Zango Kataf Local Government Area of Kaduna State. Five (5) villages was purposively selected due to high concentration of millet producers in the study area, twenty (20) respondents were randomly selected from each of the villages which gave a total of one hundred (100) respondents that was used for the study. Primary data was collected through the use of structured questionnaires, administered to the respondents. The data was analyzed using multiple regressions and likert scale. The results shows that The coefficient of $X_{2,}$ *which is the household size was positive and significant at 1% level of probability in pearl millet production, while the coefficient of farming experience was also positive and significant at 1% level of probability. This increase will lead to an increase in profit in pearl millet production. This implies that shortage of capital is a major problem in millet production. The problem with the highest rank is small volume and inconsistency in production of millet and the least of most minor constraint is lack of market for millet products. The result also shows that the constraints has a mean mark of 2.97. The following recommendations were made farmers should look into ways of taking care of the shortage of millet seed and also government providing market for millet and reducing high cost of production by providing input at subsidize rate since these are the major problems the farmers encounter., K.A.D.P around the study area should provide good quality seed for the farmers since is a major determinant in cereal production, and to also increase millet production farmers should be provided with financial assistance from micro-credit banks.*

Energetic Herbs and Farming Activities in Nigeria

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Abstract

Natural herbs are excellent way for the farmers to stay energised. Most farming activities involve expenditure of energy or the doing of some kind of work with power. Apart from the use of medicinal plants for preventing and curing certain illnesses, medicinal plants otherwise known as herbs either singly or mixture can also be used to boost mans' energy to better perform agricultural activities. Medicinal plants are useful for energetics because of the presence of phytochemical compounds. Energetic herbs can either be Phytostimulants or adaptogens. Phytostimulants are the classes of herbs that speed up the message between the brain and the body. It makes person feel more awake, alert, confident or energetic. It quickens and enlivens the physiological activities of the body. Examples include Cola nitida, Alligator pepper, Xylopia aethiopica, Dennettia tripetala and Nicotiana tobacum. While Phytoadaptogens are non-toxic plants that help the body resist stressors of all kinds by improving the body ability to respond to stress, increase energy and attention, and fight off fatigue. The plants with adaptogenic potentials include Garcinia kola, Cola nitida, Curcuma longa and Camellia sinensis. They are cheap and readily available especially in the forest, fringe area and farmlands. Herbal energizers have a lot to offer, but an understanding of how they work is required for safe and effective use.

Repellant Effect of Urine insecticides spray and NPK(15:15:15) Compound Fertilizer Application on the Growth and Yield of watermelon (Citrullu lonatus Thumb)

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Abstract

A field study conducted to investigate the Repellent effects urine insecticide spray and NPK(15:15:15) compound fertilizer on the growth and yield of watermelon (Citrullus Lonatus Thumb) in forestry Research Institute of Nigeria, (FRIN) experimental plot at Agbede, Etsako West Local Government Area of Edo State. Four regimes of Urine insecticide spray and four rate of NPK compound fertilizer application were factorially combined and laid out in a completely randomized block design (CRBD) with three replication. Urine insecticide spray and fertilizer application did not affect the period of flowering and poddring significantly (P> 0.05). NPK compound fertilizer application significantly (P< 0.05) increase the number and length of main vines, pod number and yield while Vines insecticide spray significantly (P< 0.05) increase the length of the main virus and yield. In the rate of application, 200kg/ha NPK was optimum and this recommended for watermelon cultivation. Twice spray regimes of urine insecticide was recommended for watermelon cultivation.

Yield of Exotic Sweetpotato Varieties in Umudike Rainforest Agro-Ecologies of Southeastern Nigeria

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Abstract

A study was carried out in Umudike Abia State in the rainforest agro-ecology of South Eastern Nigeria during the 2018 and 2019 cropping season at the Western farm research field of NRCRI-Umudike to investigate the yield of exotic sweetpotato varieties in Umudike rain forest agro-ecologies of Southeastern Nigeria. The following objectives were carried out: to broaden the genetic base of sweetpotato varieties in Nigeria through crop introduction, to select varieties for high storage root yield, to select these exotic varieties for crop improvement in the country, and to determine the leafless and leafed seed vine yield (t/ha) of the varieties under consideration and their implication in nursery establishment. Data collected were analyzed using ANOVA and results obtained indicated that based on selection differential on number of large storage roots and fresh weight of large roots, 5 exotic sweetpotato varieties were nominated for being superior to others. The varieties were: Namanga, Erica, NASPOT12, Delvia, and Tio –Joe. Their yield superiority was a good trait that could be incorporated into the local germplasm during gene recombination. Varieties with leafless seed-vine weight of less than 0.1kg per bundle should be taken care of especially during dry period to avoid crop failure or genetic erosion, although leafless seed vine contributes to ease of transportation.

Generation Of Sweetpotato Botanical Seeds In Two Diverse Agro-Ecologies Through Genetic Recombination

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Abstract

Experiments was conducted in two locations, Abia State in the rainforest agro-ecology and Ebonyi State in the derived savanna also of the Southeastern Nigeria in June 2nd 2019 in Abia State while in Ebonyi State the experiment was established in June 22nd, 2019. The following objectives were investigated to generate ten thousand botanical seeds through genetic recombination for evaluation for high dry matter content and resistant to SPVD, to increase the genetic base of the sweetpotato crop through genetic recombination and to select parents that yields high number of good botanical seeds for inclusion into future hybridization block for further recombination and to find out which location appears best for establishment of hybridization blocks for botanical seed generation. The results obtained indicated that UMUSPO/4 had mean of 4048.0 seeds in the two locations followed by Tio –Joe with mean of 3360 seeds in the two locations while Buttermilk did not produce any seeds. These two varieties will be included in future hybridization block for future botanical seed production. It was also observed that total number of seeds from Abia State was higher with 32062 seeds while Ebonyi State was 12200 seeds. It appeared that Abia State will be better for establishing hybridization block. The seeds obtained will be planted to broaden the genetic base of the sweetpotato plant from where selection could be made to select for the traits sort for by the end users.

Evaluation of the Performance of white fleshed Sweetpotato Landraces for official Registration as *Variety and* for commercial Sweetpotato Production

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Abstract

Experiments were conducted at both the NRCRI- Umudike and Imo State University Owerri in 2018 and 2019 with seventeen sweetpotato landraces with the objectives to evaluate the yield performances and pests and disease reactions of sweetpotato landraces for pre- release in Nigeria, to select sweetpotato landraces with high yielding marketable root for commercial storage root production and for export, to select for good storage roots free from weevils and cracks, to select genotypes with high harvest index. Result indicated that high yielding storage root landraces per unit area were selected for registration and release for commercial sweetpotato root production. These varieties (Ex-Igbariam (0.3), Nwoyorima (0.3), Buttermilk (0.4) and Solo-Abuja (0.5)) were selected as a result of their high harvest index. The varieties selected could be used as parents in the breeding programme to utilize their good qualities for progeny development.

Prelimininary Yield Evaluation Of New Sweetpotato Breeding Lines For Storage Root Yield And Quality Traits

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Abstract

Sixty clones were selected from polycross progenies and evaluated on the bases of preliminary storage root yield, high dry matter content and flesh colour in a rainfed agroecology of Umudike Southeastern Nigeria. The result obtained indicated that genotypes with storage root weight more than the check varieties were selected for further advancement. Most of the genotypes had storage root size more than 4.0 cm with no oxidation and could be selected for further evaluation.

A Review of Phytochemistry, Metabolic Changes and Medicinal Uses of Mung Bean Seeds

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Abstract

The seeds of mung bean (Vigna radiata), contain an abundant nutrients with biological activities. This review provides an insight into the nutritional value of mung bean seeds, its chemical constituents such as flavonoids, phenolic acids, organic acids, amino acids, carbohydrates and lipids, in line with dynamic changes in metabolites and related biological activities, like antioxidant, anti-inflammatory, lipid metabolism accommodation and anti-diabetic which evidenced its consumption as medicine.

Control of *Callosobruchus maculatus* (f.) (Coleoptera: Chrysomelidae), using some natural plant materials

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Abstract

A laboratory study was conducted to investigate the effects of some natural materials on mortality, reproduction and progeny of the cowpea bruchid, (Callosobruchus maculatus) on mung bean seeds. The mung bean variety NM – 94 was used in the study at different levels (1g, 2g, and 3g) of each of the plant materials (Piper guineense fruits, Xylopia aethiopica fruits, Carica papaya seeds and Tephrosia vogelii leaves) were added to 20g of the mung bean seeds. Results shows that plant powders were effective significantly (P<0.05) compared with the control. T. vogelii leaves and P. guineense fruits provided the best protection compared to other treatments. The phytochemical compounds underpin the bioactivity of the plant products. The result obtained suggest that powders of P. guineense fruits, T. vogelii leaves, X. aethiopica fruits and C.papaya seeds can be utilized in protecting stored mung bean from C. maculatus infestation since they are cheaper, safe and environmental friendly.

Agronomic Response of Sweet Potato (*Ipomea batatas* {L.} Lam) to different levels of vine pruning in Dadin-Kowa, Gombe State

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Abstract

Field experiment was conducted to study the agronomic response of sweet potato to different levels of vine pruning in Dadin-Kowa, Gombe State, Northeastern Nigeria during the 2019 rainfed cropping season. Randomized Complete Block Design (RCBD) was used. Sweet potato vines were subjected to two cutting regimes: Treatment 1 was pruned at 8 weeks after planting (WAP) only while treatment 2 was pruned at 8 and 10 weeks after planting (WAP). The control plot was treatment 3 and unpruned. The result of the experiment indicated that treatment 3 (control) gave the highest mean vine length across the weeks, this was followed by treatment 1 (pruned once) while treatment 2 (pruned twice) gave the least mean vine length across the weeks. Also, treatment 2 gave the highest tuber yield. The results of the study indicated significant differences between the growth and yield parameters. From the findings of this study, pruning sweet potato vines is recommended to farmers so as to improve tuber yield.

Field trial of different Weed Control Measures on the yield of Fluted Pumpkin (*Telfairia occidentalis* Hook F.) in Dadin Kowa, Gombe State

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Abstract

A field study was conducted during the 2019 rainfed cropping season to evaluate the effect of different weed control measure on the yield of fluted pumpkin (Telfairia occidentalis) in Dadin-Kowa; Gombe State. The parameter measured were vine length, number of leaves and weight of harvests. The experimental design was Randomized Complete Block Design (RCBD) with four (4) treatments and three (3) replicates. The four treatments were: T1- Chemical, T2 - Manual, T3 - Cover crop, T4 - Control. The findings of the study indicated the following: T3 (Cover crop) gave the highest mean value of vine length with 56.2 cm followed by T2 (manual) with 49.7 cm. T1 (Chemical) had the mean value of 49.3 cm while T4 (Control) had the least with 49.0 cm. There were no significant differences in the vine length. On the number of leaves, T3 (Cover crop) gave the highest mean value of 27.2 cm while T4 (control) had the least mean value of 25.2 cm. For the weight of harvest, T3 (Cover crop) gave the highest mean value of 5.4 kg while T4 (control) gave the least value of 2.4 kg respectively. Analysis of variance showed that significant differences was only observed between treatments in the number of leaves and weight of harvest. It was observed that different weed control measure had effect on the yield of fluted pumpkin. Cover crop and manual weeding control measures are recommended as sustainable option for weed management in fluted pumpkin (Telfairia occidentalis) production.

Growth and Yield of Cowpea *Vigna unguiculata* (L.) as influenced by Botanical Solutions in Gwagwalada, FCT, Abuja

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Abstract

Field trials were conducted at the Teaching and Research Farm of the Faculty of Agriculture, University of Abuja, Nigeria to study the efficacy of Neem (Azadirachta indica A. Juss), Eucalyptus (Citriodora den), Bitter leaf (Vernonia amygdelina L.), and African Bush tea (Hyptis suaveolens Poit) and their mixture on the growth and yield of cowpea (Vigna unguiculata L. Walp) Sampea 7 variety. The results showed that application of Neem + African bush tea, and Bitter leaf + African Bush tea produced significantly (P<0.05) the highest growth in terms of number of leaves per plant, plant height and total seed weight compared to bitter leaf, Eucalyptus and control which produced the lowest growth and yield. These extracts mixtures caused great reductions in pod damage per plant and ensured higher grain yield compared with the unsprayed plots during the investigation. The complementary roles played by the mixture of Neem and African bush tea, and mixture of Bitter leaf and African Bush tea in increasing grain yields suggest the future direction of new formulations of Biopesticides in the increase in growth and yield of Cowpea in the study area.

Botanical Solutions and their effects on the Management of Post-Flowering Insect Pest of Cowpea *Vigna unguiculata* (L.) in Gwagwalada, FCT, Abuja

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Abstract

Field trials were conducted at the Teaching and Research Farm of the Faculty of Agriculture, University of Abuja, Nigeria to study the efficacy of Neem (Azadirachta indica A. Juss), Eucalyptus (Citriodora den), Bitter leaf (Vernonia amygdelina L.), and African Bush tea (Hyptis suaveolens Poit) and their mixture on the performance of cowpea (Vigna unguiculata L. Walp) Sampea 7 variety and the management of major post flowering insect pest (Maruca pod borers) of cowpea. The results showed that application of Neem + African bush tea, and Bitter leaf + African Bush tea produced significantly (P<0.05) the highest growth in terms of number of leaves per plant, plant height and total seed weight compared to bitter leaf, Eucalyptus and control which produced the lowest growth and yield. The results also revealed that the mean number of Maruca vitrata (F.) was reduced (< 1.0 / plant) at week 10 on plots sprayed with leaf extracts of Neem + African bush tea, and Bitter leaf + African Bush tea. These extracts mixtures caused great reductions in pod damage per plant and ensured higher grain yield compared with the unsprayed plots during the investigation. The complementary roles played by the mixture of Neem and African bush tea, and mixture of Bitter leaf and African Bush tea in reducing pests numbers and increasing grain yields suggest the future direction of new formulations of Biopesticides in the management of field pests of crops on farms owned by resource limited farmers in low input agriculture characterized in the developing countries.

Ginger Yield and Soil Properties as influenced by Legume Intercrop and Poultry Manure in Gwagwalada, FCT, Abuja

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Abstract

Ginger (Zingiber officinale Roscoe) is a soil-exhausting crop requiring heavy fertilization and organic manures have been found to improve soil fertility and are environment-friendly. A field trial was carried out in the Teaching and Research Farm of the Faculty of Agriculture, University of Abuja with the aim of studying how Ginger yield and soil properties are influenced by legume intercrop and poultry manure. The trial was conducted during the 2018 farming season. The trial had six treatments comprising of Erect Brown Cowpea (Vigna unguiculata), Erect White Cowpea (Vigna unguiculata), Groundnut (Arachis hypogea), Soybean (Glycine max), Poultry Manure 5t/ha and Control. The trial was laid out in a Randomized Complete Block Design with three replications. Results obtained showed that plots treated with poultry manure had the highest values for plant height (45.87cm), number of leaves (21.97) and rhizome yield (3t/ha) while ginger and erect brown cowpea intercrop had the highest amount of tillers (3.83). Soil analysis results showed that Poultry manure had most influence on soil p^H *(5.50), Total Nitrogen (1.50), Available Phosphorous (7.60), Potassium (0.75), Calcium (2.92), Magnesium (3.52) and Organic Carbon (0.76) while Control plots had the highest amount of Sodium (0.90).*

Effects of NPK Fertilizer and Legume crops on Ginger Yield and Soil Properties in Gwagwalada, FCT, Abuja

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Abstract

NPK 15:15:15 fertilizer (0.2t/ha) and four different short-duration legumes (Erect White Cowpea, Erect Brown Cowpea, Soybean and Groundnut) were introduced to a ginger based system to analyze their effects on ginger yield and soil properties in Gwagwalada, FCT, Abuja. The results showed that ginger-soybean intercrop had the highest ginger plant height (39.47) while control plots had highest values for number of leaves (19.37), ginger-brown cowpea intercrop had the highest number of tillers (3.83) while plots treated with NPK had highest ginger yield (2t/ha). The experimental soil was sent to the laboratory for routine analysis and the results showed that NPK fertilizer had the most effect on Total Nitrogen (1.30), Available Phosphorous (7.40), Potassium (0.90), Calcium (2.40), Magnesium (3.50), Control plots had the highest p^H (5.43) and Sodium (0.90) while ginger-groundnut intercrop had the highest value for Organic Carbon (0.68).

Irrigated and Rain-fed Farming System of Sugarcane Production in Bauchi State, Nigeria

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Abstract

The study assessed the irrigated and rain-fed farming systems of sugarcane production in Bauchi State, Nigeria. Three – stage sampling technique was employed to select 123 sugarcane farmers under rain-fed and 108 sugarcane farmers under irrigated farming systems on which structured questionnaire complemented with interview schedule was employed to collect primary data. Data collected were analyzed using descriptive statistics (such as means, percentages and frequency counts), productivity index and z – test statistics as well as attitudinal measuring scale such as Likert scale. The result of analysis revealed that majority of the respondents under rain-fed (78.9%) and irrigated (88.0%) farming systems were within the age group of 26 – 55 years with mean age of 44 and 42 years, respectively, while 96.7% and 97.2% under rain-fed and irrigated farming system were married. The mean years spent in formal education by the respondents under rain-fed and irrigated farming system was 6 and 8 years, respectively, while mean farming experience was 10 and 12 years, respectively. The result of sugarcane productivity revealed that 60.2% of the respondents under rain-fed farming system had sugarcane productivity ranges of 261 – 1000 kg with an average productivity of 382 kg, while 58.3% of the respondents under irrigated farming system had sugarcane productivity greater than 1000 kg with an average productivity of 1824 kg. The result of the pair-wise z – test revealed t – statistic value of 4.009 at 1% level of probability implying that there was a significant difference in the mean income of the sugarcane farmers under irrigated and rain-fed farming system. The major constraints associated with sugarcane production under irrigated and rain-fed farming system was inadequate capital and access to credit facilities ($\bar{X}$= 2.41) and ($\bar{X}$= 2.74) ranked 1st, respectively. In conclusion, sugarcane farmers under rain-fed and irrigated farming systems are producing below the optimum level of productivity as indicated by the mean productivity. It was therefore recommended that Agricultural extension agency should intensifies efforts to educate and sensitize sugarcane farmers on how to appropriately combine available resources to reach optimum level of sugarcane productivity.

Performance of eight yellow cassava (*Manihot esculenta* Crantz) varieties in Nigeria

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Abstract

The study was carried out to quantify the genotype × environment interaction (G × E) of eight yellow root cassava clones and two checks (TMS30572 and TMS970539) varieties. The experiment was carried out in a randomized complete block design with three replications in three locations in Nigeria. In the combined analysis, significant variation existed in all the traits studied. The highest beta carotene (BC) was found in clones TMS011413, TMS011663, TMS011115 and TMS011662 while the least value was observed in TMS30572 (check variety). For fresh root yield (FRY), clone TMS30572 was the best yielder with 31.45 t/ha followed by TMS011368. TMS940330 had the highest root dry matter content (RDMC) (38.45%) while the least clone was TMS011413. A wide range of variation was observed among the clones for all the traits evaluated. A combined analysis of variance showed that traits studied varied significantly among the clones, environment and G x E. This indicates the presence of genetic variation in the population. The environmental effect was significant for all traits which justified the importance for multilocational testing to identify best performers for specifically and generally adapted to the environments. There were significant responses of G x E for all traits. This implies that the clones have different adaptation explaining the need to identify and select environment specific clones. Otobi location recorded the highest value for BC, FRY and plant height, while Umudike recorded highest for RDMC. The ANOVA revealed high significant difference (P<0.001 and P<0.01) for BC, FRY and RDMC in all the environments. In Kano, plant height, height at first branching and CGMS were not significantly different among the clones. The results also showed that the performance of plants was resistant to cassava mosaic disease severity (CMDS) and cassava green mite severity (CGMS). Beta carotene content cassava varieties are developed to overwhelm the prevalence of vitamin A deficiency in Nigeria.

Key words: cassava, vitamin A, beta-carotene, yellow root cassava, yield.

Effect of Poultry Manure Application on the Performance of Sweet basil (*Ocimum basilicum* L.) in Jalingo, Taraba State

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Abstract

A field experiment was conducted in 2018 and 2019 rainy seasons at the Teaching and Research Farm of Crop Science Department, Taraba State College of Agriculture, Jalingo to determine the effect of poultry manure on the performance of sweet basil. The treatments evaluated were 0, 30, 60, 90 and 120 t/ha poultry manure (PM) replicated three times and arranged in a randomized block design (RCBD). Parameters measured include: plant height, number of primary / secondary branches, leaf length / width, fresh / dry weight of leaf and fresh herbage yield. Data collected were subjected to analysis of variance (ANOVA), and mean difference were separated using least significant difference (LSD) at P ≤ 0.05. Result obtained indicated that poultry manure enhanced the performance of sweet basil in all the agronomic parameters measured, with the best obtained at 120 t /ha of PM. Sweet basil in this treatment were tallest (46.8 / 46.9cm), highest number of primary branches (9.8 / 9.9) and secondary branches (81.3 / 81.5), longest leaf (5.0 / 5.0cm) and widest leaf (3.3 / 3.3), highest fresh leaf weight (242.6 / 243.2g) and dry leaf weight (86.5 / 87.5g), highest fresh herbage yield (12.9 / 13.1 t/ha) and highest dry herbage yield (2.8 / 3.0t/ha) in 2018 and 2019 respectively. This performance trend indicates that the best agronomic parameters could be obtained for the sweet basil by adopting 120t/ha poultry manure in the study area.

Key words: Performance, Poultry manure, Sweet basil, Jalingo Taraba State.

Assessment of Off-Season Scent Leaf (*Occimum Gratissimum)* Marketing In Anambra State, Nigeria

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Abstract

The study assessed off-season scent leaf (Ocimum gratissimum) marketing in Anambra State, Nigeria. There are enough profitability, income generation opportunities in vegetable marketing, such opportunities are being neglected by potential dwellers, men and women, youths, farmers, entrepreneurs and all categories in Anambra State. Ocimum gratissimum is vegetable with short gestation period, drought tolerance characteristic, provides heavy nutritional, medicinal and industrial values: scent leaf is lucrative business that has health benefit. We eat them for rich flavor, colour, taste, and medicinal benefit it gives to our food. The problem statement: There are too much hunger, lack of income generation, unemployment opportunities and non self employed among the dwellers in Anambra State. The benefit of the study is to assure the dwellers, traders, farmers and marketers and unemployed women and youths that there are a lot of benefits, and profitability in scent leave marketing in Anambra State, because Anambra State is among the states which have registered with other developed country like United Kingdom (UK), United State of America (USA) and other countries to export all kinds of vegetables and other valuable crops. With empowerment assured by our amiable Governor – His Excellency Willy Obiano. With this promise and assurance all the dwellers will embark in vegetable business of ones choice. This study assessed off-season scent leave market in Anambra Agricultural zone of Anambra State, Nigeria. Date for this study were collected from primary source and from 60 respondents comprising of 20 wholesalers and 40retailers sampled through snow Ball method from the 4major markets (Aguata: Nkwo-Igboukwu, and Eke-Ekwulobia), Orumba North/South: Nkwo-Umunze and Nnewi North/South – Nkwo-Nnewi) of the study area. The markets were purposively selected as the largest in each of the 5 local government areas. Descriptive statistics, gross margin analysis, and shephered-futerl model for the determination of marketing efficiency were used in data analysis. The study indicated that proportion of 25% of scent leave consumed in the study areas were sourced by the markets from outside Aguata agricultural zone of Anambra state showing that the zone of Anambra State showing that the zone is self sufficient in vegetable production. The result also indicated that the respective return on investment made by the wholesalers and retailers were 0.49% and .99%, indicating that scent leave (ocimum gratissimum) business is more profitable/efficiency on both wholesalers and retailers and that higher leaves of transportation cost, inadequate fund to increase business bid and poor storage facilities were the vital challenges of the marketers. The study explore/reveal that motivating producers, processors and business opportunities exist on scent leave's marketing and recommends that the potential players can profitably and efficiently invest on scent leave (Ocimum gratissimu).

Keywords: Assessment, off season, scent leave, marketing.

Assessment of Suitability of Indigenous Rhizobia as Inoculant for Recently Released Groundnut Genotypes

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Abstract

This study has been conducted in search of the best inoculant for recently released groundnut genotypes, released in Nigeria. The treatments include two groundnut genotypes; SAMNUT 25 and SAMNUT 26 and 5 N sources; NC 92; KBU 026; MJR 518; positive N and uninoculated control. These make a total of ten treatment combinations replicated three times in a Randomized Complete Block Design (RCBD). The plants were grown for 6 weeks, then harvested and number of flowers, shoot dry matter, root dry matter and N uptake were determined. The results showed significant difference ($P < 0.05$) and interactions ($P < 0.05$) among the treatments, with respect to all parameters. These were used to arrive at the best inoculant for SAMNUT 25 as KBU 026 while that for SAMNUT 26 is MJR 518, even though the former generally performed better than the latter for both genotypes. This indicates variation among the indigenous rhizobia for suitability as potential as future inoculants for groundnut and the possibility of arriving at a universal inoculant for both genotypes and others.

Keywords: Biological nitrogen fixation, groundnut genotypes, indigenous rhizobia, legumes.

Contribution of Yam (*Dioscorea species*) Production for Food Security and Income Generation in Nigeria

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Abstract

Production of yam could be an antidote to fight hidden hunger and food security issues in Nigeria. This paper on the contribution of yam (Dioscorea species) production for food security and income generation in Nigeria targets to review the production, socio-economic impact, constraints and yam opportunities for food security and income generation in Nigeria. It depended on information from secondary sources such as documented relevant review literature on yam production, NRCRI Annual Reports and field experience of Researchers. Yam is an indigenous and preferred staple with high potential for assuring food security and income generation to many rural dwellers and cheap carbohydrate staple for 80% of the populace. This leads to reduction in poverty level and improvement of social-cultural life of people in Nigeria. Farmers and stakeholders are therefore encouraged to engage in increased cultivation and commercialization of yam for secured food assurance and income generation in Nigeria. This paper therefore recommends for more production of yam in Nigeria for income generation and enhances food security in Nigeria

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Keywords: Yam production, Food security, Income generation

Precision Agriculture:An Important Tool For Improving Crop Yield

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Abstract

Improving crop yield in the face of increasing population is one key issue that must be addressed with current trend in agricultural production. Precision Agriculture (PA) aims to improve crop yield and productivity. In this review, steps in precision agriculture were identified. Such include; soil preparation which entails preparing the field for cultivation, planting using PA technologies such as seed control system, crop management methods such as pesticide application, disease identification, monitoring using machine learning algorithms and sensors, harvesting using combined harvesters and evaluation of the PA technologies. With the increase in demand for agricultural produce amidst population explosion, precision agriculture will be much more adopted to enable farmers to meet the ever increasing demand.

Keywords: Precision agriculture, Artificial intelligence, Agriculture, Application, Crop

On-Farm Evaluation of Selected Pre-Release White Yam (*Dioscoreae Rotundata*) Genotypes for Disease Resistance and Agronomic Performance in some Nigeria Agro-ecozones

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Abstract

Trials were conducted to evaluate some genotypes of white yam (Dioscoreae rotundata), a national check and one local check included and evaluated only in each particular location in five different agro-ecologies in Nigeria. The yield, field performance and disease reactions of the yams were evaluated with the view to ascertaining best performing white yam genotypes in terms of virgour, yield and disease resistance for release to farmers for cultivation. The experimental design was a Randomised Complete Block Design in three replications. Data were collected on plant vigour, disease incidence and severity of yam anthracnose disease (YAD) and yam mosaic disease (YMV) and, yield. The results showed that the variety TDr10100021 had the highest YAD resistance significantly different (P<0.05) from TDr0900067 but not TDr1000344. TDr10100021 had the highest YMV resistance and was not significantly different (P<0.05) from TDr0900067 and TDr1000344 but different (P<0.05) from controls. TDr10100021 had tuber yield not significantly different (P<0.05) from TDr0900067 but TDr1000344 the three genotypes had tuber yields better than national and local checks. TDr0900067 had the highest yield stability followed by TDr1000344 and TDr10100021 and three yams are recommended for consideration and release to farmers.

Keywords: *Dioscorea rotundata*, Genotype, Yam, anthracnose, disease severity, yield.