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REMITTANCES AND INCOME GAPS OF FARMING HOUSEHOLD. EVIDENCE FROM FARMING HOUSEHOLDS IN SOUTHWEST, NIGERIA.

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Abstract

This study examined effect of remittances on income gaps status of farming households in Southwest region of Nigeria. The study looked at sources of remittances, purpose which remittances were used for. Also, the beneficiaries of the remittances and the influence of remittances on income gaps among respondents in the study areas. Multi- stage sampling techniques was used to select 160 respondents for data analysis. This study identifies different sources of remittances, and the results revealed that 68.8 % of the respondents that had access to external fund (remittances) outside their place of residence had farm expansion among others. Moreover, findings showed that the rate at which money received from abroad influenced increased farm inputs expenses. Results revealed that access to remittances households (38.8%) led to more income in meeting other household basic needs than those households without access to remittance. This implication of this finding is that remittances played a significant role in the improvement of farming households of beneficiary. The finding revealed that remittances not only narrow the income gap among rural poor households, but also disproportionately improve income of the poorest poor. Therefore, remittances serve as a solution for the absorption of rural surplus fund with an additional source of income, improving their living standards and narrowing income gaps as well.

Keywords: Remittances, Household survey, Income-gaps, Migration, Southwest, Nigeria.

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Introduction

Capital movement in the world has a great impact on developing economies where migration and remittances occur mainly (Mora-Rivera and Van-Gameren 2021)). Remittances of migrants' workers to their home countries are today seen as an important channel for economic growth, and can play an important role in reducing poverty, income inequality and could influence a wide range of economic decisions (Abdul-Nasser and Salifu 2021). It has been evidenced that remittances could improve entrepreneurial activities and assurance of transfer of newly developed skills and knowledge in the recipient's countries of origin. In the short run, migrants are now being increasingly considered as agents of development that can strengthen co-operation between home and host societies (Ogunniyi et al, 2020). Studies have shown that migration occurs mostly from the rural areas; where lack of basic-economic infrastructures, low access to the factors of production, poverty, natural disasters, and social conflict, has become strong 'push' factors for rural-migration (Abebaw, et al, 2020). Moreover, low level industries and government investment that cannot absorb the growing active young men and women into a lucrative livelihood, has force many indigenes to abandon the local terrain in search of greener pastures elsewhere (Obi et al, 2020). But whether remittances

truly represent flows of investment capital is an open question. It merits careful investigation, because of the significant implications for development policy.

There are several ways to approach this question, but a rather simple and direct way is to examine whether remittances behave in the same way as other capital flows. In particular, we expect that remittances would have a positive correlation with output growth if they are like other capital flows. Remittances have come to represent a substantial flow of financial resources, predominantly from developed economies to developing economies. For example, Djido and Shiferaw (2018) estimated that total remittances (plus compensation of employees) flow to developing areas averaged \$81 billion per year during the 2010s. This was further estimated (based on data available), that remittances accrued which, peaked at over \$59 billion per year in the mid-2010s (Ewubare and Okpani 2018). It is difficult to see these numbers and not think that remittances could be an important tool for economic development. Indeed, a common theme motivating much of the research on immigrant remittances is that if they can be better understood, then perhaps they can either be shown to promote development on their own, or they can be channeled into productive investment by wise policies (Abebaw *et al.*, 2022). Evidence from past works divulge those remittances from abroad are increasingly crucial to the survival of communities and have a direct contribution to the improvement of livelihoods and survival of recipient's families left behind (IMF Country Analyses 2015, World Bank, 2017).

It is estimated that between 20 percent and 65 percent of family needs were met through international remittances (Iraoya and Isinika 2022). Records have shown that Africans in Diaspora living in developed economies have returned a considerable amount of their earnings to families in home countries (World Bank, 2017). It has been documented that Nigerians abroad has the largest remittances in the Sub-Saharan Africa (World Bank, 2010). This is a significant contribution to the Nigeria economy, as remittances to Nigeria were valued at 10% of exports and takes up to about 12 percent of the sender's household income (Olomola and Nwafor 2018). Remittances have grown in the large two decades and its size is counted as the second largest capital flow to developing countries.

Table 1 show that formal remittances have increased from US\$10 million to US\$3200 million between 1990 and 2020 Department of Economic and Social Affairs (World Bank, 2020), Evidence has shown that these values were not translated to improvement in the development of local economy (Olomola and Nwafor 2018). Moreover, data obtained from various publications of Central Bank of Nigeria (CBN 2020) revealed growth of inflow of remittances to Nigeria from different countries particularly, from Europe and America. With regards to the uses of remittances, it influences on the local economy remains insignificant; probably, that these resources have not been put into productive uses. Although the work of Taylor (2007) reported that remittances were put to some household and community uses which mention or describe some of the impact: increasing household income to buy non-farm goods, completion of residential building, construction facilities like event centres for community uses among others.

Most times; these remittances are spent on foods and non-food items such as: building new houses acquiring more farmland, starting a small trade and /or enterprise, and marrying new wives, among many other material acquisitions (Agwu *et al.*, 2018). The study intends to use the theoretical construct of Abebaw *et al.*, (2020) that remittances influence local economy and rural livelihoods. Therefore, the scope of this study is to examine the economics of migration and remittances and it influence on farming household's income gaps in southwest, Nigeria. In addition, it has been discovered that over the last decade, Nigeria is the single largest recipient of remittance in sub-Saharan Africa. Remittance from Nigerians in various parts of the world was 6.8 billion USD in 2007, ranking second only to oil exports as a source of foreign exchange

earnings. However, despite the ever-increasing size of remittances, both on internal and international scene, there has been little effort to analyze its effect on economic development especially on household income gaps among farming households in Nigeria particularly in the southwest region. Are remittances correlated to decrease income gaps? This is the rationale of the study. Therefore, analyzing the economics of remittances and its effects on farming household income gaps can give a policy direction on welfare improvement.

Labour Migration and Economic Development

Labour migration is a pervasive feature of economic development. People mobility can be for temporary or permanent and sometimes may be a routine part of agricultural activity (Funkhouser 1992). There are significant migration flows in some developing areas, with considerable impacts on individuals, households and regions of rural areas (Giuliano and Ruiz-Arranz 2005).

Table 1.1 Global Remittances

| US\$ billions | 1995 | 2000 | 2004 | 2005 | 2006 | 2007 | 2010 | 2015 | 2020 |
|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| Inward remittance flow | 101.3 | 131.5 | 237.0 | 274.9 | 317.9 | 385.0 | 443.2 | 416.0 | 440.1 |
| All developing countries | 55.2 | 81.3 | 159.3 | 192.1 | 226.7 | 278.5 | 324.8 | 307.1 | 325.5 |
| Outward remittance flows | 97.5 | 108.5 | 168.0 | 185.3 | 213.7 | 255.2 | 295.7 | 282.5 | 200.8 |
| All developing countries | 10.4 | 9.5 | 28.5 | 33.0 | 41.0 | 52.7 | 67.3 | 58.7 | 37.6375 |

Sources: World Bank (2020) “Migration and Remittances Factbook 2020” The International Bank for Reconstruction and Development / The World Bank, 2nd Edition.

Table 2: Resource Flows to Nigeria US\$ millions

| | 1995 | 2000 | 2004 | 2005 | 2010 | 2015 | 2020 |
|------------|---------|---------|---------|---------|---------|---------|---------|
| FDI | 1079.27 | 1140.14 | 1874.03 | 4982.53 | 8824.80 | 6033.00 | 4876.45 |
| Remittance | 804.000 | 1391.80 | 2272.70 | 3328.70 | 5435.00 | 9221.00 | 9584.75 |

Note: FDI is foreign direct investment

Despite the growing debate about motivations and impacts of recent migration flows, costs and returns of this global phenomenon are still unclear. This is true especially with respect to migration of people from rural areas of developing countries. Consequently, this study intends to review key issues related to rural labour migration and remittances therefore its linkages to economies development at origin. i.e. (rural community). Table 2 indicated that there were huge remittances flows to developing countries. What is then the impact of remittances from both internal and international, on rural, agricultural development and household welfare? At theoretical level, the economic analysis offers some answers to this question, even though they are not clear-cut *a priori*. Past studies have stated that empirical evidence helps in shedding some light, on this issue insightful literature that reveals the complex ways in which migration influence

rural economies at the origin is just beginning and much is left to further exploration (Gupta *et al.*, 2009). A further intention of this study, then, is to depict lingering questions to explain determinants and consequences of remittances

Theoretical Framework

Many migrants send remittances back to their home country. Some do it in favour of themselves and some do it in favour of their family and friends in the home country. In order to understand remittances, there are two main approaches for analyzing remittances: the 'portfolio' approach and the 'altruism' approach (IMF, 2005). These approaches present two main channels for remitting behaviour. The portfolio approach sees remittances as a self-interest that controlled capital transfer between home and host country to diversify the migrant's savings. Portfolio motives come out of investment opportunities and saving. Altruistic motives come out of the investment opportunities and saving differentiation between home and host country (Chami *et al.*, 2005).

Therefore, macro-economic factors can explain the size of this kind of remittances. Empirical research on this subject has not agreed on how macro-economic factors affect the amount that exchange rates and interest rates have (Dehesa, *et al.*, 2007). The altruistic approaches see remittances as a transaction that benefits the receivers in the home country without and demand on the receiver for performance in order to get the remittances (Ahmed, 2018). Altruistic motives start in ties with or for caring in the family income and are expressed as either repayment of an old loan or some kind of aid to the receiver. Among the various models attempting to explain why migration from sub-Saharan Africa begins, four major approaches are discernible (Mora-Rivera, *et al.*, 2019). They include;

- a. Neoclassical economics in Europe and Africa (Macro and Micro). Macro theory views geographic differences in the supply and demand for labour in origin and destination countries as the major factors driving individual migration decisions.
- b. Neoclassical micro economic theory focuses on the level of individual rational actors such as the numerous sub-Saharan Africans who make decisions to migrate based upon a cost-benefit calculation that indicates a positive net return to movement.
- c. Dual labour market theory holds that demand for low-level workers in more developed economies such as Western Europe, is the critical factor shaping migration from sub-Saharan Africa to Europe.
- d. World systems theory focuses not on labour markets in national economies, but on the structure of the world market; notably the "penetration of capitalist economic relations into peripheral, non-capitalist societies," which takes place through the concerted actions of neo-colonial governments, multinational firms, and national elites.

The weakness of migration theory is paramount and visible. Migration is a process that responds to a variety of stimuli (push and pull factors) and has a variety of consequences, depending on the context. These diffused patterns have made it almost impossible to create a unified theory of migration (Jones *et al.*, 2019). Couching from the central premise of economic theory, people tend to move from places of labour surplus (i.e. low wages and high unemployment) to areas of labour scarcity (low unemployment and high wages exists). This is considered almost tautological by many in the field of the migration studies (Crush and Caesar 2018). The economic theory of migration seems to be supported by analysis which is based on the scenario that people leaving low- or middle-income countries to seek refuge in core prosperous states (Durão, *et al.*, 2020). From this perspective, further questions arise, how are migrants helped in meeting the need of recipients in the home countries? The economic perspective of this concept is reinforced by Arends-Kuenning *et al.* (2019) that examines the micro-economic effects of remittances on receiving countries? These studies highlighted that with declining foreign aid and foreign direct investment, the importance of

remittances as main sources of foreign exchange becomes visible. Remittances have come to represent a substantial flow of financial resources, predominantly from developed economies to developing economies. For example, Berloff and Giunti, (2019) estimated that total remittances (plus compensation of employees) flow to developing areas averaged \$81 billion per year during the 1990s.

This was further estimated (based on data available), that remittances accrued which, peaked at over \$59 billion per year in the mid-2010s. It is difficult to see these numbers and not think that remittances could be an important tool for economic development. Indeed, a common theme motivating much of the research on immigrant remittances is that if they can be better understood, then perhaps they can either be shown to promote development on their own, or they can be channeled into productive investment by wise policies (Berman, 2005).

Remittances Distribution and Income Inequality

The impact of rural out- migration upon the distribution of household income by size in rural areas is central to the relationship between economic growth and equity in less developed countries (LDCs). As long as a larger proportion of the population resides in the rural areas, rural income inequalities must constitute an important source of overall income inequality. Changes in rural income inequality therefore can have important implications for both social welfare and economic development. To the extent that rural incomes are lower than incomes in other sectors, concerns for issues of poverty highlights the importance of rural component of national income distribution. In addition, deterioration in the national income distribution caused by an increase in inequalities at the low (i.e., rural) end may have different economic implications, particularly with regards to investment and consumption patterns, than a deterioration caused by either an increase in inequality at the high (i.e. urban) end or raise in inequality between the sectors. A focus on the rural income distribution is also a prerequisite for understanding which households, at which segments of the rural income spectrum would be most affected by changes in migration policy, migrant labour market conditions, or the rural employment and production environment (Ssozi *et al*, 2019).

Despite these considerations and the number of studies on remittances and income gaps there is still no consensus about the general or typical effect of migration from rural areas on the distribution of rural income by gaps. Bellon *et al* (2020) argued that migrants' absence from rural areas generates negative externalities of various types; these externalities are responsible for worsening income gaps. In Bittencourt (2011) view, migrants' remittances do not compensate for this adverse impact because, in net terms, the remittances are either very small or go disproportionately to those better off. Thus, the impact of migration and remittances on income distribution in source regions remain a matter of interest in the literature but also attached along with dispute on the advantages of remittances.

Migration and Local Economy

The effect of rural out-migration on economic welfare in the affected areas depends critically on how emigration affects the local capital ratio among non-migrants- that is, on the distributional effects of migration (Narayanan 2020). Moreover, an important concern of the literature on migration is that the poorest are rarely found as the major beneficiaries of remittances, at least directly. This is due to the inability to finance expensive moves, such as those overseas or those requiring some degree of education, but also to the largely recognized exchange motive of remittances to protect an inheritance, to insure property, or to repay education costs which make larger remittances flowing to better-off some farm families in the rural community. Investigations into the existence of a correlation between well-being (i.e asset ownership in rural areas) and migration arrive at apparently conflicting conclusions about causality (Levine and Smith, 2001). On the one hand, people are in a position to and aspire to migrate because they are better off; on the

other hand, migration improves the economic position of those who migrate and as a consequence increases inequality.

This issue of inequality and poverty is not only affecting the rural areas; the urban areas are beginning to be over crowded due to migration (urbanization). No developing country can afford to ignore the phenomenon of urbanization, which will be one of the strongest social forces in coming years, especially in developing countries. Urban population in the developing countries is growing faster than that of the rural population. This has been attributed among others, to rural-urban migration and the rapid transformation of rural areas to urban places. There is the possibility that urban population growth rate will increase by almost twice that of the world's population growth rate between 2003 and 2030 (World Bank, 2020). According to Zoli (2007) estimates from the data of eight countries deduced that two-thirds of the developing world's people is shifting from rural areas to urban areas. However, there seems to be consensus, that remittances influence income gaps of beneficiaries' households.

Methodology

Area of Study

The study area is Southwest region of Nigeria, Southwest region of Nigeria has six states which are Ekiti, Lagos, Ogun, Ondo, Osun and Oyo states respectively. However, Ekiti state and Osun State are selected for this study. Ekiti state is chosen as the study area because data from CBN 2020 revealed that remittances flow to the state in recent times has increased tremendously and the state received second highest after Lagos in the south west region. However, Osun State received the least among the states in the south west region. The study area lies between latitude 7°15' and 8°07' North of the equator and longitude 4°47' and 5°45' East of the Greenwich meridian. It has a mean annual temperature of about 27°C, and a mean annual rainfall of about 1400 mm with vegetation mainly rainforest. The soil of the selected states is largely rich in organic minerals thereby making the study area a major producer of food crops such as rice, cassava, yam, and maize. Southwest region is made up predominantly of the Yoruba ethnic group with a few other ethnic groups. The indigenous populations are more or less homogenous groups who speak same language with minor dialects differences. There are other tribes that co-exist with each other. In addition, majority of the people engaged in agriculture and agricultural related livelihoods and pocket of others are into paid employment with both the government and private establishments.

Sampling Technique

Multistage sampling technique was used for data collection. The first stage of the selection was done through random sampling of two local government areas in Ekiti state and Osun state. Local government areas selected in Ekiti state are Ido-Osi and Ikere-Ekiti. Osun state local government areas selected are Ife south and Ilesa west. Second stage entails selection of two towns/ villages from each local government. In the final enumeration, selection of twenty-five respondents in each town / village on the final stage to give 200 respondents, but only 160 data (80% response rate) were useful for data analysis. The rest of the unused questionnaires were discarded due to insufficient information, improper filled, missing information and lost in transit.

Table 3: Selection of respondents in the identified communities of the study area.

| | | Ekiti | Osun | |
|-------------|-------------|-------|------|-----|
| Town/State | Igbole | 20 | 0 | 20 |
| Ekiti State | Orin | 20 | 0 | 20 |
| | Ikere | 20 | 0 | 20 |
| | Ise | 20 | 0 | 20 |
| | Abiri ogudu | 0 | 20 | 20 |
| Osun State | Ayesan | 0 | 20 | 20 |
| | Igbogi | 0 | 20 | 20 |
| | Ilaje | 0 | 20 | 20 |
| | Total | 80 | 80 | 160 |

Source: Field survey, 2022

Method of data collection

Questionnaire was administered mainly to households’ heads, but other household members were allowed to provide relevant information which could not be adequately supplied by the households’ heads. Data were sourced from two main sources - primary and secondary data. Primary data came from those identified houses that had records of access to remittances and those who did not in the last two years. Data collected were through personal interviews with the aid of structured questionnaire. Secondary data came from journals, books, and other secondary sources.

Analytical Techniques and Estimation Process

The Choice of analytical techniques is to provide a good explanation for the research problem and consequences of the identified dependent variable. In order to analyze the effect of migration of able-bodies men on socio-economic characteristics, descriptive statistics was used. Descriptive statistics like mean, coefficient of variation, standard deviation among others. Also, data were analyzed through the use of Logistics regression model to measure the cause and effect of remittances on income gaps of respondents.

Logistics Regression model:

Assume an income equation is defined as:

$$Y = X\beta + \varepsilon \tag{1}$$

Where Y is the per capita income (₦) and X is an n x M matrix of independent variables with the first column given by the vector ε (residuals)

β is an M-vector of regression co-efficient, and ε is an n-vector of residuals.

The M co-efficient will be estimated by using appropriate econometric techniques with specification corrections as required.

To allow for the most flexible form of interaction between migration and rural production, the study separately consider two income regimes; households with access to remittances (1) households with no access to remittances (0).

The study is interested in predicting the total income for each household i in regime 0, Y_0 , and remittances access household i in regime 1, Y_1 ,

$$1 P_1^{0-\alpha} Z_{1+\epsilon_1} \quad P_{1=1} \iff P_1^0 > 0; P_{1=0} \iff P_{1 \leq 0} \quad P_{1=0} \quad (2)$$

observed for

This distributional assumption on the unobserved terms conditional on group participation implies that:

$$E(\log y_{0i} / P_1) = \beta_0 X_i + y_0 \lambda_i \quad P_{i=0}$$

$$\text{With } \lambda = E(\epsilon / P_i) = \{-\phi(Z_i) (1 - \phi(AZ_i)) \quad P_{i=1} \quad (3)$$

The log-income in regime 0 is then estimated on the group $P_{i=0}$

With $E(\mu_0 / P_1) = \sigma^2_0$. For this sub-sample of observations y_{0i} , for all households i . Equation (3) includes two terms: a conditional expected value of farm log-income in regime 0 is given by:

$$E \log Y_{0i} = \beta X_i + y_0 \lambda_i$$

Combining these two terms gives a predicted log-income in regime 0 for all households:

$$\begin{aligned} \log y_{0i} &= \beta_0 X_i + y_0 \lambda_i + \mu_{0i} & P &= 0 \\ E \log y_{0i} + \mu_{0i} &= \beta_0 X_i + y_0 \lambda_i + \mu_{0i} & P &= 1 \end{aligned} \quad (4)$$

$$Y = f (X_1, X_2, X_3, X_4, X_5, \dots, X_8, \epsilon_i) \quad (5)$$

Where $Y =$ Household income

Where: $X_1 =$ Sex dummy variables (male =1 otherwise female =2)

$X_2 =$ Age (years)

$X_3 =$ Educational level (years)

$X_4 =$ Marital Status (married =1 and 0 otherwise)

$X_5 =$ Household size (number)

$X_6 =$ Religion (Christianity =1, others=0)

$X_7 =$ Access to extension services

$X_8 =$ Access to credit facilities

$\epsilon_i =$ error term

Maximum Likelihood Estimates (MLE) was used as an estimation technique

Result and Discussion

Descriptive statistics of the selected socio-economics variables of the respondents

The survey revealed that the majority of people involved in farming are male 76.3% and female are 23.7%. This implies that we have more men than women engaged in farming, while women assist in marketing the products. The distribution of the respondents according to their marital status revealed that 76.3 % are married, 8.8% are widow 12% are widower (Table 4). Household size is an important variable in agricultural activities because it affects the availability of labour for production. Table 4 reveals that minimum of two children are outside the community and total number of children on the average are eight, mean number of children living with farmers are three.

Education is an important socio-economic factor that influences people's decision because of its influence on people's awareness, perception, reception and adoption of innovation that can bring about increase in profit margin of enterprise. The educational status of the respondent is presented in the table 4 below. It shows that those who have higher education (University degree) do not depend on remittances because they have sufficient income. Education plays an important role in the degree of remittances to farmers. Table 4 shown that the rate at which remittances are available to farmers and that most of this money comes from abroad. Percentage of money received from abroad is 53.8% and local is 15.0%. Results of the region where remittances are coming from and the category of sender analysis revealed that the bulk of the remittances come from Europe (53.8%) and from relations (46.3%). This implies that bulk of the remittances available to farmers come from abroad (Europe). Table 4 shows that the estimate of money received from the respondent are mostly above 50,000 naira per send, while remittances received were used for expansion of farmland and acquisition of farm inputs (37.5%). Others uses of remittances are fishing enterprise (30%), poultry (8.7%), business enterprise (6.2%) as well as meeting basic needs (5.6%) (Table 4).

Table 4: Description of Selected Socio-economics variables of the respondents

| Description | Frequency (%) |
|--|---------------|
| Sex: Male | 122 (76.3) |
| Female | 38 (23.7) |
| Marital Status: Single | 12 (7.5) |
| Married | 122 (76.3) |
| Divorced/Separated | 16 (10.0) |
| Widowed | 10 (6.2) |
| Education: Primary | 26 (16.3) |
| Secondary | 48 (30.0) |
| Post-secondary | 72 (45.0) |
| University | 14 (8.8) |
| Age-grouping: 41-50 | 12 (7.5) |
| 51-60 | 102 (63.8) |
| 61-70 | 23 (28.8) |
| Household size (No.): 1 – 3 | 38 (23.8) |
| 4 – 6 | 76 (47.5) |
| 7 – 9 | 22 (13.8) |
| 10 – 12 | 24 (15.0) |
| Remittances access: Access yes | 110 (68.8) |
| Access No | 50 (31.2) |
| Access remittances thru: Children | 36 (22.5) |
| Relations | 74 (46.3) |
| Friends | 50 (31.3) |
| Remittances location: Nigeria | 24 (15.0) |
| Europe | 86 (53.8) |
| America | 50 (31.3) |
| Remittances access duration: Monthly | 50 (31.3) |
| 2 – 4 months | 72 (45.0) |
| 5 – 6 months | 38 (23.7) |
| Remittances amount: ₦10, 000 – ₦20,000 | 26 (16.3) |
| ₦20, 001 – ₦50,000 | 36 (22.5) |
| ₦50, 001 – ₦100,000 | 60 (37.5) |
| Above ₦100, 000 | 38 (23.7) |
| Remittances received used for: Fishing enterprise | 48 (30.0) |
| Farmland expansion and input acquisition | 60 (37.5) |
| Poultry | 14 (8.7) |
| Business | 10 (6.2) |
| Meet basic needs | 9 (5.6) |
| Remittances proportion in household income: Less than 1-24% | 22 (13.8) |
| 25 – 50% | 60 (37.5) |
| 51 – 75% | 64 (40.0) |
| Above 75% | 14 (8.7) |

Source: Field survey, 2022

Results from Table 5 indicated that education and remittances access enhance remittances receipt. As the majority (76.4%) had formal education. However, those with higher education do not believe in receiving remittances. This probably explains that they have sufficient access to fund that can take care of their basic needs.

Table 5: Highest education * Access to remittances Crosstabulation

| | Access to remittances | | |
|---------------------------------------|-----------------------|----|-------|
| | Yes | No | Total |
| Highest education No formal Education | 26 | 0 | 26 |
| Primary School | 48 | 0 | 48 |
| Secondary School | 36 | 36 | 72 |
| Post-Secondary | 0 | 14 | 14 |
| Total | 110 | 50 | 160 |

Source; Data analysis results, 2022

Moreover, those household that had access to remittances indicated that access has really enhances buying a new thing like buying properties, cars (29%) and developing or venturing into a new enterprise (54.8%) among others (Table 6).

Table 6: New activity as remittances come in * Access to remittances

| | Access to remittances | | |
|---|-----------------------|----|-------|
| | Yes | No | Total |
| New activity as Establishing a new farm | 14 | 0 | 14 |
| remittances come in Buying new things | 24 | 26 | 50 |
| Developing new agricultural enterprise | 46 | 0 | 46 |
| Total | 84 | 26 | 110 |

Source: Field Survey 2022.

Logistics regression model results and discussions

Logistics regression model was used to assess patterns of remittances received by house heads from children, relations and friends local and abroad. Logistic regression model approach used here is appropriate as the data captured households with migrants who had not remitted and otherwise treated as censored data. Also, how remittances indices influenced income gaps households. Households with better educated labor are more likely to participate in migration for two reasons: in terms of capacity, the better-educated are in general more likely to find a job in urban sectors (see also Agwu *et al*, 2018). Abebaw *et al* (2020) deduced that when living standard improved due to an exogenous shock, such as economic reforms, labour with median level of skills are more likely to migrate because of the relaxation of financial constraints, while the high-skilled labour may be less willing to migrate because of the high opportunity cost.

Using logistics regression model as the selection equation, the study estimates the income gap equation of the remittances non-grant households as well as grant households. The results suggest that religion does have significant impacts on household income (Table 7). However, better schooling is associated not only

with higher probability of participating in migration, but also with higher household income. The effect of education on remittances access is positive and significant (Table 7). This study thus explains that the strong impacts of remittances on the depth of income gaps of the identified households. As the study suggests that remittances reduce the income gap of the receiver households. The study observed that households that choose to concentrate on local production are usually those with comparative advantages in rural areas and with higher expected income earnings.

Table 7: Estimates of the Logistics Regression Coefficients

| Variables | Coefficient | Standard error |
|-------------------------------------|--------------------|-----------------------|
| <i>Maximum likelihood estimates</i> | | |
| Constant | 3.967*** | 0.290 |
| Age | 0.079* | 0.071 |
| Education | 0.010*** | 0.009 |
| Marital status | 0.033 | 0.022 |
| Household size | 0.097** | 0.046 |
| Religion | 0.173 | 0.193 |
| Access to extension services | 0.1062** | 0.3416 |
| Access to credit facilities | 0.1026** | 0.0417 |
| # Observations | 160 | |
| Log-likelihood | -1016.8 | |

Source: Data analysis results, 2022

*, **, *** signify significance at 10%, 5% and 1% levels, respectively.

Conclusion and policy implications

The study revealed that remittances have played an important role in reducing the income gaps of beneficiary households. In this line, education plays an important role in the degree of remittances received, however, those with higher education do not believe in receiving remittances. Moreover, those household that had access to remittances indicated that access has really enhances buying a new thing like buying properties, cars and developing or venturing into a new enterprise. Remittances not only provide household with inflows of resource to invest in farming activities but also serve as an insurance system to mitigate income fluctuations. The finding of this study is in line with the study of Agwu *et al* (2018) that deduced that households with larger labour endowment relative to land resources, are more likely to participate in migration as their opportunity costs are in general lower. Remittances not only narrow the income gap among rural poor households, but also disproportionately reduces income gaps of the poorest poor. Therefore, remittances provide rural households with an additional source of income, improving their living standards and narrowing income gaps well.

The study has shown the significant of remittances in reducing the income-gaps of benefitted households, hence, the study suggests that good financial infrastructures for remittances should be put in place. As many remittances go through informal channels and discourage their use for saving and investment. Rural development policies should recognize remittance for policy initiatives to develop financial structures and infrastructures for smooth inflow of remittance of the local economy. This study revealed that remittance can boost household income, by making money available to meet basic needs then policy makers should make relevant policies that will embrace the linkage between migration, remittances and income generation particularly in the rural areas.

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PHYSICAL AND CHEMICAL CHARACTERISTICS OF SOME SOILS IN A DRY UPLAND FOREST OF NIGERIA AND THEIR IMPLICATION FOR SUSTAINABLE SOIL MANAGEMENT.

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Abstract

The importance of having knowledge on the types and properties of soils has been shown to be critical for making informed decisions with respect to agricultural production and other land use types. This study was carried out to characterize, classify and evaluate some selected soils of Ekiti State for sustainable management. The ancillary data about the area were collected (topographic map, remote sensing imageries, climatic data) to produce digital terrain map and base map for the soil survey. Thirteen mapping units were identified (P1,P2,P3,P4,P5,P6,P7,P8,P9,P10,P11,P12 and P13) and profile pits were dug, described and sampled in each of the units. The soils were moderately acidic to strongly acidic. The soils were generally low in total nitrogen, exchangeable bases and cation exchange capacity. Incorporation of organic manure to improve the texture of the soil; use of improved tillage methods that will cause minimal disturbance of soils; judicious use of inorganic fertilizer based on soil testing; maintaining a level of crop residues mulch on the soil surface in order to improve the aggregate stability of the soil; and construction of contour ridges along with use of vegetative cover crops to conserve the soil against surface runoff by erosion were recommended.

Keywords: Physical and Chemical Characteristics of Soil, Upland Forest of Nigeria

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Introduction

Knowledge of the types and properties of soil is critical for decision making with respect to crop production and other land use types. It is through precise measurement and full understanding of the nature and properties of soils as well as proper management of the nutrient and moisture requirement that one can maximize crop production to the allowable potential limits (Esayas and Debele, 2006, Esu, 2004, Chukwu and Ogbodo, 2012). In order to evaluate quality of our soil resources and their potential to produce food, fodder and fiber for the present and future generation, detailed information on soil properties is required (Lekwaet *al*, 2001). Soil characterization provides the information for our understanding of the physical, chemical, mineralogical and microbiological properties of the soils which we depend on to grow crops, sustain forest, grazing land as well as support homes and structures (Ogunkunle and Ande 2004).

Different soil properties encountered along landscapes will affect pattern of crop production. Soil physical properties such as clay content distribution with depth and sand content have been shown to be highly correlated to soil genesis while soil organic matter has been shown to vary with slope position (Miler *et al*, 1988). The changing situation of our soil properties due to the soil forming

process had also been discovered by some research findings (Ewulo, 2012, Nwachokor and Uzu, 2008 and Fasina *et al.*, 2015). Therefore, there is need for periodic update on information of our soil quality through survey system. This should be carried out on a much smaller scale ratio to adequately capture the local agrarian communities. Sharu *et al.*, (2013) reported that coupling of soil characterization and classification provides a powerful resource

for the benefit of mankind especially in the area of food security and environmental sustainability while Lekwa *et al.*, (2004) reiterated that soil characterization provides the basic information necessary to create functional soil classification scheme and assess soil fertility in order to unravel some unique soil problems in an ecosystem.

There is no adequate information about the soils of the study area for land use planning and agricultural production. Also, these soils must have undergone several transformation owing to continental interaction of the soil forming factors over one another. Therefore, this present study examines the physical and chemical characteristics of some selected soils in Ekiti State for sustainable soil management.

Material and Methods

Description of the study area

The study area is Ido/Osi Local Government Area of Ekiti State (Figure 1), located within latitude $7^{\circ}86'$ and $8^{\circ}5'$ North and longitudes $4^{\circ}5'$ and $5^{\circ}45'$. It covers an area of 332 square kilometers (33,200ha) and is 250m above sea level.

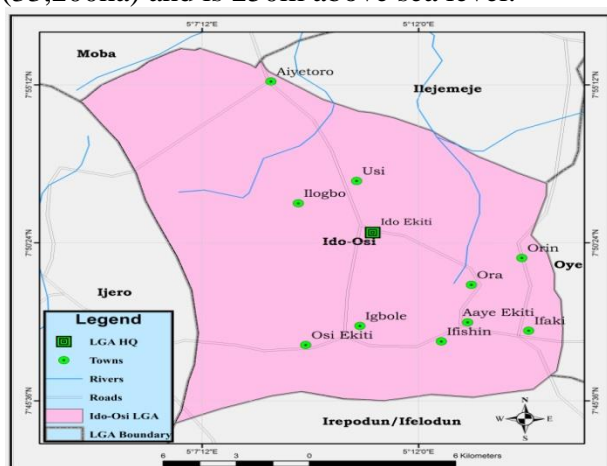


Figure 1: Map of the study area (Ido/Osi Local Government) showing the major towns

The climate is of the tropical upland rainforest type with distinct wet and dry seasons. The mean annual rainfall of 1470.1mm and average number of rainy days of 119.3. The mean annual temperature of the area is 25.5°C . The mean monthly relative humidity is 75 percent (Weather Base, 2018). It lies within the pre-Cambrian of Southwestern Nigeria which is a part of the basement complex of Nigeria and mostly underlain by crystalline rocks ranging from pre-Cambrian to paleozonic (Oyawoye, 1970). Original vegetation characteristic was a semi-deciduous upland rainforest. The original vegetation had been drastically disturbed and in its place are cultivated crops and secondary vegetation successions like bush regrowth, thicket derived

savanna and secondary forest. Arable crops mostly cultivated include yam (*Dioscoreaspp*) cassava (*Manihotspp*), maize (*Zea mays*) and vegetables.

Soil Survey and Sampling

Reconnaissance survey was conducted to know vegetation, cropping pattern and the rural landscape of the study area. A free-soil survey procedure was adopted to identified soil types and thirteen pedons were identified. Profile pit were dug in each pedon, described and sampled for soil laboratory analysis following the procedure described by Soil Survey Staff Division (2017). The location of the pedons were georeferenced with global positioning system (GPS) (GerminiEtrex). At each pedon positions, the local relief, soil erosion or deposition hazards, rock outcrops, surface characteristics, vegetation and land use were recorded.

Laboratory Analysis

The soil samples were air-dried and sieved for the laboratory determinations of soil physical and chemical properties using the IITA (1979) procedure for soil analysis. The following were determined: percent gravel, particle size analysis, bulk density, particle density, total porosity, moisture content, soil pH, organic carbon, total nitrogen, available phosphorus, exchangeable cations (exchangeable K, Na, Ca, and Mg), exchangeable acidity, effective cation exchange capacity (ECEC), base saturation (BS) percentage, electrical conductivity, micro nutrients (Mn, Fe, Cu and Zn), and calcium carbonate (CaCO_3).

Results and Discussion

Soil Physical Properties

The soil physical properties are presented in Table 1.

The distribution of soil particle sizes (sand, silt and clay) determines the soil texture. Percentage gravel content of the surface horizons ranged from 8.7% to 59.9%. Lowest gravel content was recorded at pedon 7 (8.7%) while the highest gravel content was recorded at pedon 9 (59.9%). Higher percentage gravel content of most of the pedons of the study area might be due to the formation of the soils in situ (Adekayode, 2008). Percentage sand contents are high and are predominantly coarse textured ranging from 52.9% to 86%. The total sand fraction is higher than that of other fractions (clay and silt) in each of the pedons of the study area. This can be due to the parent material, type of weathering and the downward translocation of clay (Babalola, 2017). The profile distribution of clay content shows irregular increase with depth in most of the pedons. This may be as a result of eluviation – illuviation process, as well as the contribution of the underlying decaying parent materials by biological and / or agricultural activities, clay migration or surface erosion by runoff or a combination of all these (Malgwiet *al.*, 2000). The silt fraction is generally low in all the pedons of the study area ranging from 3.3% to 19.3%. Soils derived from the basement complex rocks had been reported to be low in silt (Babalola, 2017).

Bulk density of the surface horizon ranged between 1.48g/cm^3 to 1.65g/cm^3 while the bulk density of the subsurface horizons of the pedons in the study area ranged between 1.33g/cm^3 to 1.64g/cm^3 . The bulk density showed a variation among and within the soil pedons. The variation indicates the difference in mineralogy, clay content and structural development (Malgwiet *al.*, 2000). The argillic horizons had the lowest bulk density values possibly due to the presence of the lighter clay size minerals and also the good structural development. The Bulk density within the rooting zones (that is upper one meter) of the soils were optimal for good crop growth. Particle density ranged

from 2.10g/cm^3 and 2.99g/cm^3 in the surface horizon of the study area and 2.0g/cm^3 and 2.84g/cm^3 for the subsurface horizon of the study area indicating that perhaps quartz, feldspars, mica and other colloidal silicate which have densities between the range of 2.50g/cm^3 and 2.70g/cm^3 made up the major portions in the soils (Ayolagha and Opene, 2012). Total porosity for surface horizons ranged from 51% to 76.8% while for subsurface horizon total porosity ranged between 35.32% and 86.12%. According to Sposito (1991), soils having porosity of over 50% and 40% of their volume are good agricultural soils. The result from this study showed that most of the horizons studied appear to be well aerated and have free water movement at the surface horizon.

The moisture content of the surface horizons ranged between 5.1% and 18.7% and for the subsurface horizons it ranged between 6.3% and 24.7%. The pattern of change of soil moisture

content in the study areas might be influenced by organic matter (Waniyo *et al.*, 2015). It was reported that moisture increased with increased organic carbon (Sial, *et al.*, 2007). The water holding capacity ranged between 26.57% and 67.44% in the surface horizons and the subsurface horizons values ranged between 26.20% and 62.24%. Water holding capacity was higher in pedons with highest clay contents compared to pedons of lower clay content and in most case increased with depth in general terms that may be attributed to dominance of their micropores resulting from clay accumulation (Abagyeh *et al.*, 2017). Incorporation of organic matter in the soils will lower the soil bulk density, further raise porosity and enhance water holding capacity.

Soil Chemical Properties

The soil chemical properties are presented in Table 2 and 3.

The surface horizons of all the pedons have the highest values of pH both in water and calcium chloride ranging from 4.0 to 7.3 (pH water) and 3.8 to 7.2 (pH CaCl_2). The soil pH ranged between moderately acidic and neutral in most of the pedons except in pedon 7 (Ipokin farm, Osi Ekiti) and pedon 9 (Ifishin Ekiti) that are strongly acidic. The subsurface horizons ranged from 4.1 to 6.6 (pH water) and 3.7 to 6.7 (pH CaCl_2). The pH values of most of the pedons except pedon 7 and pedon 9 soils are above the critical soil pH (>5.0) for Nigerian soils. Bessah *et al.* (2016) reported that crop yields are usually high in soils with pH values between 6.0 and 7.5 indicating that the soils of most of the pedons are good agricultural lands.

The electrical conductivity of surface horizon ranged between 0.18mmhos and 0.79mmhos while the subsurface horizons values ranged from 0.02mmhos to 0.19mmhos. All the soils are rated as non-saline as the values recorded in them are below the critical value of 4.00mmhos rated for saline soils (Brady and Weil, 2005). Low salinity soil below 0.2mmhos is corrosive and tends to leach surface soil free of soluble minerals (especially). This affects soil aggregates and structure (James, 2010). Soil organic carbon values ranged in the surface horizon from 0.7% to 8.0% and the values ranged in the subsurface horizon from 0.2% to 1.1%. the organic carbon of the soils of all the pedons are rated low since the values are less than 10% (Esuet *et al.*, 2014). The organic carbon contents of the surface horizons are higher than that of the subsurface horizons. This is due to the presence of more decomposable, photocycling and enhanced activities of soil microbes; and also due to better aeration and moisture regime (Olayinka, 2009). According to Greenland *et al.*, (1975), it is impossible to obtain potential crop yield where soil organic carbon is less or equal to 1% whereas soils with organic carbon at 2% are characterized by lack of cohesion and stability.

Soil organic matter values are higher at the surface horizons of all the pedons ranging between 1.2% and 13.8%. The organic matter values for the subsurface horizon ranged between 0.3% and 19%. Organic matter content decreases irregularly with soil depth. The high organic matter values obtained at surface horizon is as a result of increased litters inputs and its decomposition as observed by Groenendijk *et al.*, (2002), while the lower organic matter values in the underlying horizons might be attributed to decreased faunal activities with soil depth. The total nitrogen values ranged between 0.08% and 0.22% at surface horizons while the value of corresponding subsurface horizon ranged between 0.07% and 0.14%. The higher values of total nitrogen in the surface horizon reflects the higher organic matter status of the surface horizon which were enhanced by nutrient cycling through litter fall (Onyekwere *et al.*, 2005) and also the decrease with soil depth could be attributed to influence of continuous cultivation, a common practice on Nigerian soils caused by crop residue removal (Noma *et al.*, 2011). The values in many of the pedons are below the critical value of 0.2% in the surface horizon and

are even lower in the subsurface horizon. The total nitrogen was relatively higher in forest lands (pedons 1, 3, 9 and 10), followed by tree crops (pedons 2 and 13) while arable land and fallow were both low in total nitrogen fractions which could be as a result of the farming activities in both areas. Such result is expected since most soil nitrogen is bound in organic carbon. However, studies have shown that total nitrogen is not significantly varied with land uses (Moyes and Holden, 2008). The high total nitrogen observed in the forest and tree crops than that of the arable land and fallow could be associated with the relatively high organic carbon which in turn resulted from plant and root biomass as well as residues being returned to the soil system. It has been observed that the main cause nitrogen deficiency in tropical soils is intense leaching and erosion due to high tropical rainfall (Isirimah *et al.*, 2010; Fasina *et al.*, (2007).

The surface horizons values of available phosphorus ranged from 1.4mg/kg to 58.5mg/kg while the values at the subsurface horizons ranged from 0.53 to 45.50mg/kg. These values are mostly considered low as they were below or slightly above the 10mg/kg critical level recommended for most crops in the area (Aduyiet *et al.*, 2002; Obigbesan, 2009). Low values of available phosphorus have similarly been reported in some Nigerian soils and attributed to their fixation in acidic or alkaline soil environments (Esu, 1989). Available phosphorus values of pedon 10 (Ora Ekiti) were relatively high due to location of a paddock close to the area with addition of animal faecal material in the area.

The surface horizon values of calcium ranged between 1.13 and 9.68cmol/kg and the corresponding subsurface horizon exchange calcium ranged between 0.10cmol/kg and 4.69cmol/kg. There is higher accumulation of exchangeable Ca^{2+} at the surface horizons and this can be attributed to continuous recharge by mobile constituent liberated by decomposition of organic residue, irrespective of its exposure to leaching and runoff. The exchangeable calcium recorded according to the ratings of FAO (2004) are low for soils derived from basement complex rocks. The exchangeable calcium dominates the exchange sites in all the soils of the study area. This agrees with the findings of Amalu and Antigha (1999) that calcium has higher absorptive power than other cations in the soil.

The values of Exchangeable Magnesium in all the pedons were found to be low with irregular reduction in values with increase in depth. The values ranged from 0.46cmol/kg to 17.92cmol/kg

on the surface horizons and 0.13cmol/kg to 12.71cmol/kg in the subsurface horizons. Higher values were recorded in the surface horizons in all the pedons except pedon 5 (OkeIdo, Ido Ekiti) that recorded higher values at the subsurface horizon. Low level of Ca, Mg and K, have however been reported for most Nigerian soils (Akinride and Obigbesan, 2000) and could be attributed to leaching losses by the high tropical rainfall as well as low content in the parent rock (Denton *et al.*, 2017). Exchangeable Mg values are low to medium.

The value of Exchangeable K ranged between 0.08cmol/kg and 1.03cmol/kg in the surface horizons and 0.03cmol/kg to 0.36cmol/kg in the subsurface horizons. Exchangeable K content generally decreases irregularly with depth. These values are low to moderate according to FAO (2004). Isirimahet *al.*, (2010) reported critical values between 0.16cmol/kg and 2.0cmol/kg for different land uses in Nigeria. There is likelihood of K deficiency in the soils of the area. The values of exchangeable sodium at the surface horizons ranged from 0.01cmol/kg to 0.04cmol/kg and the values at subsurface horizons ranged between 0.01 and 0.04cmol/kg.

Generally, the soils of the surface horizons of the study area fall into very low values of exchangeable Na (<0.2cmol/kg). The value of exchangeable acidity values ranged from 0.44cmol/kg to 2.60cmol/kg in the surface horizon and increased irregularly with depth. The subsurface values ranged between 0.40cmol/kg and 3.44cmol/kg. Exchangeable acidity values obtained are generally low except for pedon 9 (Ifishin Ekiti) where considerable high values were obtained. The latter can be related to Exchangeable Al³⁺ status, and this is considered to be an indication of acid weathering which is characteristic of heavy rainfall areas of the tropics. The values of cation exchange capacity (CEC) showed that the surface horizons value ranged from 1.69 to 26.83cmol/kg and tends to decrease irregularly with depth. The CEC values for the subsurface horizons ranged between 0.30cmol/kg and 15.85cmol/kg. The cation exchange capacity values (CEC) are low to moderate. In most soil profiles higher values are obtained from the topsoil and again from lower depth. The higher CEC values of A-horizons can be attributed to the influence of the organic matter contents while slight increases lower in the profile are caused by increase in clay content. The low to moderate content of the exchangeable cations could be a limitation to the soil which will need to be ameliorated to obtain optimum agricultural productivity.

The base saturation values at the surface horizons ranged between 43.85% and 98.10% and the subsurface horizon values ranged between 12.90% and 90.43%. The Base Saturation of soils of the study areas are rated moderate to high except for soils of pedon9 (Ifishin Ekiti) (FAO, 2004).

The surface horizon calcium carbonate (CaCO₃) values ranged between 2.73% and 23.38% and between 0.24% and 11.33% for the surface and subsurface horizons. There are higher values of CaCO₃ at the surface horizons than the subsurface horizons and it decreases down the depth. According to Fasina (2008) rating of CaCO₃ status as one of other soil characteristics for irrigation suitability, these soils CaCO₃ contents fell mostly within <0.3% and 0.3-10% and were rated to be 90-95% suitable for gravity, and drip localized irrigation. Pedon 10 (Ora Ekiti) soil recorded CaCO₃ contents higher than 10% and this could make it unsuitable for irrigation. The SAR values of the surface horizons ranged from 0.018 to 0.137 and tend to increase with depth in all the profile except in pedon 13 (Ifaki Ekiti) where higher SAR values were obtained at the surface horizons. The SAR values for the subsurface horizons ranged between 0.020 and 0.243. The exchangeable sodium percentage (ESP) for the surface horizon ranged between 1.099% and 7.407% and the

subsurface horizon values ranged between 1.052% and 22.22% the ESP values is generally lower at the surface horizons and tend to increase with depths in all the profiles. The value of ESP in all the profiles in this study were below the critical level of 15% (Brady and Weil, 2005) except in 'B₂' horizon of pedon 9 (Ifishin Ekiti) where a value of 22.22% was recorded. Therefore, the ESP values are not able to cause sufficient structural breakdown through dispersion and swelling to affect permeability of soils, indicating that the soils are not sodic.

The values of aluminum saturation on the surface soil ranged between 0.96% at pedon 10 (Ora Ekiti) and 10.03% at pedon 9 (Ifishin Ekiti). The Al³⁺ saturation generally increased irregularly with depth. The subsurface values of Al³⁺ saturation ranged between 1.33% at pedon 5 (OkeIdo, Ido Ekiti) and 10.95% at pedon 9 (Ifishin Ekiti). It was observed that Al³⁺ saturation values recorded high value at pedon 9, where very strong soil acidity was recorded (pH H₂O of between 4.0 and 4.3 and pH CaCl₂ of between 3.8 and 4.5). This shows that Al³⁺ contributed to the soil acidity. The values of the Extractable Mn ranged from 36.1mg/kg (pedon 11) and 425mg/kg at pedon 3 in the surface horizons and the values decreased with depth in all the profiles. According to the rating of Esu (1991), the Mn values in the soil of the study area is very high. Extractable Fe²⁺ values ranged from 0.6mg/kg at pedon 11 (Orin Ekiti) to 48mg/kg at pedon 9 (Ifishin Ekiti) where the values decrease with depth. High values of Fe²⁺ were recorded in soil of pedon 9. The Fe²⁺ values in the soil of the study area rated between low and medium (Esu, 1991). Extractable Zn and Cu in these soils are also medium to high based on the rating of Esu (1991).

ABLE 1: PHYSICAL PROPERTIES OF SOIL

| HORIZON DEPTH (CM) | HORIZON DESIGNATION | GRAVEL % | SAND % | CLAY % | SILT % | BULK DENSITY g/cm ³ | PARTICLE DENSITY g/cm ³ | MOISTURE CONTENT % | WA |
|--|---------------------|----------|--------|--------|--------|--------------------------------|------------------------------------|--------------------|-------|
| PEDON ONE, OKE IGI FARM, AYETORO EKITI | | | | | | | | | |
| 0 – 15 | A1 | 24.8 | 81.1 | 4.8 | 14 | 1.65 | 2.99 | 17.5 | 57.7 |
| 15 – 29 | A2 | 25.4 | 73.1 | 10.9 | 16 | 1.52 | 2.72 | 16.7 | 60.9 |
| 29 – 70 | B1 | 35.7 | 65.1 | 24.9 | 10 | 1.45 | 2.39 | 24.7 | 55.3 |
| 70 – 170 | B2 | 36.7 | 68.4 | 20.3 | 11.3 | 1.47 | 2.48 | 17.7 | 58.3 |
| PEDON TWO, AISABA FARM, AYETORO EKITI | | | | | | | | | |
| 0 – 10 | A1 | 31.3 | 84.4 | 6.2 | 9.4 | 1.63 | 2.49 | 18.7 | 33.3 |
| 10 – 25 | A2 | 42.3 | 82.6 | 8.2 | 9.3 | 1.59 | 2.69 | 11.3 | 38.3 |
| 25 – 40 | A3 | 44.3 | 74.4 | 17.4 | 8.2 | 1.51 | 2.52 | 11.5 | 39.3 |
| 40 – 70 | B1 | 56.0 | 68.4 | 22.3 | 11.3 | 1.54 | 2.51 | 13.4 | 39.3 |
| 70 – 135 | B2 | 55.9 | 74.6 | 22.2 | 3.3 | 1.49 | 2.84 | 14.8 | 52.3 |
| PEDON THREE, USI EKITI | | | | | | | | | |
| 0 – 11 | A1 | 21.9 | 83.1 | 6.9 | 10 | 1.65 | 2.83 | 14.2 | 67.4 |
| 11 – 50 | A2 | 72.0 | 78.6 | 8.2 | 13.2 | 1.59 | 2.74 | 8.2 | 47.4 |
| 50 – 95 | B1 | 66.9 | 74.6 | 18.2 | 7.2 | 1.47 | 2.41 | 9.5 | 46.4 |
| 95 – 125 | B2 | 63.9 | 80.6 | 14.2 | 5.2 | 1.52 | 2.52 | 12.5 | 43.4 |
| 125 – 160 | B3 | 55.8 | 73.8 | 18.9 | 7.3 | 1.48 | 2.46 | 13.6 | 44.4 |
| PEDON FOUR, ILOGBO EKITI | | | | | | | | | |
| 0 – 16 | A1 | 21.9 | 74.6 | 10.2 | 15.2 | 1.57 | 2.72 | 15.1 | 44.4 |
| 16 – 33 | A2 | 41.6 | 76.4 | 8.2 | 15.4 | 1.60 | 2.59 | 9.3 | 41.4 |
| 33 – 51 | B1 | 44.3 | 63 | 24.2 | 12.8 | 1.37 | 2.11 | 8.9 | 46.4 |
| 51 – 130 | B2 | 38.0 | 76.4 | 10.2 | 13.4 | 1.52 | 2.53 | 14.5 | 47.4 |
| PEDON FIVE, OKE IDO, IDO EKITI | | | | | | | | | |
| 0 – 24 | A1 | 28.2 | 82.4 | 12.3 | 5.3 | 1.51 | 2.36 | 15.4 | 37.14 |
| 24 – 52 | A2 | 44.3 | 64.9 | 24.2 | 12.9 | 1.45 | 2.31 | 14.8 | 46.68 |
| 52 – 95 | B1 | 47.2 | 63 | 22.2 | 14.8 | 1.44 | 2.35 | 8.6 | 50.61 |
| 95 – 150 | B2 | 51.3 | 66.6 | 24.2 | 9.2 | 1.46 | 2.42 | 6.3 | 54.89 |
| PEDON SIX, IGBOLE EKITI | | | | | | | | | |
| 0 – 18 | A1 | 50.8 | 82.6 | 8.2 | 9.2 | 1.59 | 2.70 | 11.3 | 46.93 |
| 18 – 31 | A2 | 64.6 | 86.6 | 6.2 | 7.3 | 1.61 | 2.56 | 12.5 | 41.42 |
| 31 – 75 | B1 | 73.5 | 54.4 | 36.2 | 9.4 | 1.36 | 2.30 | 13.5 | 57.38 |
| 75 – 160 | B2 | 84.9 | 68.4 | 21.4 | 10.2 | 1.42 | 2.46 | 14.8 | 60.46 |
| 160 – 200 | B3 | 55.8 | 66.6 | 28.2 | 5.2 | 1.40 | 2.39 | 18.0 | 62.24 |
| PEDON SEVEN, IPOKIN FARM, OSI EKITI | | | | | | | | | |
| 0 – 18 | A1 | 8.71 | 78.4 | 6.3 | 15.3 | 1.65 | 2.59 | 16.7 | 37.9 |
| 18 – 32 | A2 | 28.1 | 75.1 | 16.9 | 8 | 1.54 | 2.56 | 13.9 | 35.9 |
| 32 – 111 | B1 | 17.9 | 58.7 | 38.2 | 3.3 | 1.33 | 2.20 | 12.8 | 48.9 |
| 111 – 155 | B2 | 19.1 | 52.9 | 36.2 | 10.9 | 1.35 | 2.35 | 16.8 | 57.4 |
| PEDON EIGHT, ODO OKO FARM, OSI EKITI | | | | | | | | | |
| 0 – 25 | A1 | 8.9 | 86.4 | 6.2 | 7.4 | 1.63 | 2.59 | 9.3 | 41.9 |

| | | | | | | | | | |
|--|----|------|------|------|------|------|------|------|------|
| 25 – 46 | A2 | 28.1 | 82.4 | 10.3 | 7.3 | 1.50 | 2.15 | 9.4 | 26.3 |
| 46 – 70 | B1 | 36.9 | 69.1 | 22.9 | 8 | 1.44 | 2.31 | 16.3 | 45.9 |
| 70 – 90 | B2 | 29 | 82.4 | 14.3 | 3.3 | 1.58 | 2.48 | 16.8 | 36.9 |
| PEDON NINE, IFISHIN EKITI | | | | | | | | | |
| 0 – 18 | A | 59.9 | 76.4 | 12.2 | 11.4 | 1.57 | 2.69 | 8.8 | 44.9 |
| 18 – 49 | B1 | 68.7 | 63 | 24.2 | 7.4 | 1.39 | 2.31 | 13.9 | 49.9 |
| 49 – 91 | B2 | 66.9 | 57 | 32.2 | 10.9 | 1.35 | 2.28 | 17.8 | 56.9 |
| 91 – 168 | B3 | 43.2 | 63.8 | 16.9 | 19.3 | 1.48 | 2.41 | 17.0 | 51.9 |
| PEDON TEN, ORA EKITI | | | | | | | | | |
| 0 – 14 | A1 | 18.9 | 85.8 | 6.9 | 7.3 | 1.63 | 2.72 | 5.1 | 51.9 |
| 14 – 33 | A2 | 25.7 | 76.6 | 12.2 | 11.3 | 1.52 | 2.51 | 18.6 | 43.9 |
| 33 – 91 | B1 | 22.2 | 75.0 | 12.2 | 12.9 | 1.55 | 2.09 | 14.8 | 35.9 |
| 91 – 140 | B2 | 51.5 | 63.8 | 32.9 | 3.3 | 1.45 | 2.36 | 15.2 | 54.9 |
| PEDON ELEVEN, ORIN EKITI | | | | | | | | | |
| 0 – 12 | A1 | 20.6 | 70.4 | 16.3 | 13.2 | 1.48 | 2.10 | 9.5 | 26.9 |
| 12 – 28 | A2 | 35.4 | 79.1 | 8.9 | 12.0 | 1.56 | 2.31 | 10.3 | 28.9 |
| 28 – 60 | B1 | 51.6 | 62.4 | 30.2 | 7.4 | 1.40 | 2.31 | 18.2 | 50.9 |
| 60 – 102 | B2 | 49.3 | 58.6 | 30.2 | 11.3 | 1.38 | 2.25 | 18.2 | 51.9 |
| 102 – 200 | B3 | 34.5 | 75 | 14.2 | 10.9 | 1.47 | 2.48 | 19.3 | 52.9 |
| PEDON TWELVE, FARM SETTLEMENT, ORIN EKITI | | | | | | | | | |
| 0 – 10 | A | 55.2 | 82.4 | 8.3 | 9.3 | 1.61 | 2.64 | 11.1 | 54.9 |
| 10 – 50 | B1 | 38.1 | 80.6 | 14.2 | 5.3 | 1.52 | 2.31 | 12.9 | 26.9 |
| 50 – 70 | B2 | 5.9 | 81.8 | 6.9 | 11.3 | 1.64 | 2.53 | 17.1 | 26.9 |
| PEDON THIRTEEN, IFAKI EKITI | | | | | | | | | |
| 0 – 20 | A1 | 17.9 | 79.0 | 6.2 | 14.8 | 1.65 | 2.49 | 8.9 | 32.9 |
| 20 – 35 | A2 | 20.4 | 80.6 | 8.2 | 11.2 | 1.62 | 2.41 | 8.5 | 27.9 |
| 35 – 90 | B1 | 18.0 | 59.1 | 32.9 | 8 | 1.37 | 2.21 | 9.1 | 46.9 |
| 90 – 175 | B2 | 37.9 | 58.4 | 34.2 | 7.4 | 1.36 | 2.53 | 9.1 | 49.9 |

TABLE 2: CHEMICAL PROPERTIES OF SOILS OF IDO-OSI

| Depth (cm) | Horizon | pH ^H H ₂ O | pH ^H CaCl ₂ | EC Dsm | OC % | OM % | TN % | Avail. P mg/kg | K cMol/k g | Na cMol/kg | Ca cMol/kg | Mg cMol/kg |
|--|---------|-------------------------------------|--------------------------------------|-----------|---------|---------|---------|-------------------|------------------|---------------|---------------|---------------|
| PEDON ONE, OKE IGI FARM, AYETORO EKITI | | | | | | | | | | | | |
| 0 – 15 | A1 | 6.4 | 6.5 | 0.22 | 3.1 | 5.4 | 0.20 | 4.2 | 0.25 | 0.01 | 4.88 | 1.00 |
| 15 – 29 | A2 | 5.9 | 5.4 | 0.16 | 1.5 | 2.5 | 0.10 | 2.8 | 0.15 | 0.01 | 3.70 | 0.90 |
| 29 – 70 | B1 | 5.8 | 5.4 | 0.02 | 0.8 | 1.4 | 0.08 | 1.4 | 0.13 | 0.03 | 3.30 | 1.00 |
| 70 – 170 | B2 | 5.6 | 5.2 | 0.06 | 0.6 | 1.0 | 0.07 | 1.05 | 0.13 | 0.02 | 2.80 | 0.90 |
| PEDON TWO, AISABA FARM, AYETORO EKITI | | | | | | | | | | | | |
| 0 – 10 | A1 | 6.6 | 6.3 | 0.18 | 2.2 | 3.7 | 0.15 | 1.40 | 0.24 | 0.02 | 4.34 | 1.00 |
| 10 – 25 | A2 | 6.7 | 6.2 | 0.18 | 1.8 | 3.2 | 0.10 | 0.53 | 0.13 | 0.02 | 3.96 | 0.90 |
| 25 – 40 | A3 | 6.4 | 6.1 | 0.04 | 1.9 | 3.2 | 0.07 | 0.53 | 0.09 | 0.01 | 2.83 | 1.00 |
| 40 – 70 | B1 | 6.1 | 5.5 | 0.04 | 1.1 | 1.9 | 0.10 | 2.80 | 0.36 | 0.04 | 0.78 | 5.00 |
| 70 – 135 | B2 | 5.9 | 5.7 | 0.07 | 0.7 | 1.2 | 0.08 | 1.40 | 0.17 | 0.02 | 2.30 | 0.90 |
| PEDON THREE, USI EKITI | | | | | | | | | | | | |
| 0 – 11 | A1 | 7.3 | 7.2 | 0.33 | 8.0 | 13.8 | 0.22 | 18.20 | 0.44 | 0.04 | 7.50 | 1.00 |
| 11 – 50 | A2 | 6.4 | 5.9 | 0.40 | 2.5 | 4.3 | 0.15 | 1.40 | 0.46 | 0.04 | 5.73 | 9.00 |
| 50 – 95 | B1 | 6.4 | 5.8 | 0.06 | 0.9 | 1.5 | 0.10 | 5.60 | 0.11 | 0.03 | 3.01 | 0.90 |
| 95 – 125 | B2 | 6.5 | 6.7 | 0.03 | 0.4 | 0.6 | 0.08 | 1.40 | 0.16 | 0.02 | 2.34 | 0.90 |
| 125 – 160 | B3 | 6.6 | 6.5 | 0.03 | 1.0 | 1.8 | 0.08 | 1.40 | 0.21 | 0.03 | 3.78 | 1.00 |
| PEDON FOUR, ILOGBO EKITI | | | | | | | | | | | | |
| 0 – 16 | A1 | 6.0 | 6.0 | 0.79 | 3.0 | 5.2 | 0.14 | 8.40 | 0.23 | 0.03 | 1.22 | 1.00 |
| 16 – 33 | A2 | 5.2 | 5.2 | 0.19 | 1.7 | 2.9 | 0.08 | 1.40 | 0.05 | 0.01 | 3.25 | 0.90 |
| 33 – 51 | B1 | 5.5 | 4.9 | 0.03 | 1.0 | 1.7 | 0.10 | 2.80 | 0.04 | 0.01 | 0.71 | 0.90 |
| 51 – 130 | B2 | 6.0 | 6.0 | 0.02 | 0.3 | 0.6 | 0.08 | 1.40 | 0.06 | 0.02 | 0.33 | 0.90 |
| PEDON FIVE, OKE IDO, IDO EKITI | | | | | | | | | | | | |
| 0 – 24 | A1 | 6.6 | 6.8 | 0.45 | 1.8 | 3.0 | 0.10 | 12.60 | 0.24 | 0.02 | 3.26 | 0.90 |
| 24 – 52 | A2 | 6.5 | 6.5 | 0.30 | 2.8 | 4.7 | 0.11 | 2.80 | 0.33 | 0.04 | 9.18 | 1.00 |
| 52 – 95 | B1 | 6.3 | 6.7 | 0.07 | 0.7 | 1.2 | 0.10 | 1.05 | 0.36 | 0.09 | 2.70 | 1.00 |
| 95 – 150 | B2 | 5.4 | 6.2 | 0.06 | 0.3 | 0.4 | 0.07 | 0.53 | 0.24 | 0.02 | 2.46 | 1.00 |
| PEDON SIX, IGBOLE EKITI | | | | | | | | | | | | |
| 0 – 18 | A1 | 5.6 | 5.7 | 0.51 | 2.2 | 3.8 | 0.13 | 2.80 | 0.11 | 0.02 | 4.66 | 1.00 |
| 18 – 31 | A2 | 5.9 | 5.6 | 0.16 | 2.1 | 3.5 | 0.11 | 0.70 | 0.08 | 0.01 | 3.06 | 1.00 |
| 31 – 75 | B1 | 5.0 | 4.7 | 0.07 | 0.9 | 1.5 | 0.10 | 2.80 | 0.07 | 0.02 | 1.35 | 0.90 |
| 75 – 160 | B2 | 5.2 | 5 | 0.03 | 0.3 | 0.6 | 0.07 | 1.40 | 0.05 | 0.03 | 1.24 | 0.90 |
| 160 – 200 | B3 | 4.9 | 4.9 | 0.03 | 0.4 | 0.7 | 0.07 | 1.40 | 0.04 | 0.03 | 1.05 | 0.90 |
| PEDON SEVEN, IPOKIN FARM, OSI EKITI | | | | | | | | | | | | |
| 0 – 18 | A1 | 6.3 | 6.4 | 0.50 | 2.9 | 5.1 | 0.15 | 9.10 | 0.36 | 0.04 | 4.08 | 1.00 |
| 18 – 32 | A2 | 5.1 | 4.9 | 0.08 | 1.0 | 1.8 | 0.08 | 1.05 | 0.16 | 0.03 | 0.99 | 0.90 |
| 32 – 111 | B1 | 4.01 | 3.9 | 0.15 | 0.6 | 1.0 | 0.08 | 1.40 | 0.08 | 0.03 | 1.15 | 0.90 |
| 111 – 155 | B2 | 4.7 | 4.5 | 0.19 | 0.4 | 0.7 | 0.08 | 1.05 | 0.06 | 0.02 | 0.81 | 0.90 |
| PEDON EIGHT, ODO OKO FARM, OSI EKITI | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|----|-----|-----|------|-----|-----|------|-------|------|------|------|-----|
| 0 – 25 | A1 | 5.6 | 6.4 | 0.59 | 2.4 | 4.2 | 0.11 | 5.95 | 0.16 | 0.01 | 4.19 | 0.9 |
| 25 – 46 | A2 | 6.2 | 6 | 0.45 | 2.3 | 4.0 | 0.07 | 2.80 | 0.09 | 0.03 | 1.93 | 0.4 |
| 46 – 70 | B1 | 5.9 | 5.3 | 0.05 | 0.9 | 1.5 | 0.10 | 1.40 | 0.09 | 0.01 | 2.45 | 0.8 |
| 70 – 90 | B2 | 5.2 | 5.2 | 0.03 | 0.6 | 1.1 | 0.10 | 0.35 | 0.19 | 0.03 | 1.48 | 0.5 |
| PEDON NINE, IFISHIN EKITI | | | | | | | | | | | | |
| 0 – 18 | A | 4.0 | 3.8 | 0.78 | 4.2 | 7.2 | 0.20 | 4.90 | 0.19 | 0.02 | 1.33 | 0.5 |
| 8 – 49 | B1 | 4.1 | 4.4 | 0.05 | 1.2 | 2.0 | 0.11 | 0.70 | 0.08 | 0.02 | 0.23 | 0.1 |
| 49 – 91 | B2 | 4.2 | 3.7 | 0.20 | 0.7 | 1.2 | 0.14 | 0.70 | 0.07 | 0.01 | 0.15 | 0.1 |
| 91 – 168 | B3 | 4.3 | 4.5 | 0.03 | 0.4 | 0.7 | 0.13 | 0.70 | 0.05 | 0.02 | 0.10 | 0.1 |
| PEDON TEN, ORA EKITI | | | | | | | | | | | | |
| 0 – 14 | A1 | 7.1 | 6.9 | 0.21 | 4.2 | 7.2 | 0.20 | 43.50 | 1.03 | 0.04 | 9.68 | 16 |
| 14 – 33 | A2 | 5.9 | 5.6 | 0.16 | 2.0 | 3.4 | 0.13 | 58.50 | 0.25 | 0.02 | 3.68 | 0.7 |
| 33 – 91 | B1 | 6.4 | 5.5 | 0.13 | 1.1 | 1.8 | 0.10 | 45.50 | 0.10 | 0.01 | 4.69 | 0.4 |
| 91 – 140 | B2 | 6.3 | 6.3 | 0.02 | 0.5 | 0.9 | 0.08 | 1.40 | 0.21 | 0.02 | 4.56 | 0.5 |
| PEDON ELEVEN, ORIN EKITI | | | | | | | | | | | | |
| 0 – 12 | A1 | 5.6 | 5.7 | 0.24 | 0.7 | 1.2 | 0.14 | 2.80 | 0.41 | 0.04 | 3.08 | 10 |
| 12 – 28 | A2 | 5.9 | 5.3 | 0.12 | 0.9 | 1.6 | 0.10 | 2.80 | 0.15 | 0.04 | 1.22 | 0.5 |
| 28 – 69 | B1 | 4.7 | 4.3 | 0.10 | 0.7 | 1.2 | 0.14 | 2.80 | 0.06 | 0.02 | 1.06 | 0.7 |
| 69 – 102 | B2 | 4.9 | 5.0 | 0.07 | 0.6 | 1.0 | 0.10 | 1.05 | 0.05 | 0.03 | 1.81 | 0.7 |
| 102 – 200 | B3 | 5.7 | 5.7 | 0.02 | 0.2 | 0.3 | 0.08 | 1.05 | 0.04 | 0.02 | 2.04 | 0.6 |
| PEDON TWELVE, FARM SETTLEMENT, ORIN EKITI | | | | | | | | | | | | |
| 0 – 10 | A | 5.3 | 5.5 | 0.36 | 4.3 | 7.4 | 0.11 | 4.90 | 0.23 | 0.02 | 3.75 | 1.4 |
| 10 – 50 | B1 | 5.3 | 4.9 | 0.12 | 0.5 | 0.8 | 0.10 | 4.20 | 0.12 | 0.02 | 0.74 | 0.3 |
| 50 – 70 | B2 | 5.4 | 4.5 | 0.03 | 0.9 | 1.5 | 0.07 | 2.10 | 0.03 | 0.02 | 0.56 | 0.3 |
| PEDON 13, IFAKI EKITI | | | | | | | | | | | | |
| 0 – 20 | A1 | 5.4 | 5.2 | 0.22 | 1.7 | 3.0 | 0.13 | 4.20 | 0.08 | 0.02 | 1.31 | 0.4 |
| 20 – 35 | A2 | 5.8 | 5.9 | 0.18 | 0.8 | 1.3 | 0.14 | 3.50 | 0.11 | 0.01 | 1.28 | 0.6 |
| 35 – 90 | B1 | 4.6 | 4.5 | 0.05 | 1.1 | 1.8 | 0.10 | 1.40 | 0.04 | 0.01 | 1.18 | 0.4 |
| 90 – 175 | B2 | 5.1 | 4.8 | 0.03 | 0.5 | 0.8 | 0.07 | 1.05 | 0.04 | 0.02 | 1.44 | 0.5 |

TABLE 3: CHEMICAL PROPERTIES OF SOILS OF IDO-OSI INCLUDING SOME MICRONUTRIENTS

| HORIZON DEPTH (CM) | HORIZON DESIGNATION | EXCH. AL ³⁺ | EXCH. H ⁺ | CEC | % BASE SATURATION | % AL ³⁺ SATURATION | Mn mg/kg | Fe mg/kg |
|--|---------------------|------------------------|----------------------|-------|-------------------|-------------------------------|----------|----------|
| PEDON 1 OKE IGI FARM, AYETORO EKITI | | | | | | | | |
| 0 - 15 | A1 | 0.06 | 0.74 | 6.38 | 88.86 | 3.57 | 120 | 5 |
| 15 - 29 | A2 | 0.06 | 0.5 | 4.66 | 89.26 | 5.11 | 45.9 | 11 |
| 29 - 70 | B1 | 0.08 | 0.84 | 3.53 | 83.11 | 5.30 | 8.8 | 9 |
| 70 - 170 | B2 | 0.06 | 0.66 | 3.72 | 83.78 | 4.92 | 10.4 | 13 |
| PEDON 2 AISABA FARM, AYETORO EKITI | | | | | | | | |
| 0 - 10 | A1 | 0.04 | 0.56 | 5.62 | 90.35 | 2.86 | 118 | 4 |
| 10 - 25 | A2 | 0.04 | 0.36 | 5.09 | 92.71 | 3.85 | 108 | 2 |
| 25 - 40 | A3 | 0.02 | 0.62 | 4.23 | 86.86 | 1.73 | 91.8 | 4 |
| 40 - 70 | B1 | 0.04 | 0.64 | 6.43 | 90.43 | 2.37 | 49.1 | 5 |
| 70 - 135 | B2 | 0.04 | 0.64 | 3.24 | 82.66 | 3.40 | 11.1 | 5 |
| PEDON 3 USI EKITI | | | | | | | | |
| 0 - 11 | A1 | 0.06 | 0.72 | 25.90 | 97.44 | 1.62 | 425 | 0.8 |
| 11 - 50 | A2 | 0.06 | 0.66 | 15.36 | 95.52 | 2.21 | 104.7 | 0.5 |
| 50 - 95 | B1 | 0.04 | 0.72 | 3.83 | 83.43 | 3.13 | 11.6 | 2 |
| 95 - 125 | B2 | 0.02 | 0.66 | 3.18 | 82.27 | 1.73 | 12.6 | 1 |
| 125 - 160 | B3 | 0.04 | 0.6 | 5.02 | 88.69 | 2.96 | 13.2 | 2 |
| PEDON 4 ILOGBO EKITI | | | | | | | | |
| 0 - 16 | A1 | 0.06 | 0.86 | 3.18 | 77.58 | 4.07 | 67.2 | 5 |
| 16 - 33 | A2 | 0.1 | 2.7 | 4.11 | 59.50 | 3.06 | 19.5 | 12 |
| 33 - 51 | B1 | 0.04 | 1.12 | 1.53 | 56.93 | 2.94 | 18.7 | 4 |
| 51 - 130 | B2 | 0.04 | 0.64 | 1.20 | 63.81 | 4.62 | 13.6 | 10 |
| PEDON 5 OKE IDO, IDO EKITI | | | | | | | | |
| 0 - 24 | A1 | 0.04 | 0.48 | 4.06 | 88.65 | 3.45 | 41.8 | 17 |
| 24 - 52 | A2 | 0.04 | 0.64 | 19.80 | 96.68 | 1.33 | 154.8 | 5 |
| 52 - 95 | B1 | 0.04 | 0.76 | 15.85 | 95.20 | 1.44 | 7.2 | 5 |
| 95 - 150 | B2 | 0.04 | 0.8 | 4.11 | 83.02 | 2.69 | 1.3 | 3 |
| PEDON 6 IGBOLE EKITI E | | | | | | | | |
| 0 - 18 | A1 | 0.06 | 0.46 | 5.88 | 91.87 | 4.92 | 57.7 | 2 |
| 18 - 31 | A2 | 0.02 | 0.62 | 4.21 | 86.79 | 1.75 | 36.8 | 2 |
| 31 - 75 | B1 | 0.1 | 1.14 | 2.07 | 62.58 | 6.56 | 25.1 | 6 |
| 75 - 160 | B2 | 0.06 | 0.66 | 1.85 | 71.94 | 6.17 | 3.9 | 7 |
| 160 - 200 | B3 | 0.06 | 0.8 | 1.66 | 66.37 | 3.75 | 5.1 | 4 |
| PEDON 7 IPOKIN FARM, OSI EKITI E | | | | | | | | |
| 0 - 18 | A1 | 0.04 | 0.52 | 18.02 | 96.99 | 1.47 | 159.8 | 4 |
| 18 - 32 | A2 | 0.06 | 0.62 | 1.88 | 73.39 | 5.79 | 42.5 | 4 |
| 32 - 111 | B1 | 0.34 | 4.06 | 1.97 | 30.92 | 7.24 | 25.6 | 4 |
| 111 - 155 | B2 | 0.14 | 1.94 | 1.54 | 42.54 | 6.06 | 8 | 3 |

PEDON 8 ODO OKO FARM, OSI EKITI

| | | | | | | | | |
|---------|----|------|------|------|-------|------|------|---|
| 0 – 25 | A1 | 0.04 | 0.4 | 5.30 | 92.34 | 3.55 | 41.5 | 1 |
| 25 – 46 | A2 | 0.02 | 0.54 | 2.51 | 81.75 | 2.18 | 32.6 | 4 |
| 46 – 70 | B1 | 0.08 | 3.16 | 3.42 | 51.35 | 2.18 | 5.1 | 4 |
| 70 – 90 | B2 | 0.04 | 0.68 | 2.21 | 75.41 | 3.51 | 6.7 | 4 |

PEDON 9 IFISHIN EKITI

| | | | | | | | | |
|----------|----|------|------|------|-------|-------|------|----|
| 0 – 18 | A | 0.3 | 2.3 | 2.03 | 43.85 | 10.03 | 80.6 | 48 |
| 18 – 49 | B1 | 0.44 | 3.44 | 0.47 | 10.78 | 10.95 | 7.6 | 11 |
| 49 – 91 | B2 | 0.38 | 3.06 | 0.39 | 10.26 | 10.69 | 4.5 | 5 |
| 91 – 168 | B3 | 0.14 | 1.86 | 0.30 | 12.90 | 6.69 | 3.3 | 2 |

PEDON 10 ORA EKITI E

| | | | | | | | | |
|----------|----|------|------|-------|-------|------|-------|----|
| 0 – 14 | A1 | 0.04 | 0.48 | 26.83 | 98.10 | 0.96 | 39.5 | 9 |
| 14 – 33 | A2 | 0.04 | 0.72 | 4.64 | 85.94 | 2.73 | 199.2 | 6 |
| 33 – 91 | B1 | 0.04 | 0.6 | 5.21 | 89.06 | 3.16 | 36.9 | 15 |
| 91 – 140 | B2 | 0.04 | 0.72 | 5.35 | 87.56 | 2.68 | 4.8 | 4 |

PEDON 11 ORIN EKITI

| | | | | | | | | |
|-----------|----|------|------|-------|-------|------|------|-----|
| 0 – 12 | A1 | 0.04 | 0.68 | 14.32 | 95.21 | 1.56 | 36.1 | 0.6 |
| 12 – 28 | A2 | 0.04 | 0.60 | 1.90 | 74.84 | 3.98 | 20.6 | 0.4 |
| 28 – 69 | B1 | 0.16 | 1.64 | 1.85 | 50.69 | 7.80 | 25 | 6 |
| 69 – 102 | B2 | 0.08 | 0.76 | 2.68 | 76.12 | 6.77 | 10.1 | 4 |
| 102 – 200 | B3 | 0.06 | 0.7 | 2.78 | 78.54 | 5.47 | 1.7 | 4 |

PEDON 12 FARM SETTLEMENT, ORIN EKITI

| | | | | | | | | |
|---------|----|------|------|------|-------|------|-------|----|
| 0 – 10 | A | 0.06 | 0.78 | 5.48 | 86.71 | 5.71 | 130.2 | 17 |
| 10 – 50 | B1 | 0.08 | 0.92 | 1.20 | 54.53 | 6.45 | 48 | 4 |
| 50 – 70 | B2 | 0.06 | 0.7 | 0.93 | 55.14 | 6.67 | 13.9 | 73 |

PEDON 13 IFAKI EKITI

| | | | | | | | | |
|----------|----|------|------|------|-------|------|-------|---|
| 0 – 20 | A1 | 0.04 | 0.56 | 1.69 | 73.85 | 4.62 | 177.6 | 3 |
| 20 – 35 | A2 | 0.02 | 0.94 | 2.03 | 67.93 | 1.57 | 79.2 | 3 |
| 35 – 90 | B1 | 0.12 | 1.16 | 1.71 | 57.26 | 7.99 | 76 | 3 |
| 90 – 175 | B2 | 0.04 | 0.88 | 2.03 | 68.84 | 3.42 | 30.5 | 3 |

Sustainable Soil Management Practices for Ido-Osi Soils

Arising from the evaluation of the physical and chemical properties of pedons, the following limitations were observed and accompany sustainable soil management were suggested:

1. Poor soil physical characteristics and low fertility were observed in pedons 1, 2, 3, 4, 5, 6, 7, 11 and 13. Suggested sustainable management area: (i) Protection of soil aggregate through the use of minimum soil disturbance and maintaining organic matter cover on the soil. (ii) Minimizing soil disturbance by mechanical tillage to reduce physical soil problems such as compaction. Also planting directly to untilled soil in order to maintain soil organic matter, soil structure and overall soil health. (iii) Enhancing and maintaining organic nutrient cover on the soil surface, using crop residues or cover crops. This protects the soil surface, conserves water and nutrient, promote soil biological activity. (iv) Diversification of species (both annual and perennial) in association, sequences and rotations that can include trees, shrubs, pastures and crops. This will also contribute to enhanced crop nutrition and improved crop resilience. (v) Use of well adapted high yielding varieties and good quality seeds. (vi) Enhanced soil nutrition based on soil health. (vii) Integrated soil fertility management. This according to Ogunkunle, 2015 is a set of soil fertility management practices that include the use of fertilizer, organic inputs and improved germplasm with the knowledge to adopt these practices to local conditions, aiming at optimizing agronomic use efficiency of the applied nutrients and improving crop production.
2. Soil acidity and presence of concretions in pedons 8 and 9. (i) Management practices that can be adopted in improving performance of crops on acid soils are liming, gypsum application and the use of an adequate rate of fertilizers and organic manures. (ii) the use of acidity tolerant crop species or cultivars within species is another important strategy in improving crop yields on such soils. (iii) Minimum tillage is recommended because of the presence of concretions in these pedons. Soils with plinthite and concretions must always be under cover to prevent serious erosion.
3. No limitation was observed in pedon 10. Sustainable land management practices should be employed to maintain the present soil quality of this pedon through appropriate management practices that will enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources.
4. Wetness (water logging) in pedon 12. The management practices that can be used to ameliorate water logging stress include the use of flood tolerant varieties, adjusting management practices, improving drainage by construction of bunds and ridges.
5. Erosion in pedon 2, 3, 8 and 9. Some of the sustainable land management techniques used with a view to reducing erosion damages are: (i) contouring – this entails making sure that cropping follows contour lines. Soil clods and small hollows must be perpendicular to the slope, so that the eventual runoff sheet is slowed as much as possible. (ii) Contour Ridging – The ridges are set perpendicular to the greatest slope so that the furrows can hold a considerable amount of water containing suspended sandy or loamy solids. (iii) Buffer strip cropping - The strips are effective in the case of light or medium rainstorms and can quickly become water logged under exceptional rainfall. They act as filters slowing down the runoff flow. The leafy plants provide good cover on erosion control strips, particularly natural fallow plants. Also, the presence of pulses with tap root and large, deep rooting

perennial grasses improves infiltration. (iv) Natural or artificial mulching – Preventing destruction of the structure of the surface horizon, according to Ogunkunle (2015) the formation of slaking crusts is some of the achieved by this technique. (v) Cover plants – this is another good way of erosion control on slopes. It slows down the rate of runoff on the slope.

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ENTOMOTOXIC EFFECT OF SOME BOTANICALS ON THE OVIPOSITION PREFERENCE OF *CALLOSOBRUCHUS MACULATUS* (FABRICIUS) (COLEOPTERA: CHRYSOMELIDAE) ON FIVE SELECTED LEGUMES.

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Abstract

Powders from ten plant materials purchased from Oja-Oba market Akure, Ondo State were evaluated for their entomocidal effects on the beetle. The evaluation of the insecticidal effects of the powders was based on oviposition and percentage weight loss of seeds caused by *C. maculatus*. The results from the evaluation of powders from the ten plant materials (*Piper guineense*, *Eugenia aromatica*, *Nicotiana tabacum*, *Oryza sativa* bran, *Zanthoxylum zanthoxyloides*, *Zingiber officinale*, *Allium sativum*, *Mormordica charantia*, *Ocimum gratissimum*, *Xylopiya aethiopica*) tested at 2% on five legume seed types revealed that *Zanthoxylum zanthoxyloides* was superior to *Piper guineense* (77%) and *Eugenia aromatica* (73%) in inhibiting oviposition by *C. maculatus*. *Zanthoxylum zanthoxyloides* inhibited oviposition by (87%) which was next to the synthetic insecticide cypermethrin with (88%) inhibition. The efficacy ranking when comparing the dosage of 2% at 0.2g/10g cowpea and non-cowpea legumes was in the order of Cypermethrin (88.16%), *Zanthoxylum zanthoxyloides* (87.02%), *Piper guineense* (77.36%), *Oryza sativa* [Rice bran-(76.55%)], *Eugenia aromatica* (73%), *Nicotiana tabacum* (46.51%), *Allium sativum* (29.81), *Mormordica charantia* (9.29%), *Xylopiya aethiopica* (9.07%), *Zingiber officinale* (6.88%) and *Ocimum gratissimum* (1.11%). *Zanthoxylum zanthoxyloides* treated seeds recorded least percentage weight loss compared with cypermethrin, indicating that it can compete favourably with the synthetic insecticides. Results from this study show that *Mucuna pruriens* (99%) and *Sphenostylis stenocarpa* (88%) of the non-cowpea legumes were tolerant to infestation by *C. maculatus*. Therefore, incorporation of the use of varietal resistance and powder of *Z. zanthoxyloides* for the management and control of *C. maculatus* proved a promising biopesticide for the protection of legumes as alternatives to synthetic pesticides.

Keywords: Entomotoxic, Influence, Botanicals, Oviposition, Legumes, Protection

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Introduction

Grain legumes are rich in protein, oil, and micronutrients such as iron and zinc – all of which tend to be deficient in the diets of the poor. However, they are heavily infested by many insect pests both in the field and during postharvest storage (Adebayo *et al.*, 2013). The most important species of stored product pests of food legumes include: *Callosobruchus chinensis*, *Callosobruchus maculatus*, *Callosobruchus analis*, *Acanthoscelides obtectus* and *Bruchus incarnatus* (Kashiwaba *et al.*, 2003). In addition, *B. rufimanus*, *B. dentipes*, *B. quinqueguttatus*, *B. emarginatus*, *B. ervi*, *B. lentis* and *B. pisorum* may also cause significant losses in some legumes (Desroches *et al.*, 1995). Bruchid beetles (Coleoptera: Chrysomelidae) such as

Callosobruchus maculatus (F.) and *Callosobruchus chinensis* (L.) are peculiar to stored grain legume such as cowpea (Kashiwaba, *et al.*, 2003). *Callosobruchus maculatus* (F.) is a cosmopolitan polyphagous pest in the tropics and subtropical areas. Knowledge of host, pest and environment interaction is important to know its host range, so that storage planning can be made to avoid infestation among susceptible legume seeds species when stored in one place which will prevent a heavy build of *C. maculatus* population. Infestations on stored grains may reach 50% within 3-4 months of storage (Oparaeke and Dike, 2005).

The destructive activities of insects and other storage pests have been subdued by chemical control methods comprising fumigation of stored commodity with carbon disulphide, phosphine or dusting with malathion, carbaryl, pirimiphos methyl or permethrin. Over the years in Nigeria and in other parts of the world, management of *C. maculatus* on the field and in storage has been dominated by chemical control using fumigants and synthetic insecticides (Park *et al.*, 2003; Akinkurolere *et al.*, 2006). These chemicals have been reported to be effective against stored products pests (Oni and Ileke, 2008; Ileke and Oni, 2011). In the developed countries, conventional fumigation technology is currently being scrutinised for many reasons, such as ozone depletion potential of methyl bromide and carcinogenic concerns with phosphine. Also as a result of serious problems of genetic resistance by insect species, pest resurgence, residual toxicity, photo-toxicity, vertebrate toxicity, widespread environmental hazards and increasing costs of application of the presently used synthetic pesticides have directed the need for effective, biodegradable pesticides (Talukder and Howse 2000; Elhag 2000). In this regard several botanicals that were effective and environment friendly have been evaluated for the management of storage insect pests (Oni, 2009; Idoko, 2011; Adebayo and Eyo, 2014).

Worldwide concerns on the unjust use of chemical fumigants by farmers further lead to the development of alternative strategies, among which is the re-examination of using plant derivatives against agriculturally important insect pests. Plant-derived materials are more readily biodegradable. Most of these plant products are cheap, readily available, edible and ecologically safer means of controlling insect pest infestations of stored cereal and grains especially in the tropics (Ileke and Oni, 2011; Adebayo and Ibikunle, 2014). In the last two decades, considerable efforts have been directed at screening plants in order to develop new botanical insecticides. It was reported that when mixed with stored-grains, leaf, bark, seed powder, or oil extracts of plants reduce oviposition rate and suppress adult emergence of bruchids, and also reduced seed damage rate (Tapondjou *et al.*, 2002).

This study was conducted in addition to efforts of crop researchers to minimize the indiscriminate use of synthetic chemicals and their effects. Oviposition decisions are crucial in the life cycle of bruchid beetles because they set the conditions in which an offspring must develop from egg to adult stage. Hence, the need to investigate on how oviposition can be reduced in *C. maculatus* through use of insecticidal active botanicals.

Materials and Methods

Experimental Site

The study was carried out in the Pest Management Laboratory of the Department of Crop, Soil and Pest Management, the Federal University of Technology, Akure, Ondo State Nigeria (Latitude 7° 16' N and Longitude 15° 12' E) under ambient conditions of 28 ± 2°C temperature and 70 ± 5% relative humidity.

Collection and preparation of legume seed types

Seeds of five non-cowpea legume listed in Tables 1 and 2 were collected from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. The morphological characteristics of the five legume seeds used in this study is presented in table 1. The legume seeds were first cleaned and disinfested by keeping them in a freezer at -5°C for 7 days to kill all hidden infestations.

Table 1: Morphological characteristics of the six Non- cowpea legumes.

| Legumes | Common name | Texture | Colour |
|---|--------------------|----------------|---------------|
| <i>Cajanus cajan</i> (L.) Mill- | Pigeon pea | Rough | Brown |
| <i>Glycine max</i> (L.) Merrill | Soya bean | Smooth | Milky |
| <i>Vigna subterranean</i> L. Verdcourt | Bambara Groundnut | Smooth | Brown |
| <i>Sphenostylis stenocarpa</i> Hochst. Ex A. R. | African yam Bean | Smooth | Glossy milk |
| <i>Mucuna pruriens</i> (L.) | Devil Beans | Smooth | Black |

Preparation of botanical powders used as treatment:

Ten well researched insecticidal plants, *Piper guineense*, *Eugenia aromatica*, *Nicotiana tabacum*, *Oryza sativa* bran, *Zanthoxylum zanthoxyloides*, *Zingiber officinale*, *Allium sativum*, *Momordica charantia*, *Ocimum gratissimum*, *Xylopi aethiopica* were purchased from various locations at Oja-Oba Akure and brought to the laboratory. The different parts of the plants underlisted in Table 2 were sun dried, separately milled into fine powders. The powders were sieved through a 4.5mm² mesh and stored in an airtight nylon. They were all preserved under ambient conditions prior to use. Cypermethrin dust was also obtained and used as standard.

Table 2: Botanical Powders with the different part used including Cypermethrin used as standard.

| Scientific Name | Common name | Part Used |
|--|----------------------------|------------------|
| <i>Eugenia aromatica</i> (Baill.) | Clove plant | Pod |
| <i>Zanthoxylum zanthoxyloides</i> (Lam.) | Tooth ache plant | Root bark |
| <i>Piper guineense</i> (Schum and Thonn) | West African black pepper- | Seed |
| | Seed | |
| <i>Oryza sativa</i> L. | Rice | Bran |
| <i>Allium sativum</i> L. | Garlic | Bulbs |
| <i>Momordica charantia</i> Linn. | Bitter melon | Leaf |
| <i>Ocimum gratissimum</i> (OG) | Clove Basil | Leaf |
| <i>Xylopi aethiopica</i> (Dunal) A. | Negro pepper | Pod |
| <i>Nicotiana tabacum</i> L. | Tobacco | Leaf |
| <i>Zingiber officinale</i> Rosc. | Ginger | Rizhomes |
| Cypermethrin | | |

Insect culture

The initial culture of cowpea storage beetle, *Callosobruchus maculatus* used was obtained from cowpea grains already infested with bruchids from Oja-Oba market in Akure, Ondo State, Nigeria and was sub-cultured on a well-known susceptible cowpea variety Ife Brown which was sourced from the International Institute of Tropical Agriculture (IITA). Ife Brown cowpea seeds were first disinfested by deep-freezing for two weeks and acclimatized in the open laboratory conditions for 24hours before

subsequent use. Bruchid cultures were established according to Beck and Blumer (2011). Cleaned cowpea seed 400g were set aside in a plastic container and infested with twenty adult bruchids (10 males and 10 females) for oviposition. The condition was maintained at temperature of $28 \pm 2^\circ\text{C}$ and $70 \pm 5\%$ R.H. Adult *Callosobruchus maculatus* were removed 5 days after introduction an plastic container with its content was then left undisturbed for twenty one days for adult emergence. Day old teneral adults that emerged from the container were used to infest cleaned disinfested legume seeds. Insect culture was maintained for subsequent assay through regular re-culturing.

Entomotoxic test

For toxicity tests, sterilized petridishes (9-cm diamter) containing 40g of disinfected cowpeas were treated with 2g of plant powders separately. Each of the petridishes from both groups was then infested with 10 newly emerged adult bruchids of both sexes. Each treatment and control were replicated three times. Temperature and relative humidity ranges between $25\text{-}30^\circ\text{C}$ and $70\text{-}75\%$ respectively. Ten days after the death of the female, observations were made on number of eggs laid, hatched eggs, unhatched eggs were counted and the weight loss after the emergence of adult.

Calculations and data analysis

Data collected on number of eggs laid, number of hatched eggs and unhatched eggs were subjected to analysis of variance using SPSS version 16.0. Where necessary, data were transformed before analysis. Percentage data were arc-sine transformed and data based on count were square root transformed. Abbot formula was also employed to evaluate the efficacy of the botanicals (Abbot, 1925).

Abbot Formula: $= (1 - \text{Ta}/\text{Ca}) * 100$.

Where Ta=Number of eggs in treated petri dish

Ca=Number of eggs in the control petri dish.

Treatment means of the varietal parameters were separated by Tukey at 5% level of significant.

Ovipositional Response of *C. maculatus* reared on Six Non-cowpea Legumes.

The mean number of eggs laid, hatched, unhatched eggs and percentage pest tolerance of *C. maculatus* screened among the six (6) legume seed types were summarized in Table 5. Mean number of eggs was significantly higher in *Mucuna pruriens* (85.33) than the other legume seed types followed by *Sphenostylis stenocarpa* (72.00) while *Cajanus cajan* (46.67) gave the least. Mean hatched eggs was significantly higher in *Glycine max* (59.67) in than the other legumes, followed by *Vigna subterranean* (44.00), meanwhile *Cajanus cajan* (18.67) had the least. Mean number of unhatched eggs were significantly higher ($P > 0.05$) in *Mucuna pruriens* (48.00), *Sphenostylis stenocarpa* (45.67) *Cajanus cajan* (28.00) and *Vigna subterranean* (27.00) than *Glycine max* (13.53) which recorded the least. A significantly higher ($P < 0.05$) percentage pest tolerance was recorded in *Mucuna pruriens* (99.17), followed by *Sphenostylis stenocarpa* (83.33) and *Cajanus cajan* (67.50) as pest tolerance decreases in Ife Brown (20.83). It was observed that mean number of eggs was significantly higher ($P > 0.05$) in *Mucuna pruriens*, however it recorded the highest percentage pest tolerance as most of the eggs laid were unhatched.

Table 5: Ovipositional Response of *C. maculatus* reared on Non-cowpea Legumes.

| Non-cowpea Legumes | Number of eggs laid | Hatched eggs | Unhatched eggs | Percentage pest tolerance |
|--------------------------------|---------------------|--------------|----------------|---------------------------|
| <i>Sphenostylis stenocarpa</i> | 72.00ab | 26.33ab | 45.67a | 83.33ab |
| <i>Glycine max</i> | 63.00ab | 59.67a | 13.53b | 50.83cd |
| <i>Cajanus cajan</i> | 46.67b | 18.67b | 28.00a | 67.50bc |
| <i>Mucuna pruriens</i> | 85.33a | 37.33ab | 48.00a | 99.17a |
| <i>Vigna subterranean</i> | 71.00ab | 44.00ab | 27.00a | 30.83de |
| Ife Brown (control) | 53.67ab | 42.33ab | 11.33bc | 20.83e |

Means in each column bearing the same letter are not significantly different at the 5% level of probability by Tukey test.

Mean number of eggs laid by *C. maculatus* on Non-cowpea legume seeds treated with botanical powders and cypermethrin.

Table 10 showed mean number of eggs laid on *Cajanus cajan* ranging from 157.33 to 4.33 across all the treatment and 177.67 with the control. Mean number of eggs was significantly lower on seeds treated with *Piper guineense* (4.33), *Eugenia aromatica* (7.67), Cypermethrin (12.67) and *Zanthoxylum zanthoxyloides* (17.00). This indicates their effectiveness in reducing oviposition by *C. maculatus* on pigeon pea. Meanwhile mean number of eggs were significantly higher ($P < 0.05$) in seeds treated with *Ocimum gratissimum* (157.33), *Xylopiya aethiopica* (141.00), *Zingiber officinale* (139.00) and *Allium sativum* (124.00). These treatments were proved not to be effective in reducing oviposition by *C. maculatus*. *Glycine max* had mean number of eggs laid ranged from 151.00 to 8.67 across all the treatment and 96.33 with the control. Mean number of eggs significantly reduced on seeds treated with *Piper guineense* (8.67), *Eugenia aromatica* (11.00) and Cypermethrin (15.67) as a result they were proved effective in reducing oviposition by *C. maculatus*. On the other hand, mean number of eggs were significantly higher ($P < 0.05$) in seeds treated with *Ocimum gratissimum* (151.00), *Momordica charantia* (145.00), *Allium sativum* (144.00), *Zingiber officinale* (141.33) and *Xylopiya aethiopica* (130.67). These indicated their ineffectiveness in reducing oviposition by *C. maculatus*.

It was also observed that *Vigna subterranea* had mean number of eggs laid to range from 114.67 to 9.00 across all the treatment and 201.33 with the control. Mean number of eggs was significantly lower on seeds treated with Cypermethrin (9.00). This was followed by *Piper guineense* (24.00), *Zanthoxylum zanthoxyloides* (24.00) and *Eugenia aromatica* (28.67). Meanwhile mean number of eggs was significantly higher ($p < 0.05$) on seeds treated with *Xylopiya aethiopica* (114.67), *Ocimum gratissimum* (106.33), and *Momordica charantia* (96.33). *Sphenostylis stenocarpa* had mean number of eggs ranging from 175.33 to 14.67 across all the treatment and 160.33 with the control. Mean number of eggs was significantly lower treated on seeds treated with Cypermethrin (14.67) than the other treatments. This was followed by *Oryza sativa* (17.33) and *Zanthoxylum zanthoxyloides* (31.33).

On the other hand, seeds treated with *Zingiber officinale* (175.33) increased mean number of eggs significantly. This was followed by *Xylopi aethiopica* (152.67), *Momordica charantia* (135.33) and *Allium sativum* (105.67). They proved ineffective at preventing egg laying in *C. maculatus*. *Mucuna pruriens* had mean number of eggs laid ranging from 142.33 to 3.67 within all the treatments and 62.67 with the control. Mean number of eggs was significantly lower ($P < 0.05$) on seeds treated with *Zanthoxylum zanthoxyloides* (3.67). This was followed by Cypermethrin (16.33) and *Oryza sativa* (17.00). Meanwhile mean number of eggs were significantly higher ($P < 0.05$) in seeds treated with *Zingiber officinale* (142.33), *Ocimum gratissimum* (106.33) and *Momordica charantia* (129.67). This shows that they were not effective in reducing oviposition by *C. maculatus*.

Table 10: Mean number of eggs laid by *C. maculatus* on Non-cowpea legume seeds treated with botanical powders and cypermethrin.

| Plant species | <i>Cajanus cajan</i> | <i>Glycine max</i> | <i>Vigna subterranea</i> | <i>Sphenostylis stenocarpa</i> | <i>Mucuna pueriens</i> |
|--------------------------|----------------------|----------------------|--------------------------|--------------------------------|------------------------|
| <i>E. aromatic</i> | 7.67 ^d | 11.00 ^c | 28.67 ^{cde} | 84.67 ^{abcd} | 44.33 ^{abc} |
| <i>P. guineense</i> | 4.33 ^d | 8.67 ^c | 24.00 ^{cde} | 82.00 ^{abcd} | 26.00 ^{abc} |
| <i>X. aethiopica</i> | 141.00 ^{ab} | 130.67 ^a | 114.67 ^{ab} | 152.67 ^{ab} | 90.00 ^{abc} |
| <i>Z. officinale</i> | 139.00 ^{ab} | 141.33 ^a | 83.33 ^{abcd} | 175.33 ^a | 142.33 ^a |
| <i>M. charantia</i> | 93.00 ^{abc} | 145.00 ^a | 96.33 ^{abc} | 135.33 ^{abc} | 129.67 ^a |
| <i>O. gratissimum</i> | 157.33 ^{ab} | 151.00 ^a | 106.33 ^{abc} | 98.00 ^{abcd} | 139.33 ^a |
| <i>O. sativa</i> | 26.33 ^{cd} | 15.67 ^{ab} | 53.00 ^{bcde} | 17.33 ^{cd} | 17.00 ^{bc} |
| <i>Z. zanthoxyloides</i> | 17.00 ^d | 23.00 ^{bc} | 24.00 ^{de} | 31.33 ^{bcd} | 3.67 ^c |
| <i>A. sativum</i> | 124.00 ^{ab} | 144.00 ^a | 64.00 ^{bcde} | 105.67 ^{abcd} | 57.33 ^{abc} |
| <i>N. tabacum</i> | 55.00 ^{cd} | 45.67 ^{abc} | 53.33 ^{bcde} | 71.33 ^{abcd} | 104.33 ^{ab} |
| Cypermethrin | 12.67 ^d | 15.67 ^c | 9.00 ^e | 14.67 ^d | 16.33 ^{bc} |
| Control | 177.67 ^a | 96.33 ^{ab} | 201.33 ^a | 160.33 ^a | 62.67 ^{abc} |

Means in each column bearing the same letter are not significantly different at the 5% level of probability by Tukey test

Mean hatched eggs from eggs oviposited by C. maculatus on Non-cowpea legume seeds treated with different botanical powders and cypermethrin.

Table 11 shows mean hatched eggs on *Cajanus cajan* ranging from 140.67 to 2.33 and 153.67 with the control. Mean number of hatched eggs was significantly lower on seeds treated with *Piper guineense* (2.33), *Eugenia aromatica* (5.00), Cypermethrin (11.67) and *Zanthoxylum zanthoxyloides* (14.33). On the other hand, mean hatched eggs were significantly higher ($P<0.05$) in seeds treated *Ocimum gratissimum* (140.67), *Zingiber Officinale* (124.33) and *Xylopi aethiopica* (115.67). They proved ineffective in reducing hatchability in *C. maculatus*. Also, *Glycine max* had mean hatched eggs ranging from 130.67 to 5.00 within all the treatments and 66.33 with the control. Mean Hatched eggs was significantly lower ($P<0.05$) on seeds treated with *Piper guineense* (5.00) and *Eugenia aromatica* (8.33) among others treatment. This was followed by *Oryza sativa* (11.67), Cypermethrin (13.33) and *Zanthoxylum zanthoxyloides* (14.33). Meanwhile seeds treated with *Allium sativum* (130.67) were significantly higher in hatched eggs followed by *Momordica charantia* (98.67) and *Zingiber officinale* (89.67).

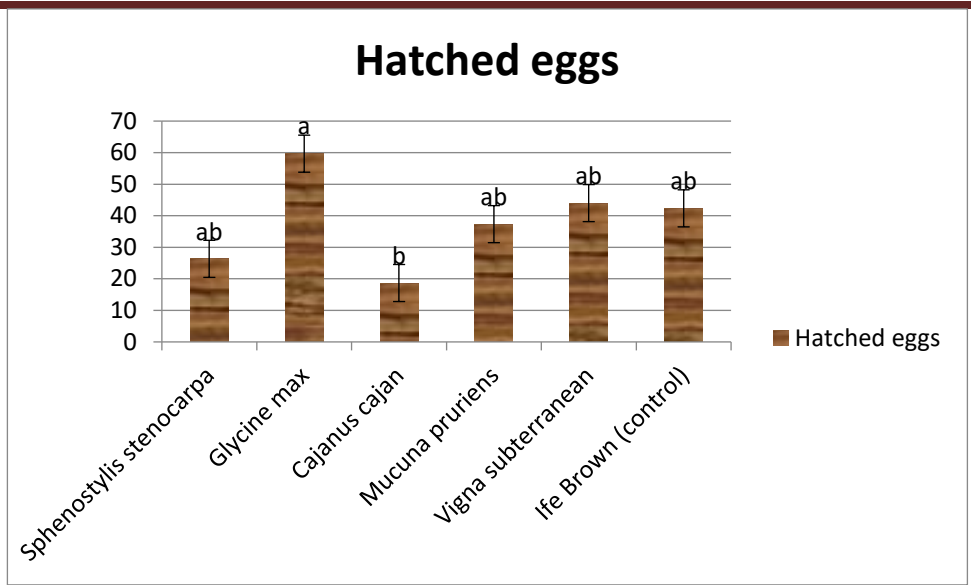
Vigna subterranean had mean hatched eggs ranging from 96.67 to 6.00 in all the treatments and 171.33 with the control. Mean hatched eggs was significantly lower ($P<0.05$) on seeds treated with Cypermethrin (6.00) as expected, followed by *Zanthoxylum zanthoxyloides* (17.00). On the other mean hatched eggs were significantly higher ($P<0.05$) in seeds treated with *Xylopi aethiopica* (96.67), *Momordica charantia* (89.33) and *Zingiber officinale* (70.67). They proved ineffective in reducing hatchability of eggs laid by *C. maculatus*. *Sphenostylis stenocarpa* had mean hatched eggs ranging from 119.67 to 11.67 in all the treatment and 119.00 with the control. Mean hatched eggs was significantly lower ($P<0.05$) on seeds treated with Cypermethrin (11.67) and *Oryza sativa* (12.67). Meanwhile seeds treated with *Xylopi aethiopica* (119.67) had significantly higher ($P<0.05$) mean hatched eggs than the other treatment. This was followed by *Zingiber officinale* (108.33), *Momordica charantia* (104.00), *Allium sativum* (80.67) and *Ocimum gratissimum* (78.33). They proved ineffective in reducing hatched eggs in *C. maculatus*.

Mucuna pruriens had mean hatched eggs ranging from 109.67 to 2.33 in all the treatment used and 39.67 with the control. Mean hatched eggs was significantly lower on seeds treated with *Eugenia aromatica* (2.33) and *Zanthoxylum zanthoxyloides* (2.67). On the other hand, seeds treated with *Zingiber officinale* (109.67) and *Momordica charantia* (95.67) had significantly higher ($P<0.05$) mean hatched eggs indicating their ineffectiveness in reducing hatched eggs in *C. maculatus*.

Table 11: Mean hatched eggs from eggs oviposited by *c. maculatus* on Non-cowpea legume seeds treated with different botanical powders and cypermethrin

| S/N | Plant species | <i>Cajanus cajan</i> | <i>Glycine max</i> | <i>Vigna subterranea</i> | <i>Sphenostylis stenocarpa</i> | <i>Mucuna pueriens</i> |
|-----|--------------------------|----------------------|----------------------|--------------------------|--------------------------------|------------------------|
| 1 | <i>E. aromatic</i> | 5.00 ^d | 8.33 ^d | 23.33 ^{bcd} | 57.67 ^{ab} | 2.33 ^c |
| 2 | <i>P. guineense</i> | 2.33 ^d | 5.00 ^d | 22.67 ^{bcd} | 27.00 ^{ab} | 5.00 ^{bc} |
| 3 | <i>X. aethiopica</i> | 115.67 ^a | 98.67 ^{ab} | 96.67 ^{ab} | 119.67 ^a | 52.00 ^{abc} |
| 4 | <i>Z. officinale</i> | 124.33 ^a | 89.67 ^{ab} | 70.67 ^{abc} | 108.33 ^{ab} | 109.67 ^a |
| 5 | <i>M. charantia</i> | 84.33 ^{abc} | 103.33 ^{ab} | 89.33 ^{ab} | 104.00 ^{ab} | 95.67 ^a |
| 6 | <i>O. gratissimum</i> | 140.67 ^a | 82.67 ^{ab} | 93.67 ^{ab} | 78.33 ^{ab} | 94.67 ^{ab} |
| 7 | <i>O. sativa</i> | 24.00 ^{cd} | 11.67 ^{cd} | 49.33 ^{bcd} | 12.67 ^b | 13.67 ^{abc} |
| 8 | <i>Z. zanthoxyloides</i> | 14.33 ^d | 14.33 ^{cd} | 17.00 ^{cd} | 18.33 ^{ab} | 2.67 ^c |
| 9 | <i>A. sativum</i> | 103.00 ^{ab} | 130.67 ^a | 55.33 ^{bcd} | 80.67 ^{ab} | 54.00 ^{abc} |
| 10 | <i>N. tabacum</i> | 35.00 ^{bcd} | 38.33 ^{bcd} | 45.67 ^{bcd} | 12.67 ^{ab} | 70.00 ^{abc} |
| 11 | Cypermethrin | 11.67 ^d | 13.33 ^{cd} | 6.00 ^d | 11.67 ^b | 11.33 ^{abc} |
| 12 | Control | 153.67 ^a | 66.33 ^{abc} | 171.33 ^a | 119.00 ^a | 39.67 ^{abc} |

Means in each column bearing the same letter are not significantly different at the 5% level of probability by Tukey test.



Mean unhatched eggs from eggs oviposited by *C. maculatus* on Non-cowpea legume seeds treated with different botanical powders and cypermethrin.

Mean unhatched eggs among all the treatment used on the different legume seed types were summarized in Table 12. It was observed that *Cajanus cajan* had unhatched eggs ranging from 25.33 to 1.00 across all the treatment with the control recording 24.00. Unhatched eggs were significantly lower ($P < 0.05$) on seeds treated with Cypermethrin (1.00) and *Piper guineense* (2.00) similar result was observed with seeds treated with *Oryza sativa* (2.33), *Eugenia aromatica* (2.67) and *Zanthoxylum zanthoxyloides* (2.67). Meanwhile unhatched egg was significantly higher on seeds treated with *Xylopia aethiopica* (25.33), *Allium sativum* (21.00) and *Nicotiana tabacum* (20.00) than the other treatment.

Glycine max had mean unhatched eggs ranging from 61.67 to 2.33 across all the treatment with the control reading 30.00. Mean unhatched eggs was significantly lower ($P < 0.05$) on seeds treated with Cypermethrin (2.33), *Eugenia aromatica* (2.67), *Piper guineense* (3.67), *Oryza sativa* (4.00) and *Nicotiana tabacum* (7.33). On the other hand, mean unhatched eggs significantly higher in seeds treated with *Ocimum gratissimum* (61.67). This was followed by *Zingiber officinale* (51.67) and *Momordica charantia* (41.67). Also, *Vigna subterranean* had unhatched eggs ranging from 18.00 to 1.33 across all the treatment with the control recording 30.00. Seeds treated with *Piper guineense* (1.33), Cypermethrin (3.00) *Oryza sativa* (3.67) and *Eugenia aromatica* (5.33) had significantly lower number of unhatched eggs. Meanwhile seeds treated with *Xylopia aethiopica* (18.00), *Zingiber officinale* (12.67) and *Ocimum gratissimum* (12.67) had significantly higher ($P < 0.05$) unhatched eggs.

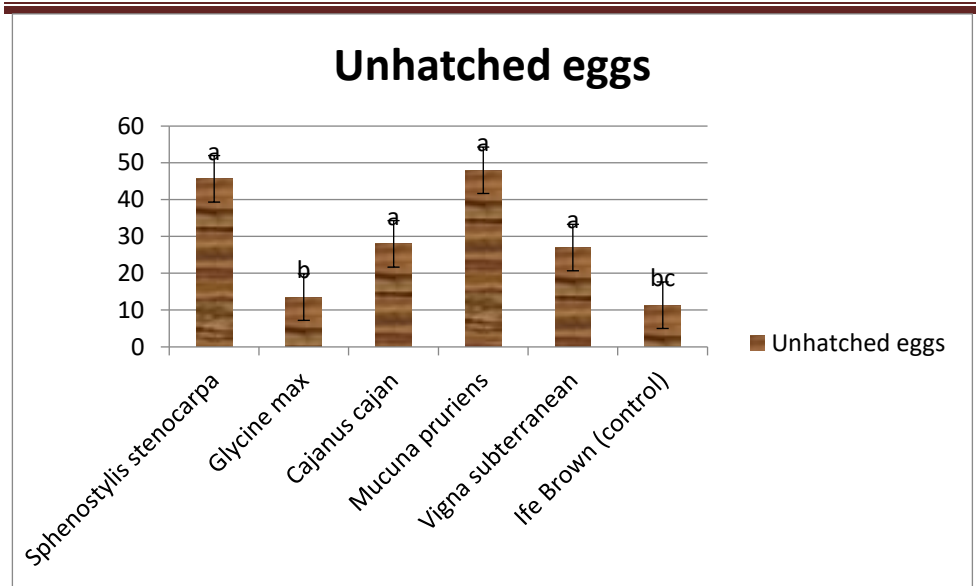
Sphenostylis stenocarpa had unhatched eggs ranging from 67.00 to 3.00 across all the treatment and 41.33 with the control. Mean unhatched eggs was significantly lower on seeds treated with seeds treated with Cypermethrin (3.00) and *Oryza sativa* (4.67). This was followed by *Zanthoxylum zanthoxyloides* (13.00). Mean unhatched eggs increased significantly on seeds treated with *Zingiber officinale* (67.00), *Nicotiana tabacum* (58.67), *Eugenia aromatica* (57.67) and *Piper guineense* (55.00) had than the other treatments. It was discovered that *Mucuna pruriens* had mean unhatched eggs ranging from 44.67 to 1.00 across all the treatment and 23.00 with the control. Mean unhatched eggs was significantly lower on seeds treated with

seeds treated with *Zanthoxylum zanthoxyloides* (1.00). This was followed by *Oryza sativa* (3.33) and Cypermethrin (5.00). Meanwhile seeds treated with *Ocimum gratissimum* (44.67) had significantly higher ($P<0.05$) number of unhatched eggs followed by *Eugenia aromatica* (42.00), *Xylopiya aethiopica* (38.00), *Momordica charantia* (34.33) and *Zingiber Officinale* (32.67).

Table 12: Mean unhatched eggs from eggs oviposited by *C. maculatus* on legume seeds treated with different botanical powders and cypermethrin.

| S/N | Plant species | <i>Cajanus cajan</i> | <i>Glycine max</i> | <i>Vigna subterranean</i> | <i>Sphenostylis stenocarpa</i> | <i>Mucuna pueriens</i> |
|-----|--------------------------|----------------------|--------------------|---------------------------|--------------------------------|------------------------|
| 1 | <i>E. aromatic</i> | 2.67cd | 2.67c | 5.33b | 57.67abc | 42.00ab |
| 2 | <i>P. guineense</i> | 2.00d | 3.67c | 1.33b | 55.00abc | 21.00abcd |
| 3 | <i>X. aethiopica</i> | 25.33ab | 32.00abc | 18.00ab | 33.00abcd | 38.00ab |
| 4 | <i>Z. officinale</i> | 14.67abcd | 51.67ab | 12.67ab | 67.00ab | 32.67abc |
| 5 | <i>M. charantia</i> | 8.67bcd | 41.67ab | 7.00b | 31.33abcd | 34.00abc |
| 6 | <i>O. gratissimum</i> | 16.67abcd | 61.67a | 12.67ab | 19.67bcd | 44.67a |
| 7 | <i>O. sativa</i> | 2.33cd | 4.00c | 3.67b | 4.67d | 3.33cd |
| 8 | <i>Z. zanthoxyloides</i> | 2.67cd | 8.67c | 7.00b | 13.00cd | 1.00d |
| 9 | <i>A. sativum</i> | 21.00abc | 13.33bc | 8.67ab | 25.00bcd | 3.33bcd |
| 10 | <i>N. tabacum</i> | 20.00abc | 7.33c | 7.67ab | 58.67ab | 34.33abc |
| 11 | Cypermethrin | 1.00d | 2.33c | 3.00b | 3.00d | 5.00bcd |
| 12 | Control | 24.00ab | 30.00abc | 30.00a | 41.33abc | 23.00abcd |

Means in each column bearing the same letter are not significantly different at the 5% level of probability by Tukey test.



Mean percentage weight loss observed on Non-cowpea legume seeds treated with different botanical powders.

The percentage weight losses of the different legume seed type after application of the insecticides were documented in Table 13. It was observed that *Cajanus cajan* had percentage weight loss ranging from 6.43 to 0.4 across all the treatment and 5.07 with the control. There was no significant difference observed in percentage weight loss among all the treatment. However, *Allium sativum* (6.43) and *Zingiber officinale* (5.3) had increased percentage seed weight loss while seeds treated with *Piper guineense* (0.40) and *Zanthoxylum zanthoxyloides* (0.83) gave the least percentage seed weight loss. *Glycine max* had percentage weight loss ranging from 2.17 to 0.00 across all the treatment. No percentage weight loss was observed on seeds treated with *Eugenia aromatica* (0.00) *Piper guineense* (0.00) and *Xylopiya aethiopica* (0.00). There was no significant difference among all the treatment used except the control which was significantly higher in percentage weight loss.

Also, *Vigna subterranean* had percentage weight loss ranging from 20.53 to 0.00 among all the treatment and 14.00 with the control. No weight loss was recorded in seeds treated with *Eugenia aromatica* (0.00) while seeds treated with Cypermethrin (3.17) had least percentage weight loss. Meanwhile percentage weight loss was significantly higher ($P < 0.05$) on seeds treated with *Xylopiya aethiopica* (21.50) and *Ocimum gratissimum* (20.53). *Sphenostylis stenocarpa* had percentage weight loss ranging from 3.37 to 1.63 across all the treatment applied and 2.83 with the control. There were no significant differences in percentage weight loss among all the treatment applied. *Mucuna pruriens* had zero percentage weight loss among all the treatments applied. This indicate that *Mucuna pruriens* is highly resistant to *C. maculatus* because despite the cowpea beetle laid so much eggs on the seed the insect could not bore a single hole on the seed.

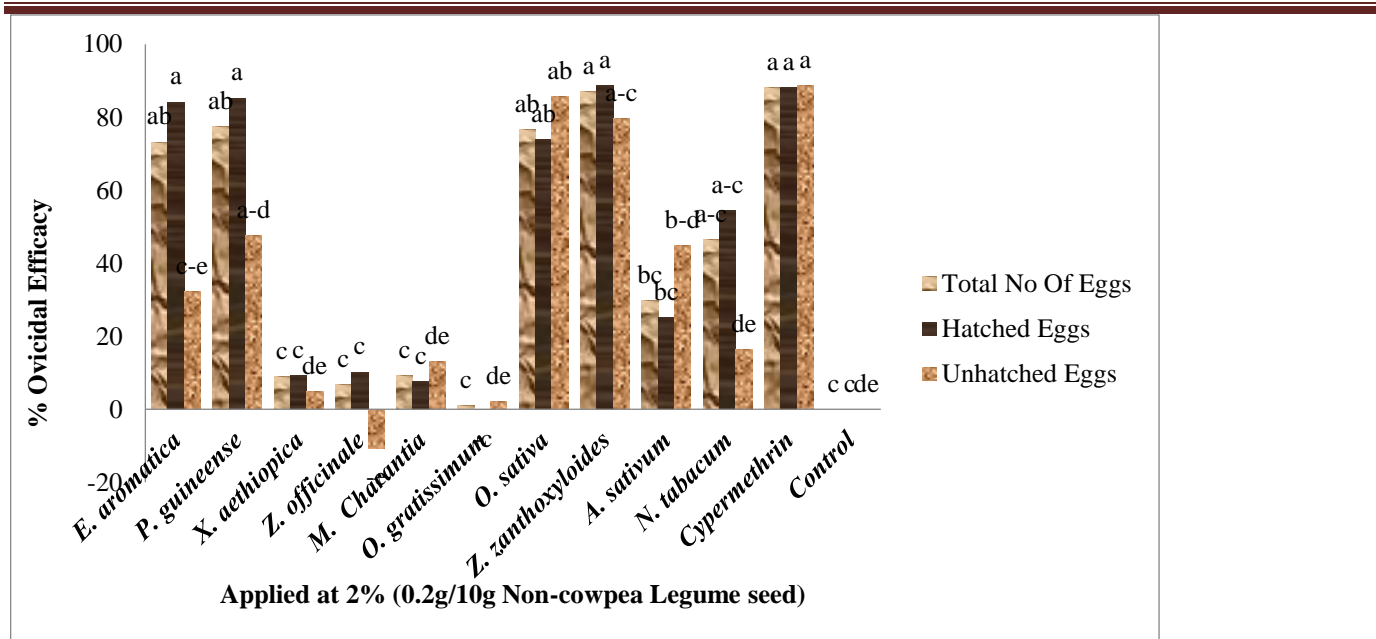
Table 13: Effect of cypermethrin dust and different plant powders on the percentage weight loss of different legume seed type.

| S/N | Plant species | <i>Cajanus cajan</i> | <i>Glycine max</i> | <i>Vigna subterranean</i> | <i>Sphenostylis stenocarpa</i> | <i>Mucuna pueriens</i> |
|-----|--------------------------|----------------------|--------------------|---------------------------|--------------------------------|------------------------|
| 1 | <i>E. aromatic</i> | 1.3a | 0.00b | 0.00b | 1.67a | 0.00 |
| 2 | <i>P. guineense</i> | 0.4a | 0.00b | 13.77ab | 1.87a | 0.00 |
| 3 | <i>X. aethiopica</i> | 3.4a | 0.00b | 21.50a | 2.23a | 0.00 |
| 4 | <i>Z. officinale</i> | 5.3a | 0.17b | 6.53ab | 2.60a | 0.00 |
| 5 | <i>M. charantia</i> | 2.43a | 1.53b | 14.37ab | 1.87a | 0.00 |
| 6 | <i>O. gratissimum</i> | 4.6a | 1.20b | 20.53a | 3.37a | 0.00 |
| 7 | <i>O. sativa</i> | 1.03a | 0.00b | 6.67ab | 2.57a | 0.00 |
| 8 | <i>Z. zanthoxyloides</i> | 0.83a | 1.23b | 6.77ab | 1.67a | 0.00 |
| 9 | <i>A. sativum</i> | 6.43a | 2.17b | 5.30ab | 3.30a | 0.00 |
| 10 | <i>N. tabacum</i> | 4.27a | 0.43b | 10.03ab | 1.63a | 0.00 |
| 11 | Cypermethrin | 1.27a | 0.50b | 3.17ab | 3.13a | 0.00 |
| 12 | Control | 5.07a | 12.33a | 14.00ab | 2.83a | 0.00 |

Means in each column bearing the same letter are not significantly different at the 5% level of probability by Tukey test

Ovicidal effects of the botanical powders on eggs laid by *C. maculatus* on non-cowpea legume seeds.

Ovicidal efficacy of all the botanicals across the legume seed types were compared and summarized in figure 2. Ovicidal efficacy of the botanicals studied ranged from 88.16% to 1.11% with control at 0.00%. It was observed that ovicidal efficacy was significantly higher ($P < 0.05$) in seeds treated with Cypermethrin (88.16%), *Zanthoxylum zanthoxyloides* (87.02%), *Piper guineense* (77.36%) and *Eugenia aromatica* (73.21%). Ovicidal efficacy among the legume types followed the same trend as that of the cowpea varieties studied amidst the the aforementioned treatments. Meanwhile seeds treated with *Momordica charantia* (9.29%), *Xylopiya aethiopica* (9.07%), *Zingiber officinale* (6.88%) and *Ocimum gratissimum* (1.11%) showed reduced ability in deterring oviposition in *C. maculatus*.



Means in each column bearing the same letter are not significantly different at the 5% level of probability by Tukey test.

Figure 1: Ovicidal effects of the botanical powders on eggs laid by *C. maculatus* on non-cowpea legume seeds.

Discussion

The present study showed that the ovipositional preference of female *Callosobruchus maculatus* varied among different types of legumes. The result of the present study has shown that some of the legume types evaluated show various degrees of resistance and susceptibility to adult *C. maculatus* attack. This supports the findings of Oke and Olajire (2012), who reported that the cowpea varieties studied, exhibited some levels of resistance and susceptibility to *Callosobruchus maculatus*. The use of plants resistant to insect attack represents a promising alternative to reduce damage, considering that plants produce chemical defenses, such as protease inhibitors, that can inhibit insect enzymes (Kuroda *et al.*, 1996). Insects of the family Bruchidea have as their main digestive enzymes serine and cysteine protease. The grains of cowpea plants grown with different nitrogen sources were assimilated differently by the insects. Various type of plant proteins has been identified as being toxic to different groups of insects, for example plant lectins. These insects discriminate grains containing these proteins. Factors such as hardness of grains, seeds size, lack of nutritional factors and presence of toxic substances may decrease the damage of *C. maculatus* to cowpea seeds. The grains containing sugars, organic acids, amino acids, proteins and peptides, flavinoids, anthocyanins, alkaloids, terpenes and steroids, with a great amount of nitrogen available, it will be possible to produce more of these molecules that can participate in the defense mechanisms of the plant. Varieties of *V. unguiculata* resistant to bruchids are rich in phenolics, alkaloids and terpenes. Result obtained from this study shows, there were significant difference in the levels of resistance and susceptibility among the legume seed types to *Callosobruchus maculatus*. *Mucuna pruriens* was discovered to be the most resistant to *C. maculatus* followed by *Sphenostylis stenocarpa*, *Cajanus cajan* and *Glycine max*.

The least resistant or susceptible legume was discovered to be Ife Brown. With scanning electron microscopy, it was revealed that; solid and compressed subepidermal sclereids were found in resistant accessions of cowpea while longitudinal ridges of subepidermal sclereids were found in susceptible materials (Ramirez, Ma. C. F; Rasco, E. T. Jr, 2015). Since seed properties including seed testa colour, mass, size and moisture content generally do not influence the susceptibility of cowpea seeds and other cereals grains to *C. maculatus* in storage (Maina and Lale, 2005; Maina and Dlamini, 2009), the above observed differences were very likely due to variations in the composition or levels of chemical substances that either deter or stimulate bruchid oviposition and/or feeding in these seeds. Alternatively, seed properties such as seed coat texture (smooth or rough) and hardness might have contributed to the differences observed. For instance, studies by Messina and Renwick (1985) that evaluated the resistance of selected cowpea lines to infestation by *C. maculatus*, found that rough seed coat was less preferred for oviposition by the bruchid beetle.

Ovicidal efficacy of the Botanicals across all the legume seeds

Earlier literature indicated the importance of plant extract in protecting seeds by way of direct mixing of the dried leaves, plant powders, solvent extracts, vegetable essential oils on seeds during post-harvest storage (Ngamo *et al.*, 2007). The justification for the comparison of *Eugenia aromatica*, *Piper guineense*, *Zanthoxylum zanthoxyliodes* and *Oryza sativa* in the control of *C. maculatus* had been predicated on claims by many authors of their effectiveness in grain protection against pest depredation in storage. It is unequivocal that the powders made from these plants manifested insecticidal action against *C. maculatus* in this study. From this study it was proved that powders made from *Eugenia aromatica*, *Piper guineense*, *Zanthoxylum zanthoxyliodes* and *Oryza sativa* (rice husk ash) at 0.2g/10g of legume seed types were found to have insecticidal effect on *Callosobruchus maculatus* in stored legume seeds. From the result obtained it was obvious that *Zanthoxylum zanthoxyliodes* performed as the best botanicals to use in preserving legumes from weight loss and consequently damage caused by *C. maculatus*. These observations confirm that of Mbata (1993) who reported that weight loss is generally highly correlated with susceptibility index.

It was also observed that *Zanthoxylum zanthoxyliodes* could compete favourably with cypermethrin in its ovicidal efficacy against *C. maculatus*. The toxic effect of *Zanthoxylum zanthoxyliodes* could be linked to the presence of secondary phenolic compound known as zanthoxylol and this had been reported to have mortality and ovicidal effect on stored product insect pests (Udo, 2011; Akinneye and Ogungbite, 2013). It was also discovered that *Zanthoxylum* spp. contain cuminic aldehyde. Hydroxy-alpha sanshool is a bioactive component of plants from the *Zanthoxylum* genus, including the Sichuan pepper. The relative amounts of these chemicals, their interactions and volatility of products may determine the observed bioactivities of the plants against *C. maculatus*. Some common chemicals such as limonene, eugenol and cineole found in *Eugenia* and *piper* may explain their similar action against the insects.

Some the botanical powders *Ocimum gratissimum*, *Xylopiia eithopica*, *Zingiber officinale*, *Momordica charantia*, *Allium sativum* and *Nicotiana tabacum* were significantly ineffective in protecting legumes which may be due to hormoligosis. Lale (1991) reported, sub-lethal doses of botanical insecticides stimulate female oviposition and also behavioral *hormoligosis* in oviposition preference was reported by Faten A. El-Daly, (2008).

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INFORMATION SOURCING AND TRAINING AMONG RABBIT FARMERS: EVIDENCE FROM SOUTH -WEST NIGERIA

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Abstract

Agricultural information is an important aspect of farming which is capable of providing farmers with useful information that could help improve the productivity, various study have being carried out in relation to rabbit nutrition, reproduction, housing, profitability and rabbit value chain but not much study exist on how farmers source for information on rabbit farming to help improve productivity hence this study was designed to have an insight into how existing rabbit farmers source for information on rabbit production and productivity. Using a structured questionnaire at scheduled interview sections necessary information was collected from 105 rabbit farmers in South-West Nigeria on the activities of extension agents, training attended and how they source for information on rabbit production. Data collected were analyzed descriptively. Result from this study revealed that majority of the respondents get information on rabbit production from the internet while only few depends on extension agents. About 73% of the respondents were not visited by extension agents and 38% of the respondents want to be visited. About 35% of the respondents had undergone formal training on rabbit keeping while 58% of the respondents have not. The study submits that there is a need for extension agents to be more proactive on various social media platforms involving rabbit farmers and be better equipped with information on rabbit production which could be of help to farmers. The study recommends that rabbit farming be included alongside other livestock practices like poultry, pig and fish production during trainings organized by stakeholders.

Keys: Information, Rabbit farming, Trainings, Extension agents, Internet.

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Introduction

Information is an essential resource for individual's growth and survival since information enriches the mind and keeps it un-deformed (Ayanyemi, 2006). Agricultural information on the other hand is an important aspect of farming in a variety of ways. It helps farmers to take good production and management decisions which could have impacts on the productivity of such agricultural venture (Kursat, 2010). To improve the productivity of any agricultural venture, there is a need for farmers to have up-to date information on new innovations as related to such ventures. Rabbit farming is not left out. The necessary information needed to bring about improvement can be sourced using various means some of which includes one on one interaction with other farmers, attending formal trainings, activities of extension officers, from book, use of internet etc. The internet has become an important tool in information dissemination particularly via the various social media available. Anirban (2017) reports that the speed, distance and coverage of the social media makes it an important tool in modern agriculture.

Rabbit farming is an aspect of micro-livestock that is gradually becoming popular particularly among small scale backyard farmers who wish to improve their household protein intake while making some extra income for the family (Ndyomugenyi *et.al*;2013). In other to increase productivity and availability of rabbit meat in Nigeria there is need for farmers to be well informed about new innovations and technologies as related to rabbit farming. Various study have being carried out in relation to rabbit nutrition, reproduction in rabbits, housing of rabbits, profitability of the rabbit industry and rabbit value chain but not much study exist on how farmers source for information on rabbits and rabbit farming to help improve productivity hence this study was designed to have an insight into how existing rabbit farmers source for information on rabbit production and productivity and to suggest how these information dissemination system can be improved to help the rabbit industry to grow.

Materials and methods

A survey was carried out among rabbit farmers in South-West Nigeria to find out how rabbit farmers get information and trainings to help them with improvement of the enterprise.

Using a multistage sampling technique, five (5) states in South-West Nigeria which were Lagos, Ogun, Oyo, Osun and Ondo states were randomly selected for the experiment which involved only rabbit framers. Then, Rabbit farmers Associations in the various states were contacted through extension agents in the Agricultural Development Projects (ADP) of each State. A snowball sampling technique was used to identify twenty (25) rabbit farmers in each of the State. Information on how the farmer's sources for information on rabbit farming, if they have attended trainings related to rabbit farming and activities of extension agents we gathered during the survey. Of the one hundred and twenty-five (125) questionnaires administered, only one hundred and five (105) were properly answered. Results obtained from the survey alongside one-on-one discussion

with the respondents were used to depict various value chain of rabbit production in the study area. Data collected were analyzed descriptively using SPSS 16.0 package.

Result and Discussion

The result on table 1 shows response of respondents on how information on cuniculture are sourced and exchanged in the study area. From this result it is observed that majority (about 54%) of the respondents get information on rabbit production from the internet, 31% from other farmers while only 5% depends on information from extension agents. The high number of farmers sourcing for information from the internet suggests that the internet plays an important role of equipping rabbit farmers with some form of informal training. With the existence of various rabbit producers groups on different social media platform on the internet, sourcing for information by farmers in such group is made easier but the authenticity of such information maybe questionable hence there is a need for livestock extension officers to be proactive on various social media platforms, this could help rabbit farmers have access to up to date innovations and knowledge exchange which could bring about positive change in the rabbit industry (Anirban, 2017).

It is important for farmers to be trained before embarking on any form of livestock production since trainings help improve the productivity of any venture as reported by Mansoor, (2007) as new information are gathered from such training. This study revealed that only about 35% of the respondents had undergone formal training on rabbit keeping while 58% of the respondents have not taken trainings on rabbit keeping hence it is assumed that such persons who have not being trained in the act of rabbit farming will be learning on the job which may involve a lot of mistakes and they learning from such mistakes (Amitabh, 2012). The high number of untrained rabbit farmers could be associated with absences of organized training focused on rabbit farming as most livestock training organized by agricultural training institutes are often centered on poultry, fishery and pig production, hence the need to include cuniculture in some livestock farm trainings organized by stakeholders in the livestock industry to help more persons get familiar with farming rabbits.

On the activities of extension officers in the rabbit production industry, the result from this study revealed that only about 27% of the farmers were visited by extension officers, about 38% of the respondents who are not visited will want to be visited by extension agents who have information on how to improve the productivity of the rabbits. During the course of the study some of the farmers who do not want to be visited by extension officers complained that some extension officer's visit is often centered on collection of data on productivity and performance of the venture and do not have necessarily new information about rabbit farming for them. In view of these, there is a need to further educate livestock extension officers on rabbit production, how to improve productivity and address common challenges related to rabbit farming. These could be archived by carrying out in-service training to help keep the available livestock extension agents abreast on new technologies and innovations that could help the farmers. This study is in agreement with that

of Jasim *et al*; (2016) on the need for an in-service training of extension agents for better performance of extension agents.

Conclusion

The findings of this study on information sourcing and training of rabbit farmers revealed the need for;

1. frequent in-service training on rabbit farming to help keep the available livestock extension agents abreast on new technologies and innovations that could help the farmers.
2. rabbit farming be include alongside other livestock practices like poultry production, pig production and fish production during trainings organized by both the governments and NGOs
3. livestock extension officers to be proactive on various social media platform, this could help rabbit farmers have access to up-to-date innovations and better knowledge exchange among rabbit farmers.

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Table 1: Responses of rabbit farmers in South-West Nigeria on how they get relevant up-to-date information on rabbit farming.

| | Frequency | Percentage |
|--|-----------|------------|
| Have you attended any form of training in rabbit farming? | | |
| Yes | 37 | 35.2 |
| No | 61 | 58.1 |
| No response | 7 | 6.7 |
| Total | 105 | 100 |
| How do you source for information on Rabbit farming? | | |
| Other farmers/ friends | 33 | 31.4 |
| From the internet | 57 | 54.3 |
| Institutions around | 10 | 9.5 |
| Extension officers | 5 | 4.8 |
| Total | 105 | 100 |
| Are their extension agents visiting you? | | |
| Yes | 28 | 26.7 |
| No | 77 | 73.3 |
| Total | 105 | 100 |
| Will you want to be visited by specific extension agents? | | |
| Yes | 40 | 38.1 |
| No | 23 | 21.9 |
| No response | 42 | 40.0 |
| Total | 105 | 100 |
| Frequency of extension visitation | | |
| No response | 77 | 75.2 |
| Forthrightly | 14 | 13.3 |
| Twice monthly | 7 | 6.7 |
| One monthly | 3 | 2.9 |
| Twice weekly | 2 | 1.9 |
| Total | 105 | 100 |
| Have you got any form of government interventions? | | |
| Yes | 0 | 0 |
| No | 100 | 95.2 |
| No response | 5 | 4.8 |
| Total | 105 | 100 |

Source: Survey 2019

ASSESSMENT OF DETERMINANTS OF OCCUPATIONAL DIVERSIFICATION AMONG RURAL WOMEN IN AKURE NORTH LOCAL GOVERNMENT AREA, ONDO STATE, NIGERIA.

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Abstract

This study examined determinants of occupational diversification among rural women in Akure North Local Government Area of Ondo State. The objectives of the study were to examine the socio-economic characteristics of rural women, ascertain area of occupational diversification among rural women, examine the determinant of occupational diversification among rural women, determine the effects of occupational diversification on the income of rural women and identify problems faced by rural women in occupational diversification in the study area. Primary data were collected with the aid of well-structured questionnaire from one hundred (100) randomly selected rural women. The data were analysed using descriptive and inferential statistics. The findings revealed that the average age of the respondents was 42 years, 64% of the respondents were married, 91% of the respondents had household size of less than 9 (average of 5 persons). The findings further revealed that 58% had formal education while 40% of the respondents are into farming. The regression result showed that age(X_2), educational level(X_6), monthly non-farm income (X_7) and months devoted for secondary occupation (X_8) were important factors determining occupational diversification of rural women in the study area. However, major problems encountered by rural women in the study area were inadequate access to loan, poor educational attainment and social norms. It was concluded that occupational diversification is an important strategy employed by rural women in order to cope with crisis and seasonal stress in both farm and non-farm activities. It was therefore recommended among others that there should be inclusion of non-farm occupations in rural extension service by the government.

Keywords: Assessment, Determinants, Diversification and Rural women

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Introduction

Occupational diversification in rural areas is the reallocation and recombination of all economic activities which display sufficiently strong rural linkages, irrespective of whether they are located in designated areas or not (Saith, 2002). The concept of occupational diversification is emerging as a survival strategy of rural household in developing countries (Bryceson, 2000 and Ellis, 2000) where rural women need to diversify into various occupations since farming is rain fed and therefore seasonal. This is to enable them acquire additional income and meet up with economic responsibilities during off-season periods. Tacolic (2004) defined occupational diversification as non-farm income generating activities undertaken by rural residents, and farming by urban residents. Occupational diversification among rural women is an increasingly important reality in Nigeria because of low level of development as a result of structural transformation and high population

density. Recent trends in agricultural modernization have failed to improve the welfare of rural women. Advances in technology and labour market imperfections have accentuated the concentration of rural women in non-farm activities in rural sector. This has led to de-agrarianisation. De-agrarianisation offers rural women an opportunity for occupational adjustment income-earning, re-orientation, social identification and spatial relocation away from agricultural-based modes of livelihood (Bryceson, 2000). Amidst high levels of uncertainty and risk in agricultural production, rural women have become occupationally flexible and increasingly dependent on non-government income generating activities. This is to overcome seasonality of farming activities, reduce poverty and vulnerability which are associated with undue reliance on agriculture (Ellis, 2004). High variability in crop yield and thus income variability arising from the vagaries of weather makes occupational diversification important to rural woman in order to improve their economic status.

In Nigeria, several poverty reduction programmes designed for rural women have not yielded good results as regards reducing poverty. The failure of many poverty reduction programmes could be attributed to the fact that great diversity and heterogeneity in assets portfolios and range of activities engaged by rural women were ignored (Alain De Janvry and Sadoulet, 2001). According to Ellis (2004), occupational diversification possesses positive attributes for poverty and vulnerability reduction. It is partly predicated and itself increases human capital in term of experience, skill and willingness to innovate. It generates earnings and remittances that alter the options open to the household by providing it with cash resources that can be flexibly deployed. It contributes to lessening vulnerability by ameliorating risk and reducing to adverse consumption effects of seasonality.

The impact of occupational diversification varies from negative effect the withdrawal of critical of labour from the family farm to positive effects the alleviation of credit constraints and a reduction in the risk of innovation. The contribution made by occupational diversification to rural occupational is a significant one which has often been ignored by policy makers who have chosen to focus their activities on agriculture (Ellis, (1998); Reardon (1997) and Turner *et al.*, (1993). Occupational diversification becomes pertinent in order for the rural women to cope with the aforementioned factors. Occupational diversification involves incorporating all economic activities in rural areas, except crop and livestock production, fishing and hunting. Agriculture led growth is an important role in reducing poverty and transforming the economics of rural communities in many developing countries, but the same has not yet occurred in Sub-Sahara Africa (SSA). Most countries in SSA are yet to meet the criteria for a successful agricultural revolution. This has led to growing doubt about the relevance of agriculture to growth and poverty reduction in the region, especially in Nigeria. There also exists lack of access to land or land ownership among rural women in Nigeria with an increasing rural population amidst a non-expanding land area as in the country.

Rural areas are the economic backbone in most developing countries, and they enhance economic growth through Job creation, labour supply, provide food and raw materials to other growing sectors of economy, and help generate foreign exchange. Rural households diversify income source by combining two or more jobs (multiple job holding) to enhance food consumption and acquire other basic needs (Oluwatayo 2009). Rural women need to diversify into various occupations since farming is rain-fed and therefore, seasonal. This is to enable them to acquire additional income and meet up with economic responsibilities during off-season periodic. This study will help to identify areas of occupational diversification among rural women, effects of occupational diversification and various governmental and non-governmental programmes/effects for economic empowerment of rural women. It will also suggest strategies for improving the rural women by diversify to different types of occupation.

Hypothesis of the Study

H₀: There is no significant relationship between occupational diversification and socio-economic characteristics of rural women in the study area.

Methodology

Study Area

The study was carried out in Akure North Local Government Area of Ondo State, Nigeria. Its headquarters is in Iju/Itaogbolu. It has a total land mass of 660km² and a population of 131,387 (NPC 2006). The state has 18 local government areas and lies between latitude 7^o10' north and longitude 5^o05' east with a landmass of 15,300km². The local government comprises of both Christians and Muslims. Airegbe festival and the odunina festival are known to be popular festivals held in Akure North. Akure and its environment experience a frequent annual rainfall of over 1500mm with short August break. The average temperature is about 22^oC during hamattan (December-February) and 32^oC in March. Major communities under Akure North include; Eleyewo, Ogbese, Igoba, Oba-ile, Ayede, Iluabo, Isinigbo among others. Farming is the major occupation of the people in the area. They mostly engaged in small scale farming and marketing of many agricultural products such as rice, watermelon, plantain, pepper, cocoyam, potato, cassava and kinds of fruits and vegetables.

Sampling Techniques

A multi-stage sampling technique was used for the study. Purposive sampling technique was first used to select 10 communities from the Local Government Area. Ten (10) respondents each were randomly selected from each of the ten communities making a total of one hundred respondents. Data were collected from the respondents through the use of structured questionnaire supplemented with oral interview. Questions were asked to draw out information relevant to the study. Responses provided information on the type of occupational diversification among rural women, socio-economic characteristics of the women and problems faced by rural women in occupational diversification.

Method of Data Analysis

Descriptive statistical tools such as frequency distribution table, percentage, mean and standard deviation were used to analyse data collected from the field. Also, inferential statistics such as regression was used to determine occupational diversification among rural women in the study area. The implicit form of the regression model is specified below:

$$Y = F(X_1, X_2, X_3, X_4 \dots X_n) \quad (1)$$

Where Y = Numbers of Occupation engaged in by respondents

X₁ = Marital status (Married = 1, Otherwise = 2)

X₂ = Age (Years)

X₃ = Household size (Number of persons)

X₄ = Family structure (Monogamy=1, Polygamy=2)

X₅ = Religion (Christian = 1, Islamic = 2, Traditional =3)

X₆ = Educational status (Years spent in school)

X₇ = Monthly non-farm income

X₈ = Months devoted for secondary occupation

Chi-square was used to test the hypothesis of the study. The formular for Chi-square is given below:

$$X^2 = \sum \frac{(F_o - F_e)^2}{F_e} \quad (2)$$

Where \sum = Summation

X^2 = Chi-square

F_o = Observed frequency

F_e = Expected frequency

Results and Discussion

Table 1 reveals that 64% of the women were married, while 93% of the respondents were below 60 years, with an average of 42 years, this implies that the respondents are in their active age and very energetic to diversify into different occupations. Moreover, the findings showed that 91% of the respondents had household size of less than 9 with an average of 5 persons imply that the respondents will have more workforce and helping hand if they diversify on their occupation. The findings also revealed that 58% of the respondents has tertiary education which implies that they can engage in white collar job with their certificate and can also diversify their occupation by engaging in vocational job after normal working hour. The respondents had different occupation where farming ranked highest 40%, trading and Civil service ranked second with 25% each and Artisan was just 10%, this is because majority of the respondents do not depend solely on one source of income.

Furthermore, the findings revealed that approximately 77% of the rural women generate a monthly income above 200,000-naira monthlies in their farm with an average of N746, 570 (Table 2) while 68% of the rural women earn above N200,000 per month from non-farm activities with an average of N624,340. This implies that the respondents' diversity will help to improve their standard of living. Table 3 showed major problems encountered by rural women in the study area as Poor educational attainment and access to credit facilities which implies that the respondents may not be able to diversify their occupation because of low level of education and inadequate fund.

Table1: Socio-Economic Characteristics of the Respondents

| Characteristics | Frequency | Percentage Mean | (%) |
|--------------------------|------------|-----------------|-----------|
| Age (Years) | | | |
| 20-29 | 4 | 4.0 | |
| 30-39 | 30 | 30.0 | |
| 40-49 | 42 | 42.0 | 42 |
| 50-59 | 17 | 17.0 | |
| 60 and above | 7 | 7.0 | |
| Marital Status | | | |
| Single | 18 | 18.0 | |
| Married | 64 | 64.0 | |
| Divorced | 12 | 12.0 | |
| Widowed | 6 | 6.0 | |
| Total | 100 | 100.0 | |
| Household Size | | | |
| Less than 5 | 37 | 37.0 | |
| 5-8 | 54 | 54.0 | 5 |
| 9-12 | 5 | 5.0 | |
| 13 and above | 4 | 4.0 | |
| Total | 100 | 100.0 | |
| Educational level | | | |
| No Formal education | 22 | 22.0 | |
| Primary | 16 | 16.0 | |
| Tertiary | 58 | 58.0 | |
| Adult literacy | 4 | 4.0a | |
| Total | 100 | 100.0 | |
| Occupation | | | |
| Farming | 40 | 40.0 | |
| Artisan | 10 | 10.0 | |
| Trading | 25 | 25.0 | |
| Civil Service | 25 | 25.0 | |
| Total | 100 | 100.0 | |

Source: Computed from Field, Survey Data, 2019

Table 2: Monthly Farm Income of the Respondents

| Amount | Frequency | Percentages (%) |
|-------------------|------------|-----------------|
| Less than 100,000 | 4 | 4.0 |
| 100,001 - 200,000 | 19 | 19.0 |
| 200,001 – 300,000 | 13 | 13.0 |
| 300,001 – 400,000 | 12 | 12.0 |
| 400,001 – 500,000 | 15 | 15.0 |
| 500,001 and above | 37 | 37.0 |
| Total | 100 | 100.0 |

Mean: N746, 570, Standard Deviation: N1, 1074

Source: Computed from Field, Survey Data, 2019

Table 3: Monthly Non-Farm Income of the Respondents

| Amount | Frequency | Percentages (%) |
|-------------------|------------|-----------------|
| Less than 100,000 | 8 | 8.0 |
| 100,001 - 200,000 | 24 | 24.0 |
| 200,001 - 300,000 | 18 | 18.0 |
| 30,001 - 400,000 | 9 | 9.0 |
| 400,001 and above | 41 | 41.0 |
| Total | 100 | 100.0 |

Mean: N624, 340, Standard Deviation: N95, 792

Source: Computed from Field, Survey Data, 2019

Interpretation of the result of Chi-Square Analysis

The result shows that Age, Marital Status, Household size and Monthly farm income have significant effect on occupational diversification among women in the study area. The higher the age of the women the more they tend to diversity their occupation since they can learn more skills as they are growing older. The Marital status contributes to occupational diversification this is because the women will need to ensure food security and improve their standard of living. The more the women had more household the more they need to meet the needs of their family, in view of this, they had to diversify their occupation. The Monthly farm income also have a significant effect on occupational diversification, this is because the more the income from the farm, the more the respondent's diversity to other sector to ensure sustainability of farm activities and improve their standard of living.

Table 4: Result of Chi –Square Analysis

| Relationship | X2 | DF | P-value | Decision |
|---------------------|---------|----|---------|----------|
| Age | 77.800 | 34 | 0.0000 | S |
| Marital Status | 85.062 | 3 | 0.0000 | S |
| Household Size | 112.571 | 13 | 0.0000 | S |
| Monthly farm income | 116.596 | 31 | 0.0000 | S |

Significant @ 5%

Source: Computed from Field, Survey Data, 2019

Interpretation of the result of regression analysis

The regression result shows that R^2 is 0.646 which imply that 64.6% variation in the dependent variable is being accounted for by the independent variables in the specified model. The independent variables such as age(X_2), education level (X_6), monthly non-farm income (X_7) and months devoted for secondary occupation were significant at 5% level implying that they are important variables found to significantly influence livelihood diversification among rural women. Moreover, the positive sign associated with variable such as marital status (X_1), family structure (X_4), religion (X_5), monthly non-farm income (X_7) and months devoted for secondary occupation (X_8) implies that they are the major factor determining the number of occupation respondents engaged themselves in while the negative sign associated age (X_2), household size (X_3) and educational level (X_6) implies that increase in value of these variables will result to decrease in the number of occupation engaged by the respondents.

Table 5: Result of Regression Analysis

| Variables | Co-efficient (Standard error) | t-value |
|--|-------------------------------|---------|
| Constant | 65386.327 (69931.90) | -0.935 |
| Marital Status | 14801.896 (29603.79) | 0.500 |
| Age | 1175.164 (539.56) | -2.178* |
| Household size | 3038.765 (6798.13) | -0.447 |
| Family structure | 22027.298 (107976.95) | 0.204 |
| Religion | 19123.348 (20045.44) | 0.954 |
| Educational level | 13343.854 (6079.20) | -2.195* |
| Monthly non-farm income | 0.096 (0.01240) | 7.74* |
| Months devoted for secondary education | 3301.269 (1634.29) | 2.02* |

$R^2 = 0.646$

$R^{-2} = 0.389$

F-Value = 7.934

Source: Computed from Field, Survey Data, 2019

Table 6: Constraints faced by Respondents

| Constraints | Frequency | Percentage (%) |
|---------------------------|------------|----------------|
| Poor education attainment | 18 | 18.0 |
| Social norms | 13 | 13.0 |
| Poor road network | 12 | 12.0 |
| High cost of labour | 17 | 17.0 |
| Government policy | 11 | 11.0 |
| Inadequate access to loan | 18 | 18.0 |
| Domestic chores | 5 | 5.0 |
| Working longer hours | 6 | 6.0 |
| Total | 100 | 100.0 |

Source: Computed from Field, Survey Data, 2019

Conclusion

Occupational diversification is an important strategy employed by rural women in Sub-Saharan Africa in order to cope with crisis and seasonal stress in both farm and non-farm activities. The spread of non-agricultural employment among rural women reflects their growing desperation for income generating opportunities. Evaluating occupational diversification of rural women, reasons for diversification areas of diversification and the perceived effect of diversification is crucial for assessing poverty level and gender responsive research for development. Non-agricultural employment arises from the survival strategies of rural women unable to obtain employment or self-employment in agriculture despite the fact that the rural women are involved in non-farm activities, in order to earn additional income to meet up with family responsibilities, farming still remains the dominant occupation of the rural women. Sequel to the findings of this study it is concluded that rural women are largely employed or occupied in agricultural activities to earn their daily income.

Recommendations

Based on the findings of the study the following recommendations are hereby made:

- i. There should be inclusion of non-farm occupations in rural extension services by the government.
- ii. Government and other stakeholders should organize more relevant training programmes on occupational strategies for rural women.
- iii. Government should enlighten the rural women through the extension agents not to let their social norms to be an hindrance to their occupational diversification.
- iv. Government and other stakeholders need to open up opportunities for rural women to participate in non-farm employment through development of rural industrialization.

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PHYSIO-CHEMICAL, MICROBIOLOGICAL AND SENSORY PROPERTIES OF COMPOSITE JAMS FROM PINEAPPLE, AVOCADO AND MANGO PULPS

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Abstract

The study evaluated physico-chemical, microbiological and sensory characteristics of composite jams from pineapple, avocado and mango blends. The pineapple, avocado and mango were processed into pulps and mixed at varying proportions. Sugar was then added to the different blend. The blends were heated for 12-25 minutes after which citric acid and pectin were added. Samples were analyzed using standard methods. The result of the proximate analysis showed protein to range from 1.08 to 2.13% with sample SDB (85% Pineapple; 10% Avocado, 5% Mango) having the lowest value and sample SAE (70 Pineapple; 10% Avocado, 20% Mango) having the highest value and fat ranged from 0.23-0.41% with sample SAE having the lowest value and sample SDB having the highest value. The results for vitamin A showed sample SDB having the highest value (0.51 mg/100g) while that of vitamin C showed sample SAE having the highest value (13.71 mg/100g). Physicochemical properties like °brix (42.03-49.03 with sample SAE having the highest value), pH (3.26-3.77 with sample SAE having the highest value) were also examined. Sensory evaluation showed sample SDB as the least acceptable while sample SAE was the most acceptable of the composite jams. These results indicate that the supplementation of pineapple with avocado and mango could be adopted by food industries in the production of Jams thereby improving on the nutritional and organoleptic quality.

Keywords: Mango, Pineapple, Avocado, Jam, Sensory evaluation.

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Introduction

In the tropics there is a great deal of different fruits produced within season all year round. Most fruits are perishable in their natural state. After harvest; deterioration sets in almost immediately due to metabolic activities which continue. The perishable nature makes it difficult to store and preserve fruits; hence, there is gradual loss of *flavour* and nutritional value. Large quantities of fruits are produced and wasted in Nigeria and many other developing countries. They do not

receive the desired attention due to technological hindrances. This has led to wastage of these highly perishable fruits before reaching the consumer's table. It has therefore become imperative to explore ways of processing this fruit into shelf stable products to minimize postharvest losses. With the advancement of research into food processing and preservation, conversion of fruits into jams offer an easy, cheap, and economic yet reliable means of reducing postharvest losses (Ray and Ravi, 2005). Fruits and vegetables are fundamental and vital elements in the human diet. They are the best source of vitamins A and C, considered as protective foods and are inexpensive. Fruits are not only consumed as fresh, but are also processed in the form of value-added products. With the advances in food science and technology, processing and preservation have ensured maximum utilization of lower quality grade fruits, including deformed, de-shaped, under developed fruits for utilization and conversion into valuable food products.

Methodology

Sample Preparation

The fruits (mango, avocado and pineapple) were sorted and washed thoroughly with tap water to get rid of adhering soil or debris on the skin of the fruits. The fruits were peeled and cut into small pieces, and then crushed/blended. Sugar was then added to the different blend proportions of mango, avocado and pineapple. The blends were heated for 12-25 minutes, citric acid and pectin were then added (Kowalska *et al.*, 2018). The jam is ready when the bubbles form at the sides of the vessels. The hot jams were poured in clean, dry, wide-mouthed jars or bottles and cooled to a temperature of around 35°C in a water bath for gel formation and to make sure it gels completely, they were stored at room temperature for 24 hours.

Blend formulation

Three blends gotten from the resulting pulps of mango, avocado and pineapple were mixed in different proportions in accordance with the standard regulation governing the production of composite jams as outlined by Ihekoronye and Ngoddy (1985). The composite jams will be formulated as shown below.

Table 1: Formulation for jam production

| Samples | Pineapple (%) | Avocado (%) | Mango (%) |
|----------------------|----------------------|--------------------|------------------|
| SEA (control) | 100 | 0 | 0 |
| SDB | 85 | 10 | 5 |
| SCC | 80 | 10 | 10 |
| SBD | 75 | 10 | 15 |
| SAE | 70 | 10 | 20 |

SEA (Control) = 100% Pineapple

SDB = 85% Pineapple; 10% Avocado, 5% Mango

SCC = 80% Pineapple; 10% Avocado, 10% Mango

SBD = 75% Pineapple; 10% Avocado, 15% Mango

SAE = 70 Pineapple; 10% Avocado, 20% Mango

Analytical Methods

Proximate Composition

The moisture content, crude fibre, crude fat, crude protein and ash content were determined using the method of AOAC (2005) while carbohydrate content of the samples was determined in accordance with the method described by Ihekeronye and Ngoddy (1985).

Sensory evaluation

The sensory evaluation was performed for seven days on the samples by (20) semi-trained panelists. Colour, mouthfeel, *flavour*, taste and general acceptability were estimated using a nine-point Hedonic scale with 9 and 1 representing 'Liked Extremely' and 'Disliked Extremely' respectively (Iwe, 2007)

Statistical Analysis

Data were reported as mean \pm SD. Statistical significance was established using One-Way Analysis of Variance (ANOVA) at 5% level of confidence as described by Steel *et al.* (1997). The mean separation for parameters found to be significantly different was carried out using Duncan's Multiple Range Test (Ihekeronye and Ngoddy, 1985).

Results

The result for the proximate composition of the jam samples from pineapple, avocado and mango fruit blends is presented in Table 2. Moisture content of the jam samples ranged from 20.03% - 27.81% with sample SAE (70:10:20) having the highest value while sample SDB (85:10:5) had the lowest value. It has been reported by Eke-Ejiofor and Owuno (2013) that moisture has a great impact on the shelf life of products. Ashage and Adeleke (2019) also stated that the moisture content of any food material is a measure of its shelf life. The high moisture content observed in this study for pineapple composite jam is comparable to that reported by Correa *et al.* (2011) and Aina *et al.* (2015) for pineapple jam.

Crude protein values of the jam samples ranged between 1.08%- 2.13% with SSC (80:10:10), having the highest and SDB (85:10:5) the lowest. Results showed that SEA (100:0:0), SSC (80:10:10), SAE (70:10:20) were not significantly ($p < 0.05$) different from each. Protein contents observed in this study are within the ranges for pineapple composite, water melon and apple jams reported by Nafisah *et al.* (2020).

The fat contents of the jam samples showed SDB (85:10:5) had the highest and SAE (70:10:20) had the lowest with no significant difference ($p \leq 0.05$) among all the jam samples. The crude fat content of the jam was lower than the 3.40% reported for pineapple jam by Aina *et al.* (2015). This could be attributed to the ratio of the fruits in the pulps as was reported by Nafisah *et al.* (2020). The carbohydrate content of the jam samples ranged from 69.31% - 77.89%. Jam samples with low carbohydrate content might be ideal for diabetic and hypertensive patients requiring low sugar diets (Ogori *et al.*, 2021). The carbohydrate contents of the fruit jam samples were similar to the findings of Homi (2016) for pineapple jam (63.73%-70.98%).

Table 2: Proximate composition of jams from fruit blends

| Sample | Moisture | Protein | Fat | Fibre | Ash | CHO |
|--------|--------------------------|-------------------------|-------------------------|-------------------------|-------------------------|--------------------------|
| SEA | 23.41 ^c ±0.84 | 1.95 ^a ±0.07 | 0.37 ^a ±0.01 | 0.08 ^a ±0.01 | 0.30 ^c ±0.07 | 73.89 ^c ±0.48 |
| SDB | 20.03 ^d ±1.88 | 1.08 ^c ±0.05 | 0.41 ^a ±0.01 | 0.05 ^a ±0.01 | 0.41 ^c ±0.05 | 77.12 ^d ±0.23 |
| SCC | 24.27 ^c ±0.35 | 2.13 ^a ±0.08 | 0.31 ^a ±0.02 | 0.09 ^a ±0.03 | 0.60 ^b ±0.06 | 73.50 ^c ±1.78 |
| SBD | 26.56 ^b ±0.35 | 1.46 ^b ±0.05 | 0.26 ^a ±0.01 | 0.06 ^a ±0.02 | 0.76 ^a ±0.08 | 70.90 ^b ±1.98 |
| SAE | 27.81 ^a ±0.75 | 1.80 ^a ±0.04 | 0.23 ^a ±0.01 | 0.05 ^a ±0.01 | 0.80 ^a ±0.11 | 69.31 ^a ±0.06 |
| LSD | 0.87 | 0.33 | 0.15 | 0.05 | 0.15 | 1.61 |

Values are Mean ± SD

Values with the same superscript in the same column are not significantly different

SEA (Control) = 100% Pineapple

SDB = 85% Pineapple; 10% Avocado, 5% Mango

SCC = 80% Pineapple; 10% Avocado, 10% Mango

SBD = 75% Pineapple; 10% Avocado, 15% Mango

SAE = 70 Pineapple; 10% Avocado, 20% Mango

Vitamin and Physical properties of jam from pineapple, avocado and mango fruit blends are presented in Table 3. Vitamin A values of the jam samples ranged between 0.38%-0.51 mg/100g with SEA having the highest and SAE the lowest. Vitamin C values of the jam samples ranged between 11.50%-13.71 mg/100g with SDB having the highest and SAE the lowest.

From the result, vitamin C content was higher; which is similar to the result obtained for vitamins A and C analysis of fresh grape fruit jam (Jaranmond and Endan, 2010). Vitamin A, and in particular vitamin C are some of the major non-enzymatic antioxidants in the body that produce beneficial health effects by scavenging free radicals (Xu *et al.*, 2008). The application of prolonged heat treatments on fruits, such as in the case of jams, can lead to important losses of the beneficial properties of these citrus fruits (Jaranmond and Endan, 2010). Vitamin C functions as a water-soluble antioxidant, and it is also an effective antioxidant that readily scavenges reactive oxygen species (ROS) and reactive nitrogen species (RNS). Sample SAE had the highest amount of vitamin C which might be as a result of high vitamin C in pineapples and mango. Vitamin A (retinol) is required by humans for the normal functioning of the visual system (Annette, 2002). Another main function of vitamin A is in the maintenance of growth and epithelial cellular integrity and immune function in the body.

Brix is an important parameter in the production of jams. Pineapple jam had the highest brix value of 49.03 °Brix. This may be attributed to the natural high sugar level present in the fruit. All the jam samples had sugar contents significantly ($p < 0.05$) different from each other.

Result showed that pH ranged from 3.26-3.77. pH values for the composite jam samples were slightly lower than that reported by Fasogbo *et al.* (2013) for pineapple jam (3.95%). The pH of all the jam samples is within the acidic pH range and thus, are desirable for the inhibition of bacterial growth (Rahman *et al.*, 2003). This range of pH could be associated with the natural low pH value of the selected fruits and high level of sugar content in the products. High pH values and sugar contents are recommended to hinder microbial growth and maintain keeping quality (Aina and Adesina, 1999).

Table 3: Vitamins A and C, Brix and pH of jams from fruit blends

| Sample | Vitamin A mg/100g | Vitamin C mg/100g | Brix | pH |
|------------|-------------------|-------------------|-------------|------------|
| SEA | 0.43a±0.07 | 12.56d±0.05 | 42.76e±0.11 | 3.77d±0.07 |
| SDB | 0.51a±0.09 | 11.50c±0.01 | 42.03d±0.01 | 3.60c±0.03 |
| SCC | 0.50a±0.05 | 11.56c±0.00 | 45.13c±0.04 | 3.56b±0.00 |
| SBD | 0.41a±0.07 | 11.63b±0.01 | 45.51b±0.07 | 3.43b±0.00 |
| SAE | 0.38a±0.09 | 13.71a±0.09 | 49.03a±0.21 | 3.26a±0.01 |
| LSD | 0.20 | 0.09 | 0.21 | 0.11 |

Values are Mean ± SD

Values with the same superscript in the same column are not significantly different

SEA (Control) = 100% Pineapple

SDB = 85% Pineapple; 10% Avocado, 5% Mango

SCC = 80% Pineapple; 10% Avocado, 10% Mango

SBD = 75% Pineapple; 10% Avocado, 15% Mango

SAE = 70 Pineapple; 10% Avocado, 20% Mango

The Total Fungi Counts of the formulated jam samples are shown in table 4. The result indicated that all the samples are safe for human consumption with the total plate counts not exceeding the acceptable limits of $>10^5$ recommended by the International Commission of Microbiology Specifications of Foods, (ICMSF, 2005). Presence of microorganisms in food items usually hastens quality degradation. In severe cases, it makes preserved food items unsuitable for human consumption.

Table 4: Total Fungi Counts of jams from fruit blends

| Sample | Total Fungi Count (log CFU/g) |
|------------|-------------------------------|
| SEA | 1.03a±0.06 |
| SDB | 1.08a±0.05 |
| SCC | 1.05a±0.06 |
| SBD | 1.00a±0.03 |
| SAE | 1.01a±0.05 |
| LSD | 0.13 |

Values are Mean ± SD

Values with the same superscript in the same column are not significantly different

SEA (Control) = 100% Pineapple

SDB = 85% Pineapple; 10% Avocado, 5% Mango

SCC = 80% Pineapple; 10% Avocado, 10% Mango

SBD = 75% Pineapple; 10% Avocado, 15% Mango

SAE = 70 Pineapple; 10% Avocado, 20% Mango

Sensory analysis is a scientific discipline used to evoke, measure, analyze and interpret reactions about the characteristics of foods and other materials as they are perceived by the senses of sight, smell, taste, touch and hearing. Sensory attributes include Appearance, aroma, texture, taste and overall acceptability. It is important in determining the overall characteristics of a product. Traditionally these attributes are evaluated independently of each other by receptors of the different senses, although the possibility of a multimodal perception by human beings has recently been suggested (Hui, 2006).

The result of the sensory properties of the jam from pineapple, avocado and mango fruit blends is as presented in Table 5. The sensory score for the *colour* of the jam samples ranged from 6.07-8.53 with sample SDB least preferred and sample SEA most preferred by panelists. Sample SEA

was also the most preferred for taste and *flavour*. Overall acceptability of the jam samples showed sample SEA was most acceptable while SDB was least acceptable. Sample SDB (85:10:5), SCC (80:10:10), and SBD (75:10:15) were not significantly ($p < 0.05$) different from each other.

The recorded sensory scores are an indication that the fruit jam samples were highly acceptable by the panelists with overall acceptability beyond 5.50 on a 9-point hedonic scales. The high sensory values of these jams could be due to the *colour*, *flavour*, and texture of these fruits which is transferred to the final products on processing. Olugbenga *et al.* (2018) reported the same trend for banana, pineapple and watermelon jam blends in which pineapple jam recorded the best acceptability due to the colour and taste which the fruit supplies. Othman (2011) stated that pineapple and mango supply a range of sensory characteristics which enhances their eating attractiveness.

Table 5: Sensory evaluation of jam from pineapple, avocado and mango fruit blends

| Sample | Colour | Taste | Texture | Flavour | Appearance | General acceptability |
|------------|------------|-------------|------------|-------------|------------|-----------------------|
| SEA | 8.53c±0.52 | 8.25c±0.79 | 8.70c±0.73 | 8.05b±1.05 | 8.65b±1.08 | 8.90b±1.59 |
| SDB | 6.87a±1.36 | 6.85a±1.81 | 7.70b±0.47 | 7.05a±1.47 | 7.50a±1.15 | 6.55a±1.28 |
| SCC | 6.07a±1.39 | 7.20ab±0.83 | 7.65b±0.93 | 7.65ab±1.09 | 7.55a±1.19 | 6.95a±1.15 |
| SBD | 7.20b±1.08 | 7.75bc±0.77 | 7.55b±1.10 | 7.70ab±0.66 | 7.55a±1.15 | 6.65a±1.60 |
| SAE | 7.67b±0.90 | 8.15c±0.93 | 6.45a±1.47 | 7.90b±0.91 | 7.60a±1.14 | 7.30ab±1.81 |
| LSD | 0.80 | 0.69 | 0.63 | 0.67 | 0.72 | 0.94 |

Values are Mean ± SD

Values with the same superscript in the same column are not significantly different

SEA (Control) = 100% Pineapple

SDB = 85% Pineapple; 10% Avocado, 5% Mango

SCC = 80% Pineapple; 10% Avocado, 10% Mango

SBD = 75% Pineapple; 10% Avocado, 15% Mango

SAE = 70 Pineapple; 10% Avocado, 20% Mango

Conclusions

This study revealed that acceptable jams can be produced from pineapple, avocado and mango pulp blends with good nutritional and organoleptic properties. Significant increase was observed for crude protein, ash, and brix compared to the control sample. Mango and Avocado substitution, however, decrease the protein and fat contents of the jams. This would make the jams less nutrient dense and suitable for a target group. The study also established an increase in vitamin A and C contents with increasing substitutions of mango pulp. From the study, the 70:10:20 levels of pineapple, avocado and mango pulp blend was the most acceptable of the experimental jams.

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EFFECT OF DIFFERENT PROCESSING METHODS ON THE QUALITY, YIELD AND STORAGE STABILITY OF SOYMILK (*Glycine max. L*)

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Abstract

This work aimed at producing and evaluating the quality of soymilk obtained from soybeans processed by different methods (boiling, steeping, and roasting). The beans were processed, wet milled and sieved to obtain soymilk. The milks were subjected to proximate, microbial and sensory analyses using standard methods. Results for proximate composition of the samples showed crude protein content to range from 30.66% - 42.49% with sample RSM (roasted soymilk flour) having the least value while sample SSM (steeped soymilk flour) had the highest, fat content ranged from 22.33% - 23.67% with sample SSM having the least value while RSM had the highest value. RSM had the least milk yield while sample SSM had the highest. Sample BSM (boiled soymilk flour) had the least microbial count of all. Sensory evaluation showed that soymilk produced from roasted soybean was the most acceptable and differs significantly ($P \leq 0.05$) from other samples.

Keywords: Food processing, Soymilk, Sensory evaluation, Cooking

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Introduction

Soybean is an excellent source of protein both in quality and quantity. According to Ayo *et al.*, (2011) soybean contributes approximately 20% protein to diet of animals and humans. Soybean contains 35 – 40% protein with all the indispensable amino acids (Serrem *et al.*, 2011). For thousands of years, the Chinese and people in the neighboring countries consumed soybean in various forms including Tofu, Soy sauce, Miso among others. Like soymilk, soy foods are becoming some of the fastest growing categories in the food industry. Despite the benefits derived from soy proteins, proper processing of soybeans in various products is important to remove trypsin inhibitors and lipoxygenase enzyme. The greatest setback to the general acceptability of soymilk from soybean is the beany off flavor (Oloye, 2014) and the concept is to minimize the beany off flavor based on specific principles.

Soymilk, a dairy milk substitute, easily prepared from mature dry beans is fast becoming a household food in developing countries including Nigeria because of its diet improving capabilities (Obiegbuna *et al.*, 2014). Like animal milk, soymilk is used in the manufacture of other food products due to its functional properties and nutritive value. Despite its intrinsic beany flavor, it has gained wild acceptances.

Soybeans are rich in vitamins, minerals and acids. Meanwhile Africa's serious malnutrition problem is essentially acute in terms of protein deficiency. Livestock constitute the major source of protein for human body, but a combination of factors including the recent persistent drought and the poor performance of indigenous animals have led to the situation where the prices of such conventional livestock product such as meat, eggs, and milk have risen beyond the reach of ordinary man. In view of this problem an alternative source of high-quality cheap protein was sought for and soybean was found to have the potential to meet part of this need.

Materials and Methods

Soybean (yellow variety) was purchased from Ikole Market, Ekiti state and was taken to the department of Food Science and Technology, Federal University, Oye Ekiti for further processing. Thereafter it was pasteurized for 75°C – 80°C and the soymilk was obtained.

Reconstitution Index

This is a property that gives an idea of how easily a product can be mixed in water before consumption. It was determined according to the method described by Banigo and Akpapunam (1987). About 50grams of each sample was dissolved in 300ml of distilled water, 15grams of sugar was also added and mixed for 30 minutes.

Proximate Composition

The moisture content, crude fibre, crude fat, crude protein and ash content were determined using the method of AOAC (2005) while carbohydrate content of the samples was determined in accordance with the method described by Ihekeronye and Ngoddy (1985).

Yield determination

Yield was determined by the method of AOAC (2000).

% of Yield = $\frac{\text{Weight of soil milk extracted}}{\text{Weight of sample collected}} \times 100$

Weight of sample collected 1

Sensory evaluation

The sensory evaluation was performed for seven days on the samples by (20) semi-trained panelists. Colour, mouthfeel, flavor, taste and general acceptability were estimated using a nine-point Hedonic scale with 9 and 1 representing 'Liked Extremely' and 'Disliked Extremely' respectively (Iwe, 2007)

Total plate count

The method of Adegoke (2004) was adopted in determining the total plate counts.

Calcium and Iron determination

Calcium and iron were determined by method of AOAC (2000).

Calcium= Weight of the sample (in a 10ml aliquot of the sample) = mg calcium oxide \times 0.7147

Statistical analysis

Data were reported as mean \pm SD. Statistical significance was established using One-Way Analysis of Variance (ANOVA) at 5% level of confidence as described by Steel *et al.* (1997). The mean separation for parameters found to be significantly different was carried out using Duncan's Multiple Range Test (Ihekoronye and Ngoddy, 1985).

Results and Discussion

Proximate Composition

The results of proximate analysis of soy milk samples from different processing methods are presented in Table 1. The moisture content ranged from 4.50 % to 4.67% with sample RSM having the lowest value while sample SSM had the highest value. The moisture had no significant difference ($p < 0.05$) between boiled and steeped samples respectively. However, roasted soymilk flour was significantly different with a value 3.17%. Agume *et al.* (2016) reported the same effect, stating that the low level of moisture in roasted soybean flours probably results from the high temperature (which eliminates water more quickly), and the intermolecular cross-linking that might occur. The higher moisture content in steeped sample may be due to partial coagulation of protein leaning to expulsion of water (Udeozor, 2012).

The protein content ranged from 30.66% to 42.49% with sample RSM having the lowest value while sample SSM had the highest value. The protein composition of soybeans has been generally reported to be between 20 and 48% (USSEC, 2015). This is in accordance with was reported by Aurelie *et al.* (2017) who stated in their work that roasted and unroasted soybean had a protein content of 35.5 and 46.0 g/100g (dry weight basis) respectively.

The carbohydrate content ranged from 25.25% to 40.09% with sample SSM having the lowest value while sample BSM had the highest value. All samples were significantly different ($p < 0.05$) from each other.

The fat content ranged from 22.33% to 23.67% with sample SSM having the lowest value while sample RSM had the highest value. The fat of the three sample had no significant difference ($p < 0.05$) between them. These figures obtained were compared to those obtained by Babajide (1985) This result shows that fat content of soymilk is not affected by the different processing methods. Fat is important in the diets of infants and young children, as it provides high energy density and facilitates the absorption of fat-soluble vitamins. It also provides essential fatty acids such as omega-3 and omega-6 polyunsaturated fatty acids (PUFAs) needed for proper neural development in infants and young children (Igyor *et al.*, 2011).

The ash content ranged from 3.33% to 4.50% with sample BSM having the lowest value while sample SSM had the highest value. The ash of the three samples had no significant difference ($p < 0.05$) between them. The ash content of the three samples shows that they have relatively low values. This is also similar to what was reported by Akubor and Onimawo (2003), Aurelie *et al.* (2017) where values of 3.48-6.00% has been reported. This reduced ash content was attributed to be as a result of solubilisation of minerals in the cases of steeping and boiling, or the difference in variety and agro-ecological zone of cultivation.

The fiber content ranged from 0.55% to 0.76% with sample RSM having the lowest value while sample SSM had the highest value. The fiber content of soymilk is trace as seen from the result. This agrees with the work done by Enwere (1998) that soymilk contains no crude fiber in minute quantity, reason could be as a result of processing.

Table 1: Proximate composition of soy milk flour Sample

| Sample | Protein (%) | Fat (%) | Ash (%) | Moisture (%) | Crude fibre (%) | Carbohydrate (%) |
|------------|---------------------------|---------------------------|--------------------------|---------------------------|--------------------------|---------------------------|
| RSM | 30.66 ^c ± 0.01 | 23.67 ^a ± 4.60 | 4.00 ^a ± 0.87 | 3.17 ^{ab} ± 1.04 | 0.55 ^a ± 0.01 | 37.95 ^b ± 0.36 |
| BSM | 31.52 ^b ± 0.01 | 23.00 ^a ± 0.01 | 3.33 ^a ± 0.58 | 4.50 ^a ± 1.00 | 0.56 ^a ± 0.01 | 40.09 ^c ± 0.65 |
| SSM | 42.49 ^a ± 0.02 | 22.33 ^a ± 1.53 | 4.50 ^a ± 0.50 | 4.67 ^a ± 2.08 | 0.76 ^a ± 0.01 | 25.25 ^a ± 0.82 |

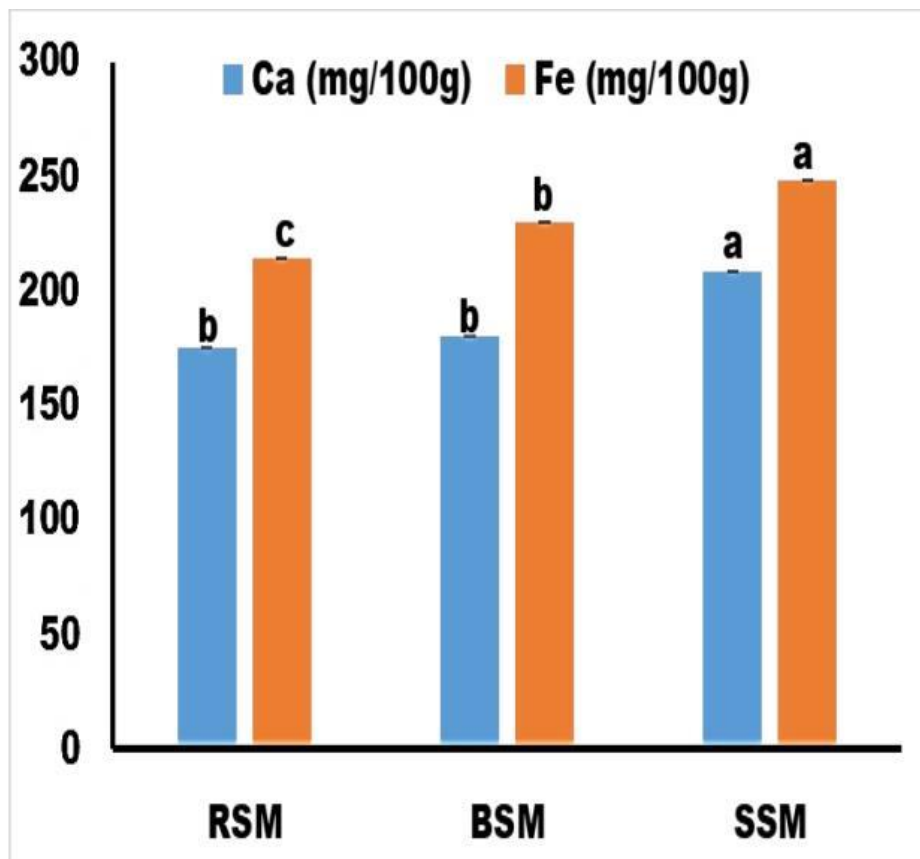
RSM: Roasted soy milk flour, BSM: Boiled soy milk flour, SSM: Steeped soy milk flour

Values with the same superscript in the same column are not significantly different

Mineral composition

The mineral composition of different methods (Boiling, Steeping and Roasting) employed in the processing of soy milk is presented in Figure 1. The calcium content ranged from 175.11 mg/100g to 208.25 mg/100g with sample RSM having the lowest value while sample SSM had the highest value. Calcium content varies significantly ($p < 0.05$) across the three samples. This shows that the application of heat has an impact on the level of micronutrients in the soy milk.

The iron content ranged from 214.01 mg/100g to 248.25 mg/100g with sample RSM having the lowest value while sample SSM had the highest value. Iron content varies significantly ($p < 0.05$) across the three samples. The values obtained is close to the value reported by Enwere (1998).



RSM: Roasted soy milk flour, BSM: Boiled soy milk flour, SSM: Steeped soy milk flour

Figure 1: Mineral composition of soymilk flour using different processing methods

Microbial count of Soymilk

The microbial quality of soy milk flour is reported in Table 2. The microbial analysis was done to ascertain the safety of the soy milk flour samples for human consumption. These counts ranged from $2.10-1.52 \times 10^{10}$ coliform unit. Boiled (BSM) and Roasted (RSM) samples had considerably lower bacterial counts (2.00×10^9 and 2.10×10^9 cfu/ml) when compared to that of the steeped sample having a bacterial count of 1.52×10^{10} cfu/ml.

Table 2: Coliform count of soy milk flour samples using different processing methods

| Sample | CFU/ml in original sample |
|---------------|----------------------------------|
| BSM | 2.00×10^9 |
| SSM | 1.52×10^{10} |
| RSM | 2.10×10^9 |

Dilution factor: 10-8

RSM: Roasted soy milk flour, BSM: Boiled soy milk flour, SSM: Steeped soy milk flour

Yield determination

The results of soy milk produced from different processing methods are presented in Table 3. The yield of the soymilk samples ranged from 64 - 81 with sample RSM having the lowest value while SSM had the highest value. Soymilk yield were significantly different ($p < 0.05$).

Table 3: Effect of different processing methods on the % yield of soy milk

| Sample | Yield |
|---------------|--------------|
| BSM | 72 |
| SSM | 82 |
| RSM | 64 |

RSM: Roasted soy milk flour - BSM: Boiled soy milk flour - SSM: Steeped soy milk flour

Sensory Evaluation

Table 4 presents the result of the organoleptic evaluation of different processing methods on soy milk flour over a 7-day period. The colour of samples is expressed as the level of sensation of product provided to the eye by the rays of light (Udensi *et al.*, 2010). The mean scores for colour ranged between 7.03-8.05 for the three samples (SSM, RSM, BSM) respectively with no appreciable decline in colour. The taste of the soymilk samples ranged from 5.33 -7.85, significant difference ($p < 0.05$) exists between the heat-treated samples (BSM and RSM) and non-heated sample (SSM). Flavor is regarded as the expression of the aroma of a product, based on the sensory evaluation, it ranged between 5.34 and 7.55.

The heat-treated sample also had a better preference than the steeped sample. Although, the three samples had almost similar preference after the fourth day. This was described by the sensory panelists as having a reduced flavour compared to the first 2-days. A similar trend was observed for the mouthfeel mean scores of the soy milk, where significant difference ($p < 0.05$) was observed between the soy milk samples. The values observed ranged from 5.01-8.00, representing moderately like to like very much based on a 9-point hedonic scale. In addition, a viscous texture was reported after the fourth day, this was also reported Achouri *et al.* (2008) who found similar trends after a storage period of four days. For the overall preference, the roasted sample (RSM) recorded the highest preference compared to the other two samples. Although, the boiled sample (BSM) was reported to have better sensory properties than the steeped soymilk (SSM). The lower preference by the panelists for sample SSM may be due to the beany flavour associated with the sample.

Table 4: Effect of different processing methods on the sensory properties of soy milk Sample

| Samples | No of Day(s) | Colour | Taste | Flavour | Mouth feel | Overall Acceptability | Ranking |
|---------|--------------|--------------|--------------|---------------|---------------|-----------------------|--------------|
| SSM | 1 | 7.80a ± 2.01 | 7.25b ± 1.07 | 7.55a ± 0.76 | 7.25b ± 1.25 | 7.60ab ± 0.94 | 2.10a ± 0.85 |
| BSM | | 8.05a ± 1.15 | 7.85a ± 0.88 | 6.85b ± 1.34 | 7.45ab ± 1.10 | 7.35c ± 1.04 | 2.15a ± 0.75 |
| RSM | | 7.85a ± 1.70 | 7.85a ± 0.68 | 7.20a ± 0.95 | 8.00a ± 0.86 | 8.00a ± 0.92 | 1.70b ± 0.80 |
| SSM | 2 | 7.80a ± 1.10 | 7.21b ± 0.25 | 7.48a ± 0.80 | 7.18b ± 0.97 | 7.83b ± 0.84 | 2.09a ± 0.74 |
| BSM | | 8.01a ± 2.15 | 7.83a ± 0.52 | 6.78b ± 1.09 | 7.38ab ± 0.98 | 7.44b ± 0.93 | 2.12a ± 0.51 |
| RSM | | 7.82a ± 1.20 | 7.82a ± 0.98 | 7.14a ± 0.89 | 7.90a ± 0.69 | 8.30a ± 0.82 | 1.68b ± 0.03 |
| SSM | 3 | 7.68a ± 1.10 | 6.41b ± 1.30 | 7.48a ± 0.93 | 7.08b ± 0.89 | 7.33ab ± 0.82 | 2.01a ± 0.05 |
| BSM | | 8.04a ± 2.15 | 7.63a ± 0.78 | 6.78b ± 1.04 | 7.02ab ± 0.76 | 7.24b ± 1.42 | 2.07a ± 0.92 |
| RSM | | 8.81a ± 1.21 | 7.19a ± 0.38 | 7.14a ± 0.32 | 7.26a ± 0.76 | 7.30a ± 0.99 | 1.64b ± 0.75 |
| SSM | 4 | 8.53a ± 1.30 | 6.04b ± 0.30 | 7.49a ± 0.90 | 7.00b ± 0.90 | 7.33a ± 0.82 | 2.84c ± 0.55 |
| BSM | | 7.32a ± 1.55 | 7.51a ± 0.98 | 7.78b ± 1.34 | 6.72ab ± 0.31 | 5.24b ± 1.42 | 2.01b ± 0.42 |
| RSM | | 7.62a ± 0.21 | 6.69a ± 0.91 | 7.01a ± 0.94 | 5.26a ± 0.02 | 6.30a ± 0.99 | 1.61a ± 0.61 |
| SSM | 5 | 8.03a ± 1.02 | 5.73b ± 0.59 | 6.31ab ± 0.90 | 7.00b ± 0.90 | 6.33a ± 0.08 | 2.20c ± 0.32 |
| BSM | | 7.22a ± 1.06 | 6.31a ± 1.08 | 6.90a ± 1.34 | 6.72ab ± 0.31 | 5.24b ± 1.40 | 1.96b ± 0.22 |
| RSM | | 8.02b ± 0.76 | 5.89c ± 1.91 | 5.91b ± 0.94 | 5.26a ± 0.02 | 6.20a ± 0.90 | 1.51a ± 0.40 |
| SSM | 6 | 7.43b ± 0.82 | 5.63b ± 0.92 | 5.83a ± 0.65 | 6.00ab ± 0.77 | 6.13a ± 0.38 | 2.22c ± 0.29 |
| BSM | | 7.86a ± 0.36 | 5.83a ± 0.80 | 5.90a ± 0.34 | 6.17a ± 0.34 | 5.94ab ± 0.29 | 1.64b ± 0.31 |
| RSM | | 7.92a ± 0.62 | 5.65b ± 0.94 | 5.75b ± 0.45 | 5.26b ± 0.32 | 5.23b ± 0.83 | 1.51a ± 0.61 |
| SSM | 7 | 7.03b ± 0.23 | 5.33b ± 0.92 | 5.34b ± 0.52 | 5.01a ± 0.47 | 5.13b ± 0.49 | 2.12c ± 0.51 |
| BSM | | 7.86a ± 0.56 | 5.83a ± 0.80 | 5.80a ± 0.24 | 5.11a ± 0.31 | 5.24b ± 0.29 | 1.24a ± 0.18 |
| RSM | | 7.42b ± 0.23 | 5.64b ± 0.94 | 5.56b ± 0.85 | 5.04a ± 0.27 | 5.30a ± 0.52 | 1.41b ± 0.31 |

RSM: Roasted soy milk flour, BSM: Boiled soy milk flour, SSM: Steeped soy milk flour

Values with the same superscript in the same column are not significantly different

Conclusions

The study shows that it is possible to produce rich and nutritious soymilk from different processing methods. There is significant difference between the samples with respect to proximate analysis and mineral analysis. Processing by steeping methods produced the highest yield and roasted method produced the lowest yield.

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SOCIO-ECONOMIC CHARACTERISTIC AND INNOVATION TECHNOLOGY OF KOLANUT PRODUCTION IN OGUN STATE

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Abstract

Kolanut production was characterized by price fluctuations through spaces and time in Nigeria due to instability of global economy. This is linked to the large numbers of farmers and intermediaries who acts between the primary producers, middle-men and the consumers. The study was carried out in Sagamu Local Government Area (LGA) of Ogun State. Lack of meaningful farming activities prevents the farmers from transiting into commercial kolanut farming which stimulates production increases. The general objective of this study is to describe the socio-economic characteristics of kolanut production and factors influencing the kolanut farmers using primary data sourced from 120 farmers. Data analytical tools included descriptive statistics, farm budget analysis (net farm incomes) and gross margin; while the constraints were rated on a 4-point Likert type scale to determine their severity. The results revealed that kolanut farming yielded positive outcomes in the study area. The study revealed that majority of the farmers are males (75.83) percent while (24.16) percent were females; modal group is between 31-60 years with a mean age of 57. Majority of the farmers have formal education (75.83) percent; with a minimum average family size of nine (9) per households while (70.0) percent were married. (45.83) percent sourced their fund from personal savings; (75.0) percent owned land while (43.3) percent belongs to cooperative groups; an average annual income of ₦450,500 farmers and net profit of ₦490, 950; making a substantial income available for use in expanding their production. The study recommended an accelerated improvement in scaling up of kolanut enterprises by extending buy-back policy to more states; organizes workshops and field trips for farmers; incorporate them into virile cooperatives groups and initiates adult literacy programmes to enhance production and productivity in order to make kolanut more attractive at the local and international market.

Keywords: kolanut farming, gross margins, cost and returns, constraints.

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Introduction

Agriculture is a major contributor to Nigeria's GDP and small-scale farmers which played a dominant role in this contribution (Rahji and Fakayode 2009); but their productivity and growth rate are being delayed by limited access to credit facilities (Odoemenem and Obinne 2010). It is

the main source of economic gains and livelihood for most Nigerians. However, agricultural sector is made up of four sub-sectors which are crop production, livestock, forestry and fishing. Technology innovation is the ability to create or develop new products, processes or new industries in response to changing economic environment (Kim, 1997). Therefore, Ikpi *et al* (2002) show that where farmers have to adopt a new technology that shifts time from their processing to home production activity sector, the probability and rate of adoption of such technology are higher.

Technologies are viable only when they are used by farmers. No matter how well new technologies work on research stations, if farmers do not use them, their development would have been in vain (Sandra *et al*, 1989). Kola is an important economic cash crop to a significant proportion of Nigerian population who are involved in kola farming, industrial utilization, trading, marketing and transportation. Therefore, the place of kolanut production and innovation technology before the dependence of the economy on petroleum cannot be over-emphasized (Akinbode, 1982). Kolanut is the fruit of the Kola tree; a genus of trees native to the tropical rain-forest of Africa. Over forty varieties, of which four species are commonly and widely cultivated and edible can be found in West Africa (Lovely, 1980) and the popular ones are kola Nitida; Cola Acuminata; Cola Vertiaillata and Cola Anomala. Only the first three have relevance for kola trade in Nigeria. Kolanut are second in importance as a commercial crop to Cocoa in the Southern part of Nigeria (Adejomo, 2014). It is used as a masticatory stimulant by Africans which has numerous uses in social, religious, ritual, and ceremonial functions by the natives in the forest region of Africa (Asogwaet *al.*, 2006).

In recent years, the commodity has gained a significant attention during ceremonies related to marriage, child naming, and installation of chiefs, funeral, and sacrifices made to the various gods of African mythology (Daramola, 1978 and Opeke, 1992); and even in daily entertainment of important visitors where it is being offered as a valuable gifts. Hence, the consumption of *Cola acuminata* (*kola of social and traditional significance*) known as *abata nutsis* greatly cherished by the Yoruba of South-west and Northern part of Nigeria while South-east prefers the *Cola nitida* (*kola of commerce*). In addition to the economic and social importance of kolanut, it enjoys special favour with the people of Northern-Nigeria who have accepted *Cola nitida* as a stimulant substitute for alcoholic drinks because of Islamic belief on alcoholic drinks. Therefore, there is also increasing demand for its usage in pharmaceutical industries and in production of soft drinks, wines, and candies (Beattie, 1970 and Ogunuga, 1975). Its uses have inevitably created a high demand in excess of its production (Oladokun, 1985).

Kolanuts are widely cultivated in Nigeria. Large quantities of the nuts are exported to Europe and North America, it also contains about 2 percent of caffeine and chewed by many people as stimulant. It is used in the manufacture of dyes and cola group of beverage drinks where they are used chiefly for flavouring cola drinks such as Coca-Cola, Pepsi-Cola, Afri-Cola, Sena-Cola to a mention a few which are refreshing or stimulating substitutes for tea or coffee (Irvine, 1956). Beverages such as kola wine, kola cocoa and kola chocolate-a type of chocolate containing cacao and kola powder in cocoa butterfat (Opeke, 1992); and one interesting sounding concoction called "Burroughs and Wellcomes Forced March Tabloid" were once tried in Britain, but they were short lived (Tindall, 1998). Kolanuts also have medicinal and socio-cultural values and uses. A Kolanut tree is sacred and its sacredness is used in divinity as it can explain the oracle. It is an evergreen

tree, the genus includes about forty species. It has glossy green leaves, violet striped flowers and star-shaped fruits. The seeds are taken from the pod as their outer coat or cover is removed. They are chewed while fresh or dried.

Ndagi, *et al.*, (2012) also stated some of the challenges of kolanut production which is low yields, lack of information on improved technology, pests and diseases infestation, lack of intervention from the government, processing, packaging and transportation. In recent times, farmers still hold kolanut production in high esteem, and there is vast area of land which could be used for kolanut production. In Adejomo (2012) study, he reveals that there is a significant positive impact of kolanut production on employment creation, poverty alleviation, industrial development and socio-cultural values. He further revealed that kolanut as an important stimulant and a source of feed to animals. In a period of global economic recession, Kolanut production is used for socio-economic revival, revamping and rejuvenation. In conclusion, the research works further posited that kolanut production if well encouraged, it will have a multiplier effect, serving as a liberator from unemployment quagmire, which is one of the banes and major clog in the wheels of development, especially in the African continent (Oluwalana, *et al.*, 2017). The trend in decline still continues till present as the bulk of the agricultural products consumed in the country are imported with little coming from the subsistence system of farming majorly practiced in the country. Alademirin and Odusina (2009) in Makinde, *et al.*, (2013) also corroborated that as Nigerian economy fortunes have turned in cycle, much attention is being paid to rehabilitation of estate plantation and the development of new ones, and that most estates plantations are being put up for outright sale or long management lease to private investors/enterprises.

This neglect culminates into scarcity of kolanut in the market as the production and supply has been inadequate. Considering this fact, there is no doubt that the potential uses and importance of kolanut can be both a saver and earner of considerable foreign exchange for Nigeria, more income for kolanut farmers, and serves as employment or wealth creation for the Nigerian youths. A few substantial quantities are exported to other African countries as well as to Europe and North America which generate the necessary foreign exchange earning to the government (Akinbode, 1982). It employs a greater percentage of the people as kolanut farmers, assemblers-processors, bulking agents, wholesalers, exporters, importers and retailers.

Furthermore, Komolafe *et al.*, (1970) and Ajiboye (1995) reported that Nigeria produces about 120,000 tonnes of kolanut annually and mostly found in the south-western region of the country which covers Ogun, Oyo, Osun, Ondo, Ekiti, and Lagos state. Invariably, Ogun state produces the largest amount of Kolanut in the country devoting about 65,000 hectares of land and producing 80,000 MT of the crop in 2010/2011 (National survey on Agricultural Exportable Commodities, 2013). More so, the production of Kolanut is influenced by soil fertility and the ability of any soil to replace nutrients absorbed by crops depends mainly on the clay type, mineral composition of the fine fraction and soil fraction in topo-sequence.

Ogun State as a case study like the rest of Nigeria (Ashaye, *et al.*, 2017) has inefficient allocation of inputs, low returns on farmer's investment and government's support. In order to remove this biasness in kolanut production in Nigeria, this however necessitated for this study. Therefore, the objective of this study is to describe the socio-economic characteristics of the respondents in Ogun

state; to estimate the cost and returns of kolanut farming; and to identify the major constraints of Kolanut production in the study area.

Methodology

Description of the Study Area

This study was carried out in Sagamu Local Government Area of Ogun State, Nigeria. The state has land mass of 16,409.26km², with a population of 3,728,098 people; while Sagamu Local Government Area has a total population figure of 253,421 people (National Population Commission, 2006); this has been leap-frogged to about 4.5million with over 360,000 farm families. It has a mean annual temperature of 32°C; with a relative humidity (RH) of 95%. The state has 4 Agricultural Development Programme (ADP) zones namely: Abeokuta, Remo, Yewa and Ijebu. The study area is located in the tropical rain forest region which is known for the production of tree crops mainly timber, cocoa, kola, citrus, rubber, oil palm, etc. The arable crops grown mostly as mixed crops include maize, yam, cassava, melon, cocoyam, rice, sugar cane and leafy vegetables.

The study area is an important commercial and industry area. Apart from agriculture a considerable number of people of Remo-land have shown interest in kolanut trading; daily, periodic and night markets which serves as outlets for agricultural produce and other goods within and outside. The State has 20 Local Government Areas (LGAs) with its administrative capital at Abeokuta. The predominant occupation of the people in Ogun state are farming, hunting, trading, goldsmithing, tailoring, oil palm processing, processing and milling of rice, palm wine, weaving, carving, transportation, agro-allied and cement industries, oil and gas and manufacturing companies with over three hundred and fifty (350) spring-ups industries.

Sampling Techniques/ Analytical Technique

A multi-stage sampling procedure was adopted in this study. In the first stage, Sagamu Local Government Area (LGA) was randomly selected from Remo (Ikenne) Agricultural zone. The second stage involved a random selection of five communities such as Agbowo, Sabo, Igodo, Odelemo and Simawa within the LGA. In the third stage, 24 kolanut farmers were randomly selected from each of the five (5) communities; making a total of 120 respondents. Field trips were also made to complement the information gathered through the questionnaires. The choice of the communities was because of the predominant kolanut farming in the area. Primary data were collected using structured interview schedule as instrument. Ogun State Agricultural Development Programme (OGADEP), Cocoa Research Institute of Nigeria (CRIN) Ibadan, Journals, Agricultural Development Programme (ADP)/Extension Agents, Research reports, Publications, Proceedings and market surveys provided the sampling frame while others were administered from the instruments of the kolanut farmers.

Descriptive statistics and Net profit model (farm budgetary analysis) were carried out on the retrieved questionnaire from the respondents. Descriptive statistics was used to analyze and compare the socio-economic characteristics of the kolanut farmers and production scale in the study area which include age, sex, educational status, years of kolanut farming experience, family size, marital status, farm size,, land ownership status, access to credit, group membership; while production inputs, harvesting, labour for processing, sorting and grading, packaging, storage,

transportation and the revenue generated from sales of kolanut, etc.; were presented in form of frequency tables, percentages, means and standard deviations. Nine (9) constraints to kolanut farming were identified and captured.

Net Profit Model: Farm budgeting analysis was constructed to determine the profitability of kolanut production. This is the difference between the gross revenue and total cost of production. The total cost of production is the total expenses incurred during the production period; which includes variable and fixed costs. However, this is used to determine the net farm income and the profit obtained in study area

Thus;

$$NP = TR - TC,$$

Where

NP=Net Profit,

TR=Total Revenue,

TC=Total Cost of Production i.e. (Fixed Cost + Variable Cost)

TC= TVC+TFC

Results and Discussion

The summary statistics of socio-economic variables involved in kolanut farming were presented in the table 1.

Socio-economic characteristics of respondents

The age distribution of respondents as shown in Table 1 revealed that respondents within the age bracket of 31-60 years formed the majority (92.5%). With the mean age of 57 years, this can be deduced that the bulk of the respondents fall in the economically active age bracket, which can have a positive implication on kolanut output. The findings imply that good number of kolanut farmers were in their productive and economically active age which means there is willingness to take risk in adopting modern technologies and spread of innovation practices than the old ones in the age category. The age ranges of the respondents from 18-30 years fall within age bracket of 7.5%. This agrees with statement by Olowosegun-Sanni (2004); Egbe and Eze, (2014) that young people are more likely to adopt innovations, which therefore served as better agents of innovation transfer in their economically active age.

Table 1 further showed the gender distribution of respondents; the data summaries revealed that majority (about 75.8%) of the respondents were males while about 24.16% were female. The results indicated that kolanut farming was dominated by males probably because they have herculean tasks of males and equally, by their more energetic nature, which better fitted to do than female counterparts. This finding is in line with report by the World Bank (1993) which states that most females find it very difficult to cope with labour-intensive works compared to their male counterparts. This is a further corroboration of what was stated earlier that kolanut productions were male-dominated activities in the study area. This active productive age is in line with United Nation Department of Economics and Social Affairs which stated that numbers of men and women in the world is roughly equal, that is, out of 1,000 People; 504 are men (50.4%) and 496 are women (49.6%); (UNDESA, 2019) and (World Population Prospects, 2019) respectively.

Furthermore, marital status of respondents as shown in Table 1 revealed that a larger proportion (70.0%) of respondents were married while the remaining was either singles (8.3%) and widowed (19.2%). This indicated that majority of the kolanut farmers were mature persons who had access to the opinions and advises from their spouses in making a critical decision in kolanut production as postulated by Mafimisebi *et al.* (2014b). Table 1 further revealed the *production trends and farming experience of the respondents which revealed that* majority (95.0%) of the respondents had between 6-15 years of experience in kolanut farming activities while 5.0% had less than five (5) years. This revealed that the respondents' years of experience is above the mean value; while mean years of experience in kolanut farming was 10. This further assumed that kolanut farmers in the study area were quite experienced in production. This also connotes that they are likely to be very knowledgeable and self-motivated in kolanut production.

This however is in line with the previous researchers' findings which reported that years of experienced, highly influenced decision-making by farmers (Mafimisebi *et al.*, 2014b). The results in Table 1 revealed the educational level of the kolanut farming is about 24.1% of the respondents (1-3) years had no formal education (i.e. less than 1); 58.3% of the respondents had spent 4-6 years in primary education school; 15% of the respondents had spent 7-9 years in post-primary education; while only 2.5% of the respondents were graduates of tertiary institutions. In summary, the results revealed that majority (58.3%) of the respondents ended their education at the primary school level. This generally low level of formal education may affect farmers' willingness to adopt innovations which may positively impact on their farming, owing to the inability to read and write (Mafimisebi *et al.*, 2014b). Most of the farmers were illiterate to semi-illiterate; that is, they had at least one form of education. This implies that closed to half of the farmer's population has formal education as reported by Abiola and Omoabugan (2001).

This finding corroborates with Ohen *et al.* (2013) that majority of farmers in Southern-Nigeria were without appreciable level of formal education. *Table 1 further revealed the distribution of respondents by household size which shows that respondents with family size 5-8 were in the majority (60.0%) with average family members of 9. Household size ranged from 1-4 have 41.3%; while the least ones have the family size of 5.8% respectively. This connoted that farmers can possibly engaged some of their household members in kolanut production and other activities. One implication of a large household size is that a huge proportion of income may be spent on consumption which may restrict farm business expansion and reduce the high level of output. The fact that farmers' propensity to commercialize their production declines with increasing numbers of household members has been reported by Lapar et al. (2003).*

The results of distribution of respondents by land size revealed that 97.0% had between 1ha and above 4.9 ha while only about 2.5 % have more than 10 ha for farming activities. From this result, it can be hypothesized that kolanut farmers in the study area operated on medium to large size which may by itself induced production expansion. Randela *et al.* (2008) further opined that increased of land productivity and that the size of land is important because transactions costs are largely fixed costs that can be spread across more volume of outputs on large farms. The distribution of respondents by forms of land ownership showed that majority (75.0%) of kolanut farmers did not own the land used for kolanut cultivation. This is because they benefitted from the policy of leasing of 5 ha of land and above to farmers by government. This can however enhance

and increased their output. This result conformed to earlier report from distribution of respondents by land size in this study where majority (75.0%) owned more than 5ha of land; which about 25.0% of the respondents owned the land cultivated to kolanut through either inheritance or purchase.

The results in Table 1 revealed that about 45.8% of the respondents had access to credit in the last growing season while about 56.7% had no access to credit in the same period. This implies that kolanut farmers mostly depended on their personal and relations capital to finance their farming activities. As a result of this, the production capacity of the farmers is likely to be conditioned by the magnitude of their personal capital base which may, to some extent, determine their level of participation. These findings were consistent with Adenegan *et al.* (2013) and Hlongwane *et al.* (2014) who reported that majority of smallholder farmers had no access to credit which hindered their production. Results of summary statistics further showed that about 56.7% of the respondents did not belong to any associations/groups, while about 43.3% do. Involvement in associations/groups is one of the key determinants of good output as it gives farmers the opportunity for increased strength/ power which enables selling their produce at remunerative prices and satisfactory profit (Adenegan *et al.*, 2013).

Group/association membership is also of assistance in getting relevant information on price, price trend and other farming conditions (Adenegan *et al.*, 2013). Result of distribution of respondents by annual income is also displayed in Table 2. From the table, it is revealed that about 57.5% of the respondents earned between ₦300,000-₦500,000 per annum; about 26.6% earned between ₦100,000-₦300,000 while about 15.8% earned above ₦500,000 per annum. The average annual income of the respondents was about ₦450, 500. It can be hypothesized that farmers in the study area made substantial income from kolanut farming. This income level, if judiciously used, is capable of bringing about kolanut acreage expansion thereby increasing their level of kolanut returns. Samuel *et al.* (2015) opined that with increased income, the farmer could save more and acquire assets useful in aiding both their cultivation and participation which led to further income based.

Table 1: Socio-economic Characteristics of Kolanut Farmers in the Study Area

| Variable | Frequency | Percentage |
|---|------------------|-------------------|
| Age | | |
| <20 | 3 | 2.50 |
| 21 – 30 | 6 | 5.00 |
| 31 – 40 | 30 | 25.00 |
| 41 – 50 | 42 | 35.00 |
| >50 | 39 | 32.50 |
| Mean = 56.6yrs | | |
| Gender | | |
| Male | 91 | 75.83 |
| Female | 29 | 24.16 |
| Total | 120 | 100 |
| Marital Status | | |
| Single | 10 | 8.30 |
| Married | 79 | 65.80 |
| Widowed | 23 | 19.20 |
| Divorced | 3 | 2.50 |
| Single parent | 5 | 4.16 |
| Total | 120 | 100 |
| Educational Level | | |
| No formal education | 29 | 15.00 |
| Primary education | 69 | 71.67 |
| Secondary education | 17 | 11.67 |
| Tertiary education | 5 | 1.67 |
| Experience in production (years) | | |
| <5 | 6 | 5.00 |
| 6-9 | 65 | 54.17 |
| >10 | 49 | 40.83 |
| Household size | | |
| 1 – 4 | 7 | 5.83 |
| 5 -12 | 72 | 60.00 |
| >12 | 41 | 34.16 |
| Income (N'000) | | |
| >100, 000 | 10 | 8.33 |
| 101, 000-300, 000 | 69 | 57.50% |
| 301, 000-500, 000 | 32 | 26.67% |
| >500, 000 | 9 | 15.83% |
| Farm size (Ha) | | |
| 1.00-1.99 | 18 | 15.00 |
| 2-2.99 | 22.50 | 49.16 |
| 3-3.99 | 27 | 22.50 |
| 4-4.99 | 13 | 10.83 |
| >5 | 3 | 2.50 |
| Land ownership status | | |
| Owned | 90 | 75.0 |
| Not owned | 30 | 25.0 |
| Group membership | | |
| Group membership | Group membership | Group membership |
| Yes | 52 | 43.3 |

| | | |
|----|----|------|
| No | 68 | 56.7 |
|----|----|------|

Source: Field survey (2018).

3.2 Net Profit Model (Farm Budgetary Analysis)

The results on Table 2 revealed that gross revenue realized from the kolanut farming was estimated as ₦591, 500. 00; Total variable cost (TVC) was estimated as the minimum and maximum such as the cost of labour for processing, cost of labour for harvesting, cost of labour for supplementary weeding, and cost incurred on kolanut transportation of the respondents which are ₦10, 587.50 and ₦84, 700 respectively with the estimated mean variable cost as ₦295, 750; fixed cost (depreciation of fixed assets) which includes the cost of go-to-hell, cutlasses, baskets, files, hoes, etc. was estimated as ₦15, 850; while the gross margin was estimated as ₦506, 800 for a production cycle. This means that kolanut farming in the study area made profit even though the cost of production was considerably high. Net profit was estimated as ₦490, 950 which show that kolanut production is profit-driven business in the study area.

Table 2: Estimated Cost and Returns of Kolanut Farming in the Study Area

| Items | Mean estimate in Naira (₦) |
|---|----------------------------|
| Cost of Labour | 7, 000 |
| Cost of Transporttion/fuel | 29, 000 |
| Cost of supplementary weeding | 4, 500 |
| Cost of Agro-chemicals | 5, 400 |
| Cost of fertilizer | 28, 800 |
| Cost of Harvesting | 3, 000 |
| Cost of Sorting and Grading | 3, 500 |
| Cost of Packaging and Storage | 3, 500 |
| TVC | 84, 700 |
| GR | 591, 500 |
| GM | 506, 800 |
| Fixed Cost (depreciation of fixed assets) | 15, 850 |
| Net Profit | 490, 950 |

Source: Field survey (2018).

Estimated Cost and Returns of Kolanut Farming in the Study Area

Table 3: Analysis of Constraints to Kolanut Farming (₦120)

| S/N | Constraints | 4 Very severe | 3 Severe | 2 Not severe | 1 Indifferen t | Σ | \bar{x} | Ran k | Remark s |
|-----|-----------------------------|---------------------|-------------|--------------------|----------------------|-----|-----------|----------|-------------|
| 1 | High Cost of Transportation | 28(23.3) | 80(66.7) | 7(5.83) | 5(4.2) | 371 | 3.36 | 1 | Very Severe |
| 2 | Poor road condition | 35(29.2) | 60(50) | 22(18.3) | 3(2.5) | 367 | 3.05 | 4 | Severe |
| 3 | Inadequate capital | 72(60) | 20(16.7) | 27(22.5) | 1(0.83) | 403 | 3.09 | 3 | Very Severe |
| 4 | High cost of Labour | 61(50.8) | 40(33.3) | 14(11.7) | 5(4.2) | 397 | 3.31 | 2 | Very Severe |
| 5 | Less Impacts of Extension | 50(41.7) | 30(25) | 28(23.3) | 12(10) | 358 | 2.98 | 6 | Severe |
| 6 | Poor Pricing for Products | 16(13.3) | 91(75.8) | 11(9.2) | 2(1.7) | 361 | 3.00 | 5 | Severe |
| 7 | Government Policy | 20(16.7) | 50(41.7) | 42(35) | 8(6.70) | 322 | 2.68 | 8 | Not Severe |
| 8 | Pests and Diseases | 18(15) | 31(25.8) | 58(48.3) | 13(10.83) | 294 | 2.45 | 9 | Not Severe |
| 9 | Poor Storage Facilities | 42(35) | 5(4.2) | 69(57.5) | 4(3.33) | 325 | 2.70 | 7 | Not Severe |

Source: Field Survey (2018). Parentheses are in percentage.

Analysis of Constraints to Kolanut Farmers

Table 3 shows analysis of the severity of constraints to kolanut farming in the study area using a 4-point Likert-type scale. It was computed by summing the scores (frequency multiplied by magnitude of constraints and determine the mean (\bar{x}) which were then ranked. Results in table 3 revealed that high cost of transportation, high cost of labour, lack of credit facilities (non-availability of loan) which falls in the category of “very severe” with respective mean score of 3.36, 3.31 and 3.09. Poor road networks, poor pricing for the products and poor extension services with respective mean scores of 3.05, 3.00 and 2.98 were in the category of “severe”, while poor storage facilities, government policy and pests and diseases were considered “not severe” with mean scores of 2.70, 2.68 and 2.45 respectively.

The response regards impact of extension services in table 3 poses a surprise as extension farmer’s ratio in Nigeria is noted to be as high as 1:2,500 (Ilevbaoje, 2004) and in recent years as 1: 3, 000. Perhaps, the kolanut farmers may have underestimated the importance of extension in increasing their production, processing, packaging, grading and transportation. A similar surprise was also expressed by the response of the kolanut farmers regarding availability of grading, packaging,

processing, distribution pattern and penetration, as most farmers interviewed sourced their seeds/seedlings locally (unimproved/less graded/packages). This however, has negative implications on quality of kola nut production and grading.

Conclusion and Recommendations

Kolanut production as a cash crop, can be used to address the food insecurities; enhancing rural and foreign income. Therefore, there are prospects for high revenue generation and profitability if the farmers were more committed in use of improved technologies for upgraded productivity as well as to increase their scale of operation expanded in order to meet the global competitiveness. The findings of this study showed that;

- a. Kolanut farming enterprises in the study area engaged fairly literate farmers (75.8%) of both genders.
- b. Most farmers are in the active productive age bracket of between 30 and 50 years above.
- c. Kolanut farming is faced with 'very severe' constraints; high cost of transport, labour, capital, poor road condition and poor pricing for the products.

To mitigate the constraints identified in the study, the following recommendations were made:

1. Kolanut farmers should engage in value addition activities such as processing and sorting of kolanut for manufacturing such as textiles, etc. and industrial utilization such as pharmaceutical, beverages, soft drinks, confectioneries etc. before selling so as to increase their scale of operation and additional income to improve their livelihood;
2. Government and other stakeholders should boost extension delivery in order to increase uptake and utilization of high yielding varieties such as fertilizers, Ramets, pesticides, tractors, etc. to enhance production and productivity in order to make kolanut more attractive at the local and international market;
3. Government should put in place sustainable buy-back policy and subsidies that will encourage kolanut production, processing, packaging, storage, marketing and transportation of the products for the global competitiveness,
4. Kolanut farmers should be encouraged to form themselves into viable cooperative groups or associations in order to facilitate access to farm inputs, innovations, grading and access to single-digit micro-credit or loans facilities; and
5. Therefore, government and research institutes should endeavor to embark on enlightenment campaign for more kolanut production, marketing, and consumption patterns, manufacturing and industrial utilization among other things etc.

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ASSESSMENT OF THE EFFECTS OF AGRICULTURAL CREDIT GUARANTEE SCHEME FUND (ACGSF) ON AGRICULTURAL OUTPUT IN NIGERIA.

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Abstract

The study aimed at assessing the effects of Agricultural Credit Guarantee Scheme Fund (ACGSF) on agricultural output in Nigeria in the selected subsectors of agricultural sector of the economy i.e crop, livestock and fishery subsectors. The study made use of time series data which covered the period of 1989-2019. Specific objectives were to examine the effect of ACGSF on the crop output, to determine the effect of ACGSF on the livestock output and, to examine the effect of ACGSF on the fishery output measured by respective gross domestic product (GDP). Secondary data were source from Central Bank of Nigeria. Crop output, fishery output, livestock output and agricultural credit guarantee scheme fund for food crop, cash crop, fishery, cattle, sheep, poultry, and other livestock were used as the variables. Preliminaries tests were also carried out, using Augmented Dickey Fuller (ADF) Unit Root and Engle-Granger co-integration test to determine the level of stationary and cointegration of the variables. Fully-Modified Ordinary Least Square (FMOLS) estimation technique was adopted using E-view statistics to test the hypotheses. Findings revealed that, ACGSF for food and cash crop sector has significance effect on crop output, Agricultural credit guarantee scheme fund for poultry, sheep, cattle and other livestock sector has significance effect on livestock output and Agricultural credit guarantee scheme fund for fishery sector has significance effect on fishery output in Nigeria. The study therefore, recommend that Government should show more commitment on livestock sector in order to boost the growth earnings of the economy and reduce her level of dependency on other nations.

Keywords: Agricultural Credit Scheme; Engle-Granger, GDP, Dependency ratio, farm output

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Introduction

Agricultural Production in Nigeria is progressively on the decline in terms of its contribution to the Gross Domestic Product (GDP) as well as satisfying the country's food requirement, despite the fact that about 70 percent of the population engage in agriculture, thus Nigeria Agricultural sector is unable to fulfil its most basic and traditional role of being the source of food for the nation, therefore the food import has continued to rise (Odigbo, 2000). There is a Growing recognition by the Nigerian farmers of the effect of improved inputs and new technologies on agricultural yield. The use of these inputs and the adoption of high yielding techniques have given rise to an increased need for agricultural credit since majority of Nigerian farmers are small-scale farmers and are often limited by unfavourable economic, social, cultural and institutional conditions (Olubiyo and Hill, 2000). Insufficiency of capital has been a major constraint to agricultural development (Agu, 1998) in order to improve agricultural production modern farm inputs such as fertilizers, improved seed, feeds and plant protection chemicals and agricultural machineries are needed over the hoe and machete technology. Most of these technologies have to be purchased, yet very few farmers have the financial resources to finance such purchases (Adeniji and Joshua, 2008).

Agriculture contributes immensely to the Nigerian economy in various ways, namely, in the provision of food for the increasing population; supply of adequate raw materials (and labour input) to a growing industrial sector; a major source of employment; generation of foreign exchange earnings; and, provision of a market for the products of the industrial sector (Okumadewa, 1997; World Bank, 1998; Winters et al., 1998; FAO, 2006).

The delivery of credit to the agricultural sector has been seen to be a major input in the growth of agriculture and the whole economy (Olomola, 1990). Agricultural finance over the years has been identified to be a major contributor to the GDP and growth of the economy. The fall in the contribution of agricultural sector to Nigeria economy has been censure on the lack of a former National Credit Policy and dearth of credit institution which can be advantageous to farmers and also small and new business operators who are engaged in agriculture and agro-allied businesses (Rahji and Adeoti, 2010). The development of the agricultural sector in Nigeria is invariably associated with the extent of the growth and development of agricultural credit in order to increase production. The fact that only few farmers are buoyant enough to finance the new practices, the federal government at different period have established credit policies, institutions and schemes to facilitate the flow of agricultural credit to farmers. One of such commendable schemes has been the Agricultural Credit Guarantee Scheme Fund (ACGSF).

The Agricultural Credit Guarantee Scheme (AGCSF) is an economic policy instrument employed by the Central Bank of Nigeria (CBN) through financial institutions, the financial institutions are to provide adequate credit to the small and medium scale farmers in Nigeria for improving agricultural production, and to revive, revamp and boost the agricultural sector Growth and development, consequently to enable economic growth and development in Nigeria (Dori, 2006). Agricultural Credit Guarantee Scheme Fund (ACGSF) is one of the current agricultural financing schemes in Nigeria which has been in activity as a specific development finance scheme since 1978 till date (Onuselogu, 2014). The primary reason for this scheme is to urge banks to loan to those involve in agricultural production and agro-handling exercises. Thus, the fundamental point of the scheme is the motivation of total agricultural production for both domestic consumption and exportation, and urging financial institutions to contribute towards developing the Nigeria agricultural productive capacity through capital loaning.

The scheme is expected to provide guarantee or loans granted by financial institutions to farmers. The cover pledges to pay to the banks, 75% of the amount in default net of any amount realised by the lending bank from the sale of the security pledged by the borrower (Nwosu, Oguoma, Ben-chendo and Henri-Ukoha 2010). Nigeria of today is a country where agriculture is still greatly and relatively undermined, and or even over-looked as a mere “backyard business”. Some Nigeria youth even regard farming as “an odd job that is meant only for the illiterate rural people” Reports show, agriculture account for 40% of the GDP of our country but still, it is being given only 1% of the total commercial bank loan and this shows the character of financial negligence and insufficient fund for the agricultural sector (Dori, 2016). It also been estimated that only 5% of the farmers in Nigeria have had access to formal credit; and on an average across developing countries 5% of the borrowers have received 80% of the credit (Ranjula, 2001). Obviously, inadequate financial support to the agricultural sector has retarded the growth of the economy bringing about perpetual crises such as poverty, diseases, unemployment, hunger, declination in the country’s exportation.

The ACGSF was established to resolve the major challenges in agricultural sector i.e. Provide finance by increasing the level of bank credit to the SMEs in the agricultural sector and even without collateral unlike other financial institutions. Therefore, this study seeks to determine to what extent has ACGSF gone in achieving the purpose for which it was established via loans guaranteed by it to three selected sub-sectors of agriculture in Nigeria (crops, livestock and fishery) in relation to their

output. Each of these sectors were considered separately in order to determine their effect on the Nigeria's agricultural output from 1989-2019.

The main objective of this study is to investigate the effect of Agricultural Credit Guarantee Scheme Fund (ACGSF) on agricultural output in Nigeria. The specific objectives are:

- i. to examine the effect of Agricultural Credit Guarantee Scheme Fund (ACGSF) on crop (cash and food crops) output in Nigeria;
- ii. to determine the effect of Agricultural Credit Guarantee Scheme Fund (ACGSF) on livestock (cattle, sheep, poultry and other livestock) output in Nigeria; and
- iii. to examine the effect of Agricultural Credit Guarantee Scheme Fund (ACGSF) on fish output in Nigeria.

H₀₁: Agricultural Credit Guarantee Scheme Fund (ACGSF) does not significantly influence Crop output in Nigeria;

H₀₂: Agricultural Credit Guarantee Scheme Fund (ACGSF) has no empirical relationship with livestock output in Nigeria

H₀₃: Agricultural Credit Guarantee Scheme Fund (ACGSF) does not influence the output of the Fishery sector in Nigeria.

Theoretical Review

The Monetary Circuit Theory (MCT) is a theory of Monetary Economics, particularly money creation which was developed by Nicholas Johansen in 1903, Augusto Graziani in the year 1989 and which was later extended and made popular by Cantillon (1992), Quesnay (1994) and Jevons (1994). More recently, this theory has been systematically developed by Keen (1995, 2001, 2013, 2014) and others. The MCT, which is also, referred to as Circuitism or The Circulation Approach holds that money is being created by the banking sector internally rather than externally by the government agent through the Central bank's lending (Graziani, 1989). The theory provides the framework for specifying how money lubricates and facilitates production and consumption cycles in society (Keen, 2009).

The structural change theory formulated by Nobel laureate and Arthur Lewis in the mid-1950s which was later modified and extended by John C.H. Fei and Gustav Ranis stressed on the mechanism by which developing economies can transform their domestic structure from a heavy dependence on traditional subsistence agricultural to a more modern and advance agricultural practices through sufficient financial support. An all-inclusive version of this theory added that the fall of agricultural development cannot be realized unless government builds a supporting system which creates and provides the necessary incentives, opportunities and most importantly Productivity in the agricultural sector. The model also focusses on the process of surplus labour transfer from the traditional sector which leads to the growth of output and employment in the modern sector.

The classical theory of political economy and development in an attempt to understand the relationship between agricultural finance and agricultural development. The famous scholars driving this theory are Adam Smith (1776) expanded by David Ricardo (1820) and modified by Thomas Malthus (1903) and others. The theory believes that the banking sector plays a critical role in channelling finance and investment to the productive agents like agriculture and industry within the economy and in this manner goes about as an impetus of economic growth and development.

Empirical Review

Finance plays a fundamental role in the process of agricultural development thus access to development, finance is not just a *sine qua non* but rather a pre-requisite and an inevitable motivator that enhances the performance of the Agricultural Sector. Agricultural credit can be defined as the mobilization of resources at all levels in order to increase production and productivity in Agriculture and to enhance the productive capacity. Agricultural credit scheme was government platform to

provide sustainable Agricultural financing which has been widely acknowledged globally as the bed rock for economic development (Omosebi and Saheed, 2016).

Atagana and kalu (2014) worked on Evaluation of agricultural credit guarantee scheme in Nigeria: A tool for economic growth and development. A linear model and ordinary least square method were employed for the analysis, while time series data was used and the study covered from 1973 to 2003. The findings opined that there is a positive and significant impact on the loans guaranteed by ACGSF to the farmers has increase the GDP of the economy.

Zakaree (2014) worked on Impact of agricultural credit guarantee scheme fund (ACGSF) on domestic food supply in Nigeria. A linear model and ordinary least-square (OLS) method techniques were used for the study, while time series data was employed and the study covered period of 1988-2011. The empirical findings revealed that there has been increase in the trend of agricultural credit guarantee funds to the farmers.

Dori (2016) studied on the impact of central bank of Nigeria agricultural credit guarantee scheme fund on agricultural and economy development of Nigeria. Qualitative method of analysis and time series data were adopted, while the study covered 1981- 2011. The findings reveal that ACGSF have a positive impact on the economy to facilitate agricultural and economic development in Nigeria.

Enenche, Ohen, and Umeze (2014) studied the effect of agricultural credit guarantee scheme fund (ACG SF) on production efficiency of rural farmers. A qualitative method of analysis was used, while questionnaire schedule was adopted and the study covered 1996-2013. The findings reveal that inefficiency effect makes significant contribution to the technical inefficiencies of ACGSF beneficiaries in Nigeria.

Adetiloye (2012) worked on assessment of agricultural credit guarantee scheme for food security in Nigeria. T-test and paired T-test method of analysis were adopted, while time series data was used and the study covered the period of 1978-2006. The findings observed that though credit to the credit sector is significant, but it has not been growing relative to the economy.

Ayegba and Ikani (2013) studied on the impact assessment of agricultural credit on rural farmers in Nigeria. A qualitative method of analysis was adopted, while qualitative data was used and the study covered 1978-2011. The findings indicate that unregulated private money lenders constitute the major source of credit to the sector which is not healthy for an economy that is struggling to grow. They also established that the concentration of banks in urban area has left rural farmers without formal source of credit, while according to Odoemenem and Obinne (2010), output of the sector is hindered by non-availability of funding in terms of loans and advances from organised financial institutions. Nasir (2016) examined the Impact of Central Bank of Nigeria: Agricultural Credit Guarantee Scheme Fund on Agricultural and Economic Development of Nigeria. A descriptive method of techniques was adopted for the analysis, while qualitative data was used and the study covered the period of 1979-2015. The empirical findings reveal that the scheme have increased the inflow of credit to the Nigerian farmers which ultimately affected the entire economic well-being of the beneficiaries.

Okonkwo et al (2017) worked on Sustainable Agricultural Financing in Nigeria: Agricultural Credit Guarantee Scheme Fund (ACGSF) in Perspective. A multiple linear regression model and ordinary least square technique of analysis were adopted, while time series data was used and the study covered 1989-2015. The findings shown that ACGSF has not contributed significantly to economic development of Nigeria and that the distribution of the number of loans guaranteed by the scheme tends lopsided in favour of North West political zone of Nigeria.

Nwosu et al (2010) worked on the Agricultural Credit Guarantee Scheme: Its roles, problems and prospects in Nigeria's Quest for Agricultural Development. A multiple linear regression model and ordinary least square techniques were adopted for the analysis, while time series data was used and the study covered the period of 1987-2008. The empirical findings suggested that the three tiers of government should give the scheme the required support and publicity so that farmers (particularly small farmers) can benefit from its laudable objectives which will go a long way to ameliorate the seeming dismal output of our farmers.

Ijaiya et al (2009) examined the impact of Agricultural Credit Guarantee Scheme on Food Security in Nigeria applying a time subscript and a different-in-difference estimator that describes the changes in food as a function of a change in food crops as a function of changes in agricultural credit guarantee scheme fund, while the study covered 1973-2007. The findings show that only the initial level of ACGSF on food security has helped improve food security more than the changes in subsequent years.

Olagunju and Ajiboye (2010) worked on Agricultural Lending Decision: Autoregressive model and Tobit regression method of Analysis were adopted, while primary data was used and the study covered from 1987-2006. The findings observed that lack of a formal national credit policy and inadequate number of credit institutions in Nigeria is a major cause for the decline in the contribution of Agriculture to the economy, and made a case for the ACGSF.

Adams and Mortimore (1997) worked on Agricultural Intensification and Flexibility in the Nigerian Sahel. A linear regression model and Ordinary Least Square (OLS) method of analysis were employed, while primary data was used in the analysis and the study covered from 1979-1996. The empirical investigation discovers that access to finance increases the average inputs of labour and capital which has positive effects on production output. They argued that early development theories especially the classical economists considered agriculture as an indispensable source of raw materials to finance the development of the industrial economy. As a result, Agricultural production serves as an engine that propels and sustains the real economy.

Kehinde (2012) examined the Impact of Central Bank of Nigeria: Agricultural Credit Guarantee Scheme Fund on Agricultural and Economic Development of Nigeria. T-test and paired t-test, granger causality test and descriptive method of analysis were adopted, while time series data was used and the study covered the period of 1978-2006. The findings revealed that settled claims are negatively significant and the tardiness is observed in the claims process, which implies that Nigeria is food insecure because of high import bills that is growing daily.

Nwosu et al (2014) worked on Loan Accessibility and Repayment Performance of Livestock Farmers under the Agricultural Credit Guarantee Scheme Fund in Southeast, Nigeria. A logistic regression model, descriptive and quantitative techniques were employed in analysing the data, while primary data was used and the study covered southeast states with 195 respondents. The finding shows that inadequate access to credit limits agricultural output and by extension the farmers' income. This study, also investigated livestock farmers' accessibility and repayment performance of credit loans obtained from financial institutions under guarantee by the Agricultural Credit Guarantee Scheme Fund (ACGSF).

Obansa and Maduekwe (2013) examined the impact of Agricultural financing on economy growth in Nigeria. Ordinary least square method of analysis was adopted, while time series data was used and the study covered the period of 1973- 2011. The findings revealed that there is bidirectional causality between economic growth and agricultural financing; and there is bidirectional causality between economic growth and agricultural growth.

Ojeka, Effiong *et al* (2016) studied on Constraint to agricultural development in Nigeria. Error correction model (ECM) was employed as a method of analysis, while time series data was used and the study covered from 1970-2010. The findings opined that rainfall exchange rate and food export (lag one) are the most significant positive determinant of agricultural output in Nigeria

Omorogbe *et al* (2014) studied on the role of agriculture in the economic development of Nigeria. Trend analysis and Qualitative analysis were employed, while time series data was used and the study covered from 1979-2011. The empirical findings suggest that in-depth research on the development of the agricultural sector is essential to the progress of the country's economy growth. Eze *et al* (2010) studied on Agricultural financing policies and rural development in Nigeria. Ordinary least square method of analysis was adopted for the study, while time series data was employed and the study covered from 1992-2009. The findings reveal that though the government has made serious efforts at making good agricultural policies through schemes, programmes and institutions .it has been able to back them up with adequate budgetary allocation and financing coupled with corruption in the execution of the policies.

Trzeciak (2003) examined the impact of Agricultural Financing on Agricultural Development in Nigeria. A multiple linear regression model and ordinary least square method of analysis were adopted, while time series data was used in the analysis and the study covered from 1973-2000. The empirical findings reveal that agriculture like any other sector of the economy needs credit for increase output and development. He suggested that through government channelling of fund to the agricultural sector by it policy, agriculture could be more profitable.

Rahji and Fakayode (2009) studied on the Role of Agricultural Financing on Agricultural output in Nigeria. Ordinary least square method analysis was employed, while time series data was used and the study covered the period of 1972-2005. The findings held that agriculture play a compelling role in the nation's development that is remarkable being a dominant contributor to Nigeria's gross domestic product. They acknowledged that the performance of small and medium scale farmers maintained significant part of this contribution to GDP. Hazell (2003) ascertained that agricultural loan able funds play a fundamental role in determining access to the needed inputs that facilities farming and other extensive agricultural practices which ultimately transfers into increased output.

Research Methodology

Nature and Sources of Data

Secondary data in form of time series data was obtained from the Central Bank of Nigeria annual statistical bulletin 2019.

Model Specification

The study adopted and modified Aduralere (2019) model to measure the long run relationship between ACGSF and Agricultural Output in Nigeria from 1989-2019.

$$AGO = f(ACGSFCRP, ACGSFLSP, ACGSFFSP).....(3.4)$$

Where:

AGO = Agricultural Output

ACGSFCRP = Total ACGSF Loan to Crop production

ACGSFLSP = Total ACGSF Loan to Livestock production

ACGSFAFP = Total ACGSF Loan to Aquaculture fish production

U = Error Time

t = Time Trend

Ln = Natural Logarithmic

The model in its explicit form can be expressed as:

$$AGO = \beta_0 + \beta_1 ACGSFCRP + \beta_2 ACGSFLSP + \beta_3 ACGSFAFP + U \dots \dots \dots (3.5)$$

To reduce the problems of heteroscedascity, serial correlation, and other regression problems associated with the time series data, the transformation of equation into natural logarithmic form provide the better result when compared to functional form linear equation

$$Ln(AGO) = \beta_0 + \beta_1 \ln(ACGSFCRP)_t + \beta_2 \ln(ACGSFLSP)_t + \beta_3 \ln(ACGSFAFP)_t + U \dots \dots \dots (3.6)$$

Data Analysis

According to zikmund (2003), data analysis is the application of reasoning to understand and interpret the data that has been collected. This analysis was carried out through employing statistical tool of regression. Fully Modified Ordinary least- square (FMOLS) of multiple linear regression technique was used to establish the relationships between the variables. Using E-view software for the hypotheses. The signs and significance of the regression coefficients was relied upon in explaining the nature and effects of the independent and dependent variables as to determine both magnitude and direction of effects. The form of FMOLS model implies that there is a one-way causation between the dependent and independent variables. The signs of the coefficient and the p-value were used to explain the direction and magnitude of the effects of the independent variables on the dependent variables.

Test for Stationarity

Before estimation, Data were processed through several preliminary test such as unit root, error correction model, cointegrated and normality test in order to determine whether the variables are stationary or not. This was used to determine the underlying properties of process that generate our time series data.

Augmented Dickey Fuller Test (Unit Root)

The study employed Augmented Dickey-Fuller (ADF) to examine the stationarity of the variables under consideration in order to avoid having spurious result, and to determine the co-integration properties of all the variables involved in this research. The unit root property requires all variables to be stationary in levels or first differences. In carrying out the ADF test, the following model was estimated.

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \Delta Y_{t-1} + U_t \dots \dots \dots (3.7)$$

Where:

Y_t = variable under investigation;

$\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$; and

U_t = pure white noise error term

The null hypothesis of non-stationary will be rejected if the t-statistic (i.e, the value of calculated t) is greater than critical (or tabular) t-value, or otherwise.

Johansen Co-integration Test

The co-integration property requires all variable to converge in the long run. To carry out the co-integration test, Johansen co-integration method was employed. Using this method, the null hypothesis of no co-integration will be rejected if the calculated value is greater than the tabular value (at a considered relevant significance level), or otherwise.

Below is the formula for Johansen co-integration test

$$\Delta Y_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{K-1} \Delta X_{t-K+1} + \Pi X_{t-K} + \mu + e_t \dots \dots \dots (3.8)$$

Results and Discussion

In this section, the results of the analysis are presented and discussed

Unit Root test for variable use in the analysis

This study carried out a unit root test to examine the stationary nature of the variables employed in the analysis. This is important in order to avoid having a spurious regression result. The unit root test employed here follows the augmented Dickey-Fuller (ADF) procedure.

Table 1.0: Augmented Dickey Fully Test Results (Unit Root)

| S/N | Variable | Level | | First Difference | | Order of Integration |
|-----|-----------------|-------|-------------|------------------|-------------|----------------------|
| | | ADF | Crit. Value | ADF | Crit. Value | |
| 1 | Cropoutput | -0.90 | -3.58 | -4.46 | -3.58 | I(1) |
| 2 | Fishoutput | -0.71 | -3.58 | -6.00 | -3.58 | I(1) |
| 3 | Livestockoutput | -2.35 | -3.58 | -4.41 | -3.58 | I(1) |
| 4 | Acgcrop | -1.25 | -3.58 | -4.87 | -3.58 | I(1) |
| 5 | Acgfishery | -3.16 | -3.58 | -7.53 | -3.58 | I(1) |
| 6 | Acglivestock | -1.55 | -3.58 | -4.98 | -3.58 | I(1) |
| 7 | Acgfoodcrp | -1.05 | -3.58 | -4.79 | -3.58 | I(1) |
| 8 | acgsfcashcrp | -4.25 | -3.58 | -4.89 | -3.58 | I(1) |
| 9 | Acgcattle | -2.13 | -3.58 | -5.98 | -3.58 | I(1) |
| 10 | Acgpoultry | -1.71 | -3.58 | -5.44 | -3.58 | I(1) |
| 11 | Acgsheep | -1.09 | -3.58 | -4.89 | -3.58 | I(1) |
| 12 | Acgotherlst | -1.02 | -3.58 | -3.72 | -3.58 | I(1) |

Source: Author's Computation, 2020.

The ADF results presented in Table 1.0 revealed that all the variables upon which the unit root test was carried out are not stationary at their level series. This was verified by their respective ADF statistic values being less than the test's critical values at the 5% level of significance. However, Table 1 also revealed that each of these variables became stationary at first difference (i.e. when each of them was differenced once). Showing that each of the ADF statistic values are now greater than the critical values, suggesting the rejection of null hypothesis that there is unit root in their differenced series and accepting the alternative that there is no unit root. This indicates that the variables are stationary at first difference, hence, regarded as I(1) series, in other words, integrated of order one.

Results for Cointegration Test

The cointegration test was carry out to verify if these non-stationary variables together have long run relationship. Given that all variables are I(1) series, the cointegration test was carried out following the Engle-Granger cointegration procedure which are presented in Table 4.5. The test was carried out for each of the models of this study.

Table 1.2: Johansen Cointegration Test Results

| Test Statistic | Crop Agric | Fishery Agric | Livestock Agric |
|----------------|------------|---------------|-----------------|
|----------------|------------|---------------|-----------------|

| | | Value | p-value | Value | p-value | Value | p-value |
|----------------------------|------|--------|---------|--------|---------|--------|---------|
| Engle-Granger statistic | tau- | 10.76 | 0.033 | -2.68 | 0.243 | -13.18 | 0.040 |
| Engle-Granger statistic | z- | -29.21 | 0.016 | -65.44 | 0.000 | -31.48 | 0.021 |

Source: Author's Computation, 2020.

The cointegration test result presented in Table 1.2 revealed from both the tau and z-statistic that the model for crop agricultural output and livestock agricultural output are cointegrated, indicating that the variables of this models have long run relationship. This was verified by the low p-value (i.e. lower than 0.05), which indicates a rejection of null hypothesis that the variables are not cointegrated and acceptance of the alternative that the variables are cointegrated. This signifies that long run estimates of this model are not spurious. The cointegration test result for fishery agricultural output shows that only the z-statistic has a significant value while the tau-statistic has an insignificant value. Since one of this statistic is significant, it also indicates that there is cointegration in the model. With each of these models being cointegrated, it implies that estimation of long run model is plausible and appropriate for them. This led to the estimation of the parameters of these models with the fully-modified OLS cointegrating regression model which are presented in Tables 1.3, 1.5 and 1.6 respectively.

Table 1.3: FMOLS Result for Crop Output

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|--------------------|-------------|-------------|-------------|--------|
| LOGACGFOODCROP | 0.792912 | 0.203257 | 3.901024 | 0.0006 |
| LOGACGSFCASHCROP | 0.141595 | 0.203803 | 0.694762 | 0.4936 |
| C | 1.925477 | 0.805855 | 2.389357 | 0.0247 |
| R-squared | 0.908116 | F-statistic | | 62.72 |
| Adjusted R-squared | 0.900766 | p-value | | 0.0000 |

Source: Author's Computation, 2020.

The FMOLS result for crop output shows that agricultural credit for food crop and cash crop are included as explanatory variables in the model. All these agricultural credits, as well as crop output are in logarithm transformation in other to linearize the model and for easier interpretations of the coefficients. The reported R-squared and adjusted R-squared of the model show values of 0.908116 and 0.900766 respectively, which indicates that about 90.81% (90.07% after adjustment for loss of degree of freedom) of the variations in crop output are accounted for by agricultural credit scheme to food crop and cash crop. The F-statistic shows a value of 62.72 and p-value of 0.000, which indicates that the overall model is statistically significant and in good fit.

As to the performance of each independent variable, the result shows that agricultural credit for cash crop farming does not have significant effect on crop output. This was shown by the p-value being greater than 0.05 level of significance. On the other hand, agricultural credit to food crop has significant effect on crop output. This was shown by its p-value being less than 0.05 significance level. This implies that only the agricultural credit to food crop affects the crop output in Nigeria while agricultural credit to cash crop does not affect crop output. Agricultural credit to food crop has a positive coefficient. Its positive coefficient indicates that a percent increase in the amount of agricultural credit made available for food crop farming will lead to a rise in crop output by approximately 0.793 percent.

Table 1.4: Variance Inflation Factor (VIF) Result

| Variable | Coefficient Variance | Centered VIF |
|-----------------|----------------------|--------------|
| LOGACGFOODCRP | 0.041314 | 2.073371 |
| LOGACGSFCASHCRP | 0.041536 | 2.073371 |
| C | 0.649403 | NA |

Source: Author's Computation, 2020.

As to the estimation diagnostic of the result for crop output in terms of multicollinearity, table 1.4 presents the result of variance inflation factor to verify if the model is free from multicollinearity. The result shows that the centred VIF values of the coefficients of the model are below the threshold value of 4, beyond which the model can be adjudged to suffer from multicollinearity problem. This implies that this model is free from multicollinearity problem.

Table 1.5: FMOLS Result for Fishery Output

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|--------------------|-------------|-------------|-------------|--------|
| LOGACGFISHERY | 0.605543 | 0.072960 | 8.299605 | 0.0000 |
| C | 2.096709 | 0.306016 | 6.851634 | 0.0000 |
| R-squared | 0.818714 | F-statistic | | 68.88 |
| Adjusted R-squared | 0.811742 | p-value | | 0.0000 |

Source: Author's Computation, 2020.

The FMOLS result for fishery output shows that agricultural credit for fishery is included as explanatory variable in the model. Both the agricultural credit and fishery output are in logarithm transformation in order to linearize the model and for easier interpretations of the coefficients. The reported R-squared and adjusted R-squared of the model show values of 0.818714 and 0.811742 respectively, which indicates that about 81.87% (81.17% after adjustment for loss of degree of freedom) of the variations in fishery output are accounted for by agricultural credit scheme to fishery. The F-statistic shows a value of 68.88 and p-value of 0.000, which indicates that the overall model is statistically significant and in good fit. As to the performance of the independent variable, the result shows that agricultural credit for fishery has significant effect on fishery output. This was shown by its p-value being less than 0.05 significance level. This implies that agricultural credit to fishery affect the fishery output in Nigeria.

Agricultural credit to fishery has a positive coefficient. Its positive coefficient indicates that a percent increase in the amount of agricultural credit made available for fishery will lead to a rise in fishery output by approximately 0.605 percent. As to the estimation diagnostic of the result for fishery output in terms of multicollinearity, no test was carried out for this model, since there is only one independent variable in the model and multicollinearity problem can only arise with more than one independent variable in the model.

Table 1.6: FMOLS Result for Livestock Output

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|--------------------|-------------|-------------|-------------|--------|
| LOGACGCATTLE | -0.096566 | 0.136725 | -0.706281 | 0.4871 |
| LOGACGPOULTRY | 0.482881 | 0.240557 | 2.007343 | 0.0466 |
| LOGACGSHEEP | 0.108746 | 0.104874 | 1.036918 | 0.3106 |
| LOGACGOTHERLST | 0.090777 | 0.210977 | 0.430271 | 0.6710 |
| C | 3.411439 | 0.570833 | 5.976251 | 0.0000 |
| R-squared | 0.908513 | F-statistic | | 40.41 |
| Adjusted R-squared | 0.892602 | p-value | | 0.0000 |

Source: Author's Computation, 2020.

The FMOLS result for livestock output shows that agricultural credit for cattle farming, poultry farming, sheep farming and other livestock farming are included as explanatory variables in the model. All these agricultural credits, as well as livestock output are in logarithm transformation in order to linearize the model and for easier interpretations of the coefficients. The reported R-squared and adjusted R-squared of the model show values of 0.908513 and 0.892602 respectively, which indicates that about 90.85% (89.26% after adjustment for loss of degree of freedom) of the variations in livestock output are accounted for by agricultural credit scheme to cattle, poultry, sheep, other livestock. The F-statistic shows a value of 40.41 and p-value of 0.000, which indicates that the overall model is statistically significant and in good fit.

As to the performance of each independent variable, the result shows that agricultural credits to cattle farming, sheep and other livestock farming do not have significant effect on livestock output. This was shown by each of their p-values being greater than 0.05 level of significance. On the other hand, agricultural credit to poultry have significant effect on livestock output. This was shown by its p-value being less than 0.05 significance level. This implies that only the agricultural credit to poultry affect the livestock output in Nigeria. Agricultural credit to livestock has a positive coefficient. The positive coefficient of agricultural credit to livestock indicates that a percent increase in the amount of agricultural credit made available to livestock activities will lead to a rise in livestock output by approximately 0.483 percent.

Table 1.7: Variance Inflation Factor (VIF) Result

| Variable | Coefficient Variance | Centred VIF |
|----------------|----------------------|-------------|
| LOGACGCATTLE | 0.018694 | 3.658687 |
| LOGACGPOULTRY | 0.057868 | 2.899090 |
| LOGACGSHEEP | 0.010999 | 3.557645 |
| LOGACGOTHERLST | 0.044511 | 2.290670 |
| C | 0.325850 | NA |

Source: Author's Computation, 2020.

As to the estimation diagnostic of the result for livestock output in terms of multicollinearity, Table 1.7 presents the result of variance inflation factor to verify if the model is free from multicollinearity. The result shows that the centred VIF values of the coefficients of the model are below the threshold value of 4, beyond which the model can be adjudged to suffer from multicollinearity problem. This implies that this model is free from multicollinearity problem.

Test of Hypothesis

Decision Rule for test of hypotheses

The decision rule is to reject H_0 (null hypothesis) if P-value calculated is greater than P-value tabulated, otherwise accept the H_0 .

H_01 : Agricultural Credit Guarantee Scheme Fund (ACGSF) does not significantly influence Crop output in Nigeria;

Results at 5% level of significance

From P- value calculated for ACGCRP of 0.000 and P-value tabulated of 0.05, we reject the null that ACGSF does not significantly influence crop output in Nigeria and concluded that Agriculture credit guarantee scheme fund has a significant influence on crop output in Nigeria.

H_02 : Agricultural Credit Guarantee Scheme Fund (ACGSF) does not influence the output of the Fishery sector in Nigeria.

Results at 5% level of significance

Based on the calculated P-value for ACGSFSH of 0.000 against tabulated P-value of 0.05, and considering our decision rules we uphold the alternative hypothesis and concluded that Agricultural Credit Guarantee Scheme Fund (ACGSF) significantly influence fishery output in Nigeria

H₀₃: Agricultural Credit Guarantee Scheme Fund (ACGSF) has no empirical relationship with livestock output in Nigeria

Results at 5% level of significance

With P-value calculated for ACGSFLST of 0.000 and P-value tabulated of 0.05, and in line with our decision rule we accept alternate hypothesis and concluded that ACGSFLST has empirical relationship with livestock output in Nigeria.

Conclusion

Resulting from the above findings, the study thereby concludes that ACGSF has a positive effect on the total agricultural output, crop, livestock and fishery output, and Agricultural development in Nigeria. from the analysis conducted on the time series data covering the period of 1989- 2019 revealed that the scheme has experienced increase in the trend of agricultural credit guarantee scheme to the agricultural sector and it also have been observed that ACGSF is measured to be an important factor to the development of agriculture in Nigeria.

Recommendations

The following are recommendations set onward from the findings and conclusion above

- i. Government should show more commitment on livestock sector in order to boost the growth earnings of the economy and reduce her level of dependency on other nations.
- ii. The participating banks should made fund available for fishery sector in order to boost production to bridge the demand and supply gap in the nation.
- iii. Government should guarantee more loans to food crop in order to increase her agricultural output level and reduce food scarcity in the nation
- iv. The Government and Management of the scheme should review the maximum amount available for individual farmer's e.g Fish, Cattle and Poultry Farmer.
- v. Participating banks should avoid the late disbursement of loan to qualify famer in order to evade diversion of the fund for other purposes.
- vi. There is also need to include absolute ban on the import of crop, livestock and fish products so that indigenous producers will grow.

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ACCESS AND USE OF ICT (WEB TOOLS) AMONG THE CASSAVA FARMERS FOR PRODUCTIVITY IN EKITI STATE, NIGERIA.

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Abstract

Information is an important factor in any human endeavor as it enables individuals make timely and informed decisions that would assist them in the realization of their goals. This article investigates the level of awareness, access and effectiveness of information and communication technology (web tools) among the cassava farmers in Ekiti State, Nigeria. Multi-stage random sampling technique was used in selecting the 200 respondents used for the study. A structured and tested questionnaires were administered to the identified cassava farmers. Information such as socio-economic characteristics and production operations. Other information obtained are farmer level of awareness, access and use of ICTs (web tools) on production activities. Data were analyzed by descriptive statistics, cross tabulations and multiple regression models. Webb-tools significant in ICT dissemination, these tools are Facebook (for information/dissemination), WhatsApp, Agric-webb and Tik-Tok. Hence, use of these Webb-tools enhanced farm income. Factors influencing assess to ICT on farm income of cassava farmers are source of information, member of farm organization. Livelihood sources, Cropping pattern and Education. The paper recommended that the agricultural extension services should provide intensive ICT training for the agricultural extension workers to enhance ICT incorporation into extension advisory service particularly in cassava farming.

Keywords: ICT adoption, Agricultural productivity; Digital divide, Ekiti State, Nigeria

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Background of the study

Information is an important factor in any human endeavor as it enables individuals make timely and informed decisions that would assist them in the realization of their production goals (Mdoda and Mdiya 2022). Agricultural information dissemination is crucial to the productivity of farmers and makes them learn about those things which they are not aware of (Banmeke and Olowu, 2005). The Information and Communication Technology (ICT) revolution is far-reaching and has turn the world into global village (Macire-Kante, *et al* ,2019). ICT tools have helped people find, explore, analyze, exchange, and present information without discrimination. ICT, if efficiently used can provide quick access to ideas and experience from wide range of people, communities and cultures. (Kwame, 2010). The efficiency of the agricultural sector has a multiplier effect on economic development. A potent agricultural sector is instrumental to self-sufficiency in food production, generation of employment, foreign exchange earnings and provision of raw materials for agro-allied industries. In Africa, agriculture accounts for more than 32% of the Gross Domestic Products (GDP) and where about 70% of African population engages in agriculture and agricultural related activities and resides in rural areas. However, despite the continent's huge potentials in agricultural production, it is worrying that most of the African countries still depend on food importation (Salami and Arawomo, 2013).

Past studies argued that, Nigeria's agricultural sector has experienced steady decline in productivity (Henri-Ukoha, *et al*, 2012). However, in recent times, indices shown that the sector have started observing a gradual growth (Oladipo, 2013). This steady growth according to past study are influenced by the intervention of agricultural innovation and technology and timely access (Henri-Ukoha *et al.*, 2012). These innovations are mechanized farming-equipment, improved and high yielding varieties, seed-disease resistant varieties, integrated pest management control, post-harvest technologies, efficiency in land use, among others. The efficiency of technology generated and disseminated depends on effective communication which is the key process in information dissemination (Oladele, 1999). Hence, effective communication of technology to farmers can enhanced agricultural productivity. Past studies argued that economic information in the face of global food crisis is a veritable tool for agriculture and rural development ((Nyarko and Kozári 2021).

In Nigeria, evidence shown that cassava is a staple crop and many rural farmers are into cassava farming (Henri-Ukoha, *et al*, 2012). Hence, awareness of, access to and use of right information pertaining to cassava farming can influence cassava productivity among cassava farmers (Luqman, *et al*, 2019). Communicating information relevance to production such as where and how to access improved cassava cuttings, the right method of planting improved cassava cuttings, how to secure agricultural loans and access other available inputs is essential for productivity (Anh, *et al*, 2019). Past studies argued that Nigeria is endowed with some good soil rich in essentials minerals suitable for cassava production as well as reliable climatic conditions for cassava farming.

Past studies contended that Nigeria government has recognized the importance of ICT (web tools) as a good tool that can be used to improve the agricultural sector. The use of ICT (web tools) had brought out seemingly under the scheme growth enhancement scheme (GES) scheme. This scheme a product of ICT (web tools) using GSM phones to disseminate information to over 10 million farmers in other to enhance agricultural productivity (Nwafor, *et al*, 2020). This scheme recorded success as evidenced by past study that the scheme provided the participating farmers timely and affordable agricultural input like fertilizers, and hybrid seeds to farmers in order to increase their yield per hectare and make their agricultural production competitive with the world standard.

The use of Information and communication technologies is relatively new when compared to the traditional way of disseminating information. Arokoyo, (2005) argues that in many developing countries of the world it is typical to extend agricultural messages through conventional means such as the use of the local radios, town-crier, drama, and role play. However, there have been effort geared towards introducing modern technology in the process of information exchange but unfortunately these channels of exchange have not been maximally exploited (Lobo, 2007). Hence there is need to explore the effectiveness of these modern technologies in the training and diffusion of the appropriate message to the farmers.

Ozowa (2004) contended that information and communication are essential ingredients needed for effective transfer of technology designed to enhance agricultural production. Hence, for any information to be useful, it must be well communicated to the end users. The nature and form in which agricultural information are package will require some specialized skills by farmers to access. If agricultural information is package in visual form and readily made available to farmers, it will greatly influence the adoption of such farming technique irrespective of age, sex and educational level. Past study deduced that the attainment of higher level of education and professional qualification is a very good springboard for the assessment of agricultural information intake or access by farmers (Torimiro, 1997). However, it remains problematic if the end users (the farmers) cannot read nor have access to agricultural information package in print media. However, different categories of household and individual have different information needs, and their current and potential access to information sources may also be varied. For this end users to improve on their current production system to a better and more commercialized farming, they need adequate agricultural information on modern agricultural farming techniques.

Moreover, the lack of knowledge on how to add value through proper storage, processing and marketing hinders agricultural growth. However, past study argued that access to relevant and timely technology can leverage on these limitations (Mdoda and Mdiya 2022). However, the extent to which these techniques are harnessed for agricultural development depends on the level of access to these techniques by cassava farmers. This is the conceptual constructs in which this study was built. Consequently, this paper examines the extent to which cassava farmers have access to agricultural information and how access to ICT enhanced their cassava productivity.

From the foregoing, raises the following research questions in which this paper find answers to:

- What kind of information (ICT web-tools) are most necessary to the Cassava farmers?
- What kind of information is disseminated to the Cassava farmers through ICT (web tools)?
- How effective is ICT (web tools) in dissemination of information on input delivery and farm income enhancement?

Objectives of the study as follows:

1. Identify sources of relevance information and technology for cassava production in the study area.
2. Assess ICT access to cassava inputs delivery, value chain and market
3. Examine access to ICT on farm income enhancement of cassava farmers? and
4. Appraise factors influencing assess to ICT on farm income of cassava farmers

Literature review

Cassava

Cassava is well known as *Manihot esculenta* or *Manihot utilissima*. The cassava is believed to have originated in Northern Brazil and Central America (Roger, 1963). This popular crop is now grown in almost every tropical country. In Nigeria it was introduced into Warri the then Bendel State of Nigeria, by Portuguese explorer in the 16th – 17th century (Lean, 1976). The cassava crop consists of 15% peel and 85% fresh tuber flesh. The tuber consists of 20 – 30% starch, 62% water content, 2% protein, 1 – 2% fiber with trace of vitamins and minerals. As main source of carbohydrate it's noteworthy to mention here that cassava also contains 2 cyanogenic glycosides namely linamarin and lotaustralin which are highly toxic to human and animals. Therefore, it must be properly processed before it become suitable for consumption. There are many derivatives from cassava example being starch, ethanol, monosodium glutamate, paper and textiles etc.

Nutritional value of cassava

The nutritional content of cassava depends on the specific plant part (root or leaves), geographic location, variety, age of the plant and environmental conditions (FAOSTAT, 2011a). The cassava root is composed of carbohydrates and is therefore mainly a source of energy. The starch content varies between 32 to 35% of the mass of fresh roots and 80 and 90% of the mass of dried roots (Montagnac et al., 2009b). of B vitamins of cassava roots is also found to be trivial (Gil and Buitrago, 2002). The nutrient density of cassava leaves differs in quantity and quality according to cassava variety, stage of development of the shrub and the relative size of the leaves and stem (Gil and Buitrago, 2002). As can be seen from Table 1, cassava leaves contain a higher amount of protein, essential amino acids, vitamins B1, B2, and C and carotenoids than roots (Adewusi and Bradbury, 1993; Okigbo 1980; West et al., 1988) and the starch content varies from 7 to 18 g/100g (Gil and Buitrago, 2002).

They also contain more minerals such as calcium, iron, manganese, and magnesium and zinc (Webeto et al., 2006). The amount of sucrose, glucose, fructose and maltose is usually low (Tewe, 2004), however, in sweet varieties more than 17% of the root content is sucrose (Okigbo, 1980; Charles et al., 2005). Fiber content differs according to the variety and stage of development of the root. In fresh roots it is less than 1.7%, while it comprises 4% of cassava flour (Gil and Buitrago, 2002). Lipid content varies between 0.1 and 0.3% of the fresh mass of cassava roots and is present as nonpolar (45%) or glycolipids (52%) (Hudson and Ogunsua, 1974). The protein content is trivial, between 1 and 3% of dry matter (Buitrago, 1990) and about 1.5 mg/100 g of fresh mass (Bradbury and Holloway, 1988). Essential amino acids are present in low quantities, with the exception of arginine, glutamic acid and aspartic acid (Gil and Buitrago, 2002). The mineral content of the roots varies

Table 1. Proximate nutrient composition of cassava roots and leaves.

| Variable | Unit | Raw Cassava | Cassava roots | Cassava leaves |
|------------------------------|------|-------------|---------------|----------------|
| Proximate composition | | | | |
| 100 (g) | | | | |
| Food energy | Kcal | 160 | 110 - 149 | 91 |
| Food energy | kJ | 667 | 526 - 611 | 209 – 251 |
| Moisture | g | 59. 68 | 45.9 - 85.3 | 64.8 - 88.6 |
| Dry weight | g | 40.32 | 29.8 - 39.3 | 19 - 28.3 |
| Protein | g | 1.36 | 0.3 - 3.5 | 1.0 - 10.0 |
| Lipid | g | 0.28 | 0.03 - 0.5 | 0.2 - 2.9 |
| Total carbohydrate | g | 3.06 | 25.3 - 35.7 | 7 - 18.3 |
| Dietary fiber | g | 1.8 | 0.1 - 3.7 | 0.5 - 10.0 |
| Ash | g | 0.62 | 0.4 - 1.7 | 0.7 - 4.5 |
| Thiamin | mg | 0.087 | 0.03 - 0.28 | 0.06 - 0.31 |
| Vitamin A | µg | - | 5.0 - 35.0 | 8300 - 11800e |
| Riboflavin | Mg | 0.048 | 0.03-0.06 | 0.021-0.74 |
| Niacin | Mg | 0.854 | 0.6- 1.09 | 1.3-2.8 |
| Ascorbic acid | mg | 20.6 | 14.9 - 50 | 60 – 370 |
| Minerals | | | | |

| | | | | |
|-------------------------|----|------|-------------|-------------|
| <i>Calcium</i> | Mg | 16 | 19 – 176 | 34 – 708 |
| <i>Total phosphorus</i> | Mg | 27 | 6 – 152 | 27 – 211 |
| <i>Ca/P</i> | | 0.6 | 1.6 – 5.48 | 2.5 |
| <i>Iron</i> | Mg | 0.27 | 0.3 – 14.0 | 0.4 – 8.3 |
| <i>Potassium</i> | % | - | 0.25 – 0.72 | 0.35 – 1.23 |
| <i>Magnesium</i> | % | - | 0.03-0.08 | 0.12 – 0.42 |

Source: Macire Kante *et al*, 2019

2.3 Information technology (IT)

Information technology (IT) is the application of computers and telecommunications equipment to store, retrieve, transmit and manipulate data, often in the context of a business or other enterprise. The term is commonly used as a synonym for computers and computer networks, but it also encompasses other information distribution technologies such as television and telephones. Several industries are associated with information technology, such as computer hardware, software, electronics, semiconductors, internet, telecom equipment, e-commerce and computer services. In a business context, the Information Technology Association of America has defined information technology as "the study, design, development, application, implementation, support or management of computer-based information systems". The responsibilities of those working in the field include network administration, software development and installation, and the planning and management of an organization's technology life cycle, by which hardware and software is maintained, upgraded, and replaced. Yekini and Lawal (2012) Sees ICT (Web tools) as: a powerful collection of elements which include computer hardware, software, telecommunication networks, workstations, robotics and smart chips, which is also at the root of information systems.

Roles of ICT (web tools) in agriculture

Since the coming of the era of information & technology, ICT (web tools) has played a great role in our society. The information communication technology revolution has brought huge changes in both social and economic development in our world. Agricultural just like other sector has benefited from ICT (web tools) revolution and the latest innovation in ICT (web tools) has expanded the development of agriculture sector in different form. In large part of the world over millions house hold own Mobile phones and Laptops which are used as the source of information to people in village and in the big cities, the use of ICT (web tools) in agriculture ranges from advanced modern technologies, such as GPS navigation, satellite communication, and wireless connectivity, to older technologies such as Facebook and Google.

However, the rural people still lack basic communication infrastructure in accessing crucial information in order to make timely decisions. The application of ICT (web tools) in agriculture generates possibilities to solve problems of rural people and also to promote the agricultural production by providing scientific information timely and directly to farmers. Here are some benefits of ICT (web tools) in agriculture

- Introduction of Web tools has brought about a tremendous change in agriculture sector resulting into dramatic improvement in the efficiency and profitability of the agriculture industry.
- The spread of Web tools services allow farmer to land their product timely and directly to the market where wholesalers are ready to purchase them without the presence of middlemen.
- ICT (web tools) has been another input in communication technology used widely by many farmers, they have been used by farmers, Entrepreneurs, and other stake holders to disseminate information on various innovation in agricultural technology.

Methodology

3.1 Study Area

The study was carried out in Ekiti State. The State is located in the South west geopolitical zone of Nigeria. Ekiti State is a state in southwestern Nigeria, bounded to the north by Kwara State, to the Northeast by Kogi State, to the South by Ondo State, and to the west by Osun State. In Ekiti state, Yoruba sub-group make up the majority of the state's population. Ekiti State was formed from a part of Ondo State in 1996 and its capital is Ado-Ekiti. The State is made up of 16 Local Government Areas, constituted into four agrarian's regions. The inhabitants are mostly farmers. Farmers who have cassava as their main crop constituted the target population of the study.

3.2 Sampling technique

Multi-stage random sampling technique was used in selecting the respondents for the study. Ekiti state has 4 agrarian zone. In the first stage one local government was randomly selected from each agrarian zone, at the second state, two communities were also randomly selected while the in the final selection, 30 cassava farmers were randomly selected in each community to give a total of 240 cassava farmers. In the final enumeration only 200 cassava farmers (83.3% response rate) were used for further analysis (Table 2). The used 40 cassava farmers contained missing information, inappropriate filling, missing questionnaire in transit among others.

**Table 2: Local government and Sampling areas
 Community * Local government Cross tabulation**

| | | Local government | | | | Total |
|--------------|------------|------------------|-----------------|-----------|-----------|------------|
| | | Ekiti east | Ekiti southwest | Gbonyin | Ikole | |
| Community | Isinbode | 25 | 0 | 0 | 0 | 25 |
| | | 25 | 0 | 0 | 0 | 25 |
| | Igbara odo | 0 | 25 | 0 | 0 | 25 |
| | | 0 | 25 | 0 | 0 | 25 |
| | Iluomoba | 0 | 0 | 25 | 0 | 25 |
| | | 0 | 0 | 25 | 0 | 25 |
| | Ayebode | 0 | 0 | 0 | 25 | 25 |
| | | 0 | 0 | 0 | 25 | 25 |
| Total | | 50 | 50 | 50 | 50 | 200 |

Source: Field survey, 2021

3.3 Method of Data Collection

A structured and tested questionnaire was administered to the identified cassava farmers in order to obtain data on their socio-economic characteristics such as occupation, age, sex, educational level and marital status among others. Other information obtained are farmer level of awareness, access and use of ICTs (web tools) and their effectiveness of ICT usage. Also information was sourced on constraints to ICT, the type of ICT used, factors influencing ICT access, input and output delivery. This study was limited mainly to the effectiveness of ICT in dissemination of agricultural information and access to the use of ICT (web tools) by respondents.

Method of data analysis

Method of data analysis used as follows, descriptive statistics, cross tabulations and multiple regression models. Descriptive statistics used were frequency counts, averages, percentages, among others, cross tabulation were used to captured the level relationship between variables, while the use of multiple regressions is to measure causal relationship between the dependent and independent variables,

Multiple Regression Model

The study adopted the use of Multiple Regression Model to examine factors influencing result of the effectiveness of using ICT (web tools) on cassava production in the identified study areas. Hence, this result was regressed against selected variables. The model is expressed as:

$$Y = a + bX_i + \epsilon \tag{1}$$

Hence, the linear form of the equation (1) stated as follows:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_{10}X_{11} + U \tag{2}$$

where Y is the likelihood of presence of the characteristics of interest (the characteristics of interest is whether a farmer use of ICT (web tools) influence cassava productivity).

Y = result of the effectiveness of using ICT (web tools) on cassava production

a = is the intercept

b = is the slope (constant)

b₁ – b₈ = Coefficients

X₁ – X₁₁ = Independent variables

ε – and is the residual (error)

U = Error term assumed to have normal distribution with zero mean, and constant variance, i.e. U ~ N (0 σ²)

and E (U_i, U_j) = 0_{ij}

- Y_i = result of the effectiveness of using ICT (web tools) on cassava production
 X_1 = Sex of farmer (male = 1, female = 2)
 X_2 = Age of farmer (in years)
 X_3 = Household size (number of adult members of the family of doing farm work)
 X_4 = Educational level (years in formal school)
 X_5 = Farming experience (years of cassava farming)
 X_6 = Farm size in hectares (ha)
 X_7 = Sources of information
 X_8 = Membership of cooperative/farmers associations (member = 1, non – member – 0).
 X_9 = Marital Status (married = 1, single = 0).
 X_{10} = Livelihood sources
 X_{11} = Cropping system
 $b_1 - b_{11}$ = Unknown parameters to be estimated.

Estimation procedure

Due to the nature of the data, Ordinary Least Square (OLS) method was adopted for estimation technique. Other techniques used to reduce measurement errors are in the use of Dublin Watson test to assess multi-co linearity among the explanatory variables to avoid co linearity problem and the use of Best Linear Unbiased Estimation (BLUE) method. Data were coded into SPSS version 17 for analysis.

Analysis of quantitative data was conducted with respect to the objectives of the study using Software Package for Statistical analysis (SPSS) version 17.0. Frequencies and percentages were computed to describe various matters related to ICTs and they were presented in tables and figures to show the differences and option of respondents on which the discussions of the results were based.

RESULT AND DISCUSSION

The presentation of results and discussions was based on the socio-economics characteristics of the cassava farmers who has deploy the use of ICT (web tools) for their farm operations. This includes among others: Age, Sex, Marital status, level of Education, level of awareness and use of ICT (web tools) to influence cassava production, cost and benefit of using ICT (web tools) and the effect of the ICT (we tools) on income generation.

Socio-Economic Characteristics of Respondents

Some of the socio-economic characteristics includes Age distribution, Sex, Production experience, Marital status etc. This is done to know how the social-economic characteristics of the respondent get access to ICT (web tools) and the usage of the specified web tools. Table 3 revealed that Access and Usage of ICT (web tools) are predominantly accessed by male consequently (55%), while 45% were female. The study also revealed that those between ages 27-40 were 60.0%. Those in the category of 41-60 years were dominant age-category (40%). This study suggested that the availability of ICT (web tools) is mainly available and also used by the middle age farmer of 27-40 years, although the old age farmers were also not left out because few of the category had access the ICT (web tools) such as WhatsApp, Facebook. Most respondent of the percentage were married (60%) while those that are single are 30% and 10% are divorced (Table 3).

Table 3: Percentage Distribution of personal Socio-economic

| Socioeconomic characteristics | Frequency | Percentage (%) |
|-------------------------------|-----------|----------------|
| Sex | | |
| Male | 110 | 55 |
| Female | 90 | 45 |
| Marital status | | |
| Married | 60 | 30 |
| Single | 120 | 60 |
| Divorced | 20 | 10 |
| Family size | | |
| 3.00 | 30 | 15 |
| 4.00 | 20 | 10 |
| 5.00 | 50 | 25 |
| 6.00 | 40 | 20 |
| 7.00 | 30 | 15 |
| 8.00 | 10 | 5 |

| | | |
|--|-----|----|
| 9.00 | 10 | 5 |
| 10.00 | 10 | 5 |
| Religion | | |
| Christianity | 150 | 75 |
| Muslim | 50 | 25 |
| Level of Education | | |
| No formal education | 10 | 5 |
| Primary school completed | 10 | 5 |
| Secondary school completed | 50 | 25 |
| OND/NCE | 70 | 35 |
| HND/B.SC | 60 | 30 |
| How do you acquire your present farm? | | |
| Inherited | 50 | 25 |
| Caretaker | 20 | 10 |
| Purchased Land | 70 | 35 |
| Rented/lease | 60 | 30 |
| Member of farm organization | | |
| Member | 100 | 50 |
| Not a member | 100 | 50 |
| Source of raw materials | | |
| Neighborhood | 100 | 50 |
| Locality | 100 | 50 |
| Local government | | |
| Ekiti east | 50 | 25 |
| Ekiti southwest | 50 | 25 |
| Gboyin | 50 | 25 |
| Ikole | 50 | 25 |
| Cropping System | | |
| Sole cropping | 130 | 65 |
| Mixed cropping | 70 | 35 |
| When did you start planting? | | |
| 1-5 | 20 | 10 |
| 6-10 | 70 | 35 |
| 11-15 | 80 | 40 |
| 16-20 | 30 | 15 |

Source: Field survey, 2021

The study showed that high percentage of those that are married had access to ICT (web tools) and make use of it more. Majority of the respondent had OND/NCE education, specifically 30% had HND/B.SC education, while 25% had SSCE education. Moreover, 5% had Primary education and 5% had no formal education. Past study argued that ICT (web tools) access and usage does not necessarily require high level of education. The study revealed that the commonly used web tools are WHATSAPP and FACEBOOK for information dissemination and also for Social Activities (30%) (Table 4).

Table 4 Access and Use of ICT (web-tools) in Farming Operations.

| WEB TOOLS | USAGE % | | | PURPOSE USED FOR % | | | | | |
|-----------|---------|----------|-------|--------------------|-------------|-------------------|------------------------|---|-------------------|
| | Low | Moderate | High | Marketing | Advertising | Social Activities | Farm input Information | Source of Information For New Varieties | Customer Services |
| TELEGRAM | 15 | 21 | 24 | 6 | 12 | 18 | 9 | 9 | 6 |
| YOUTUBE | 32.5 | 12.5 | 5 | 27.5 | 2.5 | 2.5 | 7.5 | 7.5 | 2.5 |
| INSTAGRAM | 27 | 21 | 12 | 24 | 9 | 6 | 6 | 12 | - |
| TWITTER | 32.5 | 16.25 | 16.25 | 26 | 9.75 | 19.5 | 3.25 | 3.25 | 3.25 |
| FACEBOOK | 20 | 55 | 25 | 10 | 25 | 30 | 20 | 10 | 5 |
| WHATSAPP | 30 | 45 | 25 | 5 | 10 | 20 | 40 | 15 | 10 |
| SKYPE | 23.75 | 1.25 | - | 18.75 | 1.25 | - | 3.75 | - | 1.25 |
| TIK TOK | 21.25 | 3.75 | - | 18.75 | 1.25 | - | 3.75 | - | 1.25 |
| ESOKO | 18 | 2 | - | 17 | 1 | - | 1 | 1 | - |
| AGRIWEBB | 46.75 | 8.25 | - | 33 | 5.5 | 5.5 | 8.25 | 2.75 | |
| FIGMA | - | - | - | - | - | - | - | - | - |
| WIX | 14.25 | 0.75 | - | 12.75 | 0.75 | - | 1.5 | - | - |
| BOOTSTRAP | 14.35 | 0.75 | - | 12.75 | 0.75 | 0.75 | 0.75 | - | - |
| SNAPCHAT | 34 | 6 | | 24 | 4 | 12 | - | - | - |
| ADOBE XD | 15 | - | - | 12.75 | 0.75 | 0.75 | 0.75 | - | - |

Source: Field study, 2021

Cassava farmers engaged in other livelihood activities, the study showed that 25% engaged in Trading of manufactured goods, Civil Services, and public services respectively, while 20% were Artisans (Table 3). Majority of these respondents are Christian (70%), 15% are Muslim. The study showed that 15% of those who have access to the usage of ICT (web tools) are from Isinbode, Igbara-odo and Ayebode respectively i.e the respondents that have more access to these web tools are mainly from the Towns listed above. While others respondents are 10% and they are from Iluomoba (Table 4).

Awareness and Accessibility of ICTs (web tools)

The result of the data analysis on the existing ICTs (web tools) facilities in the study area revealed numerous ICTs (web tools) were available but the result showed few of the respondents are familiar with these web tools, while some testified to the existence and awareness of these web tools. Table 4 indicated that 60.0% had access to telegram and telegram for social activities, (50.0%) had access to You-tube Marketing purposes, 60.0% had access to Instagram and 65% had access to Twitter. Likewise, Facebook and WhatsApp had 100.0% access and used for social activities, marketing among others. Moreover, 25.0% of the respondents had access to Skype and Tiktok, 20.0% had access to Esoko, 55.0% had access to Agriwebb, 15.0% had access to Wix, Bootstrap, and Adobe XD, while 40.0% had access to snapchat. None of the respondents had access Figma which had proved to effective Webb tools facilities. It is clear that WhatsApp and Facebook are vastly due to its coverage and ease of information dissemination and also ease of exchanging information as well. The findings corroborated to the policy of FAO and International Telecommunication Union (ITU), (2016) endorsement that web tools have helped in enhancing agricultural productivity and promoting value addition.

Usage of ICTs (web tools)

Data from the table 5 revealed the purpose of using the web tools which showed that majority of the respondents uses it for Marketing and Social activities, this shows that the level of ICTs (web tools) in input delivery is low cause most of the respondents are not used to some of the web tools. This collaborates with the study of Helen *et al* (2014), that the availability of ICTs (web tools) sources does not really means its use is effective in agricultural information dissemination and exchange

Objective 2: Use of ICT (Webb-tools) to enhanced cassava inputs delivery, value chain and market analysis.

Table 5 revealed that Facebook was the major source (25%) for input delivery and value chain analysis out of which 24.7% comes from farm product advertisement. Others ICT Webb tools important for information

sourcing as follows Face book for fertilizers (13.3%). Facebook for value addition of processing (12.3%), Also, WhatsApp for value addition of processing (12.3%), Agric-webb for Farm product advertisement (15.3%). Others usage of ICT (Webb-tools) for agricultural information dissemination and exchange as follows: Facebook (24.7%), Agric. Webb (13.2%), WhatsApp (13.1%), Tik tok (9.8%), Esoko (8.3%), YouTube (8.0%), Twitter (6.3%), Snapchat (4.9%), Instagram (4.6%), Telegrams (3.8%) and Skype (3.4%). This clearly evidence that access and use of ICT has really improved cassava operations and productivity.

Table 5: Use of ICT (web-tools) to source for/enhanced Farming Operations.

| Input delivery and Value chain analysis | ICT Webb-tools | | | | | | | | | | | Total |
|---|----------------|-------------|------------|-------------|-------------|-------------|------------|-------------|-------------|------------|-------------|--------------|
| | Tele grams | You Tube | Insta gram | Twitte r | Face book | Whats App | Skype | Tik tok | Agriwebb | Snap chat | Esoko | |
| Fertilizers | 2 | 24 | 10 | 5 | 65 | 41 | 2 | 10 | 25 | 5 | 10 | 199 |
| Hybrid seed | 10 | 4 | 11 | 10 | 48 | 26 | 5 | 21 | 30 | 10 | 15 | 190 |
| Agric. Mech. | 1 | 10 | 7 | 8 | 35 | 20 | 1 | 12 | 21 | 6 | 21 | 142 |
| Credit source | 15 | 15 | 5 | 15 | 51 | 35 | 6 | 10 | 28 | 2 | 25 | 207 |
| Agrochemicals | 8 | 20 | 4 | 8 | 63 | 28 | 10 | 25 | 24 | 8 | 18 | 216 |
| Sales of farm products | 10 | 15 | 6 | 18 | 48 | 16 | 14 | 30 | 35 | 11 | 31 | 234 |
| Farm product advertisement | 7 | 21 | 10 | 21 | 71 | 32 | 7 | 26 | 40 | 15 | 20 | 270 |
| Processing | 12 | 31 | 20 | 20 | 60 | 44 | 12 | 31 | 33 | 21 | 15 | 299 |
| Marketing | 11 | 18 | 18 | 19 | 49 | 19 | 10 | 30 | 26 | 19 | 9 | 228 |
| Total | 76* | 158* | 91* | 124* | 490* | 261* | 67* | 195* | 262* | 97* | 164* | 1985* |

Source: Field survey, 2021

Notes: * Multiple responses.

Objective 3: To examine access and use of ICT on farm income enhancement of cassava farmers?

The paper examines access and use of ICT (Webb-tools) to farming operations and how it has significantly contributed to farm operations, productivity and farm income (Table 7). The paper indicated mean income of cassava farmers in the production year is ₦ 34,500,00, Table 6 presented the farm income distribution among cassava respondents. Table 6 indicated that 13% made losses and this category source their information from Telegrams (20.8%), Skype (18.2%), Instagram (13.8%) and Snapchat (13.2%). Information source from here might not be relevant and helpful as the results indicated that access and use of these categories of Webb-tools does not influence positive impact on farm income rather contributed to farm losses (Table 7). Likewise, the paper also indicated that cassava farmers that made N50, 000 and above (34%) source their information from Facebook, WhatsApp, Agric. Webb and Tik-Tok and about 36% of cassava farmers who had access through these medium experienced enhanced cassava farming operations. This implies that access and the use of ICT (Webb-tools) of Facebook, WhatsApp, Agric. Webb and Tik-Tok enhanced farm income (Table 7).

Table 6: Farm Income distribution

| Farm- Income categories(₦) | Frequency |
|----------------------------|------------|
| -25000 – 1 | 26 |
| 1.01 – 10000 | 52 |
| 10001 – 25000 | 46 |
| 25001 – 50000 | 36 |
| 50001 – 100000 | 22 |
| 100001 – 250000 | 10 |
| 250001 – 1000000 | 8 |
| Total | 200 |

Source: Filed survey, 2021

Table 7: Use of ICT (web-tools) and Farm income

| Farm- Income categories(₦) | ICT Webb-tools | | | | | | | | | | | |
|----------------------------|----------------|----------|------------|----------|-----------|-----------|-------|---------|-------------|-----------|-------|-------|
| | Tele Grams | You Tube | Insta gram | Twitte r | Face book | Whats App | Skype | Tik tok | Agric. webb | Snap chat | Esoko | Total |
| -25000 – 1 | 33 | 14 | 22 | 16 | 1 | 2 | 29 | 7 | 3 | 21 | 11 | 159 |
| 1.01 – 10000 | 38 | 26 | 51 | 31 | 3 | 10 | 32 | 16 | 12 | 32 | 36 | 287 |
| 10001 – 25000 | 14 | 35 | 18 | 27 | 21 | 15 | 18 | 23 | 45 | 19 | 24 | 259 |
| 25001 – 50000 | 11 | 16 | 8 | 18 | 25 | 20 | 11 | 32 | 22 | 17 | 19 | 199 |
| 50001 – 100000 | 4 | 8 | 1 | 7 | 28 | 31 | 7 | 12 | 7 | 8 | 6 | 119 |
| 100001 – 250000 | - | 1 | - | 1 | 15 | 16 | 3 | 6 | 6 | 3 | 4 | 55 |
| 250001 – 1000000 | - | - | - | - | 7 | 6 | - | 4 | 5 | - | - | 22 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 1100* |

Source: Field survey, 2021

Objective 4: Appraise factors influencing access to ICT on farm income of cassava farmers

The multiple regression model was used to appraise factors that influence farm income of cassava farmers as a result of access and use of ICT (Webb tools). Multiple Linear Regression (MLR) model was used because of its suitability. SPSS version 17 was used for the analysis. The paper hypothesized 11 independent variables of 6 continuous and 5 discrete variables respectively. These variables were selected on the basis of theoretical explanation, reviews of similar studies and the results of various empirical studies. Table 8 revealed that 6 variables of the 11 hypothesized independent variables were found to be significant. These hypothesized variables are: Education (X₄), Source of information (X₇), Member of farming organization (X₈), Marital status (X₉), Livelihood sources (X₁₀) and Cropping system (X₁₁).

The Multiple Correlation Coefficient (R = 0.683) indicates that the degree of access and use of these ICT (Webb-tools) is very robust, as explained by these hypothesized variables, and are quite strong and positive. The results of the MLR value of coefficient of determination (R² = 0.617) and the adjusted R² of 0.60, implies that about 62% of the hypothesized 11 independent variables variation explained the farm income of cassava farmers as a result of access and use of ICT (Webb tools).

Thus, this study hypothesized that cassava farmers whose earnings are relatively high could be participating in technology packages and innovativeness which, in turn, will expose them to new business opportunities. Findings from this study indicated that source they obtained information from (X₇) was positive and significant in explaining the respondent ability to enhanced farm income. The coefficient of variable X₇ (0.554) implies that 1-unit increment in access and use pf ICT (Webb tools) would bring about 0.6 increments to farm income. The other significant variables that were positive and significant were member of farm organization (X₅) Livelihood sources (X₁₀), Cropping pattern (X₁₁) and Education (X₄). However, variable marital status (X₉) is significant but negative. The implication of this finding is that 1-unit increment in farm organization (X₅) Livelihood sources (X₁₀), Cropping pattern (X₁₁) and Education (X₄) would bring about 0.22, 0.14, 0.23 and 0.5 improvement in the farm income of the respondents respectively. However, for variable marital status (X₉) a 1-unit increase would reduce farm income by 0.7 (Table 8). This result implies the positiveness of farmers towards access and use ICT (Webb tools) for innovation and value chain advancements.

Table 8: Multiple regression model analysis results

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|-------|--------------------------------------|-----------------------------|------------|---------------------------|--------|-------|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 815.160 | 1084.693 | | .752 | .454 |
| | Religion | -49.732 | 224.471 | -.025 | -.222 | .825 |
| | Education | 0.51373 | 0.251036 | .064 | 2.046 | .0622 |
| | Marital status | -.702.975 | 350.714 | -.491 | -2.004 | .048 |
| | Family size | 173.477 | 114.985 | .327 | 1.509 | .135 |
| | Livelihood sources | .140820 | .077881 | .072 | 1.808 | .0802 |
| | Sources of information | .554 | .18556 | .000 | 2.698 | .0398 |
| | How did you acquire cassava farmland | -55.807 | 111.163 | -.062 | -.502 | .617 |
| | Farmland Size | 44.378 | 60.536 | .097 | .733 | .465 |
| | When did you start Cassava farming | 7.530 | 51.499 | .021 | .146 | .884 |
| | Cropping system | 0.2338 | 0.10225 | .130 | 2.287 | .0303 |
| | Member of farm organization | 376.815 | 185.156 | .219 | 2.035 | .045 |

Source: Computer generated results sheet

Problems to Access ICTs (web tools)

Table below shows the factors militating against the utilization of ICTs by the cassava farmers in the study area. Lack of technical experience in manipulating ICT (web tools) was low at 45%, Incessant Electricity Supply was another factor militating the effective usage of Webb tools in the study areas. Likewise, high cost of ICT (web tools) was Low at 41%, Poor network reception was low (55%) while lack of physical access was moderate at 45%

Table 9: Factors militating against the utilization of ICTs by the cassava farmers

| Factors | Low (%) | Moderate (%) | High (%) |
|--|---------|--------------|----------|
| 1 Lack of technical experience in manipulating ICT (web tools) | 45 | 35 | 20 |
| 2 Incessant Electricity Supply | 40 | 40 | 20 |
| 3 High cost of ICT (web tools) | 41 | 36 | 23 |
| 4 Poor Network Reception | 55 | 35 | 10 |
| 5 Lack of Physical Access | 30 | 45 | 24 |

Conclusion.

Information is an important factor in any human endeavor as it enables individuals made timely and informed decisions that would assist them in the realization of their production goals. The Information and Communication Technology (ICT) revolution is sweeping through the world and the windstorm has even caught up with Nigeria. ICT tools have helped people find, explore, analyze, exchange, and present information without discrimination. ICT, if efficiently used can provide quick access to ideas and experience from wide range of people, communities and cultures. The study investigates the level of awareness, access and effectiveness of information and communication technology (web tools) among the cassava farmers in Ekiti State, Nigeria.

The paper revealed that Facebook was the major source (24.7%) for input delivery and value chain analysis. While 12.3% of the respondents goes for WhatsApp for value addition of processing, 15.3% for Agric-webb for Farm product advertisement. This clearly evidence that access and use of ICT has really improved cassava operations and productivity. The paper found out that access and the use of ICT (Webb-tools) of Facebook, WhatsApp, Agric. Webb and Tik-Tok enhanced farm income. Factors influencing assess to ICT on farm

income of cassava farmers are source of information, member of farm organization. Livelihood sources, Cropping pattern and Education.

Hence, the result from this paper suggested that the Multiple regression model adopted was highly predictive of the Use of ICT-based on farm input information. In addition, use of these ICT-based farm input information was also highly predictive of the increased adoption of farm input information by cassava farmers in Ekiti State, Nigeria. This paper evaluates factors affecting the using information and communication technologies (ICTs) by cassava farmers in the Ekiti state, Nigeria. The empirical results in this paper provide many interesting evidences thus suggest more participation on the usage of Webb tools to improve their farm productivity. Hence, it was recommended that the agricultural extension services through the ministry of agriculture should provide intensive ICT training particularly those Webb tools identified by the study to be effective in agricultural information dissemination and exchange. These Webb tools to be incorporated into extension advisory service for cassava farming operations

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COVID-19 INFLUENCE ON CROP FARMERS' ACTIVITIES: COMPARATIVE STUDY BETWEEN NIGER STATE – NIGERIA AND PUNJAB – PAKISTAN

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Abstract

Against the backdrop of the challenges that be-dwelled crop farmers during the 2020 COVID-19 lockdowns, this study presents a comprehensive assessment of the COVID-19 pandemic's impacts on crop farmers' activities between Niger State of Nigeria and Punjab of Pakistan. The aim is to provide policy options against possible lockdown for the vaccine-evasive COVID-19 variants which continued to spread all over the world. The farmers [Niger State (45.1%) and Punjab (78%)] witnessed a COVID-19 case and/or know an infected patient. The production challenges were compared alongside the measures taken by each region to curb the negative impact of the pandemic. The crop farmers had numerous challenges in their farming activities and fears for future difficulties are more intense for some than others in the study areas. The challenges compared between the regions were streamlined into 'access to basic inputs', 'prices of farmers' crops', and the general 'prices of foodstuff' in the market. The farmers saw the lockdown differently while the risk-taker farmers see opportunities, the conservative farmers are not too optimistic, and the timid farmers only see high level of risk and uncertainties. The study suggests mitigating mechanisms that can be adopted to ensure smooth and sustainable farming activities.

Keywords: Crop Farmers, COVID-19 variants, lockdown, Niger State, Punjab Province.

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Introduction

Before COVID-19, developing countries were already struggling to tackle food insecurity, with the advent of the virus, pressures mounted on the fragile state of food security in many folds. Agriculture, the most important sector in emerging countries like Nigeria and Pakistan is threatened as COVID-19 hits the very fabric of economies in the world in a way no one could have predicted (Bukari *et al.*, 2022; Ahmed, 2022; Ibukun and Adebayo, 2021; Shahzad *et al.*, 2021; Pakrava *et al.*, 2021; Laborde *et al.*, 2020; Poudel *et al.*, 2020). The importance of agriculture to these economies cannot be overstressed. For instance, the share of agriculture in the Gross Domestic Product (GDP) of Nigeria and Pakistan is about 21.1% and 24.4%, the sector also engages about 70% and 42.3% of the total labor force in the countries respectively. In comparison, Nigeria is relatively more agrarian than Pakistan considering the percentage of the labor force engaged in agriculture. Agricultural land in

Nigeria constitutes about 78% of total land, out of which 34 million ha (37.3%) is used for arable crops, 6.5 million ha (7.4%) for permanent crops, and 28.62 million ha (33.3%) for permanent meadows & pastures. In Pakistan, the agricultural land constitutes about 34.2% of the total landmass where 30.51 million ha (27.6%) are used for arable crops, 0.79 million ha (1.1%) for permanent crops, and 5 million ha (6.5%) of the land under permanent meadows & pastures (FAO, 2021). Aside from the agrarian traits shared by these two countries, demographically, they have relatively the same population size: Nigeria (216.747 million) and Pakistan (216.467 million) (IMF, 2021^{a, b}). They are also former British colonies having bilateral relations with each other for decades. In trade relations for instance, as of 2019/2020, Nigeria exported \$116M worth of products to Pakistan with petroleum gas (92.3%) topping the products. Pakistan on the other hand, exported about \$46.8M worth of products to Nigeria and topping the products are telephones (11.7%), packaged medicaments (10.6%), confectionary sugar (8.3%), video displays (8%), synthetic fabrics (5.4%), and other 56% (ITC, 2020).

COVID-19 Status in Nigeria and Pakistan: The first case of COVID-19 case in Pakistan was confirmed on 26 February 2020 after the outbreak in China. The next day 27th February, the Federal Ministry of Health in Lagos State confirmed Nigeria's first case. Two years after as of March 2022, Nigeria has 4,726,096 test samples, 255,926 were confirmed cases, 2,659 active cases, 249,495 discharged, and 3,142 deaths (NCDC, 2022) while in Pakistan, 1,524,086 cases were confirmed, 8,314 active cases, 1,485,426 discharged and 30,346 death cases (Government of Pakistan, 2022). The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-COV-2), the virus that causes COVID-19 has changed and evolved significantly from its original self as it spreads globally emerging into 'variants of interest' and 'variant of concern' in many countries around the world (see Table 1). According to the Center for Disease Control and Prevention (CDC, 2021), a variant is a variant of interest if it has "mutations that are suspected or known to cause significant changes, and is circulating widely" while a variant of concern on the other hand "spread more easily, cause more severe disease, escape the body's immune response, change the clinical presentation, or decrease the effectiveness of known tools". (WHO, 2021^a).

Table 1. Current and previous Variants of concern

| | WHO Designation | Lineage | Date Identified | Country Detected | WHO Status |
|----------|----------------------|--|-----------------|-------------------|--------------------|
| CURRENT | Deltacron | Recombination of Delta & Omicron variant | November 2021 | France | Pending |
| | Omicron variant | SARS-CoV-2 B.1.1.529 | November 2021 | South Africa | Variant of concern |
| | Omicron sub-variants | BA.1, BA.1.1, BA.2, BA.3, BA.4, BA.5, & recombination BA.1/BA.2 (XE) | | Several countries | |
| PREVIOUS | Delta variant | SARS-CoV-2 B.1.617.2 | October 2020 | India | Variant of concern |
| | Alpha | B.1.1.7 | September 2020 | United Kingdom | Variant of concern |
| | Beta | B.1.351 | May 2020 | South Africa | Variant of concern |
| | Gamma | P.1 | November 2020 | Brazil | Variant of concern |

Source: World Health Organization of United Nation (WHO, 2022)

A glimpse of hope spread throughout the world as the first COVID-19 vaccines were developed in 2020 and made available to the public. Campaigns on vaccine safety and effectiveness followed immediately, and curfews and lockdowns relaxed but the impact of temporary measures used to control the spread of the virus has dented the smooth running of many sectors (Rogers, 2022). Fully vaccinated people can have strong protection against COVID-19 (Mallapaty *et al.*, 2021; Vergano, 2021). As of 27 March 2022, a total of 31,391,732 vaccine doses have been administered (WHO, 2021^b). As of 17 March 2022, a total of 226,203,802 vaccine doses have been administered (WHO, 2021^c).

On agricultural matters, Niger State of Nigeria and Punjab province of Pakistan is one of the top economic and political engines in their respective countries. Both regions have been affected by the emergence of COVID-19, disrupting their social and agricultural activities. Given the proximity of Pakistan–Punjab to China (ground zero of COVID-19) as compared to Nigeria – Niger State, the economic and political system, the disparity is expected in the effect of COVID-19 on farmers' activities and measures taken to curb the effects. Accordingly, the following research questions are raised: (i) What are the common traits to be compared between the regions that can be compared? (ii) Are the farmers in both regions adhering to COVID-19 containment rules? (iii) In comparison, which farming activities were most affected by the lockdown? (iv) Are there lessons to be learned from each region?

The main aim is to study the difference and/or similarities in the challenges faced during the 2020 COVID-19 lockdown between Niger State and Punjab province, and extract lessons from each region to support containment policy for the new threats of COVID-19 variants and subvariants. Specifically, the study will:

1. Examining the adherence to COVID-19 containment rules by the regions.
2. Determining the farming activities most affected during the lockdowns in the regions.
3. Identifying other challenges faced during the lockdown.
4. Compare and extract lessons from each region that can support the management of the contemporary threats to crop production activities.

At this juncture, this study hypothesized the followings: Null Hypothesis (H_0) – there is no significant difference in the challenges experienced during the lockdown between the Punjab and Niger State crop farmers. While the Alternative Hypothesis (H_1) – there is difference in the challenges experienced during the lockdown. The three challenges to be tested include the accessibility/affordability of critical inputs, market prices of crops produced, and the affordability of food and foodstuff in the market. The outcome of the study can reveal vital lessons that can support policymakers in coordinating policy responses to the mutated COVID-19 variants and subvariants.

Materials and Methods
The Study Areas

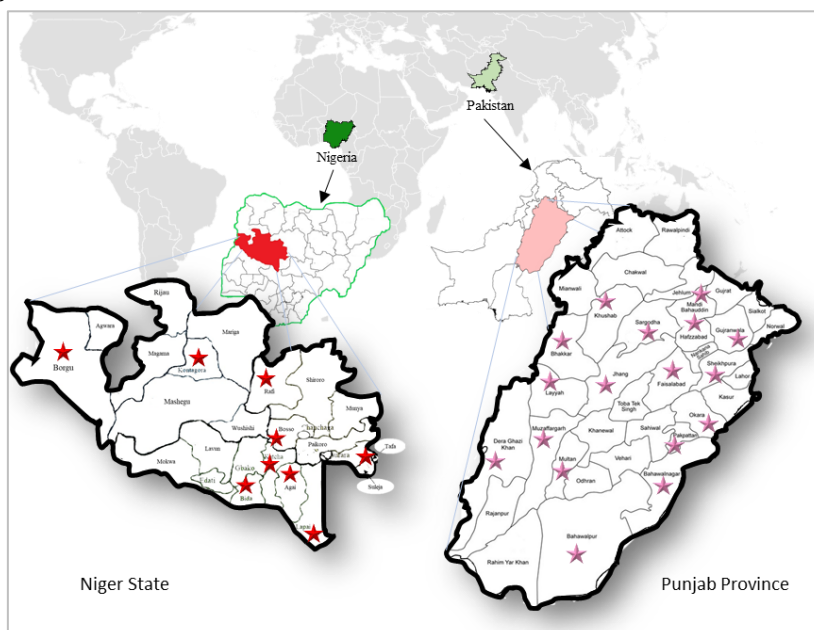


Figure 1. Map of Niger State of Nigeria and Punjab Province of Pakistan

This research was conducted in Niger State of Nigeria (Africa) and Punjab province of Pakistan (Asia) – (Figure 1). By landmass, Niger State is about 9% of the total Nigerian landmass (923,769 km²). It is in the North-central of Nigeria (Latitude 10° 00’N Longitude 6° 00’E). Punjab is in the eastern part of Pakistan (Latitude 31° N Longitude 72° E) and the landmass accounts for about 23.3% of Pakistan (881,913 km²). Table 2 provides more comparisons between the study areas.

Table 2. Summary of Niger State of Nigeria and Punjab Province of Pakistan

| | Niger State | Punjab Province |
|---------------------------|--|--|
| GDP | \$6 billion (2007) | \$200 billion |
| Landmass | 76,469.9km ² (Largest State in Nigeria) | 205,344km ² (Second largest in Pakistan) |
| Population | 5,556,247 (2016) | 110,012,442 (2017) |
| Labor force (Agriculture) | 85% | 48% |
| Climature | Seasons: wet (rainy) & dry (harmattan) Precipitation (mean): 1176.55 Temperature (mean): 28.05 °C | Seasons: rainy, hot & cool Precipitation (mean): 519.62 Temperature (mean): 24.76 °C |
| COVID-19 (March 28, 2022) | Confirmed cases – 1,148 Recovered – 998 Death – 20 | Confirmed cases – 504,926, Recovered – 490,419, Death – 13,553 |

Sources: IMF (2020), World Bank (2020^{a, b}), NCDC (2022), NBS (2021), Niger State Bureau of Statistics (2012), Government of Pakistan (2022), Government of Punjab (2021).

The Niger State is known to be an agrarian State given the size of its population (85%) in farming (see Table 2) and the vast crops and livestock it produces. Some of the crops produced in the State include Maize, Yam, Rice, Sugar cane, Sorghum, and Millet. Punjab Province is known to be an agrarian and industrialized province where its industrial sector accounts for about 24% of the province’s GDP (Government of Punjab, 2015) while its agricultural sector accounts for 51% - 64.5%

of Pakistan's agricultural sector. Hence, the larger size of the GDP compared to Niger State (see Table 2). Some of the crops produced in the province include Wheat, Rice, Cotton, Sugar cane, Maize, and Potato. In terms of size, population-wise, Punjab is larger hence the higher cases of COVID-19 in the province than Niger State.

Data Collection and Analysis

Primary data was collected using a structured questionnaire during and immediately after COVID-19 lockdowns. To reduce the risk of infection, the questionnaires were 10% paper and 90% online for Niger State respondents, and 100% online for Punjab respondents. Respondents were interviewed face-to-face while all the Center for Disease Control (CDC) and Pakistan's National Command and Operation Control (NCOC) safety protocols were observed. Using multistage sampling technique, 297 were interviewed from 9 Local Government Areas (LGAs) in Niger State and 250 from 19 districts in Punjab province. The 9 LGAs in Niger State include Agaie, Bida, Borgu, Bosso, Katcha, Kontagora, Lapai, Rafi, and Tafa. The 19 districts in Punjab province include Bahawalnagar, Bhakkar, Chiniot, Dera Ghazi Khan, Faisalabad, Gujranwala, Hafizabad, Jhang, Khushab, Lahore, Layyah, Mandi Bahauddin, Multan, Muzaffargarh, Okara, Pakpattan, Sahiwal, Sargodha, and Sheikhpura. The questionnaire covers the socio-economic characteristics of the farmers, their awareness, farming activities and challenges, the decisions taken based on the challenges, and others. The data collected were subjected to descriptive statistics alongside literature that support or contradict the findings. Student T-test comparison analysis was also used to find out if there is/are differences in the influence of COVID-19 on Crop Farmers' Activities in the study areas.

The T-test Analysis

Given the two independent random samples [Niger State (x_{ng}) and Punjab (x_{pk})] from an approximately normal distribution with slightly equal variances of samples, an unpaired t-test was applied (Amitage and Berry, 1994; Altman, 1991) and calculated as:

$$t = \frac{\bar{x}_{ng} - \bar{x}_{pk}}{\sqrt{S^2 \left(\frac{1}{n_{ng}} + \frac{1}{n_{pk}} \right)}} \quad (1)$$

The " S^2 " (pooled sample variance) is computed as

$$S^2 = \frac{\sum_{i=1}^{n_{ng}} (x_i - \bar{x}_{ng})^2 + \sum_{j=1}^{n_{pk}} (x_j - \bar{x}_{pk})^2}{n_{ng} + n_{pk} - 2} \quad (1a)$$

From the above, " t " is the student t-quantile

\bar{x}_{ng} and \bar{x}_{pk} are the respective sample mean from Niger State and Punjab province

n_{ng} and n_{pk} are the respective sample sizes from Niger State and Punjab province

" $n_{ng} + n_{pk} - 2$ " is the degree of freedom

After calculating the t-statistic, the probability (p-value) of seeing the t-statistic as extreme is determined. P-value from two-tailed t-test:

$$p\text{-value} = 2 * cdf_{t,d}(-[t_{score}]) \quad (2)$$

where $cdf_{t,d}$ is the cumulative distribution function of t-Student distribution with " d ", the degree of freedom? Prior to calculating and determining the above, decision is then made whether to reject or fail to reject H_0 based on the p-value. The three (3) areas for comparison include access to input, prices of farm products, and prices of food and foodstuff.

Result and Discussion

Socio-economic Characteristics

The two study areas (Niger State and Punjab Province) relatively share similar demographic characteristics. The age, the high percentage of male farmers, and the concentration of farmers' residency in the rural area. For example (see Table 3), the mean age of the respondents was about 35 and 34 for the respondents in Niger State and Punjab respectively; while the more female farmers managers in Niger State than in Punjab, both regions maintained a very high percentage of male farm managers (96% in Niger State and 99.6% in Punjab); the majority of the farmers are rural dwellers about 82% and 86% in Niger State and Punjab respectively.

Table 3: Socio-economic characteristics of the farmers in Niger State and Punjab Province

| Category | Niger State | Punjab Province |
|--------------------|-------------|-----------------|
| Age in years | | |
| Mean | 34.7 | 34 |
| >50 | 8.4% | 10% |
| ≤50 | 91.6% | 90% |
| Gender | | |
| Female | 4% | 0.4% |
| Male | 96% | 99.6% |
| Household size | | |
| Mean | 10 | 6.8 |
| >5 | 73.1% | 46.8% |
| ≤5 | 26.9% | 53.2% |
| Years of Education | | |
| Mean | 11.6 | 10.9 |
| Residency | | |
| Rural | 82.1% | 86.4% |
| Urban | 17.9% | 13.6% |
| Location of farm | | |
| Rural | 96% | 92% |
| Urban | 4% | 8% |

Source: Field survey data 2020/2021.

Despite Punjab having a percentage of respondents with household size greater than or equal to 5 persons compared to Niger State respondents, the mean household size in Niger State is 10 more than Punjab's household size (mean, 6.8), this is because the 26.9% of the respondent's household size far outweighs that of Punjab (see Table3). The study found out that only one respondent has a household size greater than 15 persons but 66 respondents in Niger State. The years of education of the household head, almost all the farmers 96% and 92% in Niger State and Punjab respectively have their farms located in the rural area.

Awareness and Adherence to Containment Rules

As farmers were subjected to partial lockdown to access their farms, wearing a facemask became compulsory. Generally, a large portion of the farmers adhered to the wearing of a facemask (Figure 2a and 2b). However, the regularity of wearing the facemask is extremely paramount to controlling the spread of the virus. To observe the risk perception, respondents that did not witness COVID-19 infection in their community or do not know any COVID-19 patient and those that witnessed or know any COVID-19 patient(s) was described from both regions. The study found that farmers [Niger State (45.1%) and Punjab (78%)] that witnessed COVID-19 case or know an infected patient adhered to wearing facemask (Figure 2b) than those that did not witness [Niger State (54.9%) and Punjab (22%)]. This also indicates that Punjab experienced more infections than Niger State. This is supported by the reports of COVID-19 cases in Table 2.

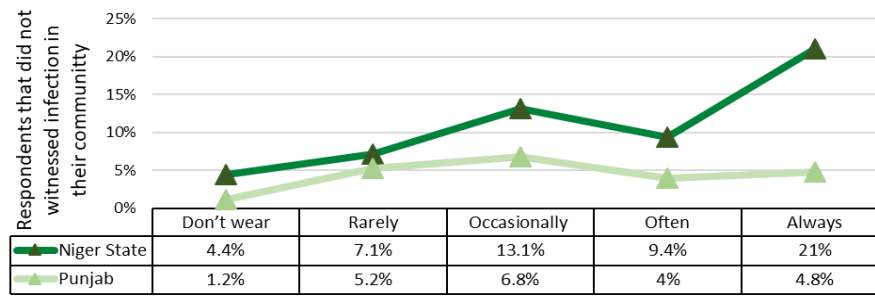


Figure 2a: Adherence to wearing facemask by respondents who did **not witness** COVID-19 infection in their community

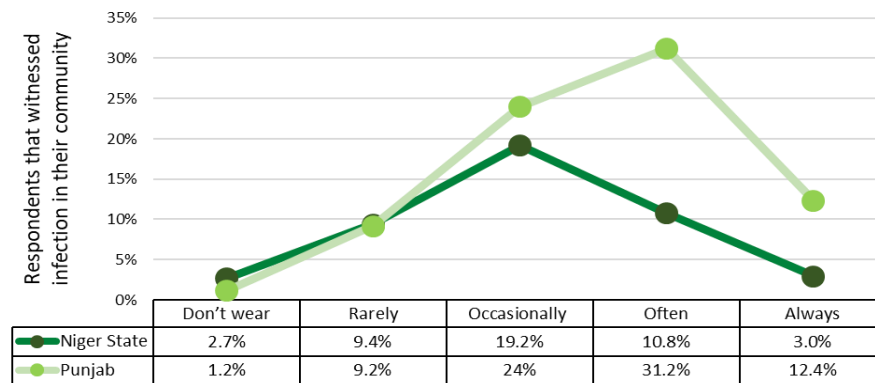


Figure 2b: Adherence to wearing facemask by respondents who **witnessed** COVID-19 infection in their community

Specifically, among the farmers in Niger State that did not witness it; 21% always wear a facemask, 9.4% often wear it, 13.1% occasionally wear it, 7.1% rarely wear it, and 4.4% do not wear while the Punjab farmers who witnessed it; 4.8% always wear a facemask, 4% often wear, 6.8% occasionally wear, 5.2% rarely wear, and 1.2% do not wear (Figure 2a). On the other hand, among the Niger State farmers that witnessed it; 3% always wear a facemask, 10.8% often wear it, 19.2% occasionally wear it, 9.4% rarely wear it, and 2.7% do not wear while the Punjab farmers who witnessed it; 12.4% always wear a facemask, 31.2% often wear, 24% occasionally wear, 9.2% rarely wear, and 1.2% do not wear (Figure 2b). Table 2a can also represent the outcome of awareness campaigns, and Table 2b strong behavior indicator of the respondents to events.

The Crop Farming Enterprises

Farm enterprises are selected based on available resources (national, physical, financial, and human resources). The farmers in the study area cultivate a combination of distinct and different crops in both regions. According to the data, only 2.4% and 2.8% of the farmers cultivated a single crop while others cultivated double or more crops. Regardless of the number of crops sown, farmers consider one as the primary or major crop to which most of their resources are channeled its production.

Primary (major) Crops: In Niger State, three crops [rice (40%), maize (32%), and groundnut (12%)] account for 84% of the major crops sown by the farmers. Other major crops cultivated as major include cowpea, millet, yam, potato, sorghum, and soybean (Figure 3). In Punjab, wheat (50%), sugarcane (25%), and rice (9%) account for 82.4% of the primary crops cultivated by the farmers. Other majors cultivated include maize, cotton (7%), and potato, 1%. (Figure 3).

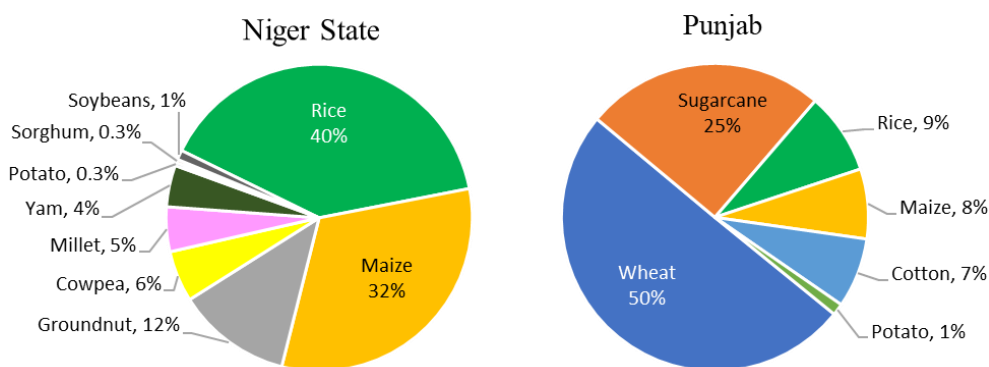


Figure 3: Primary (major) crops sown by farmers in Niger State and Punjab

Secondary Crops: The distribution of other crops (secondary crops) is depicted in Figure 4a for Niger State, and Figure 4b for Punjab Province. The farmers cultivated 2 to 6 crops in different combinations, some simultaneously and others at different periods or on different farms. In Niger State, the share of crops that most turned up as farmers' secondary crop is maize (62%) and millet (48.5%) with others such as groundnut, cowpea, rice, yam, soybean sorghum, etc. being less than 25%.

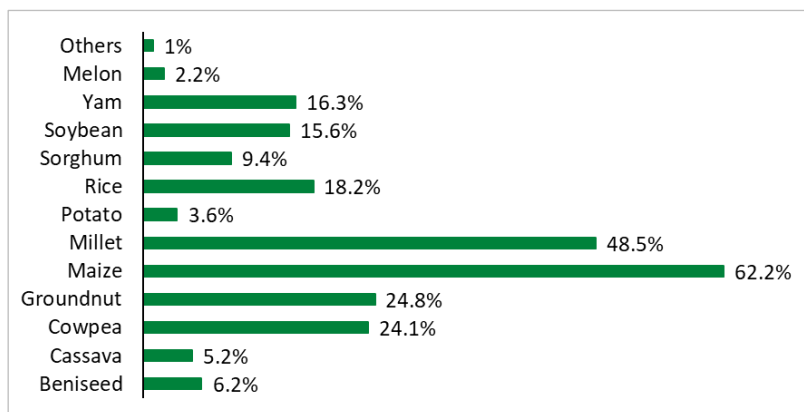


Figure 4a: Distribution of secondary crops cultivated by Niger State farmers

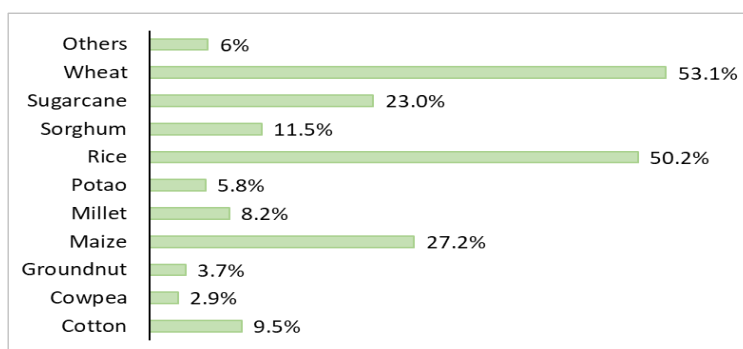


Figure 4b: Distribution of secondary crops cultivated by Punjab farmers

On the other hand, the Punjab farmers 53.1% and 50.2% cultivated wheat and rice respectively as their secondary crops compared to other farming other crops maize (27.2%), sugarcane (23%),

sorghum (11.5%), cotton (9.5%), millet (8.2%), potato (5.8%), groundnut (3.7%), cowpea 2.9% (Figure 4b).

Lockdown Challenges

Access to farms

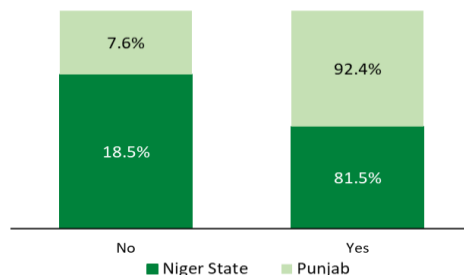


Figure 5: Farmers' response to access to farm

The location of farmers' farms is critical to production activities during the pandemic as restrictions were imposed on many aspects affecting the smooth management of farms. The study found that restriction on movement was more in the urban than the rural areas thus proximity to farms or residential areas of the farmers goes a long way to determining access to the farm. As seen in Table 3, most of the farms are in rural area as well as the farmers, on this basis, only a few farmers about 18.5% and 7.6% from Niger State and Punjab respectively, were unable to access their various farms (Figure 5).

Inaccessibility to inputs

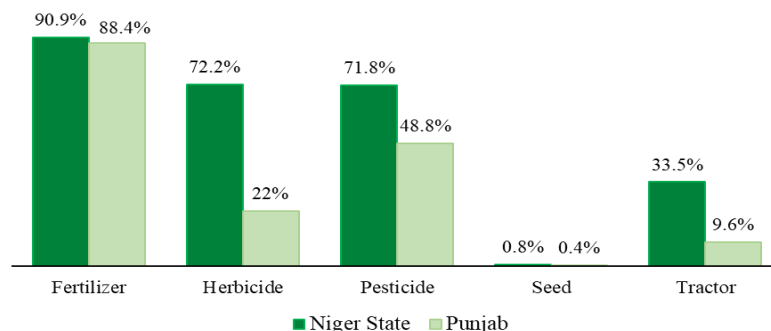


Figure 6: Farmers reporting inaccessibility to critical inputs

Although there was no restriction on the movement of basic factors of agricultural products such as agrochemicals, machines, and labor, the respondents still faced some challenges in the acquisition of critical inputs. Figure 6 depicts the percentage of respondents who were unable to access critical inputs in both regions. Comparatively, Niger State farmers experienced more challenges in the accessibility of critical inputs than Punjab farmers. The impact of COVID-19 on the accessibility of these critical inputs in Niger State is uncertain because the problem has been there way before the pandemic (Alabi and Abdulazeez, 2018; Abdul-Gafar *et al.*, 2016; Opaluwa *et al.*, 2015; Ahmed *et al.*, 2014). Inaccessible or inadequate fertilizer was the most complaint reported by the farmers 90.9% and 88.4% in Niger State and Punjab respectively. The only input that posed an insignificant challenge to the farmers in both regions was planting seeds and this is because most of the farmers save seeds from the previous harvests.

Marketing of crops

Punjab farmers sold more of their crops compared to Niger State farmers (Table 4). About 77% of Punjab farmers were able to sell above 41% of their crops during the lockdown. On the contrary, 77.7% of Niger State farmers only sold 1 to 20% of their crops. This disparity was a result of the

category of the supply chain actors in both regions. Punjab is well to be an industrious province in Pakistan thus it is expected to have more wholesalers and industrial agents who buy raw materials (crops) in bulk from the farmers.

Table 4. Percentage of crops sold by the farmers in Niger State and Punjab

| Crop Marketing | Category | Niger State | Punjab Province |
|---|-----------|-------------|-----------------|
| Percentage of crops sold | 1 – 20% | 77.7% | 8.4% |
| | 21 – 40% | 9.4% | 14.1% |
| | 41 – 60% | 9.8% | 11.9% |
| | 61 – 80% | 2.8% | 25.7% |
| | 81 – 100% | 0.3% | 32.9% |
| Price of farmers' crops during lockdown | High | 27.2% | 31% |
| | Moderate | 61.9% | 44.8% |
| | Low | 10.9% | 24.2% |

Source: Field survey data 2020/2021.

Crop prices during the lockdown: the farmers were asked to rate (high, moderate, or low) current prices compared to the price before the COVID-19 lockdown (Table 4). Many farmers 61.9% and 44.8% reported experiencing a moderate price in Niger State and Punjab respectively. Although fewer Niger State farmers (10.9%) experienced low prices than Punjab farmers (24.2%), the farmers (31%) in Punjab enjoyed high prices for their crops as compared to 27.2% of Niger State farmers.

Post Lockdown Challenges

The COVID-19 cases came in waves with each initiating complete or partial lockdowns. Some of the lockdowns were relaxed due to heavy economic costs. The farmers were asked to freely outline the basic problems they encountered after lifting the lockdown(s). Their responses were categorized into the problem of transportation, access to their customers, affordability of farm inputs, low income, and price hikes of food and foodstuff.

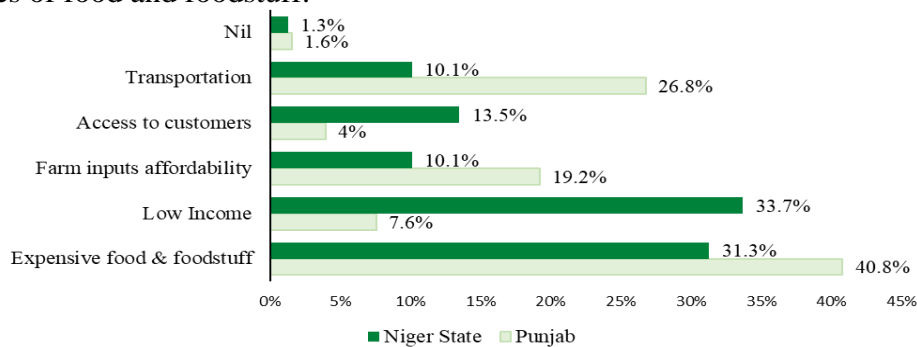


Figure 7: Post lockdown challenges faced by the farmers

Post lockdown was not left out with challenges, Figure 7 reports these challenges faced by the farmers in the study area. About 31.3% and 40.8% of the farmers reported high cost of food and foodstuff in the market in Niger State and Punjab respectively. Additionally, more Punjab farmers (19.2%) than Niger State farmers (10.1%) reported experiencing an increase in farm input prices. On transportation difficulties, 26.8% of Punjab farmers reported compared to 10.1% of the Niger State farmers. More farmers (33.7%) in Niger State complained of low income than Punjab farmers (7.6%). Researchers (Folayan et al., 2021) opined that the low income of the household is a result of the loss of jobs during the lockdown and poor or no sale of products by the farmers. About 13.5% and 4% of the farmers in Niger State and Punjab respectively reported having difficulties in reconnecting to their customers. Less than 2% of the farmers in both regions responded that everything went back to normal after lockdown.

Comparison analysis between Niger State and Punjab (Student's T-test)

To extract lessons from each region that can support the management of the contemporary threats (COVID-19 variants) to crop production activities. Three (3) pandemic challenges including access to basic inputs, the prices of farmers' products during and immediately after the lockdown, and the general prices of foodstuff in the market were streamlined and compared between the regions. The study hypothesized the followings: Null Hypothesis (H_0) – there is no significant difference in the challenges experienced during the lockdown between the Niger State and Punjab crop farmers while the Alternative Hypothesis (H_1) states otherwise. The result in Table 2 presents the summary statistics, t-test statistics, and statistical decisions taken between the two regions based on the inaccessibility to inputs, prices of farmers' crops, the general price of food, and foodstuff in the market.

Table 2. T-test comparative analysis between Niger State and Punjab Province

| Indicator | Region | Mean | Std. Err. | Std. Dev. | T-value | Degree of freedom | Decision | |
|--------------------------------------|--|--------|-----------------------------------|--------------------------------------|---------|-------------------|--------------------------------|------------------|
| INPUTS INACCESSIBILITY | Niger State | 2.6498 | 0.0533 | 0.9183 | 12.5602 | 538.451 | REJECT Null Hypothesis | |
| | Punjab | 1.692 | 0.0546 | 0.8626 | | | | |
| | <i>Difference</i> | 0.9578 | 0.0763 | | | | | |
| | <i>95% Confidence interval</i> | | | $H_0:$ | | | | |
| | <i>mean difference between rural and urban = 0</i> | | | $H_a: \text{mean difference} \neq 0$ | | | | P-value = 0.0000 |
| | | | | $H_a: \text{mean difference} < 0$ | | | | P-value = 1.0000 |
| | | | $H_a: \text{mean difference} > 0$ | P-value = 0.0000 | | | | |
| Indicator | Region | Mean | Std. Err. | Std. Dev. | T-value | Degree of freedom | Decision | |
| PRICE LEVEL OF FARM PRODUCTS | Niger State | 1.1515 | 0.0351 | 0.6045 | 1.5583 | 478.103 | FAIL TO REJECT Null Hypothesis | |
| | Punjab | 1.06 | 0.0471 | 0.7447 | | | | |
| | <i>Difference</i> | 0.0915 | 0.0587 | | | | | |
| | <i>95% Confidence interval</i> | | | $H_0:$ | | | | |
| | <i>mean difference between rural and urban = 0</i> | | | $H_a: \text{mean difference} \neq 0$ | | | | P-value = 0.1198 |
| | | | | $H_a: \text{mean difference} < 0$ | | | | P-value = 0.9401 |
| | | | $H_a: \text{mean difference} > 0$ | P-value = 0.0599 | | | | |
| Indicator | Region | Mean | Std. Err. | Std. Dev. | T-value | Degree of freedom | Decision | |
| GENERAL PRICES OF FOOD AND FEEDSTUFF | Niger State | 2.84 | 0.0233 | 0.4008 | 5.9565 | 399.011 | REJECT Null Hypothesis | |
| | Punjab | 2.56 | 0.0412 | 0.6512 | | | | |
| | <i>Difference</i> | 0.28 | 0.0473 | | | | | |
| | <i>95% Confidence interval</i> | | | $H_0:$ | | | | |
| | <i>mean difference between rural and urban = 0</i> | | | | | | | |

| | |
|--------------------------------------|------------------|
| $H_a: \text{mean difference} \neq 0$ | P-value = 0.0000 |
| $H_a: \text{mean difference} < 0$ | P-value = 1.0000 |
| $H_a: \text{mean difference} > 0$ | P-value = 0.0000 |

Source: Field survey data 2020/2021.

Inputs inaccessibility: the t-test result rejects the null hypothesis that there is no difference between Niger State and Punjab in the inaccessibility to inputs. In other words, there is significant difference between the two regions, and more inaccessibility was experienced by the Niger State farmers than the Punjab farmers. Before the pandemic, farmers in Niger State have been facing availability and affordability challenges of critical inputs especially fertilizer, herbicides, and pesticides. Although they experienced more than Punjab farmers, the Punjab farmers also compliant with inaccessibility to the input is also on a high side.

The price level of farm products: crop prices are one of the factors that motivate farmers to cultivate. On the issue of farmers' crop prices in both regions, the result failed to reject the null hypothesis that there is no difference between the regions in the changes in the price level of the crops. In other words, there is no significant difference between Niger State and Punjab changes in crop price levels compared to the pre-COVID-19 era.

General prices of food and foodstuff: just as the inputs and prices affect farmers' production activities, prices of food and foodstuffs in the market directly or indirectly affect the farmer. The Table 2 t-test result revealed that there is significant difference in the prices experienced between Niger State and Punjab farmers on other food and foodstuffs. Given the mean difference between the two regions, the Niger State farmers experienced higher prices compared to the Punjab farmers.

The Influence of COVID-19 on Farmers' Decision

If the challenges of the pandemic persist, what will be the response of the farmers to their farming activities? Will they reduce, increase, challenge enterprise or maintain the same farm scale? Figure 8 depicts the response of farmers to the above questions. Using the distributions in Figure 8, the farmers were grouped into three: the risk-takers, conserved, and timid farmers.

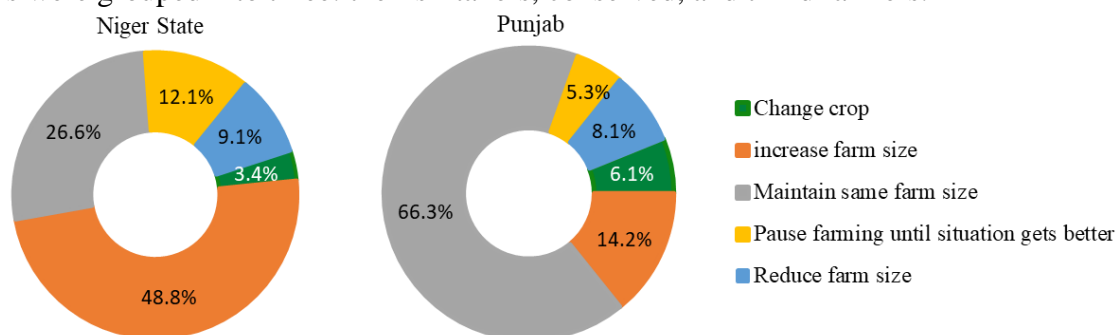


Figure 8: Response of farmers to persistent COVID-19 lockdown

The Risk-takers: include the farmers that are willing to increase their farm size if the lockdown persists and those that are willing to change their crops. Almost half (48.8%) of the Niger State crop farmers held that if the lockdowns persist, they will increase their farm size while only 14.2% of Punjab farmers said they will do the same. Increasing farmland is subject to availability, affordability of land, and suitability of the soil and weather. In Niger State, there are vast untapped arable lands including farmers' owned lands. Some of the reasons for the underutilization are the lack/inadequate

capital and inputs to embark on huge farm enterprises. As such, when the farmers see opportunities such as the instant hike in crop prices, they become encouraged to take the risk of increasing their farm. The other risk-taking farmers (Niger State 3.4%, and Punjab 6.1%) responded by changing the cultivated crop to high-priced crops.

The conserved farmers: the second group of farmers who were not too optimistic about the future thus maintained that they will continue to cultivate the same farm size if the lockdowns persist. About 66.3% of Punjab farmers stand with this opinion whereas only 26.6% of the farmers in Niger State. This decision could also easily be influenced by resource limitations and economic knowledge of measuring and differentiating opportunities from risks.

The timid farmers: while the risk-takers see opportunities, the timid farmers only see high risks and uncertainties, therefore they avoid any situation that they think will bring loss or discomfort to their production activities. The farmers here include those that held they will reduce farm size and those that will pause farming until situations get better. About 9.1% and 8.1% of the farmers in Niger State and Punjab respectively held that they will reduce their farm size while 12.1% and 5.3% said they will halt farming activities.

Conclusion and Recommendations

Nigeria and Pakistan confirmed their first COVID-19 case just a day apart. Given the proximity to the ground zero of the virus (China), social and cultural differences, and economic structure and strength of the regions, the impact of the pandemic is expected to differ in the two regions. Building upon lessons learned from the disruption caused by the 2020 COVID-19 lockdowns, particularly on the livelihood of crop farmers and food security, this study assesses the impact of the COVID-19 lockdowns on crop farmers' production activities between Niger State of Nigeria and Punjab of Pakistan to suggest measures that can be adopted to reduce the impact of any lockdown that may arise as a result of the vicious COVID-19 variants spreading all over the world.

The study found that the farmers in both regions share relatively similar socio-economic characteristics such as the age of the farmers, dominance of male farmers, year of formal education, and the location of their farms in rural areas. The household size differs as Niger State tends to have more (average of 10 persons) than Punjab (average of about 7 persons). In the cases of COVID-19, more Punjab farmers compared to the farmers in Niger State witnessed infection cases and/or know an infected patient. On adherence to wearing a facemask, Punjab farmers also observed more. This effort is given to the national orientation and task forces monitoring adherence to preventive COVID-19 rules.

There was significant difference in the challenges experienced during the lockdown between the Niger State and Punjab crop farmers on access to critical inputs and general prices of food and foodstuff in the market, but no significant difference was found in the changes in the prices of the farmers' crop compared to previous prices. Farm input accessibility challenges were more pronounced to Niger State farmers while the affordability of farm inputs was the major challenge in Punjab. The study observed that most farmers in both regions enjoyed favorable crop prices compared to the pre-COVID-19 era. However, Punjab farmers were able to sell more of their crops compared to the Niger State farmers.

After several lockdowns, some problems persist, and new ones emerged among which were difficulties in regaining customer base, low income, transportation problems, and expensive food and foodstuff. Farmers saw the lockdown differently while the risk-taking farmers see opportunities, the conservative farmers were not too optimistic, and the timid farmers only see high risk and,

uncertainties. All the decision taken by these group of farmers is subject to the availability of capital, and availability/ affordability of critical inputs. Niger State farmers were readier to take risks than the Punjab farmers. In addition to the responses to the challenges during the lockdown, Punjab farmers were more on the conserved group.

Policy implications and recommendations

Policies should rely on better information from empirical facts to have an effective implementation and efficient outcome. Based on the above assessment of COVID-19 lockdown on crop farmers' production activities, the following short- and long-term measures are recommended to reduce the impact of any future lockdown which may be initiated by fast-spreading variants.

Short- and medium-term measures: these measures stand on providing emergency coping and mitigating.

- Public awareness of the updates of COVID-19 variants and their severity is important to keep the public alert and safe. Furthermore, the vaccination campaign should be intensified especially in rural areas to reduce the chances of infections and/or lower the chance of the virus mutation.
- A stringent task force to monitor adherence to preventive rules should be adopted as these have shown to be effective in curbing the spread of the virus.
- Short-term emergency measures such as farm credits (cash, input assistance programs, or low-interest loans) should be adopted appropriately to ease farmers' production activities.
- Supply chain management: checking the activities of middlemen who could exploit the current crisis to hoard and inflate prices.
- The government should temporarily purchase farmers' leftover crops to support the farmers. The purchased crops could also be used to provide safety nets to the vulnerable in society.

Long-term policy measures: on long-term policy, actions should be shifting towards recovery and resilience building against a similar crisis in the future.

- A look at the restructuring price control mechanism especially in Niger State is needed to curb the menace of artificial prices. A good example is Pakistan's agricultural procurement center.
- Both regions have had input challenges, especially on fertilizer. A national fertilizer and other agrochemical production should be encouraged. This could be a public-private ownership

Declaration of Competing Interests

Regarding this manuscript entitled "COVID-19 Influence on Crop Farmers' Activities: Comparative study between Niger State – Nigeria and Punjab – Pakistan." there is no interest to declare.

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THE FEAR FOR LIVESTOCK SUBSECTOR AMIDST COVID-19 VARIANTS: THE CASE OF NIGER STATE FARMERS

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Abstract

There are possibilities of animal-to-human coronavirus transmission, thus this possibility should be of great concern in the future. This chance should not be taken lightly as the impact, especially on the livestock subsector could have a greater adverse economic impact than the year 2020/2021 COVID-19 impact. This research aims at assessing the impact of COVID-19 on Niger State livestock farmers and then with contemporary literature, provide containment measures for containing any animal-to-human infection in case of a possible scenario. The result presents how the pandemic affected the livestock subsector. Biosecurity measures were suggested for proactive, reactive, and general policy.

Keywords: Livestock subsector, COVID-19 variants, Biosecurity, Niger State

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Introduction

Economically, livestock is a source of livelihood for the farmers, it serves as a source of wealth creation, and it also serves as a means of festive sacrifices, ceremonies, and as well as socio-political esteem. Most Nigerian livestock farmers operate small to medium-scale farms influenced by traditional methods that involve cheap feeds (usually a free range) and health supervision. Recently there has been a dramatic development in the subsector, especially in poultry and fish farming. with an increase in livestock population comes the risk of infections either among the livestock or between livestock and human. An example of livestock-to-human is the avian influenza case recorded in January 2007 in Lagos, Nigeria (FMARD, 2022). Subsequently, the outbreak re-emerged in 2015, 2019, and 2021 (Izuaka, 2021). Animal-to-human infection is known as zoonosis and this can happen in various ways. For example, direct contact with an infected animal (saliva, urine, blood, mucus, feces, or body fluid); indirect contact (surfaces, objects); vector-borne (bites from an insect); food-borne; and waterborne.

As the world go through the phase of COVID-19, many sectors were adversely affected by various measures utilized to contain the virus thus impeding the smooth running of production activities in the agricultural sector (Bukari *et al.*, 2022; Ahmed 2022¹; Ahmed 2022²; Barman, 2021; Ibukun and Adebayo, 2021; Shahzad *et al.*, 2021; Opazo *et al.*, 2020). So far, the impact of the COVID-19 pandemic on the livestock subsector has been indirect. Cost of feed and low purchasing power of the consumers as a result of loss of jobs or poor returns in business (Folayan, 2021; Laborde, 2020) has been some of the factors limiting the livestock subsector in the pandemic. The impact

on feed is consequent to lockdown, panic buys, unavailability of critical crop production inputs, and suspension of crop farming by some farmers (Ahmed 2022¹; Opazo *et al.*, 2020).

With the rate at which the variants are mutating and spreading throughout the world, it is only a matter before new lockdowns will be initiated. Bashor *et al.* (2021) suggested that animals could be the source of the mutations. Just as Livestock provides food, fiber, livelihood, and tractor among other benefits to humans, on one hand, there is the risk of humans getting infected by any of the animals carrying any form of the disease. Possibilities of having animal-to-human coronavirus transmission are slim but cases were seen in farmed mink (Europe and USA), white-tailed deer (Canada), pets (Hong Kong), and Thailand – a cat (CDC, 2021). COVID-19 variants develop through mutations and are referred to as a variant of concern when they possess a strong impact on transmissibility, severity, or immunity to vaccines. The University of Leeds research led by Grace (2022) Opined that there is a high chance that the infamous SARS-CoV-2 was originally transmitted to humans through an animal in the Wuhan animal market, China (Worobey *et al.*, 2022; Sharun *et al.*, 2021; Bashor *et al.*, 2021; Shi *et al.*, 2020). This possibility should not be taken lightly as the impact, especially on the livestock subsector could have a greater adverse economic impact than the year 2020/2021 COVID-19 impact.

In light of this context, this research aims to assess the impact of the pandemic on Niger State livestock production activities using empirical data from the 2020/2021 survey, this will provide pivotal information about the behavior of the farmers during the crisis and then with contemporary researches, suggest effective containment measures should in case animal-to-human infection is observed.

Material and Methods

Study Area

Primary and secondary data were utilized in this research. The primary data was collected using a structured questionnaire during the 2020/2021 COVID-19 pandemic crisis in Niger State. The secondary data are fetched from several works of literature on quarantine/containment of diseases that emanate from livestock which are then compared with the existing structure to identify strengths and lapses. On the primary data, about 33 medium and large-scale livestock farmers were interviewed. The data are subjected to descriptive statistics.

Results and Discussion

Farmers Demography

Table 1: Demography of the livestock farmers

| | Category | Niger State |
|--------------------|----------|-------------|
| Age in years | Mean | 31 |
| | Gender | |
| Gender | Female | 6.1% |
| | Male | 93.9% |
| Marital Status | Married | 66.7% |
| | Single | 33.3% |
| Household size | Mean | 6 |
| Years of Education | Mean | 13.2 |
| Residency | Rural | 51.5% |
| | Urban | 48.5% |
| Location of farm | Rural | 69.7% |
| | Urban | 30.3% |

Source: Field survey data 2020/2021.

Table 1 presents the demography of the livestock farmers. On average the age of the farmers is 31 years. About 66.7% are married and 33.3% are single. The male (93.9%) dominates the female (6.1%) livestock farmers. The farmers are relatively domiciled equally in rural and urban regions: rural residents (51.2%) and urban residents (48.5%). Most of the respondents (69.7%) have their farms located in rural regions.

COVID-19 Awareness and adherence to containment rules.

Table 2: Demography of the livestock farmers

| | Category | Percentage |
|---|-------------------|------------|
| Do you believe COVID-19 exists? | No | 3% |
| | Yes | 97% |
| Have you ever witnessed any COVID-19 case? | No | 75.8% |
| | Yes | 24.2% |
| Do you think you can be infected by COVID-19? | No | 6.1% |
| | Yes | 93.9% |
| How frequently do wear a facemask? | Do not wear | 0.0% |
| | Rarely wear | 0.0% |
| | Occasionally wear | 9.1% |
| | Often wear | 24.2% |
| | Always wear | 66.7% |

Source: Field survey data 2020/2021.

As shown in Table 2, most of the farmers (97%) are well informed on the existing effects of COVID-19. About 24.2% witnessed COVID-19 cases in their locality. Despite the phenomenon of the cases, death, and recovery from the virus, some respondents (6.1%) believed they cannot be infected by the virus. Surprisingly, most of the farmers adhere to wearing a facemask. None of the farmers reported not wearing a facemask.

Farm enterprises

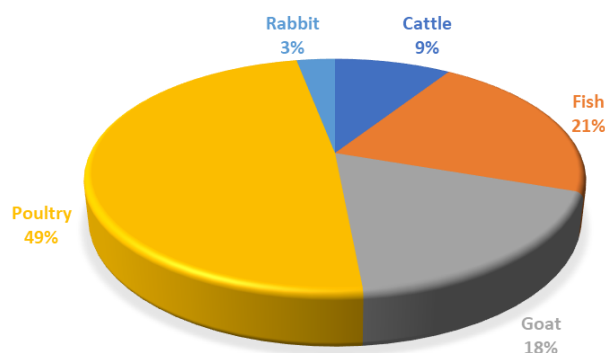


Figure 1: Primary (major) livestock of the farmers

The primary (major) livestock reared by the farmers is presented in Figure 1. About half of the respondents (49%) are poultry farmers, followed by fish farmers (21%), goat farmers (18%), cattle (9%), and rabbits (3%). The farmers rear different livestock, some combine 2-3 different livestock. The highest inter-farming observed was poultry-fish farming. About 18% of the farmers practiced poultry-fish farming. Other combinations of livestock observed were less than 6%. The farm scale differs on different farms and this is presented in Table 3.

Table 3: Major livestock farm-scale practiced by the farmers

| Farm scale (live animal) | Cattle | Fish | Goat | Poultry | Rabbit |
|--------------------------|--------|-------|-------|---------|--------|
| Less than 20 | – | – | 15.2% | – | – |
| 21 – 100 | 3% | – | 3% | – | 3% |
| 101 – 300 | 6.1% | – | – | 42.4% | – |
| 301 – 1,000 | – | – | – | 6.1% | – |
| 3,000 – 5,000 | – | 15.2% | – | – | – |
| 5,001 – 10,000 | – | 6.1% | – | – | – |

Source: Field survey data 2020/2021.

About 30.4% of the farmers operate medium-scale and the remaining 69.6% practice small- and semi-medium-scale. The cattle and farmers practice medium-scale farming systems, while others – the goat, poultry, and rabbit farmers practice small-scale.

Impact of the COVID-19 pandemic on livestock

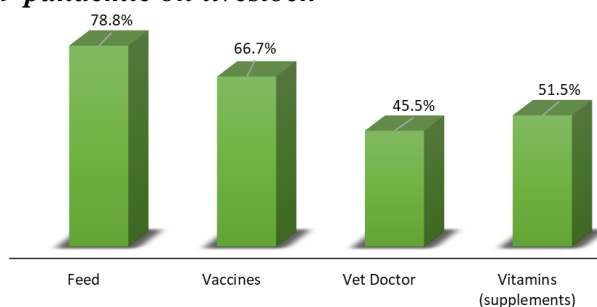


Figure 2: Challenges experienced during the COVID-19 pandemic

Figure 2 depicts the challenges the Niger state livestock farmers faced during the 2020/2021 pandemic crisis. The complaints of the farmers centered on four (4) factors: the cost and availability of feeds, vaccines, veterinary doctors, and vitamins (supplements) for their livestock. Top in these complaints is the high cost of feed and its availability, about 78.8% of the farmers reported this case. This is followed by vaccines (66.7%), vitamins/supplements (51.5%), and the availability of vet doctors on the premises. This information is paramount as it can provide focus to policymakers on issues to prioritize case of crisis.

The fear for livestock is a new case

Livestock farmers: livestock farmers fear not only the loss of their investment but possible animal-to-human infection. Farms that are not affected by outbreaks are even affected indirectly as the public fear unknown linkages. The farmers need to be assured by the government on taking timely actions to prevent, protect and control any outbreaks in the state. The livestock farmers also play a crucial part in reducing the impact of any outbreak by following the recommended measures.

Research: so far there has been no significant covid-19 infectious rate between animals and man. Nonetheless, cases were seen in some regions such as Europe and USA (farmed mink), Canada (white-tailed deer), Hong Kong (pet), and Thailand (cat). It is also believed that these cases may have been a transmission from man to animals and then back to man again as variants (CDC, 2021). Despite, these possibilities, researchers reassure that infection is more likely to be among humans than between animals and humans.

Government: the priority of any government is to protect its citizens against any threat to life, or business. Governments all over the world have proven this during the early face of the COVID-19 crisis and continue to play a vital role in curbing the virus. These come at a cost of choosing what sector needs what and at what level. This is where researchers come in to streamline issues to policymakers for efficient and effective measures.

Conclusion and Recommendations

The extent of any negative impact of any pandemic on livestock depends on many factors one of which is the time and effectiveness of decision makers' responses. Policy measures should not only adjust to the new "normal" but also set partway for rebuilding and future resilience. This research aims to assess the impact of the pandemic on Niger State livestock production activities using empirical data from the 2020/2021 survey, this will provide pivotal information about the behavior of the farmers during the crisis and then with contemporary research, suggest effective containment measures should in case animal-to-human infection is observed. To save lives, protect the less privileged, ensure smooth and sustainable farming activities and growth and restructuring and resilience should be the major priority of the government. This research suggests the following recommendations

Proactive biosecurity measures: to be bio-secured, it is important to take proactive measures to avoid the negative impact of previous lockdowns on the agricultural sector.

- Sensitization of livestock farmers and their value chain operators on:
 - Fumigating the environment to reduce insect carrier diseases
 - Regular sanitizing farm kits and equipment
 - Regular washing of hands with soap even after using sanitizers
 - Wearing a facemask, especially on enclosed farms
 - Reduction of non-farmers on farms.
 - Constant availability of clean water
 - Regular and timely vaccination of livestock
- Identify the best and most effective means of communicating
- Readily available bio-security kits, equipment, and vehicles in cases of emergencies
- Readily and timely available vaccines, drugs, and supplements.

Re-active biosecurity measures: cases come even when all measures are taken to prevent them but the most important is the steps taken to control the situation to reduce its impact.

- Quick dissemination of information to farmers and the public of any outbreak to save other farms or species or even humans from getting infected.
- Separating infected livestock species from other livestock
- Enforcement of movement control of infected farms and their products
- Sanitization of the whole farm

Policy recommendations: these are long-time plans that need to be considered to improve the livestock subsector.

- Complete restructuring of the livestock sub-sector. Easy tracking.
- Enforcing regular inspection of farms and rating (grading) hygiene for public notice.
- The use of ICT to inform, and control outbreak crises. For instance, the development of a mobile application that allows farmers to input bio-information about livestock with symptoms
- Financial support to infected farms with strict rules to encourage a continual supply of safe food.
- Establish State-pricing system that can reduce highly volatile feed prices. This should involve key stakeholders such as crop farmers.
- Ensuring an adequate supply of vaccines with livestock medicines or supplements (immune boosters).
- Ensuring that a standard vet doctor-to-farm ratio is maintained across the state.

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