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Research article

PERCEIVED FACTORS AFFECTING THE UTILIZATION OF CLIMATE SMART AGRICULTURAL PRACTICE AMONG MAIZE FARMERS IN OGUN STATE

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Abstract

Agriculture plays an important role in economic growth, poverty reduction, and rural development; among others. Recently, some farmers have employed the use of technology in agricultural production, and studies have shown that agricultural technology have increased farmers output, while minimizing cost in the long run. Agricultural technology adoption has many policy implications on agricultural development. However, in Nigeria, empirical studies on agricultural technology adoption suggest that factors such as socio-economic characteristics of farmers, access to credit or cash resources and information from extension and others; influences the adoption rate of new agricultural technology among farmers. Hence, the need to study the determinant of adoption of climate smart agricultural practices among maize farmers. In order to effectively carry out this study; the descriptive survey research design was adopted. The multistage sampling technique was used in selecting 120 maize farmers. Relevant data were collected through the use of well structured questionnaire. The data collected were analyzed using descriptive analysis, budgetary analysis and Multivariate probit regression to empirically investigate the study's objectives. Conclusively, with the budgetary analysis, it can be said that maize farming with the use of CSA practices was profitable during the last production period at a Net Total Revenue of ₦79,284, Gross Ratio of 0.51 and Rate of Return of 1.53; The coefficient of age is positive and significant at ($p<0.05$) and ($p<0.01$) in mixed cropping and mixed farming respectively while it is negative and significant ($p<0.01$) in zero tillage. The coefficient of level of education is negative and significant ($p<0.05$) for utilization of Mixed cropping. The coefficient of access to credit is positive and significant ($p<0.05$) for the utilization of improved maize variety. The coefficient of years farming experience is positive and significant ($p<0.01$) for the utilization of zero tillage and it negative and significant ($p<0.01$) for mixed cropping. The coefficient of membership of association is positive and significant ($p<0.01$) for the utilization of Zero tillage. In essence, extension agents should ensure that they communicate CSA practice to the maize farmers more as what they are used to rather than seeing it as a total new way of farming.

Keywords: factors, utilization, climate, smart, practice, agriculture

I. Introduction

Agriculture being one of the most weather-dependent of all human activities is highly vulnerable to climate change. (Rahman & Anik, 2020) confirmed that agriculture contributes to and suffer from negative effects of climate change. However, agriculture has been high on the political outlines as it is increasingly recognized as one of the biggest drivers of environmental change (Hanaček & Rodríguez-Labajos, 2018). Agricultural lands occupy about 40 to 50% of the Earth's land surface, and it is estimated that agriculture is responsible for about three-quarters of tropical deforestation (Bager et al., 2020) and accounts for about 10 to 12% of the total global anthropogenic emissions of greenhouse gases (GHGs) in 2005 (Jantke et al., 2020). Yet, the world needs more food than ever before to sustain the increasing population of people living in extreme hunger, especially in Africa where about 70% of the people are engaged in some sort of agricultural activity (Aryeetey & Covic, 2020). While there is need to redouble efforts in agriculture in order to fight hunger, there is adequate evidence for us to be wary of its environmental sustainability (Yoshida et al., 2018).

The need for a more sustainable approach to agriculture has led to suggestions that agriculture is the key and holds enormous potential to contribute to any strategy to adapt to climate change and reduce emissions particularly in an African context (Yirga, 2019)

Climate-smart agriculture (CSA) is one approach that has been championed as the cup or platter of agricultural development (Preston, 2019) ensuring that agriculture is the key to climate change adaptation and mitigation (Wallenberg *et al*., 2011; Beddington *et al*., 2012). Climate smart agriculture is derived from the acronym SMART, where S stands for specific, M stands for measureable, A for achievable, R for reliable and T for timely (McCarthy *et al*., 2012). According to the Food and Agriculture Organization (FAO) (2010), CSA is a method of agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) while enhancing the achievement of national food security and development goals. There are three main pillars to any CSA approach: the sustainable increase in agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gases emissions. As such, agriculture is considered to be "climate-smart" when it achieves these three objectives.

Climate-smart agriculture (CSA) is not yet another re-embodiment of the 'Green Revolution'. To the opposite, CSA has much in common with sustainable agricultural approaches. This means that addressing climate change does not necessitate us to discard or reinvent the whole thing that has been learned regarding agriculture and sustainable advance in modern decades.

Climate-smart agriculture embraces use of proven practical systems such as crop rotation, integrated crop-livestock management, mulching, intercropping, conservation agriculture, crop, agroforestry, improved grazing, and improved water board but also innovative practices such as better weather forecasting, early warning systems and risk insurance. It is about getting existing technologies off the shelf and into the hands of farmers and developing new technologies such as drought or flood tolerant crops to meet the demands of the changing climate. It is also about creating and enabling policy environment for adaptation (Conway & Schipper, 2011).

Nevertheless maize is flattering more and more important as a food security crop (Chambers & Momsen, 2007). Nigeria is the largest maize producer in West Africa (Oladejo & Adetunji, 2012). This crop is most widely grown in the northern guinea savanna where, with sorghum, are two of the main cereal crops on 30 to 40% of the cultivated land area (Chambers & Momsen, 2007). The demand for maize for food, animal and industrial use is escalating rapidly as population expands across the region. The Food and Agricultural Organization (Stricevic et al., 2011) reported that more than 50% of all Sub-Saharan African (SSA) countries assign over 50% of their cereal area to maize. According to (Chimonyo et al., 2019), increasing the productivity of maize-based cropping systems has considered importance for food security and socio-economic stability of African countries and the sub-region. However, frequent droughts, floods, storms and other intense weather events, due to change in the climate, provide a continuous challenge to maize production (Chimonyo et al., 2019). The intensity of production of maize is being threatened by climatic changes and this much change in the climate is likely to alter production of maize and major food staple crops for millions of people in Africa (Olesen et al., 2011)

Adoption of adaptation technologies to climate change by maize farmers will help reduce the risks of the adverse effects of climate change on maize production in Nigeria. To boost agricultural production and productivity farmers have to use improved agricultural technologies, however the adoption of these technologies is relatively expensive and smallholder farmers cannot afford to self-finance it. As a result, the use of agricultural technologies is very low(Lawal & Oluyole, 2008).A number of studies**,** conducted in various parts of Nigeria suggest some factors (constraints) that are responsible for low level of agricultural technology adoption (Joseph et al., 2019). Some of the major constraints identified are credit facilities, education, extension services, farm size, land tenure system and labour availability. Hence there is need to examine the factors that affect the adoption of technology by the farmers.

Agriculture plays an important role in economic growth, enhancing food security, poverty reduction and rural development. It is the main source of income for around 2.5 billion people in the developing world (Dhahri & Omri, 2020).

Agricultural technology adoption study has many policy implications in agricultural development. It serves as a tool for evaluating the distributional impacts of new innovations, for documenting the impact of an innovation or extension effort, for identifying and reducing the constraints to adoption, and as a research guide to focusing innovation priority (Macours, 2019)

CSA has been applied with positive outcomes in some African societies, namely Yatenga, Burkina Faso; northern Cameroon; and the Nile Delta, Egypt (Fanen & Olalekan, 2014). There is even the suggestion that the adoption of CSA practices in northern Nigeria will improve indigenous/traditional agricultural systems as well as encourage the practice of agro-ecological agricultural systems (International Assessment of Agricultural Knowledge, Science, and Technology for Development (Fanen & Olalekan, 2014). Thus, this study will empirically investigate factor that could affect the utilization of CSA practices among maize farmers in the study area as CSA practices are just new innovation and there is need to empirically investigate factor that could affect the utilization of this new technology by farmers.

The broad objective of this study is to examine the social and economic factors that interplay with the decision of maize farmers in the study area to utilize Climate Smart Agriculture Practices. The rest of this paper is organized as follows: Section II presents the literature review, Section III presents research methodology, and Section IV presents the results, while Section V concludes.

II LITERATURE REVIEW

Concept of Climate Change

Climate change as a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. According to the Panel, the most general definition of climate change is a change in the statistical properties of the climate system when considered over long periods of time, regardless of cause. The Panel further explained that, it may be a change in average weather conditions, or in the distribution of weather around the average conditions (more or fewer extreme weather events).

In the context of environmental policy, the term climate change has become synonymous with anthropogenic global warming. Within scientific journals, global warming refers to surface temperature increases while climate change includes global warming and everything else that increasing greenhouse gas levels will affect (Poulin, 2006).

(Macklin et al., 2005) indicated that, climate change is a marked change in the long-term average of a regions weather conditions. According to (Ansarifar et al., 2020), the climatic system is an open system and is in a steady state over a given period of time. According to him, if this steady state is disturbed as a result of changes in one or more components making up the system or there are changes in the amount of solar radiation powering the system, the climate will move over a to a new state of equilibrium to produce a new climatic state. He, therefore, defined climate change as the long-term persistence of either positive or negative anomalies of a given or combination of climatic events above or below the norm that characterizes climate change. He identified the indices of climate change to include a change in any or combinations of the following: (i) surface albedo, (ii) annual mean temperature, (iii) mean temperature during the growing season, (iv) day/night temperature range, (v) extreme seasonal temperatures, (vi) rainfall seasonality and replicability of the mean rainfall regime, (vii) duration of the growing season and annual precipitation rates, and (ix) shifts in rainfall belts. The manifestation of any or combinations of these changes in different ecosystems could alter significantly the composition and characteristics of the components of the ecosystems (Ansarifar et al., 2020).

Causes of climate change

Climate change is caused by factors such as biotic processes, variations in solar radiation received by the earth, plate tectonics, and volcanic eruptions. Certain human activities have also been identified as significant causes of recent climate change, often referred to as "global warming" (Frazão Santos et al., 2020). Most climate scientists agree that the main cause of the current global warming trend is human expansion of the "greenhouse effect" which is the warming that results when the atmosphere traps heat radiating from the earth toward space (Frazão Santos et al., 2020). This energy is distributed around the globe by winds, ocean currents, and other mechanisms to affect the climate of different regions of the world (Rehbein et al., 2020). In its third assessment report, the (Rehbein et al., 2020) argued that certain gases in the atmosphere block heat from escaping thereby contributing to the greenhouse effects. According to the report, gases that contribute to the greenhouse effect include:

i. Water vapour: Water vapour increases as the earth's atmosphere warms, but so does the possibility of clouds and precipitation, making these some of the most important feedback mechanisms to the greenhouse effect.

ii. ii. Carbon dioxide (CO2): Carbon dioxide is released through natural processes such as respiration and volcanic eruptions and through human activities such as deforestation, land use changes, and burning of fossil fuels. The report says that, humans have increased atmospheric CO2 concentration by a third since the Industrial Revolution began.

iii. Methane: It is a hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes in landfills, agriculture especially rice cultivation, as well as ruminant digestion and manure management associated with domestic livestock.

iv. Nitrous oxide: This is a powerful greenhouse gas produced by soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

v. Chlorofluorocarbons (CFCs): These are synthetic compounds of industrial origin used in a number of applications, but now largely regulated in production and released to the atmosphere by international agreement for their ability to contribute to destruction of the ozone layer. In this regard, (Rehbein et al., 2020) reported that the consequences of changing the natural atmospheric greenhouse gases that are likely to be of effect on the environment indicates that earth will become warmer and some regions may welcome warmer temperatures, but others may not. Warmer conditions will probably lead to more evaporation and precipitation even though individual regions will vary, some becoming wetter and others dryer. The report also shows that, a stronger greenhouse effect will warm the oceans and partially melt glaciers and other ice thereby, increasing sea level. The ocean water will also expand if it warms, contributing further to sea level rise. Furthermore, some crops and other plants may respond favorably to increased atmospheric CO2, growing more vigorously and using water more efficiently. At the same time, higher temperatures and shifting climate patterns may change the areas where crops grow best and affect the make-up of natural plant communities (Rehbein et al., 2020).

Theoretically, (Bello et al., 2020) showed that, the causes of climate change could be grouped into the following:

(A) Astronomical causes

i. Changes in the precession of the equinoxes.
ii. Change in the eccentricity of the earth’s orbit about the sun.
iii. Change in the obliquity of the plane of ecliptic.

(B) Terrestrial causes

i. Changes in the earth’s topography as a result of lithosphere motions including sea-floor spreading and continental drift, continental uplift, and mountain building.

ii. Changes in atmospheric chemistry which could arise due to extrusive volcanic activities that could produce gaseous particulate emissions and thereby leading to the formation of layers of persistent stratospheric aerosols.
iii. Changes in snow and ice cover of the earth surface.
iv. Changes in distribution of lands and water surfaces.

(C) Extra-terrestrial causes

i. Variation in the amount of incident solar radiation (solar output).

ii. Variation in the absorption of solar radiation outside the earth's atmosphere.

(D) Causes due to human activities

i. Industrial and agricultural practices, including animal husbandry.
ii. Forest and grassland clearing and burning
iii. Lumbering, fuel wood and charcoal extraction
iv. Oil extraction, burning of fossil fuel, production of cement and all forms of quarrying and mining.
Bello (2010) indicates that human activities contribute significantly to the current trend of global warming attributed to concentration of carbon dioxide and other anthropogenic greenhouse gases in the atmosphere.

Effects of climate change on agriculture: Considerable research work has been carried out on the effects of climate change on agricultural production. In its report, (Rehbein et al., 2020) showed that global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, carbon dioxide, glacial run-off, precipitation and the interaction of these elements (Rehbein et al., 2020). These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. (Frazão Santos et al., 2020) argued that the overall effect of climate change on agriculture will depend on the balance of the effects. ***Positive effects:*** Increase in temperature and carbon dioxide (CO2) can be beneficial for some crops in some places. But to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. Rising CO2 concentration in the atmosphere can have both positive and negative consequences. Increased CO2 is expected to have positive physiological effects by increasing the rate of photosynthesis. Currently, the amount of carbon dioxide in the atmosphere is 380 parts per million (ppm) (Rehbein et al., 2020). In comparison, the amount of oxygen is 210,000 ppm.

Negative effect: The Scientific Consensus on Climate Change suggests that, due to climate change, "the southern part of Africa could lose more than 30% of its main crops, especially maize, by 2030 (Ansarifar et al., 2020). In South Asia, losses of many regional staples, such as rice, millet and maize could top 10%. The IPCC‟s third assessment report (2003) concluded that the poorest countries would be hardest hit with reductions in crop yields in most tropical and sub-tropical regions due to decreased water availability, and new or changed insect pest incidences. Also, in Africa and Latin America, many rain-fed crops are near their maximum temperature tolerance, so that yields are likely to fall sharply for even small climate changes. Falls in agricultural productivity of up to 30% over the 21st century are projected(Aragón et al., 2019) . Decrease in potential yields is likely to be caused by shortening of the growing period, decrease in water availability and poor vernalization. Marine life and the fishing industry will also be severely affected in some places (Çelik et al., 2018). (Rehbein et al., 2020) also reported that climate change could affect agriculture in following ways:

i. Productivity, in terms of quantity and quality of crops;

ii. Agricultural practices, through changes of water use (irrigation) and agricultural inputs such as herbicides, insecticides and fertilizers;

iii. Environmental effects, in particular in relation to frequency and intensity of soil drainage (leading to nitrogen leaching), soil erosion, reduction of crop diversity;

iv. Rural space, through the loss and gain of cultivated lands, land speculation, land renunciation, and hydraulic amenities; and
v. Organisms may become more or less competitive, as well as humans may develop urgency to more competitive practices, such as flood resistant, salt-resistant varieties or drought-tolerant varieties.

Review of Literature: A Brief Review of Agricultural Technology Adoption Studies

Agricultural technology adoption study has many policy implications in agricultural development. It serves as a tool for evaluating the distributional impacts of new innovations, for documenting the impact of an innovation or extension effort, for identifying and reducing the constraints to adoption, and as a research guide to focusing innovation priority (Shahin et al., 2020). The rate at which innovations are used by farmers is largely dependent on sensitization, mentoring and demonstration by extension agents (Mgbenka et al., 2015). Other study in this area (Giller et al., 2009) reported low adoption rate of improved crops technology as a result of low research and extension outreach to farmers. Studies across the country showed that where awareness was high and extension contact was more than 60%, adoption of agricultural technology is usually more than 50%. In their studies, (Giller et al., 2009) identified neighborhoods effects as an important factor that can greatly influence farmers' adoption decision. They argue that as farmers make technological choices, they are influenced by the behavior of neighboring farmers or by agro-ecological characteristics. The wealth status of farmers has also been identified as critical factors influencing adoption.

Economic Importance of Maize

Maize is one of the main cereal crops of West Africa, and the most important cereal food crop in Nigeria (*RELATIONSHIPS BETWEEN SELECTED MECHANICAL AND PHYSICAL PROPERTIES OF Mucuna Flagellipes (UKPO) AND MOISTURE CONTENT*, 2014). Maize is becoming the miracle seed for Nigeria's agricultural and economic development. It has established itself as a very significant component of the farming system and determines the cropping pattern of the predominantly peasant farmers, especially in the Northern States (Mahesh, 1999). Maize has been of great importance in providing food for man, feed for livestock and raw materials for some agro-based industries. It is a basic staple for large population groups, particularly in developing countries (de Schutter, 2011).

Maize or corn is a cereal crop that is grown widely throughout the world in a range of agro-ecological environments. More maize is produced annually than any other grain. About 50 species exist and consist of different colours, textures and grain shapes and sizes. White, yellow and red are the most common types. Maize was introduced into Africa in the 1500s and has since become one of Africa's dominant food crops (de Schutter, 2011). Worldwide, production of maize is 785 million tones, with the largest producer, the United States, producing 42%. Africa produces 6.5% and the largest African producer is Nigeria with nearly 8 million tons (Aragón et al., 2019). Africa imports 28% of the required maize from countries outside the continent. Most maize production in Africa is rain fed. Irregular rainfall can trigger famines during occasional droughts. According to (Chimonyo et al., 2019)estimates, about 158 million hectares of maize are harvested worldwide. Africa harvests 29 million hectares, with Nigeria as the largest producer in Sub-Saharan Africa (SSA), followed by Tanzania . Maize is hydrolyzed and enzymatically treated to produce syrups, particularly high fructose corn syrup, a sweetener and in some cases, fermented and distilled to produce grain alcohol which is traditionally the source of bourbon whisky (Management & Security, 2010). Sweet corn is a genetic variation that is high in sugars and low in starch that is served like a vegetable. Another common food made from maize is cornflakes. Maize is used as meal pap in Africa. Corn bread is also made from maize. Reported that maize can be boiled or roasted on the cob, the grains can be cooked fresh or dry and the dry grain can be made into pop-corn *(guguru*) and eaten with roasted groundnuts. About 80% is consumed by man and animals, while 20% is utilized in a variety of industrial processes for production of starch, oil, fructose, corn sweetener and ethanol. Maize consists of 71% starch, 9% protein and 4% oil on a dry weight basis .

Maize has evolved in Nigeria from a backyard crop in the 1970s to a commodity that is third in importance to sorghum and millet, in terms of output and area cultivated (Padulosi, S., Bhag Mal , S Bala Ravi , J Gowda , KTK Gowda , G Shanthakumar, 2009). The expansion of maize production over time may reflect positive domestic supply response since the mid-1980s to selective macroeconomic policies of government, including the import ban on some cereals (Phillip et al., 2009). Other factors have been equally significant. First, is the development, through collaborative research, of fertilizer-responsive and early-maturing open-pollinated and hybrid varieties (Çelik et al., 2018). Second, is the enhanced adoption of maize-growing and maize-related technologies through the vigorous extension activities of the World Bank–assisted Agricultural Development Projects (ADPs). Third, maize has emerge as a major substitute industrial raw material following the on the importation of most cereal grains in the 1980s. And the fourth factor has been the prolonged concessional pricing of fertilizers which represent the critical input in maize production (Phillip et al., 2009). Due to the declining fertility nature of tropical soils as a result of high use of chemical fertilizers, it has become the critical input in maize production in most parts of Nigeria resulting to prolonged concessional pricing of the commodity (Phillip et al., 2009). The subsidy on fertilizer procurement, distribution, and pricing averaged over 70 percent per annum during most of the period before the mid-1990s. Presently, some of the subsidy elements are still retained. And fourth is the relative ease of transporting and storing maize grains. Several years of research have been undertaken in Nigeria on maize by IITA and NARIs toward varietal development in relation to fertilizer response, early maturity, and resistance to pests, diseases, and parasites in Nigeria (et al., 2020). Much of the research work has occurred in the Northern Guinea savannah areas, perhaps due to the proven high-yield potential in this agro-ecology. The adoption of research programmes on maize has diffused slowly through the years and over many smallholders and consumers hence the problems of fluctuating output and yield per hectare of maize in Nigeria.

III METHODOLOGY

The Study Area

The study was conducted in Ogun State, Nigeria. Ogun State was created in 1976 from the former Western State. The State is located in the South Western part of Nigeria. Ogun State is situated within the tropics, with a total land area of 16,762 square km which lies within latitude 6°20' South and 7° 58' North in the tropics and longitude 2° 40' West and 4° 35' East of the Greenwich Meridian, and has an estimated population of 4,054,272. The state borders Lagos state to the south, Oyo and Osun states to the North, Ondo state to the east and the republic of Benin to the west. The State is heterogeneous comprising the Egba, Yewa, Egun, Awori, Ijebu ethnic groups who speak different languages.

Sampling Technique

A multistage sampling technique was used in selecting 120maize farmers. Ogun State which is the focus of the study has four Agricultural Development Programme (ADP) zones which are Abeokuta, Ilaro, Ikenne and Ijebu-Ode. In the first stage of the sampling techniques, two (2) out of the four Agricultural Development Programme (ADP) zones in the State will be selected (namely, Abeokuta and Ikenne). The second stage involved the selection of three (3) blocks out of the six blocks in Abeokuta zone and two (2) blocks out of the four blocks in Ikenne zone giving a total of five (5) blocks. This is followed by the random selection of 2 cells from each block selected from the zones to give 10 cells. The final stage was the random selection of 12maize farming households in each village that falls within the farming communities selected in the cells. This gives a total of 120 maize farming households that will be surveyed in the State for this study.

Source of Data and Data Collection

Primary data was used in this study and it was collected through the administration of well-structured questionnaires. Data was collected on socio economic variables (age, sex, marital status, size of household etc.) and specific climate smart agricultural practices (intercropping, fertilizer usage, flood control, conservation agriculture etc

Data Analysis Techniques.

The study used descriptive analysis, budgetary analysis and Multivariate probit regression to empirically investigate its objectives.

Descriptive Statistics

Descriptive statistics, such as frequency distribution, means and percentages was used to describe the socio-economic characteristics (age, sex, marital status, size of household) of maize farmers in the study area. Also descriptive analysis was used to describe the CSA activities engaged in by maize farmers in the study area.

Budgetary Analysis

This involved the use of the budgetary technique to compute the costs and net revenue of the maize farmer that engage in CSA practices and those that do not engage in CSA. Profitability ratio, gross ratio and economic efficiency ratio from which inferences on efficiency level of the enterprises in the study area were determined.
The enterprise budgeting technique that was used to assess the profitability of the maize production system with CSA practices is given as:

GM= TR- TVC …………………………. (1)

NR= TR-TC …………………………….. (2)

Where:
GM = Gross margin
TR = Total revenue
TVC = Total variable cost
NR = Net farm Revenue
TC = Total cost
TFC = Total fixed cost

The performance and economic worth of the enterprises were determined by the use of the following Profitability ratios:

1. Expense Structure Ratio (ESR) = FC/VC
2. Rate of Return (ROR) = NR/TC
3. Gross ratio (GR) = TC/GM

Classification of respondents as user and non-users of CSA practices and determinants of utilization of Climate-smart agriculture practices

Climate-smart agriculture includes proven practical techniques such as mulching, intercropping, conservation agriculture, crop rotation, integrated crop-livestock management, agroforestry, improved grazing, and improved water management but also innovative practices such as better weather forecasting, early warning systems and risk insurance. It is about getting existing technologies off the shelf and into the hands of farmers and developing new technologies such as drought or flood tolerant crops to meet the demands of the changing climate for this study, climate smart agriculture practices is considered as application relevant practices applicable to maize production in the study area. These are; intercropping, crop rotation, zero or reduced tillage, improved maize seed varieties (e.g. drought resistant) and mixed farming.

According to Afolami *et. al* (2015), a farmer was defined as an adopter if he or she was found to have grown at least one of the introduced improved cassava varieties for at least one season prior to year 2013 (the year the data for the study were collected) and had the variety on his/her farms in the year 2013. Thus, a farmer could be classified as an adopter and still grow some traditional varieties. The adoption variable was therefore defined as if a farmer is an adopter of improved cassava variety and zero otherwise. This technique was being adopted for this study. A farmer was classified as a user of CSA practice if he or she has used at least one of the practices at least one planting season before interview, and is still utilizing such practices as at the time of interview.

Multivariate Probit Model Specification

The probit model is often used in situation where an individual makes choices between two alternatives which in this case, decision to either utilizes (or not to utilize) CSA practices. Analysis of smallholder farmers technology adoption decision behavior, therefore, needs the use of a multivariate (instead of univariate) modeling framework to take into account the multiple commodities, and the possible simultaneity of the decision making process. Consequently, a multivariate profit model (MVP) is used in this paper for assessing the utilization decision behavior of maize farmers on climate smart agricultural (CSA) practices. In the MVP model estimated here, the choice of climate smart agricultural practices CSA related to each of the practices corresponds to a binary choice (yes/no) equation and the choices are modeled jointly while accounting for the correlation among disturbances. Model estimates from the multivariate specification improve over those from univariate specifications when the error correlations are significantly different from zero. Otherwise, the two modeling frameworks would lead to comparable results. Hence, if a farm utilkize M different practices, M equations each describing a latent dependent variable that corresponds to the observed binary outcome for each practices would be needed to be estimated simultaneously. Following Cappellari and Jenkins (2003), a system of simultaneous probit models were constructed for M number of practices as follows:

$$Y^*_{im} = \beta_m X_{im} + e_{im} \quad \text{...(3)}$$

$Y_{im} = 1$, if $Y^*_{im} > 0$ and 0 otherwise

e_{im} m=1,…., M are error terms distributed as multivariate normal, each with a mean of zero, and variance–covariance matrix V, where V has values of 1 on the leading diagonal and correlations $\rho jk = \rho kj$ as off-diagonal elements. If we assume that $e_{im}$are distributed independently and identically with a univariate normal distribution, equation (3) defines M univariate probit models. The assumption of the independence of the error terms means that information about a farmer's choice of the type of one practices does not affect the prediction of the same farmer's probability of utilization of another practice. If the unobserved correlations among outcomes are ignored, the whole set of M equations in (3) could be estimated separately as univariate probit models. However, neglecting the correlations leads to inefficient and biased estimates.

Table 1. Description of the variables used in the Multivariate probit model

Variables (Xi)	Definition
Sex	Sex of household head, 1 male and 0 otherwise
Age of farmer	Age in years
Years of farming experience	Number of years of experience in farming
Family size	Number of
Access to credit	1 if a farmer has access and 0 otherwise
Volume of credit	Amount in Naira
Farm size	Total area of land cultivated by farmers in Hectare
Years of education	Number of years of formal education of household head
Membership of farmers association	1 if a member of farmers' association and 0 Otherwise
Access to extension agent	1 if farmer have access to extension agent and 0 otherwise

IV RESULT

1 Socio Economic Characteristics of Respondents

This involves the analysis of various socio-economic characteristics of maize farmers that influence their operations and decision making process.

Sex distribution of Respondents

Table 2 shows that 75.8% of the maize farmers were male while 24.2% of the farmers were female. This indicates that maize farming is predominantly done by men and could probably be due to the energy sapping and stressful nature as well as funds for the operations involved. It could also be because men have access to land while the women in the study area are mainly traders.

Table 2: Sex distribution of Respondents

Sex	Frequency	Percent	Cumulative percent
Male	91	75.8	75.8
Female	29	24.2	100.0
Total	120	100.0	

Age distribution of Respondent

The age of the farmer to a large extent has an important effect of his effectiveness in the performance of the various management and operational duties on the farm and affects profitability. It also affects his ability to take risks as well as seek vital information. Table 3 reveals that 19.2% of the respondents were within the age range of 21-30 years, 18.3% of the maize farmers aged between 31-40 years, while 28.3% aged between 41-50 years. In addition, 26.7% aged between 51-60 years while 6.7% were within the age range of 61-70 years. Only 0.8% were above 70 years. The mean age of respondents was 44years with a standard deviation of 12 years. Clearly the farmers were young.

Table 3: Age distribution of Respondents

Age(years)	Frequency	Percent	Cumulative percent
21-30	23	19.2	19.2
31-40	22	18.3	37.5
41-50	34	28.3	65.8
51-60	32	26.7	92.5
61-70	8	6.7	99.2
>70	1	0.8	100.0
Total	120	100.0	
Mean	44 years	Maximum 75	
Standard deviation	12	Minimum 21	

Marital Status of Respondents

Table 4 shows that 15% of the respondents were single, 75.8% were married, 5.8% were divorced while 3.3% were widows. The large number of farmers who were married implied that farmers could be assisted by their spouses at critical periods on the farm. The single farmers will have to depend on their own labour and hired labour during critical farming period.

Table 4: Marital status of respondents

Marital status	Frequency	Percent	Cumulative percent
Single	18	15.0	15.0
Married	91	75.8	90.8
Divorced	7	5.8	96.6
Widowed	4	3.3	100.0
Total	120	100.0	

Distribution of Respondent by family size.

The result from Table 5 reveals that majority of the respondents (51.7%) had a family size of between 6-10 while 47.5% of the respondents had between 1-5 only; 0.8% of the respondents had greater than 10 members. The mean family size was 6 with a standard deviation of 2. Family size tended to be large in the study area indicating ready access to family labour.

Table 5: Distribution of Respondents of family size

Family size	Frequency	Percent		Cumulative percent
1-5	57	47.5		47.5
6-10	62	51.7		99.2
>10	1	0.8		100.0
Total	120	100.0		
Mean	6	Maximum	11	
Standard deviation	2	Minimum	1	

Educational status of Respondents.

The educational status of a farmer affects the living style, mode of operations, level of exposure, level of management, productivity level, perception about and adoption of new practices and innovation (Ajayi, 2012). Table 6 shows that 26.7% of the farmers did not attend any school; 44.2% attended primary school; 22.5% had secondary school education while 6.7% attended tertiary school(universities, polytechnics and colleges of education).

Table 6: Educational status of Respondents.

Education status	Frequency	Percent	Cumulative Percent
No Formal Education	32	26.7	26.7
Primary	53	44.2	70.9
Secondary Education	27	22.5	93.4
Tertiary Education	8	6.7	100.0
Total	120	100.0	

Method of Land Acquisition

Table 7 reveal that 29.7% of the respondents obtained their land through inheritance, while 24.2% purchased their farm land; 41.4% rented/leased theirs, 5.4% got their land from the community leaders while 1.6% got their land as gifts.

Table 7. Method of Land Acquisition

Method	Frequency	Percent	Cumulative Percent	
Inheritance	35	29.2	29.2	
Purchase	14	11.7	40.8	
Rentage/ Lease	62		51.7	92.5
Community land	2	1.7	94.2	
Gift	7	5.8	100.0	
Total	120	100.0		

Distribution of respondents by membership of farmer's association

Table 8 revealed that 7.5% of the respondents belongs to form of farmers association while the remaining 92.5% did not.

Table 8. Distribution of respondents by membership of farmer's association

Method	Frequency	Percent	Cumulative percent
Yes	9	7.5	7.5
No	111	92.5	100.0
Total	120	100	

Distribution of Respondents by Occupation

Table 9 shows that56.7% of the respondents has farming as their major occupation. This is expected as farming is the prevalent occupation for rural household in Nigeria. The remaining 43.3% of the respondents have non-farm occupation as their major occupation; 5.0% Teaching,2.5% Carpentry ,5.8% mechanic, 7.5% Trading ,5.8% Transportation, 1.7% Civil Servant, 2.5% Electrician, 0.8% Fashion Designer 2.5% Hair Stylist,0.8% Painter,1.7% welder,2.5% Plumber,2.5% Students and 1.7% bricklayers Also,55.8% of the respondents that has farming as their major occupation have no other means of livelihood aside farming.

Table 9. Distribution of Respondents by Occupation

Occupation	Frequency (n=120)	Percent	Cumulative Percent
Major Occupation			
Farming	68	56.7	56.
Teaching	6	5.0	61.7
Carpentry	3	2.5	64.2
Mechanic	7	5.8	70.0
Trading	9	7.5	77.5
Transportation	7	5.8	83.3
Civil Servant	2	1.7	85.0
Electrician	3	2.5	87.5
Fashion Designer	1	0.8	88.3
Hair Stylist	3	2.5	90.8
Painter	1	0.8	91.7
Welder	2	1.7	93.3
Plumber	3	2.5	95.8
Student	3	2.5	98.3
Bricklayer	2	1.7	100.0
Secondary Occupation			
None	67	55.8	55.8
Farming	49	40.8	96.7
Trading	3	2.5	99.2
Bricklayer	1	0.8	100.0

Maize Production in the Study Area

This section provides information on maize production in the study area

Distribution of respondents by maize farm size

Table 10 revealed that 59.2% of the respondents have about one hectares of farmland while 38.3% have between 1.01 and 2.00 hectares. Only 2.5% have more than two hectares of maize farm land. The average farm size was 0.96 hectares.

Table 10. Distribution of respondents by maize farm size

Farm Size(Hectares)	Frequency	Percent	Cumulative percent
≤1.00	71	59.2	59.2
1.01 – 2.00	46	38.3	97.5
> 2.00	3	2.5	100.0
Total	120	100	

Mean	0.96	Maximum	2.02
Standard deviation	0.41	Minimum	0.07

Maize Farming experience of Respondents

Table 11 shows that 13.3% of the respondents had between 1and 10 years of farming experience while 32.5% had between 11 and 20years. Another 20.8% had between 21 and 30 years of maize farming experience while 19.2% had between 31 and 40 years. 14.2% of the respondents had more than 40 years' experience in maize farming. The mean farming experience was 27 years with a standard deviation of 14 years. Experience has a direct relationship with the ability of a farmer to make prudent economic decisions which contribute to increased production and profitability. The experience of these farmers in maize farming clearly shows that they understand the climatic, edaphic and market factors that determine maize cultivation.

Table 11: Farming experience of Respondents

Farming experience (years)	Frequency	Percent	Cumulative percent
1-10	16	13.3	13.3
11-20	39	32.5	45.8
21-30	25	20.8	66.6
31-40	23	19.2	85.8
>40	17	14.2	100.0
Total	120	100.0	

Mean	27	Maximum	60
Standard Deviation	14	Minimum	2

Access to Extension Agent among the respondents

The table 12a shows that 20.8% of the respondents had access to extension agents while 79.2% do not have access to extension agents. It is revealed in the table 12b that on the average, a respondent had contact with extension agent one time in the previous planting season. While 10% had one contact with extension agent, 7.5% had two contact with extension agent, 2.5% had three contact and 0.8% had four contact.

Table.12a Distribution of Respondents by access to Extension Agent

Access to Extension Agent	Frequency	Percent	Cumulative Percent
Yes	25	20.8	20.8
No	95	79.2	100.0
Total	120	100.0	

Table.12b Distribution of Respondents by number of contacts with Extension Agent per previous cropping season

Number of contacts	Frequency	Percent	Cumulative Percent
0	95	79.2	79.2
1	12	10.0	89.2

2	9	7.5	96.7
3	3	2.5	99.2
4	1	0.8	100.0
Total	120	100.0	
Mean	2	Maximum	4
Standard Deviation	1	Minimum	1

Access to Credit among the respondents

Table 13 below shows that majority (77.5%) of the respondents do not have access to credit while the remaining (22.5%) of the respondents do have access to credit from various sources available to them.

Table 13. Distribution of Respondents by access to Credit

Access to Credit	Frequency	Percent	Cumulative Percent
Yes	27	22.5	22.5
No	93	77.5	100.0
Total	120	100.0	

Distribution of Respondents by volume of Credit Received

Table 14 reveals that majority (77.5%) of the respondents did not received any credit while.13.2% received about ₦100,000, 7.5% received between ₦100,001 and ₦200,000. Just 0.8% of the respondents received between ₦200,001 and ₦300,000. The average credit received was ₦107,962.96 with a Standard Deviation ₦59,779.39.

Table 14. Distribution of Respondents by volume of Credit Received

Amount (₦)	Frequency	Percent	Cumulative Percent
0	93	77.5	77.5
≤ 100,000	17	13.2	90.7
100,001- 200,000	9	7.5	98.2
200,001 -300,000	1	0.8	100.0
Total	120	100.0	
Mean	₦107,962.96	Maximum	₦250,000
Standard Deviation	₦59,779.39	Minimum	₦30,000

Distribution of Respondents by revenue from maize farming

Table 15 shows that 86.7% of the respondents earned about ₦200,000 annually while 11.7% earned between ₦200,001 and ₦300,000. 1.6% of the respondents earned between ₦300,001 and ₦400,000. The average revenue of the maize farmers was ₦135,545.58 with standard a deviation of ₦65,843.658

Table 15: Distribution of respondents by revenue from maize

Income (₦)	Frequency	Percent	Cumulative percent
≤200,000	104	86.7	86.7
200,001 - 300,000	14	11.7	98.4
300,001 – 400,000	2	1.6	100.0

Total	120	100.0		
Mean	₦135,545.58	Maximum	₦375,600	
Standard Deviation	₦65,843.658	Minimum	₦16,000	

Total expenditure of Respondents

Table 16 shows that 92.5% of the respondents spent about ₦100,000, 5.8% of them spent between ₦100,001 and ₦200,000; 1.7% spent between ₦200,001 and ₦300,000. The average expenditure was ₦56,343.42 with a standard deviation of ₦36,672.70.

Table 16: Distribution of Respondents by total expenditure

Total expenditure (₦)	Frequency	Percent	Cumulative percent
≤ 100,000	111	92.5	92.5
100,001- 200,000	7	5.8	98.3
200,001- 300,000	2	1.7	100.0
Total	120	100.0	
Mean	₦56,343.42	Maximum	₦256,800
Standard Deviation	₦36,672.70	Minimum	₦4,900

Respondents' distribution by utilization of CSA Practices

Table 17 revealed that, only 12.5 % of the sampled respondents were actually non- users of CSA Practices in the study areas, while the majority (87.5 %) were users. 32.5% of the farmers used Zero tillage and 67.5 % of the farmers, did not. In the same vein, it was also observed that majority (60.8 %) of the respondents did not use Mixed framing in the study area, as shown in Table 16, while 39.2% used mixed farming. Majority (70.8%) of the respondents did not use mixed cropping while 29.2% utilized mixed cropping. 50.8% of the maize farmers utilizes crop rotation while 49.2 did not. Majority 81.7% utilizes improved maize variety while the remaining 18.3% did not.

Table 17. Respondents' distribution by utilization of CSA Practices

CSA Practice	Frequency	Percent
Utilization		
Users	105	87.5
Non Users	15	12.5
UtilizationZero tillage		
Yes	39	32.5
No	81	67.5
Utilization ofMixed Farming		
Yes	47	39.2
No	73	60.8
Utilization ofMixed Cropping		
Yes	35	29.2
No	85	70.8
Utilization ofCrop rotation		
Yes	61	50.8
No	59	49.2

Use of improved maize variety		
Yes	98	81.7
No	22	18.3

Distribution of respondents on how CSA practices has worked for them

Table 18 shows that majority (90.8%) of those that made used improved maize seed variety agree that the practices has worked for the Also, 91.8% of those that made use of crop rotation agree that the practice has worked for them while 77.1% agree that mixed cropping has worked for them.

Table 18. Distribution of respondents on how CSA practices has worked for them

CSA practices Agree Disagree	Strongly	Agree	Undecided	Disagree	Strongly
Zero tillage	13(33.3)	24(61.5)	2(5.1)	-	-
Mixed Farming	36(76.6)	9(19.1)	2(4.3)	-	-
Mixed cropping	8(22.9)	27(77.1)	-	-	-
Crop Rotation	5(8.2)	65(91.8)	-	-	-
Improved maize seed	9(9.2)	89(90.8)	-	-	-

Values in parentheses ( ) are percentages SD (Standard deviation)

BUDGETARY ANALYSIS

Budgetary analysis of users of CSA practices

Table 19 shows the profitability ratios derived from the budgetary analysis pf users of CSA practices. Clearly, the analysis showed that maize farming with the use of CSA practices was a profitable one with a net revenue value of ₦79,284.00. The gross margin of ₦101,382.92 showed that the users of CSA practices were also able to cover their variable cost for the season.

The benefit cost ratio shows that for every ₦1 spent or invested in maize production, a net return of ₦2.53 was generated and this was supported by the ₦79,284.00, average net revenue realized by users of CSA practices for that year. This shows that maize farming with the use of CSA practices was profitable during the last production period.

Table 19: Budgetary analysis of users of CSA practices

S/N	ITEMS	Amount (₦)	% in cost category
A.	**Total Revenue (TR)** 131,145.4		
B.	**Costs** - *Variable Costs*		
	Farm clearing and land preparation	(14,820.95)	49.80
	Cost incurred on planting	(5,291.05)	17.80
	Cost of herbicide application	(4,941.95)	16.60
	Cost of weeding	(4,194.29)	14.10
	Cost of harvesting	(34.29)	0.12
	Cost of transportation	(200.00)	0.67
	Cost of storage	(200.00)	0.67

Marketing cost		(80.95)		0.27	
Total Variable Cost(TVC)		(29,762.48)			
Gross Margin(GM)	(TR-TVC)		101,382.92		
- *Fixed Cost*					
Land		(19,199.05)			86.88
(Depreciation)					
Cutlass		(1,715.24)		7.76	
Hoes		(862.14)			3.90
Farm boots		(322.49)		1.46	
Sprayer		(200.63)		0.91	
Total Fixed Cost (TFC)		(22,098.92)			
Total Cost (TC)	(TVC+TFC)	(51,861.4)			
C. Net Revenue (NR)	TR- TC		79,284.00		
D. Gross Ratio	TC/GM = 0.51				
E. Rate of Return	NR/TC= 1.53				

Determinant of utilization of CSA practices among the maize farmers.

The coefficient of age is positive and significant at ($p<0.05$) and ($p<0.01$) in mixed cropping ad mixed farming respectively while it is negative and significant ($p<0.01$) in zero tillage. This shows that a unit increase in the age of the respondents would increase the probability of utilizing mixed cropping ad mixed farming among the maize farmers while decrease the probability of utilizing zero tillage.

The coefficient of level of education is negative and significant ($p<0.05$) for utilization of Mixed cropping. This is an indication that an increase in level of education among the respondents would decrease the probability of choosing Mixed cropping among the maize farmers.

The coefficient of access to credit is positive and significant ($p<0.05$) for the utilization of improved maize variety. This is an indication that as access to credit increase, the probability of using improved seed variety increases.

The coefficient of years farming experience is positive and significant ($p<0.01$) for the utilization of zero tillage ad it negative and significant ($p<0.01$) for mixed cropping. Thus, a unit increase in years of farming experience will increase the probability of utilizing zero tillage among the maize farmers ad decreases the probability of using mixed cropping among them farmers.

.The coefficient of membership of association is positive and significant ($p<0.01$) for the utilization of Zero tillage. These implies that membership of farmers association increases the probability of utilizing zero tillage.

Table 20. Determinant of utilization of CSA practices

(Independent variable)	Zero Tillage		Mixed farming		Mixed cropping		Crop rotation		Improved variety	
	Coefficient	P>z	Coefficient	P>z	Coefficient	P>z	Coefficient	P>z	Coefficient	P>z
Age	-.0544037	**0.004***	.0373873	**0.019****	.0396981	**0.005***	-.0034665	0.807	.0037943	0.836
Sex	.054083	0.863	-.1861633	0.550	.2771221	0.398	-.0746342	0.806	-.5959044	0.152
Family Size	.042214	0.593	-.040845	0.563	-.0400608	0.599	.1324923	0.111	.0153393	0.832
Education Level	-.0537441	0.798	.0593221	0.752	-.3430357	**0.049****	.2640865	0.120	.0515064	0.799
Membership of Farmers association	1.508245	**0.008***	.8019386	0.162	-.0713789	0.899	.3585775	0.475	.0884308	0.858
Farming experience	.0499217	**0.007***	.0241647	0.159	-.0373713	**0.010***	.0027249	0.850	-.001547	0.926
Farm size	-.6274817	0.110	-.1698736	0.648	-.0685434	0.853	.1628028	0.653	-.5087068	0.151
Access to extension service	.0828174	0.816	-.360947	0.301	.1404644	0.657	.039254	0.899	.3901427	0.312
Access to credit	.0918133	0.831	.0667252	0.868	.1764084	0.653	-.1584676	0.707	.9447125	**0.044****
Volume of credit	8.62e-07	0.832	3.93e-06	0.250	-7.56e-07	0.814	3.94e-06	0.286	-2.41e-06	0.549
Constant	.7087147	0.344	-2.310218	**0.003***	-.9231047	0.210	-1.144468	**0.088*****	1.36767	**0.100*****

Log pseudolikelihood = -288.20727 chi2(10) = 57.7459

*** Significant at 10% ** Significant at 5% * Significant at 1%

V. CONCLUSION AND RECONMENDATIONS

CONCLUSION

From the field analysis, it can be inferred that all though maize farming enterprise is a profitable one with the use of CSA practices. Also it was observed that use of improved seed variety in the study area was high and this could be a reason for profitability for the farmers that utilize CSA practices. It was also observed that a larger percentage of the maize farmers were not well educated and this could retard the progress that could have been made over the years in the enterprise.

RECOMMENDATION

Based on the result obtained from this study, the following recommendations are put forward to help maize farmers and maize farming in the study area.

1. Extension agents should ensure that they communicate CSA practice to the maize farmers more as what they are used to rather than seeing it as a total new way of farming
2. Since improved maize seed variety is mostly utilized among the respondents as a CSA practice, government should make more improved seed available to farmers in a subsided rate if not made free.

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