ANALYSIS OF FACTORS INFLUENCING ON-FARM BIODIVERSITY AMONG MAIZE FARMERS IN ONDO STATE, NIGERIA

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION SERVICES, FACULTY OF AGRICULTURE, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA,

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CERTIFICATION

This is to certify that this research work titled "ANALYSIS OF FACTORS INFLUENCING ON-FARM BIODIVERSITY" was carried out by Ayomide joy ADEDIPESOYE with matriculation number AGR1800001 of the Department of agricultural economics and extension services, Faculty of Agriculture University of Benin, Benin city, Edo State, Nigeria.

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Miss. O.P. Emokpae | **Prof. Mrs. M.J. koyenikan**

Project supervisor. | **Head of Department**

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Date | **Date**

DEDICATION

With a grateful heart, I dedicate this research to God Almighty for his mercies, strength, and grace upon my life during the course of this project.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Maize is a crop of notable interest for food security in many parts of sub-Saharan Africa (SSA) (Foltz *et a*l., 2014; Fisher *et a*l., 2015; van Ittersum *et al*., 2016). It is by far the largest cereal crop in terms of area and production volume and is the most consumed staple food in Nigeria (Onumah et al., 2021). Maize crop has the highest productivity per man-hour invested. In practically all of Nigeria's vegetation zones, it is produced as a single crop or with other crops as an intercrop, and its cultivation offers rural livelihood options and employment. According to Oyelade and Awanane (2013), production of maize is very central to the realization of national food security and achieving higher agricultural growth. It is a commercial crop and is highly demanded as a raw material in agro-industrial sector (Karimov *et al.*, 2014).

In 2019, Africa had a total production volume of about 90MMT and Nigeria had an average production volume of about 11 metric meter tonnes thus making it the second largest producer in the continent, after South Africa with 16 MMT (PricewaterhouseCoopers Nigeria, 2021). However there has been a decline in food security in the country and the demand for this crop outweighs the supply and this can be attributed to low productivity from maize farms and decline in its biodiversity. (Obayelu *et al.*, *2016*).

The term 'biodiversity' is commonly used to describe the number, variety and variability of living organisms (UNEP 2014) in an ecosystem. Agricultural biodiversity is the variety and variability of living organisms (plants, animals, microorganisms) that are involved in food and agricultural production (FAO, 1999).

Agricultural biodiversity plays a vital role in improving household food security, income generation, and thus regional and global food security. Diversity can also help to improve productivity by raising yield stability, contributing to pest and disease control, and improving the environment (Flood, 2010). Farmers often use cultivar mixture which are derived from genetic diversity to boost crop yield (Kong, *et al.,* 2023), offer yield stability (Giunta, *et al.,*2020), manage diseases (Duan, *et al.,*2022), boosts resource utilization and efficiency (Brandmeier *et al.*, 2021), promote soil health by reducing soil erosion (Hunt, *et al.,* 2019),and enhancing fertility (Marcos-Perez, *et al.,*2023), as well as stopping the spread of pests and diseases (Herrera, *et al* 2022). For instance the study by Di falco and Chavas (2006) found that crop genetic diversity, in the form of wheat varieties, can increase productivity and reduce the risk of cop failure for farms that use low amount pesticide.

In Nigeria farmers grow a wide range of maize varieties including the open- pollinated varieties (OPVs) and hybrid varieties (Kolawole *et al.,* 2022). Nevertheless, Nigeria's maize yield has remained relatively constant at about 1.7 tonnes per hectare since 2017. The reason for this is due to farmers' reluctance to transit from the use of open pollinated variety (OPV) to improved hybrid seeds despite the fact that local varieties produces one to two tonnes per hectare and hybrid varieties about four to six tonnes. As a result, production is low and could barely satisfy the huge maize demand estimated at 12 –15 metric meter tonnes thereby creating a maize supply gap of nearly 4 metric meter tonnes per annum (Pwc, 2021).

While some studies have looked at biodiversity from different aspect such as abundance, dominance, inverse dominance. For instance, Obayelu *et al.,* (2016) assessed biodiversity by measuring dominance, and abundance, this study looked at biodiversity from the aspect of varietal diversity (maize cultivar richness) following Isakson, (2007) and Conversa, (2019).

1.2 Problem Statement

In Nigeria, Maize has achieved a prominent status as both a crop and a significant part of the national economy and local diets. However, the crop continues to be characterized by a poor yield, low input level, and a small area under cultivation (Abdulrahman et al, 2021). Despite the importance of this crop, Nigeria is not meeting its domestic needs or international export standards as the demand of maize continues to outweigh supply (Pwc, 2021). Nigeria has become a net importer of some cereal crops with about 5.6 million tonnes total cereal import in 2019 (International Grains Council, 2020) due to a number of challenges, including low productivity, lack of access to improved technologies, and poor infrastructure .

It cannot be overemphasized that Agricultural improvements such as yield quality improvement, disease resistance and adaptation to climate changes rely upon the great diversity within crop plants. However, continuous focus on intensive selection of a few species with better economic traits will in turn leads to a loss of genetic diversity (Isundar, 2011; Molotoks *et al*., 2017; FAO, 2018).

Agro biodiversity loss leads to genetic erosion, including the loss of individual genes, and the loss of particular combinations of genes (or gene complexes) such as those manifested in locally adapted landraces and also genetic vulnerability which occurs when there is little genetic diversity within a population of plants. This loss of agro biodiversity has serious consequence not only for the environment but also the farmers who depend on agriculture for their livelihood. Without genetic diversity, options for long-term sustainability and agricultural self-reliance would be lost (Sundar, 2011).

Therefore an increase in biodiversity could lead to an increased productivity and yield of maize thereby creating food security and stability in the growth and development in the economy of the nation. Hence this study evaluated the factors influencing on-farm biodiversity among maize farmers as a case study.

The research questions this study seeks to answer are;

- What are the socio-economic characteristics of maize farmers in the study area?
- What is the extent of on-farm maize biodiversity among farmers in the study area?
- What are the factors influencing on-farm biodiversity among maize farmers in the study area?

1.3 objective of the study

The specific objectives were to:

- examine the socio –economic characteristics of maize farmers in the study area.
- describe the extent of on-farm maize biodiversity among farmers in the study area.
- determine the factors influencing on-farm biodiversity among maize farmers in the study area.

1.4 justification of the study

Maize is by far the largest cereal crop in terms of area and production volume and is the most consumed staple food in Nigeria (Onumah *et al.,* 2021). Hence, the importance of the conservation of its genetic resources cannot be overemphasized as crop genetic resource are inputs needed to enhance productivity in order to ensure food security and sustainable agriculture in Nigeria.

However this goal is impossible without identifying the factors influencing the maintenance of its biodiversity on-farm. Although some studies had been carried out on on-farm biodiversity (Chiputwa, 2011; Guachan, *et al.,* 2005; Obayelu *et al.,* 2015), however to the best of my knowledge, little or no research has been conducted to analyze the factors influencing on-farm maize biodiversity in Ondo state, Nigeria. This study aims to analyze how farmers' decision making is influenced by multiple factors and help to provide information for policy makers on how to support farmers' effort to maintain and sustain maize biodiversity thereby creating food security and stability in the growth and development in the economy of the nation.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical framework

2.1.1 Microeconomic theory of the farm household

The farm household is the fundamental unit of management where decisions and actions affecting crop biodiversity are made. The household functions as a consumer, consuming commodities made on the farm by its members as well as goods acquired with money earned from wage labor or the farm. The household generates agricultural commodities that are either consumed or sold on the market by combining its own resources of labor, land, and other capital with inputs that are acquired. (Van dusen, 2000). According to Benin *et al* (2004), farmers' decisions about which cereal crops and varieties to grow and how extensively can be understood in the context of the theory of the household farm. In this theory, the household farm maximizes utility over a set of consumption items generated by the set of crops and varieties it grows (*Cf*), a set of purchased consumption goods (*Cnf*), and leisure (*l*). The utility a household derives from various consumption combinations and levels depends on the preferences of its members. Preferences are in turn shaped by the characteristics of the household, such as the age or education of its members, and wealth. Choices among goods are constrained by the full income of the household, total time (*T*) allocated to farm production (*H*) and leisure (*l*), and a fixed production technology represented by (*F*). The production technology combines purchased inputs (X) and labor (*L*) with the physical characteristics of the farm (Ω*F*), which are fixed in a single decision-making period. (Joshi, 2006).

2.2 Methodological framework

The different approaches in literature used in measuring biodiversity are Count, Shannon, Simpson, Margalef, Herfindahl Index (HI), and Entropy Index (EI) and their modifications (Basavaraj, Gajanana and Satishkumar, 2016; Asante, Villano, Patrick, and Battese, 2018).

2.2.1 Count index

The simplest way to measure biodiversity is to count the number of species at a site; this number gives a researcher a measurement of species richness. The Count index (*C*) represents the number of Maize varieties (*S*) grown by each farmer. *C* is a count variable starting at zero for farmers growing only 1 variety. It can be shown by the following expression, $C_i = S$

2.2.2 Shannon index (H')

The most common index used to measure the degree of crop diversity is the Shannon index that accounts for the number of the species or cultivars within the crop (Gozdowski *et al.*, 2008). It measures the average degree of uncertainty, in order to predict what species an individual will randomly choose from the collection of 'S' species and total number of 'N' individual species. This average of uncertainty increases as the number of species increases and as the distribution of individuals among the species becomes constant (Meerman, 2004). The mathematical expression of Shannon's index (*H'*) is described as:

$$H' = \sum_{i}^{s} p_i . \ln p_i \text{..(1)}$$

where:

H' = Shannon's index

ni = number of individuals in species i; the abundance of species i.

S = number of species, also called species richness.

N = total number of all species.

pi = is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N)

Thus, H' has two properties that were made to reflect the popular measure of crop species diversity:

(1) H' = 0 if there is one species in the sample, and

(2) H' = it is maximum if all S species are represented by the same number of individuals in the sample, that is, a perfectly even distribution of the abundances. When all species in a sample are equally abundant, an evenness index should be maximum and decrease toward zero as the relative abundances of the species diverge away from evenness (Meerman, 2004). The Shannon index (H') increases with an increase in the number of species cultivated within one single crop. Therefore, the Shannon index (H') represents the difference between the farm households who cultivate relatively the same number of crops (Abdalla *et al*., 2013).

2.2.3 Simpson's index (D')

This index is used to quantify biodiversity of a habitat, takes into account the number of species present, the relative abundance of each species and it represents the probability that two randomly selected individuals from the habitat will not be from the same species. In other words, it gives the probability of any two individuals drawn at random from an infinitely large community belonging to different species. It is therefore expressed as 1-D or 1/D and it is heavily weighted towards the most abundant species in the sample while being less sensitive to species richness. It has been shown that once the number of species exceeds 10 the underlying species abundance distribution is important in determining whether the index has a high or low value. The D value which is standing for the dominance index is used in pollution monitoring studies. According to Obayelu and Onasanya, (2016) as D increases, diversity decreases.

Mathematically, Simpson's index is expressed as:

$$1-\sum_{i=1}^{k}\frac{n_{i(n_{i-1})}}{n(n-1)}\quad\text{...(2)}$$

Where:

n = the total number crop of a particular species

N = the total number of crops of all species

D = represents a range between 0 and 1 (1 represents infinite diversity while 0 denotes no diversity) at the lowest (zero) level.

2.2.4 Margalef index

The Marglef index has a very good discriminating ability and it is sensitive to sample size. It is a measure of the number of species present for a given number of individuals. However, it is weighted towards species richness. The advantage of this index over the Simpson index is that the values can be more than 1 and this makes comparing the species richness between different samples collected from various habitats much easier (Obayelu and Onasanya, 2016).

It is defined as:

Margalef index = $(\boldsymbol{S-1}) / \ln \boldsymbol{N}$…………………………………….. (3)

Where S is number of species; N is total arable land held by farmers

2.2.5 Herfindahl Index (HI)

It is the sum of square of the proportion of acreage under each crop to the total cropped area and is given by Equation

$\sum_{i=1}^{N} p_{i^2}$ ………………………………………………………………… (4)

Where;
Pi represents acreage proportion of the i^{th} crop in total cropped area.

The Herfindahl index takes the value of one when there is specialization and approaches zero when there is diversification. Since the index measures concentration; it is transformed by subtracting from one, i.e., 1 – HI. The transformed value of HI avoids Confusion on comparing it with other indices. (Basavaraj, 2016).

2.2.6 Entropy Index (EI)

It is a direct measure of diversification having a logarithmic character and is given by;

Equation;

$$\sum_{i=1}^{N} pi^{*} log\ (1 / p_i) \ \ldots\ldots\ldots\ldots\ldots\ \ldots\ldots\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (5)$$

The Entropy index increases with diversification. The Entropy index approaches zero when the farm is specialized and Pi equals one (perfect specialization) and takes a maximum value when there is perfect diversification. The upper limit of Entropy Index is determined by the base of logarithms and the number of crops. The upper value of the index can exceed one, when the number of crops is higher than the value of the logarithm's base, and it is less than one when the

Number of crops is lower than the base of logarithm. **(**Basavaraj *et al.*, 2016).

A number of studies have used biodiversity indices such as the Shannon index, Simpson index, Berger -parker index, Marglef index to measure biodiversity. For instance, Gauchan *et al.,*(2005) in his study used three diversity indices in his study the study used a simple count of farmer cultivated rice varieties as a measure of richness. Shannon index captures a combination of richness and equality or evenness in distribution across areas and it is also recently being used in economics research as measure of evenness for diversity measurement (Van Dusen 2000, Benin *et al.,* 2003). The Berger-Parker index is employed to represent the relative dominance of one variety versus another.

2.2.7 Poisson regression model

Poisson regression model is statistical model used to analyze count data where the outcome variable represents the number occurrence of an event within a fixed unit of observation. The model assumes that the count follows a Poisson distribution which is characterized by its mean and variance being equal. The model estimates the relationship between one or more predictor variables and the expected count of an event typically using a logarithm link function to ensure that the predicted count remains non- negative.

Poisson regression model is basically a regression model that meets the classical assumptions with only one exception. This exception is that the dependent variable assumes Poisson distribution. This is a very common distribution for the random variable having a value 0, 1, 2, 3…. n. Assuming a Poisson distribution, there is defined likelihood function and is possible to develop the maximum likelihood estimator (MLE). Within the Poisson model, it is possible to obtain estimates of unknown regression parameters $\boldsymbol{\beta_0}, \boldsymbol{\beta_1}, \boldsymbol{\beta_2}, \boldsymbol{\beta_k}$. As with other regression, in order to explain the distribution of (yi) or the expected value (yi) by the set of explanatory variables (xi). We assume that the expected value of yi is given by

E$\{\boldsymbol{y_{i/x_i}}\}$=$exp\{\boldsymbol{x_{iT}\beta}\}$…………………………………………….. (6)

A common assumption in count data models is that, for given *xi*, the count variable *yi* has a Poisson distribution with expectation $\boldsymbol{\lambda_i}$ = exp $\{\boldsymbol{x_1}^{\boldsymbol{T}}\boldsymbol{\beta}\}$. Thus the probability mass function of *yi* conditional upon *xi* is given by:

P$\{\boldsymbol{y_i = y \,/\, x_i}\}$=$exp$ $\{\boldsymbol{-\lambda_i}\}\boldsymbol{\lambda_i y/y!}, \boldsymbol{y = 0, 1, 2}$……………………………………… (7)

Where *y!* Expressed as 'y factorial'. Substituting the appropriate functional form for λi produces expressions for the probabilities that can be used to construct the log likelihood function for this model, referred to as the Poisson regression model. (Cupal *et al.*, 2014).

The Poisson regression model can be depicted as

$$\ln(\mu^{\wedge}) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p, \quad \ldots\ldots (8)$$

2.3 Empirical framework

Obayelu *et al.,* (2015) examined the determinants of on-farm cassava biodiversity in Ogun State, Nigeria. The results suggested that household characteristics affect cassava diversity. The age of the household head in the study was negative under the Shannon model. The farmer's experience was significant and positive in all the models. The arable land size controlled by the farmer was positively significant with three diversity indices. However, land squared variable is negatively significant on three diversity measures this study on the status of cassava diversity and its determinants is useful as input to policy decisions concerning Conservation. The low level of biodiversity indices and the insignificant effect of extension contact in all diversity indices indicate the fact that extension services are almost moribund and ineffective to encourage farmers on the need to grow varieties of cassava and in abundance.

Guachan *et al*., (2005) identified socioeconomic, market and agro -ecological determinants of farmers' maintenance of rice diversity at the household level and derived implications for policies in designing on-farm conservation programs. The findings showed that household-specific socioeconomic, agro-ecological and market factors are important in determining on-farm rice diversity. The significant variables in explaining richness and evenness of rice diversity include distance to the nearest market, subsistence ratio, modern variety evenness of rice diversity include distance to the nearest market, subsistence ratio, modern variety sold, land types and adult labor working in agriculture. Finally, the study implied that the cost-effective means of promoting and sustaining on-farm conservation programs is to target them in market isolated geographic locations of high crop diversity where farm households have more heterogeneity of agro ecological conditions and more active family adult labor working on-farm.

Benin *et al*., (2003), compared the determinants of inter- and infra-specific diversity on household farms in the highlands of northern Ethiopia. The result showed that the Physical features of the farm, and household characteristics such as livestock assets and the proportion of adults that are men, have large and significant effects on both the diversity among and within cereal crops grown, varying among crops. Demographic aspects such as age of household head and adult education levels affect only infra-specific diversity of cereals. Market related variables and population density have ambiguous effects. Education positively influences cereal crop diversity.

Inoni *et al*., (2021), analyzed socio-economic factors that influenced farming households' decision to adopt crop diversification strategy, as well as the determinants of the extent crop diversification using data from a cross-section of farmers in Delta State, Nigeria. The results showed that several variables drive crop enterprise diversification, but the major predictors of the propensity to diversify were extension contact, farm income, farm size, access to credit, and farmer's age. The result showed that income had significant positive effects on farmers' diversification decision; while farm size, credit access, extension contact and attitude to risk exerted positive and significant influence on intensity of crop diversification by smallholder farmers.

Abay *et al.,* (2009), in the study measuring on farm diversity and determinants of Barley Diversity in Tigray, Northern Ethiopia**,** identified the social and economic factors that influence levels of diversity maintained on-farm. The result showed that Physical characteristics (land fragmentation index, farm size), agro climatic features of the site (altitude, rainfall temperature) and household characteristics (only number of children) had a significant and positive impact on diversity and area allocation of barley. The significant negative relation of number of extension contact with barley diversity implied in this study requires further attention and analysis.

Basavaraj *et al*., (2016) in the study, **"**Crop Diversification in Gadag District of Karnataka**"** identified The factors influencing crop diversification in Gadag taluk using regression analysis wherein household richness was regressed on factors like size of holding, farm income and gross area irrigated (as a linear measure for extent of irrigation).The size of holding, family income and area under irrigation were found to have positive effect on crop diversification.

Mburu *et al.,* (2016) in the study **"**Agro biodiversity conservation enhances food security in subsistence-based farming systems of Eastern Kenya**"** reported that there existed significant relationships between smallholders' farms diversity and biophysical factors. Some of the independent factors such as age and farm size were not significantly related to smallholder farms diversity-dependent variables. Farming years positively influenced *H′* of the total crop species, indicating that species diversity increased depending on the number of years the farm had been cultivated. Moreover, the age of the household head had a positive influence on species diversity. There was a significant and a weak negative correlation between the level of education of the household head and crop diversity.

Abdalla *et al.,* (2013) identified the factors influencing crop diversity in dry land sector of sudan, the result of the Tobit regression model implied that being a male-headed household negatively influences the diversity of crop at level, the off-farm activities during the agricultural season have a significant and negative impact on the degree of crop diversity, an increase in cultivation of both food and cash crops is highly significant and positively influences the degree of crop diversity, the positive and significant impact of total adult family labor on the degree of crop diversity, cereal food saved for home subsistence has a positive and significant impact on the degree of crop diversity ,the result also showed that the experience of the head of the farm households in the agricultural activities and crop production has negatively influenced the degree of crop diversity, The censored Tobit regression model exhibited the positive and significant impact of household size on the degree of crop diversity, also the finding of censored Tobit regression model revealed that the middle level of household income significantly influenced the degree of crop diversity and also implied that the agricultural extension service positively influences the degree of crop diversity.

2.4 Conceptual framework

This study follows the Rahm & Huffman (1984) model on household utility that assumes that farmers base their adoption decisions upon the objective of maximizing their utility. In this case the farmer will grow multiple maize varieties if the utility (*UAi*) is greater than the utility derived from growing a single variety (*UNi*). In general, the utility derivable from growing maize *U* depends on *M*, which is a vector of farmer characteristics (e.g., gender, age and education), farm characteristics (e.g., farm size, labor), institutional factors (e.g. extension, credit) and bio-physical factors (e.g. topography, soil type) of the farmer. The preference of adopting one variety and that of adopting multiple varieties are assumed to be linear in relationship: this study assume farmers base their adoption of maize diversity decisions on utility maximization

$$\text{MAX } U = ((M_{ji}\, H,F,I,B), Z_{ji}))$$

$$U_{ji} = \beta_j\, F_i\, (M_i\, Z_i) + e_{ji}$$

Where *U* represents the level of utility the farmer derives

M is a vector of observable explanatory variables affecting maize diversity

H,F,I and *B* are household, farm, institutional and bio-physical factors that affect maize diversity, respectively

β_j is a vector of explanatory coefficients to be estimated of the diversity index

e is a vector of random disturbances of the unobserved factors affecting maize diversity index

j= 1, 2 where 1=adoption of diversity and 2=Non-adoption of diversity

i= 1, 2……n.

This study also assumes that farmers will diversify maize if and only if

$$U_{Ai} > U_{Ni}$$

$$y_i^* = U_{Ai} - U_{Ni} > 0$$

Where *y** is an unobservable latent variable representing the benefits of diversity.

(Chiputwa., 2011)

CHAPTER THREE

3.0 METHODOLOGY

3.1 Area of study

This study was conducted in Ondo state of western Nigeria with a land area of 14,788.723 square kilometers (sq.km), and population of 3.44milllion according to 2006 national population census.(NPC, 2006). The state lies between longitude 4˚30″and 6˚East of the GMT, and latitude 5˚45″and 8˚15″ this means that the state lies entirely in the tropics. It is bounded in the North by Ekiti/Kogi State; in the East by Edo State; in the West by Oyo and Ogun States and in the South by the Atlantic Ocean. Ondo state includes mangrove-swamp forest near the Bight of Benin, tropical rain forest in the center part, and wooded savanna on the gentle slopes of the Yoruba Hills in the north. The climate is tropical with two distinct seasons, the rainy season (April-October) and the dry season (November - March). The temperature throughout the year ranges between 21˚C- 29˚C while humidity is relatively high. The annual rainfall varies from 2.000mm in the southern parts to 1150mm in the northern areas. Ondo State, made up of 18 Local Government Areas is located in the South Western Zone of Nigeria. . (Ondo State Government, 2011).

3.2 Sampling procedure and sampling size

A three-stage sampling procedure was adopted for this study. The first stage was the purposive selection of three local government area based on the intensity of maize production by farm households in the area, (Akoko south-east, Akoko south-west, Akoko north-east). The second stage also involved the use of simple random sampling technique in the selection of five communities from each of the selected local government areas resulting in a total of 15 communities from each of the selected local government areas in the study area, and they are: Isua, Aba- ikare, Idofin community, akungba-akoko, Epe, supare, oke-oka, Eti-oro, ipe, Igbo-ose supare, ayepe, oba- akoko, ilepa, Eshe, Odo.

The third stage involved the use of simple random sampling technique to select (10) maize farmers from each of the sampled communities to give a total of 150 respondents for the study out of the 150 copies of questionnaire that were administered 132 copies of questionnaire were accurately filled and used for analysis in this study.

3.3 Types of data

Data for this study was obtained from a cross-sectional survey of maize farmers in the study area. Primary data was collected with the aid of a structured questionnaire and secondary data was obtained from relevant journal articles that were available on the internet.

3.4 Measurement of variables

Dependent variable

Table 1: Measures of maize Diversity on-farm

Index	Concept	Construction
Count	**Richness**	**D = S** **S = number of maize varieties planted by a farmer**

Adapted from Isakson, 2007: Table 1

Independent variables

Based on several related studies the independent variables selected for this study are defined as follows:

- Age: The farmers' age was measured in years.
- Sex: male or female.
- Number of years spent schooling: measured in years.
- Distance to market: measured in minutes.
- Number of Agricultural technologies:
- Land ownership: (yes=1, no=0).
- Years of experience: was measured in years.
- Contact with extension agent: (yes=1, no=0).
- farm size: was measured in hectares
- Household size: was measured by total number dependents in the family
- Group participation: (yes=1, no=0).
- Institutional support (yes=1, no=0).

3.5 Analytical Techniques

Objective one: To describe the socio-economic characteristics of maize farmers in the study area

Descriptive statistic such as the mean, standard deviation, frequency table and percentage were used to describe the socio-economic characteristics of maize farmers in the study area.

Objective two: To describe the extent of on-farm biodiversity of maize in the study area

Descriptive statistics such as percentages, bar chart were used to highlight the various ways the sample maize farmers conserve biodiversity on-farm.

Objective three: Factors influencing on-farm biodiversity among maize farmers in the study area; Poisson regression model was used to achieve this objective.

Poisson maximum likelihood regression

Poisson maximum likelihood regression (Equation 1) was used to estimate the relationship between the count index (number of maize cultivar on farm) and the independent variables. The count index (dependent variable) is discrete and small and hence the appropriateness of the Poisson maximum likelihood regression According to Obayelu *et al*., (2015) the equation for poisson regression is as follows:

Poisson regression

$$\boldsymbol{D_k = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 + \beta_5\chi_5 + \beta_6\chi_6 + \beta_7\chi_7 + \beta_8\chi_8 + \beta_9\chi_9 + \beta_{10}\chi_{10} + \beta_{11}\chi_{11} + \beta_{12}\chi_{12} + v_k}$$ ……………………………………………………………

…….. (1)

Where:

$\boldsymbol{D_k}$ = Count index (number of maize cultivar varieties on farm).

$\boldsymbol{\chi_1}$= Age of household head (years),

$\boldsymbol{\chi_2}$= Farmer's experience in cultivation of maize (years),

$\boldsymbol{\chi_3}$= Years of schooling of the farmer,

$\boldsymbol{\chi_4}$= Contact with extension, (yes = 1, 0 otherwise),

$\boldsymbol{\chi_5}$= information received (yes = 1, 0 otherwise),

$\boldsymbol{\chi_6}$= Farm size,

$\boldsymbol{\chi_7}$= Household size.

$\boldsymbol{\chi_8}$= Land ownership

$\boldsymbol{\chi_9}$= Distance to market

$\boldsymbol{\chi_{10}}$= Institutional support

$\boldsymbol{\chi_{11}}$ Group participation

$\boldsymbol{\chi_{12}}$= Number of Agricultural technologies

$\boldsymbol{v_K}$= Error term.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-economic characteristics of maize farmers in Ondo state

The socioeconomic characteristics of maize farmers in Ondo state is presented in Table 4.1 Farmers in the study area have a mean age of about 49years, this implied that the majority of the farmers are in their active years. They are less than 50 years old. This is similar to the average age of 49.79 reported by Oguniyi, *et al.,* (2021). About 60% of the respondents were males, this shows that maize farming in Ondo state is dominated by the male folks.

The mean of household size of farmers in the study area is seven, implying that farmers have large household size which can help in farming activities. Most of the farmers have about 8-9 years of formal education; this implies that they are literates, which is important in making informed production and livelihood decisions. Gizaki and Madukwe (2019) asserted that education plays a significant role in skill acquisition and technology transfer and also in risk taking endeavors among farmers. The respondents have an average farming experience of about 21 years, the average farm size of farmers in the study area is 1.32 hectares implying that farmers in the study area are small holders.

Maize farmers in the area grow at least one variety of maize and at most four different varieties of maize on the same farmland, this shows that on-farm diversity is high in the study area. On the average, the farmers utilize two or three different agricultural technologies in the production of maize. Only about 32.58 % had regular extension contact and this can affect the type of maize grown and the type of production practices that will be carried out by the farmers as farmers' access to extension service serves as a vital human capital that keeps them informed (Adeagbo *et al.,* 2021).

About 57% of the farmers are members of social/economic groups within their communities only about 29% of respondents were enlightened on the availability and importance of cultivating different maize varieties. Also only 30.30% of respondents claim that they benefitted from development programmes/ intervention that support the plight of small holder farmers.

Table 4.1: Description of Demographic and Socio-Economic Characteristics of the Maize Farmers in the Study Area.

Variable	Percentage	Mean	Standard deviation
Sex			
Males	59.80		
Females	40.20		
Age		49.43	15.53
Household size		7	3.02
Years of schooling		8.95	5.84
Farming experience		21.19	13.60
Farm size		1.32	1.36
No of maize varieties		1.92	0.99
Distance to market		8.59	5.89
No of agricultural technologies utilized by farmer		2.48	1.36
Information on maize varieties			
No	71.21		
Yes	28.79		
Participation in support program			
No	69.70		
Yes	30.30		
Membership of social/economic Group			
No	43.18		
Yes	56.82		

Source: Field survey, 2024

4.2 Extent of on-farm maize biodiversity

The extent of on- farm biodiversity of maize farmers in the study area is presented in figure 1to 8. The result in figure 1 shows that approximately 13% of maize farmers in the study area did not cultivate any local maize varieties, 70.45% of maize farmers in the study area cultivated just one local variety, and about 17 % cultivated two local varieties of maize. This might be as a result of lack of awareness on the benefit of planting different local maize varieties on the same farmland.

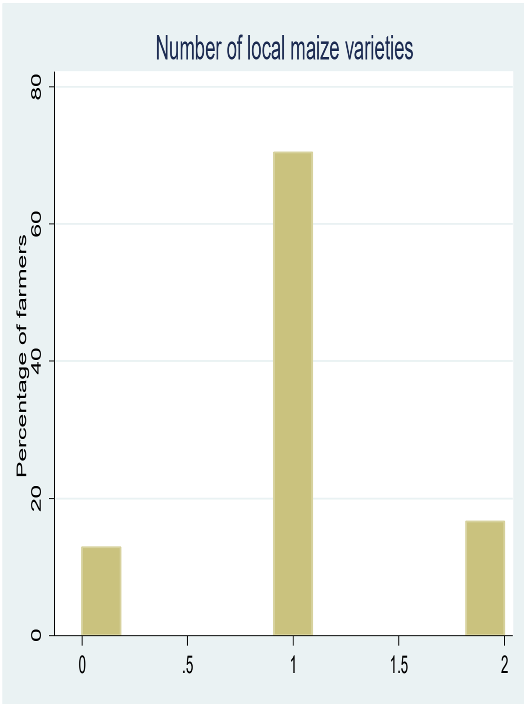
The result in figure 2 showed that about 28% of the farmers who cultivate more than one local maize variety do not grow them on the same farm land while the remaining 72% of them cultivate more than one local variety of maize on the same farm land. This finding in figure two might be as a result of farmers having limited land area as farmers with smaller plots might not have the space to dedicate separate areas for each local variety. Intercropping allows them to maximize variety within the limited space. Also farmers prioritizing specific traits in their maize, such as high yield or preferred taste, can influence the number of maize varieties planted as only a few local varieties might fulfill those needs.

The number of improved varieties planted by farmers in the study area is shown in figure 3. The result showed that 24% of maize farmers in the study area do not cultivate any improved maize varieties, about 45% of them cultivated one improved maize variety, approximately 19 % cultivated two improved maize varieties, about 7% cultivated 3 improved maize varieties while the remaining 5% cultivated 4 improved maize varieties.

Figure 4 shows that about 38% of the farmers who cultivated improved maize varieties do not do it on the same farm land while 62% of them cultivate more than one improved maize varieties on the same farm land. Farmers planting more improved varieties might be as a result of improved maize varieties being more commercially available than local varieties.

The result in Figure 5 shows that 53% of the farmers do not plant both local and improved maize varieties on the same piece of land since they either plant improved maize varieties and local maize variety while the remaining 47% of them plant both local and improved varieties. This might be as a result of some farmers adopting a partial separation strategy. They might plant a portion of their land with local varieties for personal consumption or local markets, where preserving unique characteristics is important. On the other hand, they might dedicate another portion of their land to improved varieties suited for commercial markets, prioritizing high yield.

Finally, the result in Figure 6 further explains the cultivar richness of farmers in the study area it shows that about 23% of maize farmers in the study area cultivate only one variety on of maize, that is they plant either improved or local maize varieties on their farmland. About 45% of them cultivate two maize varieties on their farmland, approximately 17% cultivate three maize varieties on their farmland, about 8% cultivate four maize varieties on their farmland, and the remaining 3% cultivate 5 maize varieties on farm. This finding suggests that a significant portion of farmers, potentially due to limited land area, might not have the capacity to cultivate a wider range of maize varieties. Additionally, managing a diverse set of varieties can be labor-intensive, which could explain the lower percentage of farmers growing three or more maize varieties.



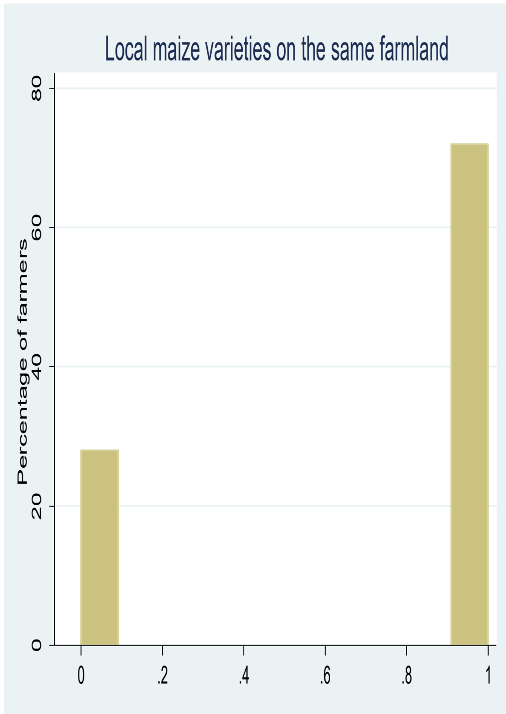
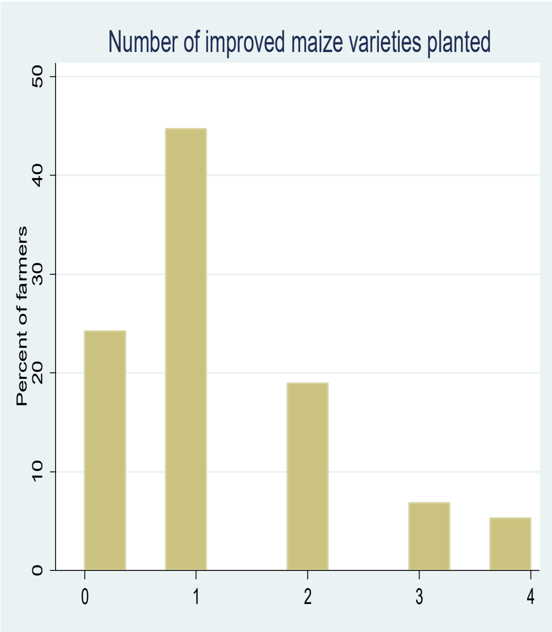


Figure 1: Number of local maize varieties **Figure 2: local maize varieties planted on same farm**



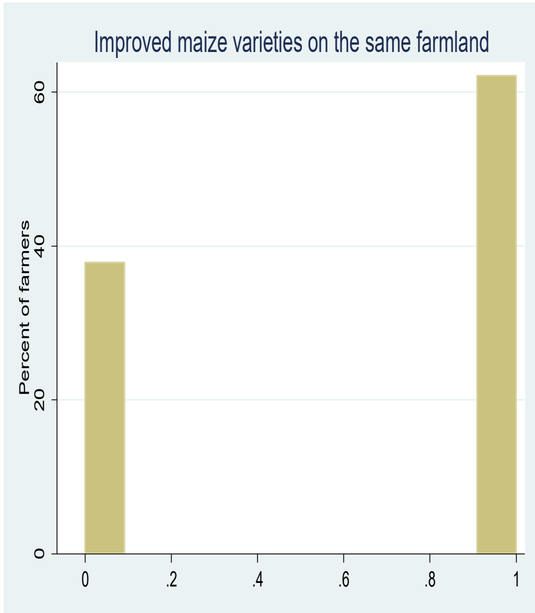
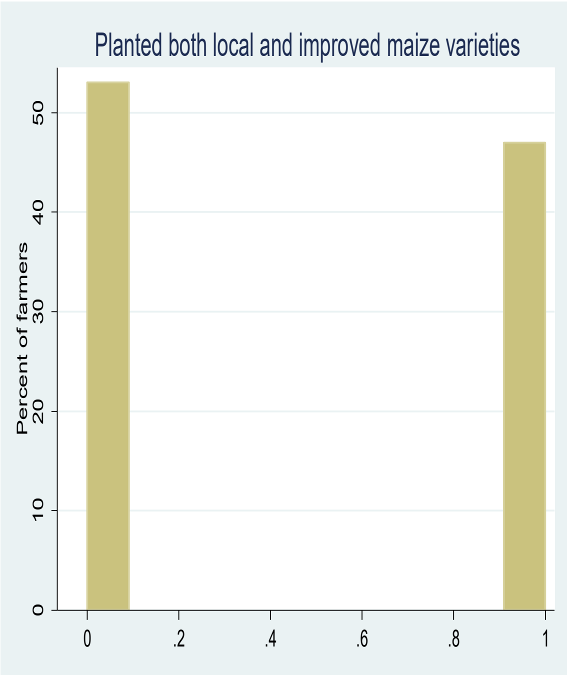


Figure 3: Number of improved maize varieties **Figure 4: improved maize varieties on the same farm**



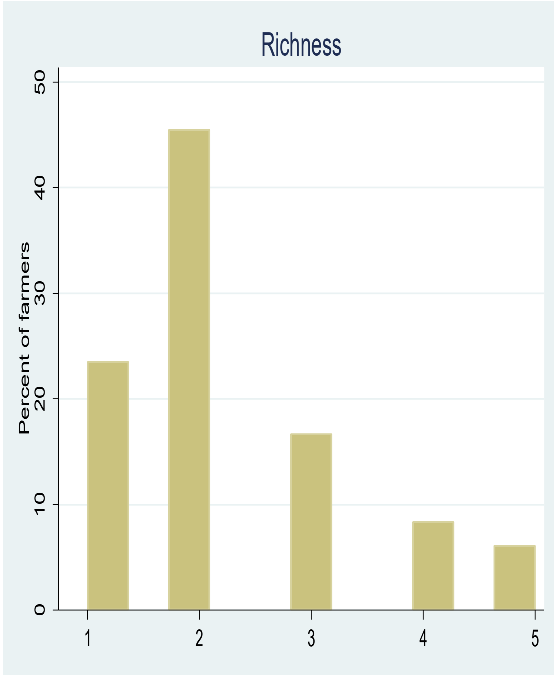


Figure 5: percentage of farmers that planted both improved and local varieties.

Figure 6: maize cultivar richness.

4.4 Factors influencing on-farm biodiversity

Table 4.3 shows the parameter estimates of the Poisson model that highlight the factors influencing the number of maize varieties (richness) cultivated by farmers in the study area. Cultivar richness has been used to describe on-farm biodiversity in other studies such as Guachan, (2005), Isakson, (2007), Chiptuwa, (2011), and Obayelu, (2016). The statistical significance of the model's Chi-square value, which is a test of the model coefficients shows that all the estimated coefficients in the model are not simultaneously equal to zero. Thus, highlighting the significance of the model. Also the result of goodness-of-fit chi-squared statistic, which is the test of the model form shows that the model fits the data reasonably well since the result of this test is not statistically significant. Hence, the Poisson regression model is an appropriate model to explain the factors influencing the on-farm maize diversity in the study area. Several variables were statistically significant in influencing maize biodiversity (cultivar richness) among farmers in the study area, and they are subsequently explained.

Farm size had a positive significant relationship with cultivar richness at 1% level of significance. This implies that an increase in the size of the farmland by one hectare will result in an increase in the difference of the logs of cultivar richness by 0.10 units *ceteris paribus,* this finding corroborates with the findings of Obayelu *et al.,* (2015) who observed that as arable land increases, on-farm cassava biodiversity increases but at a decreasing rate.
Farming experience had a negative and significant relationship with cultivar richness at 5% level of significance this finding is in variation with the *a priori* expectations that the more

experienced the farmers are, the greater the tendency to plant different varieties on their farms as a means to managing economic risks (Obayelu *et al.,* 2015). This implies that an increase in the year of farming of by one year will result in a decrease in the difference of the logs of cultivar richness by 0.0079 *ceteris paribus*. This indicates that as the farming experience of farmers increases the likelihood of them planting different maize varieties on-farm reduces. This finding is in conflict with findings of Abdalla, *et al.,* (2013), who inferred that the experience in farming activity is expected to have a positive influence on the degree of crop diversity.

Farmers who had received information on different maize varieties had a negative and significant relationship with on-farm maize biodiversity at 5% level of significance. This implies that the difference in the log of expected cultivar richness is 0.38 unit lower for farmers who have more information on the different varieties of maize than for those who do not have such information. From the result we can infer that farmers who had benefitted from institutional support had a positive and significant relationship with on-farm biodiversity at 1% level of significance this implies that the difference in the log of expected cultivar richness is 0.54 unit higher for the farmers who have received institutional support than for those who have not benefitted from institutional support.

Number of technology used by the farmer on-farm also had a positive and significant relationship with on-farm maize biodiversity at 1% level of significance. Implying that an increase in the number of agricultural technologies used will result in an increase in the difference of the logs of cultivar richness by 0.11 unit. *ceteris paribus* .

Although Age, group membership, distance to market, extension contact, land ownership were positive but they were not significant. However, Years of schooling and household size had a negative but not significant relationship with on-farm maize diversity.

Table 4.3 factors influencing on-farm maize biodiversity (cultivar richness)

Independent variables	Coefficient	Standard error	P>|z|
Age	0 .0039	0.0033	0.25
Years of schooling	-0.0058	0.0064	0.36
Household size	-0.011	0.013	0.37
Farming experience	-0.0079 **	0.0034	0.02
Farms size	0.089***	0.021	0.00
Land ownership	0.19	0.13	0.15
Information on maize varieties	-0.38**	0.16	0.02
Institutional support	0.54 ***	0.16	0.00
Number of Agricultural technologies	0.11***	0.027	0.00
Group participation	0.10	0.071	0.16
Extension contact	0.067	0.077	0.38
Distance to market	0.0071	0.0053	0.18
Constant	0.14	0 .18	0.45
Wald chi2(12) = 132.73			
Prob > chi2 = 0.000			
Pearson goodness- of- fit = 42.26			
Prob > chi2(119) = 1.0000			
Number of observation : 132			

***Statistically significant @1% **statistically significant @5%

Source: Field survey, 2024.

CHAPTER FIVE

5. 0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 summary

The study looked into the analysis of factors influencing on-farm biodiversity among maize farmers in Ondo state Nigeria. However, the specific objectives of the study were to describe the socio-economic characteristics of maize farmers in the study area, describe the extent of maize biodiversity in the study area, and determine the factors that influence on-farm maize biodiversity in the study area.

The result from the study showed that majority of the farmers were males (60%), the average age of farmers in the study area is 49 years, with the farmers having an average household size of seven. Most of the farmers have spent at least nine years attaining formal education, implying that most of them are literates. Also farmers in the study area had an average farming experience of 21 years and an average farm size of 1.32 hectares. Farmers in the study area cultivate an average of two maize varieties, and used at least two agricultural technologies on their farmland with 33% of farmers in the study area having regular extension contact, and only about 29% having information on availability and importance of planting different maize varieties on-farm. About 30% of farmers benefitted from support programs and 57% were part of a social/economic group, and 47% of farmers in the study area plant both the local and improved maize varieties on their farmland.

The regression result showed that farming experience, farm size, institutional support, and information received, number of agricultural technologies used had a significant relationship with on-farm biodiversity in the study area.

5.2 Conclusions

Based on the findings from this study it can be concluded that:

Maize farmers in Ondo State conserve biodiversity *in situ* since about 76% of them cultivate more than one variety on their farm lands. On-farm maize biodiversity (cultivar richness) among farmers is significantly influenced by several factors such as farm size, farming experience, institutional support, information received and number of agricultural technologies used. To effectively conserve and promote maize biodiversity among farmers, relevant stakeholders should focus on strengthening institutional support to farmers and also incentivize them to invest on agricultural technologies because these variables significantly influenced biodiversity conservation among maize farmers.

5.3 Recommendation

The following recommendations were made based on the findings from the study:

1. Since the number of agricultural technologies significantly increases on-farm maize biodiversity, the adoption of a wider range of agricultural technologies among farmers should be promoted, by improving extension services, conducting training programs, and increasing financial assistance to farmers**.**

2. Since farmers with larger farm size conserve more varieties of maize *in-situ* policies or incentives that encourage the consolidation of smaller farms or prioritize support for

existing larger farms to maximize their potential for cultivating diverse maize varieties shouldbeexplored.

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APPENDIX

QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENTION SERVICES

FACULTY OF AGRICULTURE

UNIVERSITY OF BENIN,

BENIN CITY, EDO STATE NIGERIA.

Dear respondent, I am an undergraduate student of the above named institution carrying out a research to gather useful information on the topic: "ANALYSIS OF FACTORS INFLUENCING ON-FARM BIODIVERSITY AMONG MAIZE FARMERS IN ONDO STATE". I hereby solicit your assistance by responding to the questions below accurately, all information given will be kept absolutely confidential and only used for the purpose of this study.

Thanks for your cooperation.

Questionnaire identification Local Government Area ___________________________

Community ________________________

INSTRUCTION: Please tick (✓) where applicable

SECTION A: Socio-Economic Characteristics

1. Sex of the farmer; Male [ ] Female [ ]
2. Age of farmer: _____________(years)
3. Household Size: _______________

   Number of males________________

Number of females______________

4. Number of years the farmer spent schooling ____________

5. Highest level of Education: (a) No formal Education [ ] (b) primary school education [ ] (c) Secondary School education [ ] tertiary education [ ]

6. For how many years have you been cultivating maize? ________________ (years)

7. Does farmer have regular contact with extension agents?. Yes [ ] No [ ]

8. Is the farmer a member of any cooperative society?(a) Yes [ ] (b) No [ ]

9. Is the farmer a member of any farmer group (a) Yes[ ] (b) No [ ]

10. Does the farmer cultivate only maize on his/her farmland? (a) Yes (b) No

11. If No, how many other crops do the farmer cultivate on his/her maize farm alongside maize? ___________________

12. Does the farmer engage in off-farm income generating activities?______ (a) Yes[ ]. (b) No[ ]

SECTION B: MAIZE PRODUCTION

13. How many farms does the farmer have? _______________

14. In how many of those farms does the farmer cultivate maize?______

15. Does the farmer own the land on which they cultivate maize? Yes [ ] No [ ]

16. If yes how was the farmland acquired? (a) Purchased [ ] (b) inherited [ ] (c) family land [ ] (d) leased [ ]

17. What is the size of the maize farm? ____________ (a) Ha [ ] (b) Acre [ ] (c) plot [ ]

18. What is the source of labor for the maize farm? (a) Hired [ ] (b) family [ ] (c) Both [ ]

19. Number of hired laborers [ ], Number of family laborers [ ]

20. Source of maize seeds for planting _______________ (a) market [ ] (b) ministry of Agriculture [ ] (c) extension agent[ ] (d) exchange with other farmers [ ] (e) others [ ]

21. Do you plant local maize varieties? Yes [ ], No [ ]

22. If yes, how many local maize varieties do you plant on your farm? ____________

23. Please list the names of these local varieties ___________

24. Do you plant them all on the same farm? Yes ( ), No ( )

25. If no, specify how you plant them by filling the table below?

Farms	**No of** local maize **varieties**
Farm 1	
Farm 2	
Farm 3	
Farm 4	
Farm 5	

26. Do you plant improved maize varieties? Yes [ ], No [ ]

27. If yes, how many improved maize varieties do youplant on your farm? ________________

28. Please list the names of these improved maize varieties _________

29. Do you plant them all on the same farm? Yes [ ], No [ ]

30. If no, specify how you plant them by filling the table below?

Farms	**No of** improved maize **varieties**
Farm 1	

Farm 2	
Farm 3	
Farm 4	
Farm 5	

31. What benefits do you enjoy from planting different varieties of maize on your farm?________________

32. Does market demand for specific maize varieties influence the type of maize varieties you Plant? Yes [ ] No [ ]

33. How much time does it take you to get to the nearest market in order to sell your harvested maize? __________________

34. Does the distance to the market affect the type of maize varieties you grow on your farm? Yes [ ], No [ ]

35. Do you think that planting different varieties of maize contribute to the success of your agricultural production? (a) Yes[ ] (b) No[ ] (c) Not sure [ ]

36. Which of these farming practices do you carry out on your farmin order to improve yield?

Farming practice	**Tick(✓)**
Use of organic fertilizers (use of manure)	
Use of inorganic fertilizers (use of Npk,urea,etc)	
Irrigation	
Application of pesticides	
Mulching	
Others (please specify)	

37. Have you received any information or training regarding the significance of planting different maize varieties? ______________

38. Have you participated in any support programs that supports the cultivation of different maize varieties on your farm? Yes ( ), No ( )

39. If yes,h ow would you rate the support you receive from such programs (a) beneficial[ ] (b) no significant improvement [ ] (c) not beneficial [ ]