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Factors Influencing the Use of Improved Maize Seed and Participation in the Seed Demonstration Program by Smallholder Farmers in Kwali Area Council Abuja, Nigeria

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Abstract:- This study identified the factors influencing the use of improved maize seeds by the smallholder maize farmers and their participation in the National Agricultural Seeds Council (NASC) seed demonstration program (SDP) in the Kwali area. A multistage sample strategy was utilized to obtain 250 cross-sectional data from nine wards (rural settlements) in the study area. The data was analyzed using linear and logistic regression models. The estimation results from the linear model revealed that total farm size and participation in NASC Seed demonstration program significantly influenced the likelihood of smallholder farmers using improved maize seeds in the study area. The logit model indicates that household income and well-being influenced the likelihood of smallholder farmers' participation in the NASC seed demonstration program. Therefore, the study recommended that the federal government and policymakers should formulate and implement policies and interventions to encourage the use of improved maize seeds in Nigeria.

Keywords:- *Demonstration, Improved Seed, Kwali, Maize, NASC, Logit, Linear Regression.*

I. INTRODUCTION

Over the last seven years (2013-2019), agriculture has contributed an average of 24% to the GDP of Nigeria, making it the country's largest sector [11]. The sector also employs more than 36% of the country's labour force, a feat that ranks the sector as the largest employer of labour in the country [11]. Maize, cassava, guinea corn, and yam are the major crops in Nigeria's households and 70% of households practice crop farming [11].

Maize is the most commonly cultivated arable crop [2], it holds an important place in its food economy due to the embargo on rice and wheat flour imports [10]. According to [6], over the 2009 – 2014 period, there was an increase in harvested maize area from 3.4 to 5.9 million hectares, with an increase in production from 3.3 to 6.8 million tonnes. Currently, Nigeria's annual maize production is about 12.745 million metric tons [1]. However, despite the evidence of sustained maize production in the last two decades, maize yields are still low compared to its potential outcomes. [7] revealed that on-farm maize yields are about 1–2 tons per ha compared to the possible outcomes of up to 7 tons per ha. The agriculture sector has faced several challenges that have led to the disparity between the potential and realized yields. These challenges include an antiquated land tenure system that restricts access to land (1.8 ha per farming household), a very low level of irrigation development (less than 1 percent of cropped land under irrigation), limited adoption of research findings and technologies, high farm input costs, poor credit availability due to the mismanagement of specialized institutions established for the sector's development and farmers' lack of collateral security; ineffective procurement and distribution of fertilizer; inadequate storage facilities; and, more recently, variations in average temperatures, rainfall, climate extremes, as well as infestation of pests and diseases.

Studies reveal that improved technology adoption is critical for agricultural productivity and the livelihoods of small-scale farmers in developing countries. Promoting agricultural productivity and global food security requires improved seeds [3] Improved seeds are high-yielding, disease-resistant, and drought-tolerant, as well as responsive to inorganic fertilizer [12], but traditional seeds, which are more adapted to the local environment, have lower yields [4]. The Nigeria Government through the National Agricultural Seeds Council (NASC) introduced the Seed demonstration program to provide solutions to the above challenges. Despite NASC seed demonstration programs across the Country, the use of improved seeds is still low. This supports the need to look into the factors influencing smallholder farmers' use of the improved maize seed and their participation in the NASC seed demonstration program. The upgraded technologies principally chosen for this study were the enhanced NASC seed demonstration program and improved maize seeds, which were introduced by the Nigerian government.

Therefore, given the significance of this study on the advancement of improved technology, the study seeks to identify the factors influencing the use of the improved maize

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seed and participation in the NASC seed demonstration program by smallholder farmers. The findings of this study will be crucial to making recommendations on areas to provide support and interventions that will boost the use of improved maize seeds and participation in NASC seed demonstration programs.

II. METHODOLOGY

A. The Study Area

This study was conducted at the Kwali Area Council of the Federal Capital Territory (FCT), Abuja, Nigeria. Abuja, the Federal Capital Territory (FCT), was established on February 3, 1976, and is Nigeria's capital, located in the country's center. The Federal Capital Territory of Abuja is divided into six Area Councils: Abuja Municipal Area Council (AMAC), Gwagwalada, Bwari, Kuje, Kwali, and Abaji. Kwali is an agricultural area council comprised of rural settlements. The population is predominantly smallholder farmers, and their main source of livelihood is through agricultural activities. Kwali Area Council was purposively selected due to the NASC seed demonstration activities in the area and it covers 9 maize growing areas across the 9 farming communities namely; Ashara, Dafa, Gumbo, Kilankwa, Kwali, Pai, Wako, Yangoji, and Yebu.

B. Sampling Techniques and Data Collection

The study used a multistage sampling technique to identify 250 maize smallholder farmers across the 9 farming communities in the Kwali Area council. The sampling strategy was employed to divide the Area Council's huge population into manageable stages, allowing for the council to be sufficiently represented in the survey. The first stage of the selection was the purposive selection of the Kwali Area Council as a result of NASC seed demonstration activities in the council. The next stage was the identification of the 9 farming communities. The final stage was the random and proportionate selection of 250 maize smallholder farmers. However, the target population across the 9 farming communities in this study was about 2,500 smallholder farmers [8]. These farming communities represent the communities in which the improved maize seeds have been introduced through the NASC seed demonstration program. Consequently, in a cross-sectional approach, 250 smallholder farmers were surveyed across these selected sites between May and June 2023. Primary data was collected through the administration of research questionnaires by agricultural extension agents using a face-to-face dialogue, and focused group discussions. The questionnaires were made up of three sections and sampled variables related to maize smallholder farmers' household characteristics, economic factors, and impact-related characteristics of the technology.

C. Analytical Techniques and Model Specification

In order to achieve the stated objectives of this study, both descriptive and inferential statistics were used. The descriptive statistics involved the use of mean, frequency distribution and percentages while the inferential statistics were linear and logit regression models.

- *Linear Regression Model:*

This study applies a linear regression model to investigate the factors influencing smallholder farmers' usage of improved maize seeds. A generalized linear modeling method called Ordinary Least Squares (OLS) can be applied to one or more independent variables and one or more response variables (dependent variables). According to this model, the independent variable, X, and the dependent variable, Y, have a linear relationship. The ordinary least squares model is is specified as:

$$Y = \beta 0 + \beta 1X1J + \beta 2X2J + \ldots + \beta KXKJ + \varepsilon \quad \ldots(1)$$

The regression coefficients are defined as βj, j=0, 1, 2……k. In the k-dimensional space of the independent variables Xj's, this model describes a hyper-plane. When all other predicted variables remain constant, the parameter βj indicates the expected change in the dependent variable Y, which in this case is income, per unit change in Xj. This study uses this model to calculate the impact of the independent variables (X1 to X19) on the dependent variable (Y), which is the quantity of improved maize seeds used.

The explicit form of the model is given as:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \ldots\ldots. \beta 19\ X19 + \varepsilon \quad (2)$$

Where:
Y = Quality of improved maize seeds used
β0 = Constant
βi = Parameters to be estimated (i = 1, 2, 3 …19)
X1 = Age of household head
X2 = Education status of household head
X3 = Size of household
X4 = Total farm size
X5 = Farmers' experience
X6 = Household Income gap
X7 = Social Networking
X8 = Increase in financial status
X9 = Poor extension PR
X10 = Illiteracy level of household head
X11 = Participation in NASC Seed demonstration program
X12 = High cost of improved seeds
X13 = Poor organization of demonstration and field day
X14 = Inadequate information on improved seeds
X15 = Demonstrated varieties over Local varieties
X16 = Unavailability of improved seeds
X17 = Inadequate information from other farmers
X18 = Unfavourable government policy
X19 = Lack of credible vendors
ε = the error term

- *Logit Regression Model*

The logit regression model is another tool used in this study to identify the variables affecting smallholder farmers' participation in the NASC seed demonstration program in the study area. The Logit regression is a mathematically extremely flexible and user-friendly function with a theoretically meaningful interpretation, it is more significant than other linear regression when the outcomes are binary, as demonstrated by the logistic regression analysis model for dichotomous outcomes.

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$L = \text{Log}\,(P(x))/(1-P(x)) = \beta 0 + \beta 1X1 + \ldots\ldots + \beta nXn \quad \ldots (3)$

L means the logit model, P(x) is the probability of the event to occur, given by 1, while the probability of the event not occurring is 1 – P(x). The P(x)/ (1 – P(x)) is the odds ratio in favour of the event to occur. The intercept regression's notation is β0, with β1, β2,...βn representing the independent variable's coefficient and X1, X2,...Xn are the regression's independent variables.

The analysis's findings are presented as odds ratios because logit regression determines the likelihood of success over the likelihood of failure. Knowledge of the connections and strengths between the variables is another benefit of using logistic regression.

This Logit model can be used to estimate the change in the probability of smallholder farmers who participated in the NASC seed demonstration program and comparison with non-participation which identifies the factors influencing smallholder farmers in the program.

The explicit model is specified as:

$Y = \beta 0 + \beta 1X1 + \ldots\ldots\ldots + \beta 6X6 + \varepsilon \quad \ldots (4)$

Where:
Y = Participation in NASC seed demonstration program (1 = Participate, 0 = otherwise)
β0 = Constant
βi = Parameters to be estimated (i = 1, 2,….n)
X1 = Size of household
X2 = Total farm size
X3 = Farmer's experience
X4 = Income gap
X5 = Wellbeing of farmers
X6 = Social Networking
ε = the error term

III. RESULT AND DISCUSSIONS

A. *Descriptive Statistics of smallholder farmers*

Table 2 presents the descriptive statistics of variables off the smallholder farmers surveyed in the study area. The most frequent gender of smallholder farmers who participated in the program was male (n=200, 80%) in this survey. The majority of smallholder farmers were aged in between 31 and 40 years old (n=83, 33.2%), and the majority of smallholder farmers were married (n=204, 81.6%). Furthermore, the most frequent smallholder farmers' household size was between 6 and 10 people (n=204, 81.6%). Also, the study revealed that most smallholder farmers in the study area were of tertiary level of education (n=110, 44%) and the farming experience of smallholder farmers with most frequent was between 11 and 20 years (n=99, 39.6%). However, the majority of the smallholder farmers surveyed were non-members of agricultural associations (n=211, 84.4%) while most frequent smallholder farmers have farm sizes ranging from 0.01 to 2 ha (n=225, 90%). In addition, most smallholder farmers in the study practice mixed cropping farming system (n=187, 74.8%) and the most frequent labour type is Family and Hired (n=201, 80.4%). The most frequently grouped monthly income earning is between 100,001 and 200,000 Nigeria naira per month (n=131, 52.4%), and most smallholder farmers engaged in trading as an alternative occupation (n=131, 52.4%).

TABLE I. DESCRIPTIVE STATISTICS OF CASSAVA SMALLHOLDER FARMERS

Variables	Frequency(n)	Percentage (%)
Age of Household Head (Years)		
< 21	13	5.2
21 – 30	38	15.2
31 – 40	83	33.2
41 – 50	77	30.8
51 -60	30	12
> 60	9	3.6
Total	**250**	**100**
Gender		
Male	200	80
Female	50	20
Total	**250**	**100**
Marital Status		
Single	44	17.6
Married	204	81.6
Widowed	2	0.8
Total	**250**	**100**
Household Size		
1 – 5 number	88	35.2
6 – 10 number	126	50.4
> 10 number	36	14.4
Total	**250**	**100**
Education status (Years)		
Informal education	31	12.4
Primary education	38	15.2
Secondary education	64	25.6
Tertiary education	110	44
No education	7	2.8
Total	**250**	**100**
Farming Experience (Years)		
1 – 10	77	30.8
11 – 20	99	39.6
> 20	74	29.6
Total	**250**	**100**
Farm Size (Hectares)		
0.01 – 2.00 Ha	225	90
> 2.00 Ha	25	10
Total	250	100
Monthly Income (Naira)		

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1 – 100,000	89	35.6
100,001 – 200,000	131	52.4
> 200,000	30	12
Total	250	100

Source: Field Survey Data (2023).

B. Factors Influencing the Use of Improved Maize Seeds by Smallholder Farmers

Table 3 reveals the main factors influencing the use of improved maize seeds by smallholder farmers in the study area. The findings show that total farm size, household income gap and participation in NASC seed demonstration program were statistically significant at $P < 0.01$ while age of household head, farming experience and inadequate information on improved seeds were statistically significant at $P < 0.05$, $P < 0.05$, and $P < 0.1$ respectively.

The coefficient of the total farm size cultivated was statistically significant at $P < 0.01$ and has a positive influence on the likelihood of smallholder farmers using improved maize seeds. The findings indicate that the amount of improved maize used increases by 10.78 as the total farm size increases by one unit. This suggests that farmers with larger farms are more likely to use improved maize seeds. It demonstrates that farmers who own more land are better able to employ improved maize seeds to raise yields. This result is consistent with the findings of [9], which showed that improved maize seed adoption was positively and significantly influenced by farm size.

Also, the coefficient of participation in the NASC seed demonstration program by smallholder farmers in the study area was statistically significant at $P < 0.01$ and positively influenced the likelihood of smallholder farmers using improved maize seeds. The result shows that as the participation in the NASC seed demonstration program increased by 1 unit, the quantity of improved maize used increased by 16.34. It means that farmers who participate in the NASC seed demonstration program are more likely to use improved maize seeds, which implies that the farmers who participate in the seed demonstration program are encouraged to use improved maize seeds.

The coefficient of income gap was positively related and statistically significant at $P < 0.01$. The result reveals that as the income gap of smallholder farmers increases by 1 unit, the quantity of improved maize used increases by 0.05. The positive significance suggests that farmers with more income gaps are trivially likely to use improved maize seeds, which means that the farmers' income gap would not significantly motivate them to use improved maize seeds.

Moreover, the findings demonstrated that the probability of smallholder farmers utilizing improved maize seeds was positively related with the farmers' farming experience, with a significant correlation ($P < 0.05$). The result reveals that as the farming experience of smallholder farmers increases by 1 unit, the quantity of improved maize used increases by 0.22. The positive significance of years of farming experience suggests that farmers with more experience are a little more likely to use improved maize seeds. This illustrates that experienced farmers may have a better understanding of the benefits of improved seeds, such as increased yields and disease resistance. They may also have developed the skills and knowledge necessary to effectively use these seeds, making them more inclined to adopt them.

The result found that the coefficient of age of the smallholder farmers was negative and significant at $P < 0.05$ influencing the likelihood of smallholder farmers using improved maize seeds. The result reveals that as the age of smallholder farmers increases by 1 unit, the quantity of improved maize decreases by 0.18. It suggests that the use of improved seeds is more common among younger farmers. This result supports research by [16] showing that younger farmers are more likely than older farmers to adopt improved maize seeds. In line with the aforementioned results, [13] reported that a farmer's age increase of one year was linked to a 2% decline in the likelihood of utilizing improved maize varieties.

The coefficient of inadequate information on improved seeds by smallholder farmers in the study area is significant at $P < 0.05$ and has a negative influence on the likelihood of smallholder farmers using improved maize seeds. The result reveals that as inadequate information on improved seeds increases by 1 unit, the quantity of improved maize decreases by 1.02. The negative sign implies that inadequate information on improved seeds will negatively influence the use of improved maize seeds. This means that the denial of smallholder farmers to adequate information on improved maize seeds will lead to the non-use of improved seeds thereby preventing them from enjoying the benefits of using improved maize seeds.

Therefore, the results suggest that variables of total farm size and participation in NASC seed demonstration program significantly influenced the likelihood of smallholder farmers in the study area using improved maize seeds.

TABLE II. RESULT OF LINEAR REGRESSION MODEL ON FACTORS INFLUENCING THE USE OF IMPROVED SEEDS BY SMALLHOLDER FARMERS

Variables	Coefficient	Std. err.	T-value
Constant	-20.95***	7.33	-2.86
Age of household	-0.18**	0.08	-2.17
Education status	0.12	0.54	0.22
Size of Household	-0.2	0.18	-1.08
Total Farm size	10.78***	0.75	14.48
Farmer's farming experience	0.22**	0.1	2.16
Household income gap	0.05***	0.01	9.05
Social networking	0.44	1.05	0.42
Household financial status	2.05	1.33	1.54

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Poor Extension PR	-0.32	0.57	-0.56
Illiteracy level of household head	-0.92	0.6	-1.54
Participation in NASC Seed demonstration	16.34***	3.13	5.23
High cost of improved seeds	-0.17	0.63	-0.27
Poor organization of demonstration	0.18	0.58	0.31
Inadequate improved seed information	-1.02*	0.54	-1.88
Demonstrated varieties over local varieties	0.53	0.62	0.86
Unavailability of improved seeds	0.25	0.63	0.39
Inadequate information	0.59	0.82	0.72
Unfavourable government policy	0.07	0.97	0.07
Lack of credible seed vendors	-0.64	0.86	-0.74

Source: Field Survey Data (2023).
*, **, *** indicate significance 10%, 5% and 1% respectively.

C. Factors influencing the participation of Smallholder farmers in the NASC Seed Demonstration program

The logit regression model was used to identify the factors influencing the participation of smallholder farmers in the NASC seed demonstration program in the study area. Three (3) variables namely; total farm size, household income gap, and household well-being were all significant at $P < 0.01$, $P < 0.01$, and $P < 0.05$, respectively. Based on the results presented in Table 5, the interpretive tables for the predictor variables below offer details on the related dependent variable (engagement in the NASC seed demonstration program).

The result reveals that the coefficient of total farm size was statistically significant at $P < 0.01$ and negatively influenced the participation of smallholder farmers in the NASC seed demonstration program. The negative relationship means an increase in total farm size leads to a decrease in the participation of smallholder farmers in the NASC seed demonstration program. This means that for smallholder farmers with larger farm size, the likelihood of participating in the NASC seed demonstration tend to decrease. It can be said that smallholder farmers with larger farm sizes may be occupied with farm activities which could prevent them from participating in the NASC seed demonstration program.

The coefficient of the household income gap was positive and significant at $P < 0.01$ influencing the participation of smallholder farmers in the NASC seed demonstration program. The result reveals that smallholder farmers with more income gaps are more likely to participate in the NASC seed demonstration program. This implies that the earning income affects smallholder farmers' decisions to participate in the NASC seed demonstration program. This result is consistent with [5] which state that the participation of smallholder farmers in Savings and Credit cooperatives (SACCO) in Uganda was positively influenced by more income earnings.

The coefficient of the well-being variable was positive and significant at $P < 0.05$ influencing the participation of smallholder farmers in the NASC seed demonstration program. The result shows that smallholder farmers with better well-being have a likelihood of participating in the NASC seed demonstration program. This implies that as the well-being of smallholder farmers improves, their participation in the NASC seed demonstration program will considerably increase.

TABLE III. RESULT OF LOGIT REGRESSION MODEL ON FACTORS INFLUENCING THE PARTICIPATION OF SMALLHOLDER FARMERS IN THE NASC SEED DEMONSTRATION PROGRAM

Variables	**Coefficient**	**Std. err.**	**Z-value**	**P-value**
Constant	-10.23***	3.61	-2.83	0.005
Household size	-0.27	0.17	-1.56	0.118
Total farm size	-10.31***	3.10	-3.33	0.001
Farming experience	0.10	0.11	0.92	0.360
Household income gap	0.03***	0.01	3.28	0.001
Household well-being	3.82**	1.57	2.44	0.015
Social networking	-1.04	1.33	-0.79	0.431

Source: Field Survey Data (2023).
*, **, *** indicate significance 10%, 5% and 1% respectively.

IV. CONCLUSION AND RECOMMENDATIONS

The study empirically identifies the factors influencing the use of improved maize seed and participation in the NASC seed demonstration program by smallholder farmers. Primary data was collected and analysed using descriptive statistics, linear and logit regression models. Descriptive statistics revealed that the age distribution of the smallholder farmers in the study area was 33.20% between 31 and 40 years old, with a mean age of 40 and 3.60% above 60. With a mean farming experience of 19, 39.60% of farmers have 11 – 20 years of experience, and 81.60% of the smallholder farmers are married. The majority of households (50.40%) had 6-10 individuals, with an average of 7 people and most of the farmers had attained tertiary education level (44%) with 89% of the smallholder farmers having farm sizes of 0.01 to 2.0 hectares. The farmers' alternative occupation was trading with 52.40% and 80% of the smallholder farmers are male. The majority (80.40) of the smallholder farmer used both family and hired labour.

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According to the findings of the linear regression model, the quantity of improved maize seeds used would increase with an increase in farm size, farmers' income gap, farming experience, and participation in NASC seed demonstration program while it decreases with an increase in farmers' age and inadequate information on improved seeds. The results showed that farming experience, farmers' income gap, participation in the NASC seed demonstration program, and farm size are positive, while farmers' age and inadequate information are negative. The Logit regression model identified that total farm size, household income gap, and household well-being are factors influencing smallholder farmers' participation in the NASC seed demonstration program. The findings show that for smallholder farmers with larger farm sizes, the likelihood of participating in the NASC seed demonstration tends to decrease while smallholder farmers with more income gaps and better well-being are more likely to participate in the NASC seed demonstration program.

Based on the empirical findings of this study, smallholder farmers are encouraged to actively participate in the NASC seed demonstration programs and adopt the new technologies to improve their household income and well-being. Accordingly, the Government and policymakers are advised to formulate and implement policies and interventions to encourage the use of improved maize seeds in Nigeria. Also, the federal government of Nigeria should increase the budgetary allocations for annual NASC seed demonstration program to create more awareness about the use of improved seeds, especially maize seeds among farmers in the country.

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