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FACTORS INFLUENCING PEST MANAGEMENT DECISIONS AMONG MAIZE FARMING HOUSEHOLDS

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ABSTRACT

Research background: Poor pest management decisions in crop production highly pronounced in most developing countries including Nigeria, result in huge crop losses, human health challenges and environmental degradation, detrimental to sustainable agriculture, food sufficiency and security. Identifying the factors influencing pest management decisions among maize farming households and providing effective solutions by relevant stakeholders can reduce crop losses and reduce the harmful effect to human health and the environment due to harmful pest management practices.
Purpose of the article: The research was carried out to determine the factors influencing pest management decisions among maize farming households in the Federal Capital Territory, Nigeria, in order to provide effective and appropriate solutions capable of enhancing pest management decisions and invariably reducing crop losses due to pests, as well as reduce the harmful effect to human health and the environment caused by harmful pest management and control practices.
Methods: Multistage sampling technique was the sampling method used, where 324 maize farmers were correctly sampled as respondents for this study. Primary data were collected from the respondents using a well-structured questionnaire. The data were analysed using descriptive statistics and multinomial probit model. The multinomial probit model was used to identify factors that influence pest management decisions.
Findings, value added & novelty: The study revealed the use of chemical pesticides as the most used pest management practice among maize farming households in the Federal Capital Territory, Nigeria, while the use of integrated pest management practices was about the least used. Also, result from multinomial probit analysis of the study showed that gender, access to extension services, age and level of education were significant factors that influenced pest management decisions. The study, therefore, recommends the need for relevant non-governmental organisations and government ministries/agencies to engage in the provision of educational facilities and incentives to crop farmers, more robust agricultural extension programmes, input subsidies and farmer field schools, targeted at enhancing pest management decisions in crop production, which can be vital to sustainable and maximized agricultural production, human health and the environment.

Keywords: pest management decisions; multinomial probit; maize farming households; integrated pest management
JEL Codes: R52; R58; H41

INTRODUCTION

Pest management is critical in agricultural production since damage from pests often results in huge economic losses. Crop pests and pathogens are widely seen as significant obstacles to reliable and regular food systems (**Savary *et al.*, 2017**). Some estimates have shown that field and storage pests destroy about 43% of potential crop production in developing African and Asian countries (**Ogendo *et al.*, 2004**). Pest infestations, from insects, weeds, fungi and other highly harmful organisms to crops, have been a major threat to agricultural production worldwide (**Ruttan, 2005**). According to **Savary *et al.* (2019)**, crop pests and pathogens reduce the yield of agricultural production, causing huge economic losses and reduced food security, even so, their global burden and their variation over time and among different agro-ecosystems remains poorly quantified.

Pests are reputed to be one of the major factors limiting maize yield in the savannah agro-ecological zone of Nigeria (**Ismaila *et al.*, 2010**). Maize (*Zea mays*) is a type of cereal, regarded as one of the most important staple foods in the world today. Maize, rice and wheat, together supply more than 50% of global calorie intake (**Knoema's World Data Atlas, n.d.**). The central role of maize as a staple food in Sub-Saharan Africa is comparable to that of rice or wheat in Asia with maize accounting for one-fifth of the calories and protein consumed in West Africa (**Macauley, 2015**).

Pesticides are most commonly and frequently used in managing pests in most agricultural sectors (**Hashemi & Damalas, 2011**). **Sarkar *et al.* (2021)** revealed that pesticide use is seen as the best means to protect crops against pests by most farmers in developing countries. Farmers in developing countries face great risks of exposure from the use of toxic and hazardous pesticides that are restricted or banned in other countries (**Asogwa & Dongo, 2009; Ibitayo, 2006**). Despite the several strategies available for controlling pest, farmers in Nigeria depend highly on the use of pesticides, to the extent where pesticides are treated as substitutes for labour and ploughing services (**Rahman & Chima, 2018**).

According to **FAO (2017)**, adequate decision-making for any intervention on pest management is vital and decisions should be justified both economically and ecologically. Pest management decisions of maize farming households in the Federal Capital Territory (FCT), Nigeria, have not been widely explored in research, and there is also a paucity of information on the factors that influence pest management decisions in the FCT, despite its importance to enhanced crop production, human health and the environment. With sound pest management decisions, losses to crops, especially the maize crop would be reduced and preservation of the environment and human health would be enhanced. Against this backdrop, this study aimed at examining the factors influencing pest management decisions among maize farming households in the Federal Capital Territory, Nigeria. Specifically, the study would identify the pest management practices in use among maize farming households in FCT, and secondly, it would identify factors that influence pest management decisions among maize farming households in FCT.

The following null hypotheses guided the study to achieve the specific objective of identifying factors that influence pest management decisions among maize farming households in FCT: (i) H_{01}: there is no significant relationship between pest management decisions and the socio-economic characteristics of the respondents in FCT; (ii) H_{02}: there is no significant relationship between farm-specific and institutional factors and pest management decisions of the respondents in FCT.

LITERATURE REVIEW

Decision, according to **Nicholson *et al*. (2020)**, is referred to as a conclusion or resolution reached after consideration. Decisions directly connected to actions influence the quality, type and quantity of agricultural output and can have major economic and environmental consequences (**Martin-Clouaire, 2017**). Decision-making is seen as a mental process resulting in the selection of an action among several alternative solutions **(Singe & Gupta, 2017).** The primary drivers of decisions are the farmer's motives, perceptions, beliefs and preferences; thus, farmers' decisions are heterogeneous from farm to farm and also from field to field (**Martin-Clouaire, 2017**).

Pest management is the decision-making process to control the populations of pests in a planned and systematic way by keeping their damage or numbers at economically acceptable levels (**Northeast Region Certified Crop Adviser, 2016**). In the opinion of **Alston (2011)**, pest managers cannot afford to take a pest management action without knowing if it is economically sound, since treating a pest needlessly does not amount to making a profit. According to **Gibb (2015)**, pest management requires knowing the pest population levels and the possible applications of various control tactics in a pest management framework where pest tolerance levels are established and used as decision-making guides to clarify if action against a certain pest is desirable.

Pest management is a crucial part of agricultural production and includes several practices aimed at controlling potentially harmful organisms (insects, weeds, diseases and other pathogens) that may cause severe damage to crop plants, lower product quality and reduce yield (**Hashemi & Damalas, 2011**). According to **Edward-Jones (2007)**, pest management aims at preventing pest damage in the form of decrease in the quality or the quantity of crops. Pest management is a means to reduce pest numbers to an acceptable threshold (**WICC, 2019**). An acceptable threshold refers to an economically justifiable threshold where the application of measures to control pests reduces pest numbers to a level below which additional applications would not be profitable (that is, where additional costs of control exceed additional benefits) (**WICC, 2019**). Complete removal or eradication of pests is not usually an economic or viable option.

According to **Waterfield & Zilberman (2012)**, farmers' pest management decisions relate to balancing the benefits of pest control against their private costs which are also impacted by information constraints, risk attitudes and their various attitudes and preferences to treatment options. **Hashemi & Dalamas (2011)** summarize the complexity of pest management decisions, stating that pest management problems are often complex, requiring detailed information about many factors, where the complexity is made worse in that farmers usually have incomplete information about both the problem and the potential techniques to manage them.

In agricultural systems, the farmer takes the main decisions. According to **Martin-Clouaire (2017)**, decisions that are directly connected to actions also called "operational decisions," influence the output of a farm and therefore have environmental and economic consequences. Developments in technology, growing commercial competition as well as stricter requirements in terms of sociological and environmental aspects make consideration of decision-making ever more important **(Martin-Clouaire, 2017)**.

Many factors affect pest management decisions and which among others include income, level of education, effectiveness of control substances, information, age, farm size, pest incidence and government regulations. A study conducted by **Melkamu (2018)** on maize farmers in East Showa, Ethiopia, showed that sex, education, age, farm experience, labour in man equivalent, awareness on the introduction of chemical pesticides, credit access, income and extension contact were significant determinants in the use of local pest management practices. Similar but fewer factors were seen in a study conducted by **Alalade *et al*.**

(2017) which examined the usage of chemical and biological pests control methods among farmers in Kwara State, Nigeria, where it was reported that age, educational level, household size, farm size and the perceived effect of both chemical and biological pest control methods were significant factors in the usage of chemical and biological pest control methods. Similarly, the results of a study carried out by **Alabi *et al.* (2014)** in Gwagwalada and Kuje Area Councils of the Federal Capital Territory, Nigeria, revealed that farmers' decision to use agrochemical inputs increased with farm size, age, family size, extension services, education-level, experiences in farming but decreased where there were off-farm incomes and access to credits.

In a study conducted by **Samiee *et al*. (2009)**, the level of knowledge showed the highest variation in the adoption level of sustainable integrated pest management (IPM) practices by wheat growers in Varamin County, Iran. Similarly, a survey conducted by **Blake *et al*. (2007)** on the United States Massachusetts cranberry grower community on the adoption of available IPM practices, showed that highly experienced, full-time growers in charge of large operations frequently used more IPM practices than part-time, less experienced growers who managed smaller farms.

Factors affecting pest management decisions can be identified using multinomial regression models. Multinomial regression models are applied in analysing data where the categorical response variable has more than two possible outcomes while the independent variables may be categorical, continuous, or both (**Hosmer & Lemeshow, 2013**). Multinomial probit (MNP) and multinomial logit (MNL) models are multinomial regression models (**Greene, 2012**). The multinomial probit model is a generalization of the probit model used when there are various possible categories that the dependent variable can fall into and has a significant advantage over the multinomial logit model since MNP relaxes the independence of irrelevant alternatives (IIA) restrictions built into the multinomial logit model (**Greene, 2012**). MNP model was used in this study to identify factors that influence pest management decisions among maize farming households in FCT. The response variable included various possible pest management decisions which include physical control, biological control, chemical control, cultural control and IPM.

Multinomial probit and multivariate probit approaches were used in a study carried out by **Velandia *et al*. (2009)** to determine the factors that affect farmers' adoption of crop insurance, spreading sales and forward contracting, while also considering the potential for simultaneous adoption and/or correlation among the adoption decisions. It was reported that the multinomial probit estimation procedure gave the same variables that the multivariate probit analysis revealed as the variables which substantially influenced the risk management tools that producers adopted, which included age, proportion of owned acres, farm size and off-farm income levels. However, the multinomial probit also provided additional information that the multivariate probit did not provide since the former looked at factors affecting the combination of tools utilized by the farmers in the study.

DATA AND METHODS

Study Area

The Federal Capital Territory (FCT) of Nigeria is the study area for this research. FCT is centrally located in Nigeria and has a land area of approximately 8,000 square Kilometres **(Ogidiolu *et al.*, 2012)**. The territory is made up of six area councils, namely: Abuja Municipal, Abaji, Bwari, Gwagwalada, Kuje and Kwali (**Tanko & Muhsinat, 2014**). FCT is of the savanna vegetation with soils which are more of Alluvial and Luvisols, rich for agriculture **(Ogidiolu *et al.*, 2012)**. The vegetation in most parts of FCT is dominated by herbaceous plants which are at times interspersed with shrubs. The soil characteristics are mostly derived from sedimentary rocks and have a strong influence on the morphological characteristics of the local soils. The major crops grown in FCT include maize (*Zea mays*), sorghum (*Sorghum vulgare*), cassava (*Manihot utilsima*), groundnuts (*Arachis hypogaea*), and some other sundry crops such as okra, garden egg and pepper (**Tanko & Muhsinat, 2014**).

Sampling Technique and Sample Size

This study adopted a multistage sampling technique for sample size selection. The study was carried out in three selected area councils of FCT, namely, Kuje, Gwagwalada and Kwali. These area councils were purposively selected because of the preponderance of maize farmers in the areas. The second stage of the sampling involved a simple random selection of three blocks from each of the three selected area councils, making nine blocks. Three villages were then randomly selected from each of the selected blocks in the third stage of sampling, making 27 villages. Agricultural Services departments in the selected area councils provided the list of maize farmers (representing maize farming household heads) which served as the sampling frame for the study. Accordingly, Cochran's formula (Eq. 1) derived for calculating sample size when a population is infinite (**Cochran, 1977; Israel, 2012)** was adopted in calculating the sample size used to select the maize farmers for this study.

$$n_0 = (z^2 pq)/e^2 \qquad (1)$$

Where:

n_0 required sample size; z selected critical value of desired confidence level (assuming 95% confidence, $z = 1.96$); p the estimated proportion of an attribute that is present in the population (assuming maximum variability which is equal to 50%, $p = 0.5$); $q = 1 - p = 0.5$; e desired level of precision (assuming $\pm$ 5% precision, $e = 0.05$).

This resulted in a required sample size of 385. However, 324 respondents (maize farmers) were correctly sampled from 27 selected villages and their responses were used for the analyses.

Method of Data Collection

The primary data used for this study were collected using a well-structured questionnaire. The questionnaire was pre-tested and adjusted to enhance its validity and reliability before administering. The questionnaires were administered to selected farmers in the selected areas through personal interviews, done with the cooperation of some local leaders and staff of Agricultural Services departments in the selected Area Councils. The staff of these Agricultural Services departments who served as data collectors were trained on how to administer the questionnaires.

Econometric Model Specification: Multinomial Probit Model

Multinomial Probit (MNP) model was used to identify factors that influence pest management decisions among maize farming households in the FCT. The dependent variable was pest management decisions which include decisions to use physical control, biological control, chemical control, cultural control and IPM. Applying the structural equation of MNP model by **Greene (2012)** as shown in Eq. (2).

$$U_{ij} = X'_{ij}\beta + \varepsilon_{ij}, \quad j = 1, \ldots, J, \quad [\varepsilon_{i1}, \varepsilon_{i2}, \ldots, \varepsilon_{iJ}] \sim N[0, \Sigma] \qquad (2)$$

where:

U pest management decision; β parameter of the factors that influence pest management decisions;

X_i factors that influence pest management decisions (socio-economic, farm-specific and institutional factors) and include: X_1 Age of household head (Years); X_2 Household size (number of persons in the household); X_3 Level of Education of household head (1, 'Formal Education'; 0, Otherwise); X_4 Gender of household head (1, Male; 0, Otherwise); X_5 Farm Size (Hectares); X_6 Farming Experience (Years); X_7 Access to Agricultural Extension Services (1, Yes; 0, Otherwise); X_8 Access to credit facilities (1, Yes; 0, Otherwise); X_9 Membership of Cooperative (1, Member; 0, Otherwise); X_{10} Access to Insurance (1, Yes; 0, Otherwise);

ε_j error terms; $j = 1,2,\ldots,J$ for a total of J pest management decision alternatives; $i = 1,2,\ldots,I$ for the total number of farmers.

For the ith farmer faced with J choices, we assume that U_{ij} is the maximum pest management decision among the J alternatives. The term in the log-likelihood that corresponds to the choice of alternative q (Eq. 3).

$$\text{Prob}[\text{choice}_{iq}] = \text{Prob}[U_{iq} > U_{ij}, \quad j = 1, \ldots, J, j \neq q] \qquad (3)$$

The probability for this occurrence (Eq. 4).

$$\text{Prob}[\text{choice}_{iq}] = \text{Prob}[\varepsilon_{i1} - \varepsilon_{iq} < (x_{iq} - x_{i1})'\beta, \ldots, \varepsilon_{iJ} - \varepsilon_{iq} < (x_{iq} - x_{iJ})'\beta] \qquad (4)$$

Hypotheses Testing

The null hypotheses in this study were tested using z-test in the multinomial probit model. The null hypotheses may be accepted or rejected at 95% confidence interval or at various levels of significance (1%, 5% or 10%).

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Maize Farming Households in the Study Area

Table 1 shows the result of socio-economic characteristics of the maize farming households in the study area. The result gives the mean gender of the maize farming household heads as 0.759, which means that 75.9% (about three-quarters) were males. The mean age of the maize farming household heads in the study is 43 years, which implies that most of the farmers were predominantly in their economically active age. This coincides with the mean age of 43 years for sampled smallholder farmers obtained in a study carried out in Gwagwalada and Kuje Area Councils of FCT by **Alabi *et al*. (2014)**.

Education promotes adoption of new technologies and decision-making processes in agriculture. The mean level of education in this study is 0.613, which means that 61.3% (majority) of the maize farmers in this study had formal education and thus, may be able to read and write in English and/or in their local dialect. **Kim *et al.* (2018)** concluded in a study carried out in Malawi, that education is a tool for enhancing an individual's decision-making quality.

The mean number of years in farming of maize farmers in the study is 16 years, which shows high experience in farming. This implies that with such high experience in farming, farmers may be able to make sound decisions in pest management and other farm management activities. The mean access to agricultural extension services by the maize farmers in the study is 0.739 (73.9%). This is similar to a study carried out by **Otitoju & Enete (2016)** where about 71% of food crop farmers in South-West Nigeria had Extension contacts. Agricultural extension service is one of the major sources of enhancing adoption and promotion of agricultural innovations and technology and also enhances farmers' decision-making processes. According to **Alabi *et al.* (2014),** farmers in FCT trust government extension services when it comes to delivery of agricultural information.

Pest Management Practices among Maize Farming Households in FCT

The result in Table 2 is a multiple response set that represents the types and frequency distributions of pest management practices among maize farming households in the study. From the result, the most used pest management practice was the 'use of chemical pesticides' (having 20.6% of the frequency of responses) which was followed by 'planting of cover crops' (13.4%) and 'planting of resistant maize variety' (12.6%). The 'use of IPM practices' (1.1%) was among the least pest management practice used among the maize farming households. There was no reported biological pest management practice.

Table 1: Socio-economic characteristics of the maize farming households in the study area

Variable	Measurement	Mean
Gender	Dummy (1, Male; 0, otherwise)	0.759
Age	Years	43.000
Household size	Units	8.000
Number of years in farming	Years	16.000
Size of maize farm	Hectares	2.400
Level of education	Dummy (1, "Formal Education"; 0, otherwise)	0.613
Access to agricultural extension services	Dummy (1, Yes; 0, otherwise)	0.739
Access to farm credit facilities	Dummy (1, Yes; 0, otherwise)	0.109
Membership of farmer cooperatives	Dummy (1, Yes; 0, otherwise)	0.512
Access to farm insurance	Dummy (1, Yes; 0, otherwise)	0.00

Table 2: Pest Management Practices among Maize Farming Households in the Study Area

Pest Management Practices [a]	Responses		Percentage of
	N Frequency	Percentage (%)	Cases (%)
Use of animal traps	94	7.2	29.0
Hand-picking of insects	18	1.4	5.6
Mulching	35	2.7	10.8
Removal of pest-infested maize plant	74	5.7	22.8
Burning of farmland before planting	45	3.5	13.9
Use of crop rotation	117	9.0	36.1
Adjustment of planting date of maize	55	4.2	17.0
Intercropping maize with other plants	138	10.6	42.6
Planting of cover crops	174	13.4	53.7
Planting of resistant maize variety	164	12.6	50.6
Increased spacing of maize crop	25	1.9	7.7
Timely crop harvesting	15	1.2	4.6
Use of chemical pesticides	267	20.6	82.4
Use of inorganic fertilizer	10	0.8	3.1
Use of maize seeds pelleted with insecticides	54	4.2	16.7
Use of IPM practices	14	1.1	4.3
Total	1299	100.0	400.9

Note: 'a' represents dichotomy group tabulated at value 1(Yes) on a multiple response set; Sample size (n) = 324.
Source: Computed from field data, 2020.

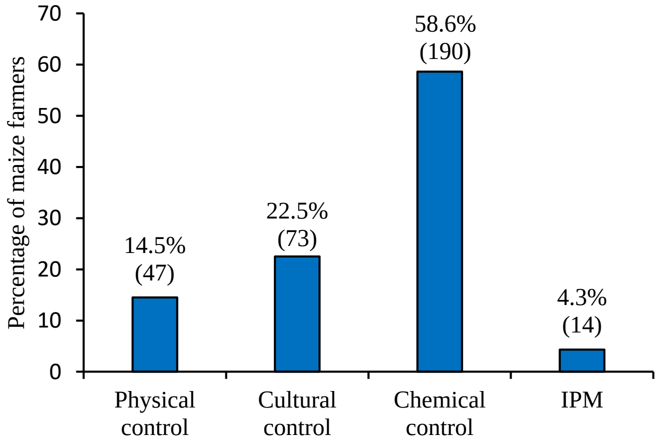

Figure 1: Pest Management Decision Categories Among Maize Farmers in the Study Area
Source: Computed from field data, 2020.

The percentage of cases in the result depicts the percentage of the ratio of the frequency of responses to the sample size of the study, and this for the pest management practice of 'use of chemical pesticides' was 82.4% (represented the highest percentage of cases) and that for the pest management practice of 'use of IPM practices' was 4.3% (represented about the least percentage of cases). The study result of the use of chemical pesticides (82.4%) which depicted the highest percentage of cases, supports the findings of **Hashemi & Damalas (2011)** which states that the application of chemical pesticides is the most frequent means of managing pest in most agricultural sectors. It also supports the study of **Sarkar *et al.* (2021)** which revealed that *pesticide* use is seen as the best means to protect *crops* against *pests by most farmers in developing countries. It also supports the study by* **Rahman & Chima (2018)** which disclosed that farmers in Nigeria depend highly on the use of pesticides, to the extent where pesticides are treated as substitutes for labour and ploughing services.

Furthermore, this study result of the use of IPM practices (4.3%) which depicted about the least percentage of cases, supports the findings of **Parsa *et al*. (2014)**, where they reported that despite the theoretical prominence and sound principles of integrated pest management, which leads to reduced use of pesticides with better results, IPM continues to suffer poor adoption rates in developing countries (including Nigeria).

The various pest management practices of the maize farming households in this study were grouped into pest management decision categories and the result obtained as indicated by the maize farmers as their main pest management decisions is captured in Figure 1. More than half (58.6%) of the maize farmers indicated that they decided to use chemical control as their main pest management decision with the least number of farmers (4.3%) indicating IPM as their main pest management decision.

Factors that Influence Pest Management Decisions among Maize Farming Households in FCT

Multinomial probit analysis was carried out to determine the factors influencing pest management decisions of maize farming households in the study. Predictor variables used in the analysis were checked for issues of multicollinearity using variable inflation factor (VIF), with all the predictors having a $VIF < 2$ (Mean $VIF = 1.27$), which showed that there was no issue of multicollinearity. The result of the analysis is presented in Table 3. Physical control was used as the reference output category for the dependent variable, pest management decisions of maize farming households in FCT. The result of the analysis showed that the multinomial probit model fits better than an empty model (Wald's Chi-square test, $X^2(21) = 54.90$; $p = 0.0001$) and thus led to the rejection of the null hypotheses.

The variable 'Gender' ($\beta = -1.2262$, $p = 0.002$) was negative and significant for cultural control outcome category, which showed that male maize farmers were less likely than females to prefer or decide on using cultural control measures relative to physical control measures in pest management control. This was expected since males are more inclined or receptive to physical or strenuous activities than females. The variable 'Access to agricultural extension services' ($\beta = 0.9475$, $p = 0.002$) was also significant but positive for the cultural control outcome category, which showed that having access to agricultural extension services increases the preferences or decision of maize farmers towards the use of cultural control measures relative to physical control measures. This was expected since most agricultural extension service programmes tend to promote cultural control measures than physical control activities in pest management.

The variable 'Gender' ($\beta = -0.9657$, $p = 0.012$) was negative and significant for the chemical control outcome category and showed that being a male maize farmer, compared to female, reduces the preference or decision towards using chemical control measures relative to physical control measures in pest management. Again, this was expected as females are more likely to prefer the use of chemical control measures which is less physically demanding than physical control measures in pest management. The variable 'Access to agricultural extension services' ($\beta = 1.0549$, $p < 0.001$) was also highly significant but positive for the chemical control outcome category, which showed that having access to agricultural extension services increases the preferences or decision of maize farmers towards the use of chemical control measures relative to physical control measures. This was expected and similar to the findings of **Alabi *et al.* (2014)** where it was observed that the tendency for smallholder's farmers to use agrochemicals increased with increase in extension services. A review by **Pan *et al.* (2021)** revealed that support and training received from extension services was a positive factor to farmers' pesticide application.

The variable 'Level of education' ($\beta = 0.2170$; $p = 0.096$ at 10% level of significance) was also significant and positive for the chemical control outcome category, which showed that the level of education increases a maize farmer's preference or decision to use chemical control measures relative to physical control measures. This was expected since chemical control measures are considered as improved technology, as adoption or utilization of improved technologies increases with education. The influence of education on the adoption of improved technology had been reported in a study by **Okonji & Awolu (2020)** where it was revealed that educational status of the farmers significantly influenced the adoption of improved maize technology.

The variable 'Age' ($\beta = -0.0491$; $p = 0.088$ at 10% level of significance) was negative and significant for the IPM outcome category, which showed that as age increases, the preferences or decision of maize farmers towards the use of IPM practices relative to physical control measures decreases. This was not expected, and since experience comes with age, it was assumed that the use of IPM practices should increase with age. However, the negative significance associated with age may be due to the lack of technical knowledge and skill of the application and benefits of IPM practices among the older respondents. This result negates the findings of **Das *et al.* (2016)** in a study carried out in District of Narail -

Bangladesh, where farmer's age was found to have a significant positive relationship with use of IPM practices. This difference may be due to the relatively younger population (mean age of 37.87) from their study and differences in geographical location.

The variable 'Access to agricultural extension services' ($\beta = 1.8204$, $p = 0.004$) was positive and significant for IPM outcome category and showed that having access to agricultural extension services increases the preferences or decision of maize farmers towards the use of IPM practices relative to physical control measures. This positive relationship was expected as agricultural extension services tend to promote improved technology. This result is supported by studies from **Mohammadrezaei & Hayati (2015)** and **Rezaei-Moghaddam & Samiei (2019)** where agricultural extension services was found to be the most important factor encouraging the adoption of IPM practices by farmers. On the contrary, the study by **Das *et al.* (2016)** showed no significant relationship of extension contact with IPM practices. The small sample size of 103 respondents may have been responsible for this non-significance in their study.

Finally, for the significant variables, the variable 'level of education' was also positive and significant ($\beta = 0.6622$, $p = 0.004$) for IPM outcome category and showed that level of education increases a maize farmer preference or decision to use IPM practices relative to physical control measures. This was expected and is supported by the studies of **Das *et al.* (2016) and Rezaei-Moghaddam & Samiei (2019)** which showed that educational level had a significant positive relationship with their use of IPM practices.

The variable 'Member of Cooperatives,' though insignificant was expected to be significant especially for the IPM outcome category, since it is assumed that being a member of a cooperative enhances dissemination of information and adoption of appropriate technology. However, this was not the case probably due to the limited knowledge of the importance of IPM practices among members of cooperatives in the study area.

The result of the multinomial probit analysis showed that the significant factors which influenced pest management decisions among maize farming households in the study, were gender, access to agricultural extension services, age and level of education. This result supports the findings of a study conducted by **Melkamu (2018)** on maize farmers in East Showa, Ethiopia, which showed that gender, education, age, extension contact, among others, were significant factors in the use of local pest management practices. The result of this study also supports that of **Alalade *et al*. (2017)** which examined the usage of chemical and biological pests control methods among farmers in Kwara State, Nigeria, and showed that educational level, age, among others, were significant factors in the usage of chemical and biological pest control methods.

Table 3: Result of MNP Analysis for Factors that Influence Pest Management Decisions among Maize Farming Households in the Study Area

MainPMP	Factors	β Coefficient	Std. Err	z	P>z	[95% Conf. Interval]	
						Lower	Upper
Cultural Control	Gender	-1.226184	0.399587	-3.07	0.002***	-2.00936	-0.443008
	Age	0.001323	0.021136	0.06	0.950	-0.0401017	0.0427484
	HHoldSize	0.026498	0.040539	0.65	0.513	-0.0529582	0.1059534
	AccessExt	0.947477	0.298754	3.17	0.002***	0.3619307	1.533023
	AccessCredit	0.225982	0.432151	0.52	0.601	-0.6210194	1.072983
	MemCoop	0.068855	0.304151	0.23	0.821	-0.5272695	0.6649791
	LevelEduc	0.181984	0.142638	1.28	0.202	-0.0975808	0.461549
	_cons	-0.025070	0.840403	-0.03	0.976	-1.672229	1.62209
Chemical Control	Gender	-0.965712	0.383792	-2.52	0.012**	-1.717933	-0.213492
	Age	0.016152	0.019268	0.84	0.402	-0.0216133	0.0539164
	HHoldSize	-0.024336	0.037588	-0.65	0.517	-0.0980084	0.0493355
	AccessExt	1.054938	0.267505	3.94	0.000***	0.5306386	1.579237
	AccessCredit	-0.444391	0.413107	-1.08	0.282	-1.254067	0.3652834
	MemCoop	0.315862	0.277916	1.14	0.256	-0.228843	0.8605687
	LevelEduc	0.217042	0.130224	1.67	0.096*	-0.0381908	0.4722758
	_cons	0.168578	0.791638	0.21	0.831	-1.383004	1.720159
IPM	Gender	-0.284814	0.564424	-0.50	0.614	-1.391064	0.8214365
	Age	-0.049085	0.028773	-1.71	0.088*	-0.1054787	0.0073089
	HHoldSize	-0.028918	0.059253	-0.49	0.626	-0.1450516	0.0872162
	AccessExt	1.820424	0.632609	2.88	0.004***	0.5805329	3.060314
	AccessCredit	-0.434129	0.602677	-0.72	0.471	-1.615354	0.7470949
	MemCoop	0.753883	0.490376	1.54	0.124	-0.2072357	1.715001
	LevelEduc	0.662162	0.227542	2.91	0.004***	0.2161869	1.108136
	_cons	-1.503261	0.876875	-1.71	0.086	-3.221904	0.2153816

Note: Model: Wald $\chi^2(21)=54.90$ and $p = 0.0001$; Outcome MainPMP==Physical Control (Base outcome); Triple asterisk (***), double asterisk and asterisk denote variables significant at 1%, 5% and 10% respectively.
Source: Computed from field data, 2020.

Similarly, the result of this study is similar to that conducted by **Alabi *et al.* (2014)** in Gwagwalada and Kuje Area Councils of the Federal Capital Territory, Nigeria, where they revealed that farmers' decision to use agrochemical inputs increased with age, extension services, education-level and experiences in farming, among others.

CONCLUSIONS AND RECOMMENDATIONS

This study examined the factors influencing pest management decisions among maize farming households in the Federal Capital Territory, Nigeria. The study revealed the use of chemical pesticides as the most carried out pest management practice among the maize farming households. Relatedly, chemical control was also shown to be the main pest management decision of the maize farming households, notwithstanding the obvious negative health and environmental effects associated with the use of chemical substances for pest control. Despite the merits of IPM practices to pest management, IPM was relatively unknown in the study area.

The factors shown to influence pest management decisions of the maize farming households in the study area were gender, access to agricultural extension services, age and level of education. Therefore, to improve pest management decisions of maize farmers in FCT, measures should primarily be targeted at improving the level of education and access to agricultural extension services to the maize farmers. Thus, relevant non-governmental organisations, ministries and agencies in education and agriculture should provide facilities and incentives aimed at promoting and encouraging crop farmers to acquire formal education through adult education programmes in continuing education centres.

Pest management aspects of agricultural extension programmes from relevant agencies should be made more robust while promoting IPM practices over chemical practices due to the enormous merits of IPM practices to the serious negative health and environmental effects of chemical pest management practices. Agricultural extension agents should be well trained on best pest management practices and adequately motivated for enhanced service delivery in boosting pest management decisions of maize farmers in FCT. Input subsidies and the establishment of farmers' field schools by relevant agencies should be provided to promote pest management decisions.

As a limitation to this study, primary data for the research were gathered from three area councils in the Federal Capital Territory of Nigeria. Secondly, the study was limited to the assessment of determinants of pest management decisions of maize farming on the field, and as such pest management decisions on maize storage and transportation were not considered. These were all due to time and financial constraints.

There is need for further research on determinants of factors influencing pest management decisions among maize farming households in other agro-ecological zones of Nigeria. Studies should also be carried out on determinants of pest management decisions in maize storage among farming households in FCT and also on determinants of pest management decisions in other crops such as tuber or vegetable crops. Determinants of risk management associated with pest control among maize farming households is another suggested area for research.

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