Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 8, July 2021: 5154 - 5171

Estimating the Determinants of Pesticide Usage in Qualitative Probit Model among Maize Farmers in South Western Nigeria

Abiola M.O.and S.O.Olowoyo

Department of Agricultural Economics and Extension, Federal University Oye Ekit

maidenjournal@yahoo.com

Abstract

The paper examined factors that explained pesticide usage among maize farmers South Western zone of Nigeria. The study used primary data to accomplished the objectives of the study. The primary data were collected through focus group discussion, personal interview and detailed questionnaire administered to maize farmers in the study area. Multi-stage sampling technique was employed in this study. There are six States in South West geo-political zone; Two States were selected randomly from the Six States and Six Local Government Areas were randomly chosen from Ondo and Ekiti making a total of Twelve. Two Towns/Villages from each of the Local Government Areas were selected giving a total of Twenty-Four Towns/Villages' Proportional random sampling was used to select 472 maize farmers for the study. Data collected were analysed using descriptive and inferential statistics. The study established that experience. Farm size, pest infestation, extension services and education status of respondents were critical determinant of pesticide usage among maize farmers in the study areas services. Farmers are encouraged to access the services of extension agent through training on pesticide usage which will lead to correct application and usage of pesticide

Keywords: Maize, Pesticide, Usage, South West

1 Introduction

Social policy models that have difficulty keeping up with the rapid change of economic and social structuring are insufficient to produce solutions to current problems. Employment, housing, accommodation, transportation, etc. that emerge in parallel with the increase in the urban population. Problems are the main ones. While problems trigger and feed each other, the institutions and rules responsible for generating solutions gradually lose their functionality. Institutional insufficiencies aggravate social problems, and as a result, the deterioration in social indicators becomes remarkable. The deep gap between regions, between different income groups within the same city and between men and women in access to education, health, social services, and implementation results, among other factors, results from the inadequate implementation of recent reforms in public administration (Sipahi & Artantaş, 2021).

Feeding the Nigerians, the most populous nation in Africa at a time of banditry, agitation for Secession, Corvid19 lockdown, Kidnapping, Fulani headmen threat, Boko haram insurgence is a great challenge to Federal Government of Nigeria. The environmental degradation, increasing human population and demand for finite resources to meet ever increasing human needs is a serious concern to researchers, policy makers and everybody It is not a gainsaying that ecosystem degradation

undermines food production and the unavailability of clean water, hence threatening human health, livelihoods and ultimately societal stability. It can also increase the vulnerability of populations to the consequences of natural disasters and Climate Change impacts. All human being depend on their environment for food and water, about seventy (70) percent of the estimated 1.1 billion people in poverty around the world live in rural areas and depend directly on the productivity of the environment for their livelihoods (FAO, 2019).

Agriculture places heavy burden on the environment in the process of providing humanity with food and fibre. Given the fundamental role of agriculture in human welfare, concern has been expressed by National agencies in Nigeria and other regions regarding the potential challenges posed by environmental factors on agricultural productivity. There is a serious conflict between environmental conservation and agricultural production vis-à-vis the use of pesticides and its overall consequence on the ecosystem as well as agricultural productivity.
Basically any agricultural activity must upset the natural ecosystem. The extent to which the natural balance is disturbed depends on the nature, intensity and duration of the activity.
A limited number of studies are available which examine various aspects and/or determinants of pesticide use at the farm level in Africa (Sheahan, *et,al*., 2017, Anang,*et.al*., 2015, Adeniyi,*et.al*., 2017, Mwatawala, *et.al.*, 2017,Oesterlund, *et.al*., 2014, and Idris, *et.al.*, 2013).
Healthy environment provides a diverse range of food sources and support entire agricultural systems, but their value to food security and sustainable livelihoods are often undervalued or ignored.

According to Food and Agricultural Organization (FAO, 2019), we will not be able to feed the world and eradicate extreme poverty, if we do not protect our valuable ecosystems and biodiversity. Healthy ecosystems are the best way to ensure productive agriculture and nutritious food. This protection of ecosystem and biodiversity is seriously threatened by the use of pesticides. More than a million people are dying each year as a result of food poisoning and chemical contamination. Therefore, linkages between environmental challenges and food security become imperative to recognize.

Maize Crop (*Zea Mayze*) is one of the major prominent and staple foods in Nigeria. It provides food for both man and animals as well as raw materials for most food industries. Cultivation of maize crop has been on the increase in the recent times due to its social acceptability and numerous value chains in terms of bye products. The current increase in the yield of maize in Nigeria can be attributed to the increased use of pesticides which to a large extent dominates the maize production cycle (FAOSTAT, 2015). The focus has always been what is the correct way of using pesticides to increase yield of crops by lowering infestation of pests in both field and post harvesting handling.

However, Pesticide use raises a number of environmental and human health concerns. Some percentage of applied pesticides that reach a destination other than their target species, including non-target species, air, water, bottom sediments and food. Via spray and vapour drift, runoff and leaching, pesticides can contaminate other areas. Once disseminated to the environment, pesticides may cause changes in the natural biological balances and may reduce biodiversity. Since pesticides are designed to be toxic to living species, they may also adversely affect human health.

Most researches on pesticides usage have focused mainly on environmental effects with little attention on the human and economic effect. Focusing on economic impact of pesticides usage, its perceived effect on human health, food safety and livelihood as well as its relationship with Climate Change will be the focus of this study. Agriculture may be able to reduce the inputs of chemicals, but

their complete elimination is currently economically not feasible. While political leaders, policy makers, citizens, and government officials try to mediate and resolve conflicts between the risks and benefits of pesticides use by producing safer chemicals, selective pesticides, better application methods and stronger pesticide admission rules, but Climate Change is likely to expand these conflicts. The paper sought to explain the determinant of pesticide usage or what predict pesticide usage among maize farmers in the study areas.

1.1Statement of Problem

The study addressed the following research questions:

- What are the socio-economic characteristics of the Maize farmers?
- What are the factors determining the use of pesticides in the study area?

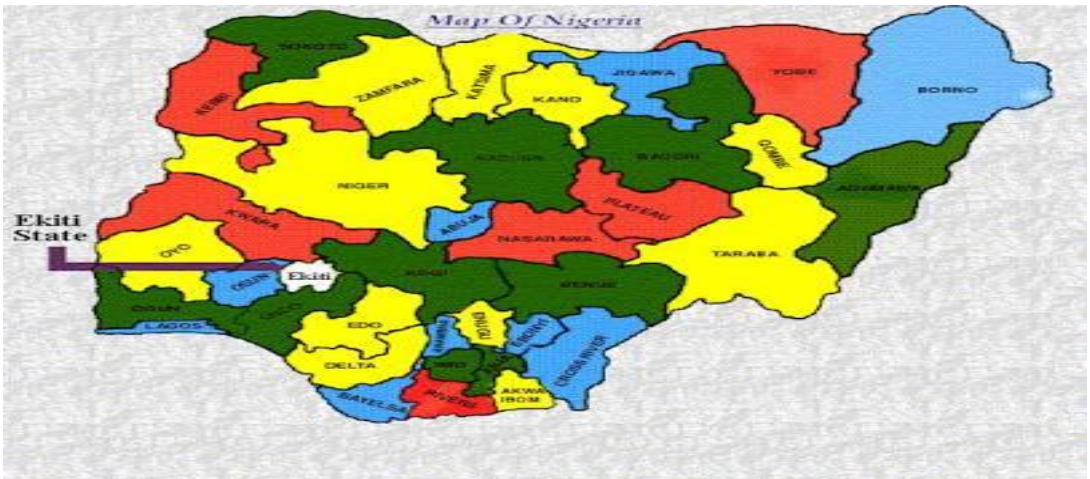
1.2 Objectives of the Study:

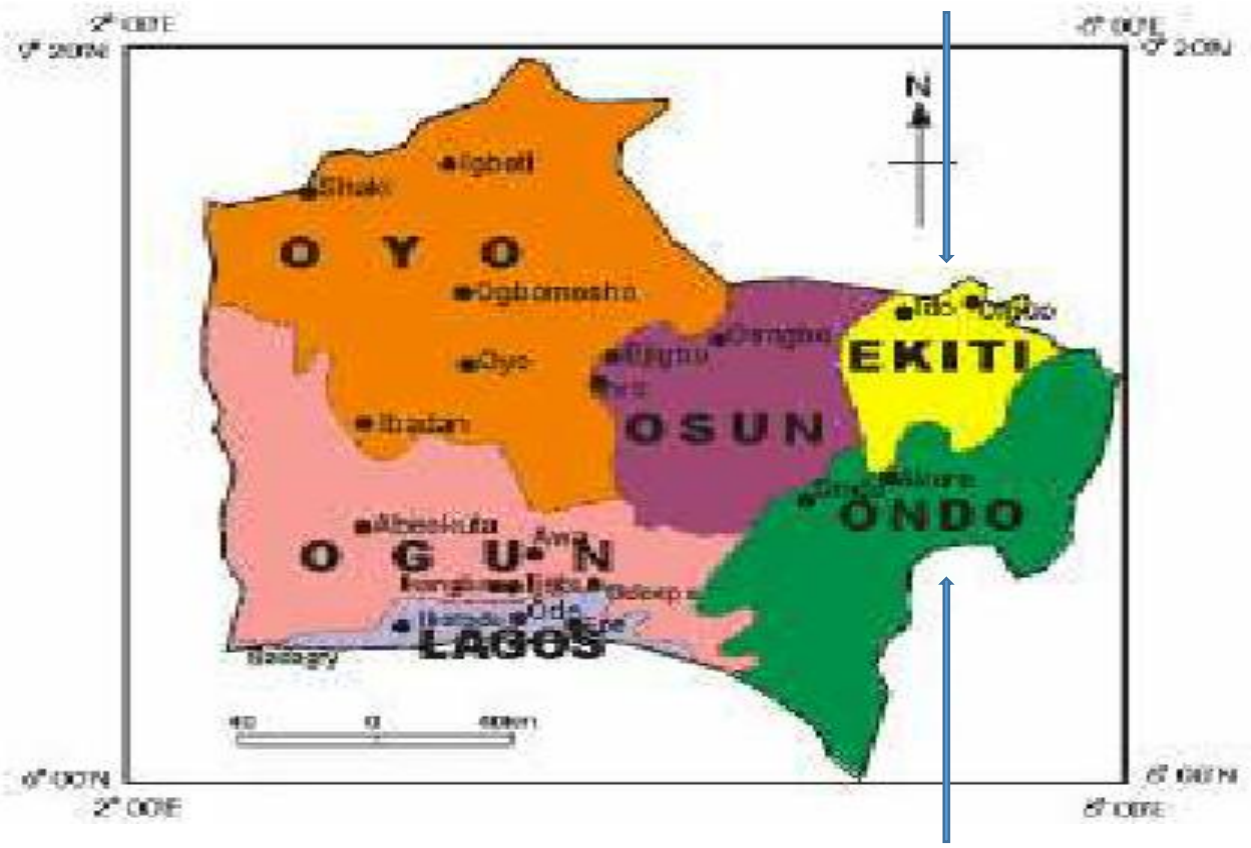
The general objective of this study is to assess the determinants of pesticides usage and the effects on Maize production in the South Western geo-political zone of Nigeria.
The specific objectives are to:

1. Describe the socio-economic characteristics of maize farmers in the study.
2. Identify the determinants of Pesticides usage by maize farmers in the study area.

2.Methodology

The study was carried out in South Western Nigeria. The total land area of Nigeria is about 923,763km^2 with population of above 190.9 million (NPC, 2019), and more than 60% of its population being rural. Nigeria is richly endowed in mineral resources which include crude oil, coal, lime stone, tin, iron ore, gold, bitumen, and bauxite. She also has a rich supply of timber, cocoa, palm produce, corn, rice, beans, cassava, groundnuts, soya bean and edible crops as well as cash crops (NPC, 2019).





Map of South West Nigeria showing the study areas (Ondo & Ekiti).

The study used primary data to accomplished the objectives of the study. The primary data were collected through focus group discussion, personal interview and administering of a detailed questionnaire on maize farmers in the study area. The questionnaire elicited information on the socio-economic and demographic characteristics of the respondents, farm size, input sources, total annual income, costs, expected returns, etc. Also information was collected on pesticides usage, type of pesticides, source, quantity, rate of usage, cost and its perceived effect on human health, food safety, farming activities and the implication of this on their livelihood and their opinion about its effectiveness over time as well as reasons behind such opinion. Multi-stage sampling technique was employed in this study. There are six (6) States in South West geo-political zone of Nigeria, namely Ondo, Osun, Ekiti, Ogun, Lagos and Oyo.The first stage was a random selection of Two (2) States (Ondo and Ekiti) from the Six (6) States. There are Eighteen (18) Local Government Areas and Sixteen (16) Local Government Areas in Ondo and Ekiti respectively.

In the second stage, six (6) Local Government Areas(LGAs) were randomly chosen from each selected State (Ondo and Ekiti). Making a total of Twelve (12) Local Government Areas.

Third stage involved random selection of two (2) Towns/Village from each of the Local Government Areas selected. Making a total of Twenty-Four (24) Towns/Villages sampled in the study area.

The Final stage involved random selection (Proportionally) of maize farmers from each of the Towns/Villages. The sample size is 472 maize farmers.

Decritive and inferential statistics were applied to data collected

Sampling Distribution:

Selected State	No of Maize farmers	No of (LGAs) selected	No of towns/villages selected	Total Sample
Ekiti	2,620	6	12	258
Ondo	1,244	6	12	214
Total	3,864	12	24	472

Ekiti State Sampling Distribution:

Selected LGAs	Maize Farmers Population	Name of Villages/ Towns.	Sample Frame	Sample size
Ado		Erinfun	85	21
	420	Ago Aduloju	80	20
Ekiti West		Aramoko	90	23
	340	Erijiyan/Ipole	75	19
Gbonyin		Ijan/Ilupeju ijan	87	22
	360	Aisegba	82	21
Oye		Ayede Gede	89	22
	450	Osin itapa,	90	23
Ido Osi,		Orin	100	25
	610	Ora	90	23
		Ogbese	82	21
Ise	440	Obada/Afolu	72	18
Total	2,620		1,022	258

Ondo State

Local Government	Maize Farmers	Name of Villages/	Sample frame	Sample Size

Areas selected	Population	Settlements.		
Owo		Fajuyi Owo	46	12
	153	Owode Owo	60	15
Ondo East		Ireje	55	14
	153	Bolorunduro	88	22
Akoko SW		Odo Irun	65	16
	148	Iwaro Oka	80	20
Akure South		Imuagun	65	16
	357	Oda	53	13
Akure North		Iju	120	30
	280	Itaogbolu	112	28
Ifedore		Igbara Oke	45	11
	153	Owena	66	17
Total	1,244		855	214

Source; Field Data,2021

2.1 Determinants of Pesticides Usage by Maize Farmers Using Qualitative Probit Model.

Probit Regression model was used to identify factors that significantly determine the use of pesticides by the maize farmers. It will examine the relationship between the probability of Pesticides usage or not with a number of explanatory variables. Since not all farmers use pesticides in their production process, meaning that the dependent variable is censored at zero, the probit model provides a suitable method for estimating the pesticide demand equation in this case, as it allows for zero use of inputs.

The stochastic model underlying Probit may be expressed as follows:

The model can be specified as:

$C^* = \beta \sum_{t=1} Z_i + e_i$

Where: C^* = Dichotomous (1, 0), indicating whether the farmer use pesticides or not in observation (i).

Z_i = Represent a vector of explanatory variables for each respondent (i)

β = A vector of parameters

e_i = A random error term.

C^* is a function of Pesticides Usage. If $C^* > 0$, it implies a farmer use Pesticides as against non-use of pesticides by the farmers.

$C = 1$, if $C^* = \beta \sum_{t=1} Z_i + e_i >/ 0$

A Probit maximum likelihood estimation will be used to estimate the parameter β. It is assumed that var (e_i) = 1 since β is estimable only to a scale vector.

Where:

C = Pesticides Usage

Z_1 = Age of respondents
Z_2 = Gender of respondents
Z_3 = Level of Education (in Numbers)
Z_4 = Farm Size (hectares)
Z_5 = Household Size
Z_6 = Family Type (Mono=1, Poly= 0)
Z_7 = Years of farming experience (Years)
Z_8 = Access to Extension Services (Yes=1, No=0)
Z_9 = Farming Practices (Mono =1, Mixed=0)
Z_{10} = Operation modalities (Commercial=1,Small Scale =2 Others =0)
Z_{11} = Primary Occupation (Farmin =1, Artisan = 2, Government =3).
Z_{12} = Access to Cooperative organization (Yes=1, No= 0)
Z_{13} = Access to Credit facility (Yes=1, No= 0)
Z_{14} = Marital Status (Married =1, otherwise, = 0)
Z_{15} = Organic Farming Practices (Yes=1, No= 0)
Z_{16} = Presence of Agrochemical Shops (Yes=1, No= 0)
Z_{17} = Income (Naira)
Z_{18} = Extension Services (Yes =1, No = 0)
Z_{19} = Pest Infestation (Yes=1, No = 0)

3.0 RESULTS AND DISCUSSION

3.1Socio-Economic Characteristics of the Maize farmers

Table 4.: Socioeconomic Characteristics of Maize Farmers.

Characteristics	Frequency	Percent	Mean
Sex:			
Male	361	76.81	
Female	109	23.19	
Age:			
< 20	1	0.21	
Between 21 – 40	206	43.74	
Between 41 – 60	226	47.98	
>60	38	8.07	
			44.5
Marital Status:			
Married	363	77.23	
Single	79	16.81	
Divorced	3	0.64	
Widowed	25	5.32	

Household Size:			
Bellow 5	319	67.87	
Between 5 – 10	143	30.43	
Above 10	8	1.70	
			4.82
Education Level:			
No Formal Education	40	8.51	
Primary	60	12.77	
Secondary	149	31.70	
Tertiary	162	34.47	
Technical/Vocational	53	11.28	
Others	6	1.28	
Farm Size:			
Between 0 – 5	408	86.81	
Between 6 – 10	57	12.13	
Between 11 - 15	5	1.06	
			3.29
Family Type:			
Monogamy	401	85.32	
Polygamy	69	14.68	
Years of farming Experience:			
Between 1 - 20			
Between 21 – 40	414	88.09	
Above 40 years	54	11.49	
	2	0.43	
Farming Practices:			11.89
Mono Cropping	121	25.74	
Mixed Cropping	349	74.26	
Primary Occupation:			
Farming			
Civil Servant	142	30.21	
Artisans	116	24.68	
Others	167	35.53	
	45	9.57	
Operation modalities:			
Commercial			
Smallholder	286	60.85	
Cooperative	163	34.68	
Others	19	4.04	
	2	0.43	
Access to Credit:			
No			
Yes	352	74.89	

	118	25.11	
Source of Credit:			
Lenders	13	11.02	
Banks	13	11.02	
Microfinance Banks	54	45.76	
Cooperative Societies	25	21.19	
Government	7	5.93	
Family/Friends	6	5.08	
Organic Farming Awareness:			
No			
Yes	85	18.09	
	385	81.91	
Organic Farming Practices:			
No			
Yes	290	61.70	
	180	38.30	
Member of Cooperative:			
No			
Yes	362	77.02	
	108	22.98	
Access to Agric Subsidy:			
No	402	85.53	
Yes	68	14.47	
Presence of Agrochemical Retails:			
No	90	19.15	
Yes	380	80.85	
Income (₦):			
< 100,000.00	128	27.23	
Betw 100,000 – 500,000	321	68.30	
>500,000.00	21	4.47	225,519.1
Source: Data Analysis, (2021).			

Interpretation and Discussion

The socio-economic characteristics of the respondents such as, age, gender, household size, marital status, education status, farm size, years of farming experience, farming practices, primary occupation, operation modalities, access to credit facility, source of credit facility, organic farming awareness and organic farming practices by the respondents are presented in Table 4.The result presented in Table 4. reveal that majority (76.6%) of the maize farmers in the study area were males during the period under consideration. This may be due to the gender considerations in agricultural sector resource allocation and technicality involves in large scale maize production. The sex distribution of the maize farmers indicates that the farming activities involved drudgery that men are

more involved in. This is consistent with the findings of Oyekale et al,(2012) and Adeoti et al. (2016) as they reported that majority of rural famers in Nigeria are male.The distribution of the respondents by marital status shows that majority (77.1%) were married and still living with their spouse, while a little fraction of the farmers (5.3%) are widowed. This could enhance more efficiency in their production activities with better economic opportunities. It agrees with Morolake, (2015) and Oyekale et al. (2012) whose findings indicate that majority of rural farmers were married.The highest percentage of the maize farmers (47.98%) were between the age of 40 to 60 years and the mean age is 45 years. This simply implies that the maize farmers in this region are still in economically active period of their lives. Significantly, this will improve their productivity, profitability and efficiency of agricultural labour use.

The majority (67.87%) of the maize farmers had bellow five (5) persons in their household, while (30.43%) of them had between five (5) and ten (10) persons in their household while a very few (%) of them had above ten (10) persons in their household. The mean size of the household is 5 persons. This reveals that there is availability of family labour to the average farming households for their farming and economic activities. The finding is in agreement with Agbaje et al. 2013 and Awotide et al. 2015. The distribution of the maize farmers according to their educational levels according to Table 4. shows that majority (12.7%, 31.6%, 34.6% 11.3%) of the farmers were educated as they had one form of education or the other ranging from primary, secondary, tertiary to vocational educations. Only very few (8.5%) of them had no formal education at all. It is significantly implying high rate of literacy among the maize farmers in this region. This will invariably contribute positively to their technical and economical proficiency because of their ability to read instructions and accustoms to new information on farming activities. In their farming practices, majority (74.3%) of the farmers engaged in mixed farming meaning that they combined different farming activities such as Yam, Cassava, Rice and other crops with cultivation of maize. While only (25.7%) of the entire population practice mono-cropping of maize. This diversification will significantly improve their livelihood and ensure food security. According to table 4, (24.8%, 35.5% and 9.6%) had their primary occupation as Civil Servant, Artisans and other occupations respectively. While only (30.1%) of the farmers engaged in farming as their major primary occupation. Also the result shows that majority (60.7%) of the farmers operate on large/commercial scales while few (35.0%) of them were only operating as a smallholder peasant maize farmer. This implies that maize production in this region is targeted for commercial purposes, consumption and industrial uses. The post covid 19 general rise in price of food item may have necessitate the participation of civil servant as a way of mitigating against inflation This may increase the rate of pesticides usage. The distribution of the maize farmers according to their farming experience shows that majority (88.1%) of the farmers had less than 20 years farming experience and few (11.9%) had more than 20 years' experience in maize production. The mean year of farming experience is 12 years. This may reflect in their productivities and efficiency of production as well as improving yield because they are not new entrants in the business. Table 4 shows that (74.3%) of the maize farmer engaged in the production of other arable crops such cassava, yam, cocoyam etc. This diversification will improve the farmers' livelihoods during the time of shocks and uncertainties. It helps to mitigate against risk

The distribution of the farmers' base on their access to credit shows that there is very poor access to credit facilities by maize farmers in this region. This is because majority (74.5%) of the farmers claimed to have been denied access to credit facilities for their farming activities. This implies that credit facilities are not reaching the main targeted farmers in the rural communities. Despites all the different intervention programmes of the government on Agricultural finance, many farmers are yet to have access to credit facility for their farming operations.

The few (25.5%) farmers that had access to credit facilities claimed to have sourced them from money lender (2.8%), Commercial Banks (3.0%), Microfinance Bank (11.7%), Cooperative Society (5.3%) Government (1.5%) and Family/Friends (1.3%). The outcome shows that the maize farmers depend largely on microfinance banks for their credit facilities. Only few of the maize farmers (23%) were found to be involved in cooperative society while a larger percentage (77%) failed to participate in cooperative society in the study area.

Organic farming is trending to replace the conventional use of inorganic chemicals in farming, the level of awareness of the farmers to this new trend was observed. As shown in table 4., majority (81.7%) of the farmers had the knowledge of organic farming, this corroborates the earlier assertion of high literacy and information awareness tendencies among the farmers in this region.

However, only minority (38.0%) of the farmers practice it while a majority (43.9%) of the farmers failed to practice organic farming. This implies that, farming activities in this region is still highly characterized with the use of inorganic chemicals of various kinds.

As regard presence of agrochemical retail shops in the study area, table 4.2 shows that, 80.85% of the farmers claimed to have agrochemical shops in their community. This will eventually enhance the use of pesticides in the study area.

Agricultural subsidy is an incentive given to farmers to improve their productivity. The study revealed that majority (85.5%) of the farmers in this study area has no access to agricultural subsidies either from government or other sources.Table 4 also shows the distribution of the farmers based on their level of their annual income; this income does not basically from maize production, but from other sources. The mean income of the farmers (₦225, 519) implies a very poor economic status of the farmers in this present economic reality in Nigeria. Majority (68.3%) of the farmers received between 100,000 and 500,000 as income annually, 27.23% of the farmers received less than 100,000 annually and a few (4.47%) of them received above 500,000 annually.

3.2 Determinants of Pesticides Usage by Maize farmers:

Table 4.: Determinants of Pesticides usage among Maize farmers

Used Pest	Coefficient	Std. Error.	dy/dx
Sex	0.23428*	0.17684	0.08483
	(0.185)		
Age	-0.01577**	0.00815	-0.00555
	(0.053)		
Marital Status	0.07943	0.10505	0.02798
	(0.450)		
Religion	0.13926	0.16148	0.05686
	(0.388)		
Family Type	-0.44370**	0.21121	-0.15633
	(0.036)		
Household Size	0.08546**	0.03968	0.030111
	(0.031)		
Farm Size	0.14681***	0.03985	0.05172
	(0.000)		
Experience	0.02374**	0.01059	0.00836
	(0.025)		
Farm Practice	-0.24466	0.17548	-0.08620
	(0.163)		

Education Level	0.07833*	0.06611	0.02759
	(0.236)		
Primary Occupation	0.02341	0.07545	0.00824
	(0.756)		
Operation Type	-0.08243	0.12529	-0.02904
	(0.511)		
Credit Access	-0.20123	0.17935	-0.07249
	(0.262)		
Organic Farming Practice	-1.3125***	0.14435	0.46421
	(0.000)		
Farming Cooperative	0.20599	0.18095	0.07039
	(0.255)		
Presence of Agrochemical	0.26341*	0.18662	0.09610
	(0.158)		
Income	1.38e-07	2.27e-07	4.85e-08
	(0.544)		
Extension Services	0.38828**	0.22463	0.12592
	(0.084)		
Pest Infestation	0.40978***	0.151860	0.14511
	(0.007)		
Constant	0.27944	0.712229	
	(0.695)		
LR Chi2	185.3		
Prob > chi2	0.0000		
Pseudo R^2	0.3056		
Log likelihood	-210.61776		

Source: Data Analysis, (2021).

Interpretation and Discussion

The study analyzed the factors that determine the usage of pesticides in the study area using Probit regression model. model.

Among the explanatory variables considered in the model, gender, age, family type, household size, farm size, farm practice, years of farming experience, education level, credit access, practice of organic farming, farming cooperatives, pest infestation, Extension Agent and presence of agrochemical shops are the factors that determine the usage of pesticides in the study area. Table 4.

Gender: the study found out that sex is significant ($p<0.10$) and positive related to the dependent variable. Implying that the more the male farmers, the higher the use of pesticides. Male farmers tend to use pesticides than the female counterpart in agricultural activities.

Age: it was revealed that, age is significant ($p<0.05$) but negatively related to the dependent variable. This simply implies that, a unit increase in age of the farmers bring about a unit decrease in pesticides usage. This result is in tandem with a priori expectations that young people used pesticides than the old people.

Family Type: this was found significant ($p<0.05$) and negatively related. This shows a negative relationship between the family types and the use of pesticides.

Household Size: there is a positive and significant relationship between the household size and pesticides usage. It means that the higher the household size the higher the pesticides usage. This is significant at ($p<0.05$). a unit increase in the household size will cause a 0.0855 unit increase in the use of pesticides.

Farm Size: a unit increase in the farm size will cause a 0.1468 unit increase in pesticides usage since there is a positive and significant ($p<0.01$) relationship between them. It implies that farmers with higher farm size would use pesticides more than those with lower farm size. This is in line with the a priori expectation and justified in the findings of .....

Years of farming experience: An increase in farming experience will increase the use of pesticides by 0.0237. The result shows a positive and significant ($p<0.05$) relationship between them. This is not in contrary to the a priori expectation. Experienced farmers are better armed with good decision making, better resource allocation and balanced management skills garnered over long period of time. The result agrees with finding of Anyaegbunam (2014).

Farming Practices: the study shows that the type of farming practice is significant ($p<0.10$) but negatively related to the use of pesticides in the study area. This implies that the use of pesticides increase with decrease in farming practices. It is expected that farmers that practices mono-cropping will use more pesticides than farmers that practices mixed cropping. This is because; pesticides are sometimes crops specific and selective to other crops.

Education levels: The level of education of the farmers is another major determinant that found to influence the use of pesticides in this study. The result shows a positive (0.0783) and significant ($p<0.10$) relationship between educational level of the farmers and pesticides usage. A unit increase in the educational status of the farmer bring a 0.0783 increase in pesticides usage.

Credit Access: As shown in table 4.2, access to credit by farmers is significant ($p<0.10$) and is negative. It implies that an increase in the access to credit by farmers would decrease the use of pesticides. This is in contrary to the a priori expectation. Because, access to credit by farmers suppose to increases the use of farm inputs.

Practice of Organic Farming: Organic farming is the only alternative to the conventional (inorganic) farming that involves uses of chemicals for farming activities. The study revealed a negative (-1.3125) but significant ($p<0.01$) relationship between the practice of organic farming and pesticides usage. This implies that organic farming serves as impediment to the continuous use of pesticides in farming activities.

Presence of Agrochemical: The study also revealed that presence of agrochemical retails shops is positively (0.2634) and significantly ($p<0.05$) influenced the pesticides usage in the study area. This simply implies that a unit increase in the presence of agrochemical shops increase the pesticides usage by 0.2634 units.

Extension Services: Access to extension services significantly increases the usage of pesticides. According to Olasehinde et al 2018), extension services serves an important source of information in agricultural production and farm management practices. The result shows that a unit increase in access to extension services increases pesticides usage by 0.3882 units. This is significant at 5% level ($p<0.05$).

Pest Infestation: Incidence of pest infestation significantly ($p<0.01$) increase the pesticides usage. Maize farmers increase their pesticides usage as a result of increase in pest infestation on their farms. It implies that, there is a positive and significant relationship between pesticides usage and pest infestation.

Marginal Effects Result of Probit Analysis as shown in table 4.2 below revealed that, a unit increase in sex (male) of the farmers will increase the probability of the farmers pesticides usage by 0.0848, a unit increase in the age of the farmers will decrease the probability of pesticides usage by 0.0055, a

unit increase in family type will decrease the probability of pesticides usage by 0.1563, while a unit increase in household size will increase the probability of pesticides usage by 0.0301.
The marginal effects also shows that a unit increase in farm size will increase the probability of pesticides usage by 0.0517, a unit increase in farmers experience will increase the probability of farmers pesticides usage by 0.0083 and a unit increase in the level of education of the farmers will increase the probability of pesticides usage by 0.0275.
The result further revealed that a unit increase in access to credit, organic farming practices, and farm practices will decrease the probability of pesticides usage by 0.0724, 0.4642 and 0.0862 respectively.
The marginal effect finally revealed that a unit increase in agrochemical shops, extension services and pest infestation will increase the probability of pesticides usage by 0.0961, 0.1259 and 0.1451 respectively.

4 Recommendation

I Training and retraining with constant regular visit by extension agent is needed for correct usage
II Experience and education influence pesticide usage positively therefore farmer are encouraged to go to school
III The bulk of maize farmer practices mixed cropping which is not ideal for pesticide usage because selective pesticide is crop specific and may affect one crop positively while affecting other crops negatively therefore mono-cropping should be encouraged among users

5 Conclusion

The study established that experience. Farm size, pest infestation, extension services and education status of respondents were critical determinant of pesticide usage among maize farmers in the study areas services. Farmers are encouraged to access the services of extension agent through training on pesticide usage which will lead to correct application and usage of pesticide

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