



# Effect of Pesticide Usage on Environment, Food Safety and Health of the Maize Farmers in South Western Nigeria.

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## Abstract

Healthy ecosystems are the best way to ensure productive agriculture and nutritious food. The protection of this 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. This study examines the effect of pesticides on the environment, food safety and health of the Maize farmers in South West, Nigeria. A multistage sampling technique was used to select 471 maize farmers used in the study. A combination of descriptive Statistics, Principal Component Analysis (PCA) and Tobit Regression model were used for the data analysis. The result revealed that majority (66.5%, 75.8%, and 55.2%) of the farmers claimed to have perceived serious effects of pesticides usage on their environment, health and food safety respectively. Some of the effects on the environment include; soil quality reduction (45%) and damages to other crops (52.7%). Prolonged exposure by farmers to pesticides also caused cardiopulmonary disorders such as difficult breathing (49.5%), incessant cough (73%), body pain (75.8%) and haematological symptoms such as skin rashes or skin diseases (61.6%). Also, the residual effects of pesticides usage on food observed by the farmers include; reduced quality of grains (44.8%), reduced shelves life (55.2%), poor taste (51.6%) and alteration of colour after food processing (45.6%). The result also shows that the application rate of pesticides ( $P<0.10$ ), safety measure ( $P<0.05$ ), Organic Farming Practices ( $P<0.01$ ), Visitation to Health centre ( $P<0.01$ ) and Livelihood options ( $P<0.01$ ) were the factors influencing the effect of pesticides usage in the study area. Therefore, to avert catastrophic damages of pesticides usage, adequate trainings on the best way of using pesticides becomes imperative because farmers who do not know about the harmful effects of pesticides sometimes overvalue their benefits and use them beyond the private and social optimum levels.

Keywords: Maize, Pesticide Usage, Health, Food Safety

## 1. Introduction

Agriculture's heavy and growing dependence on pesticides across large parts of the world, though partly fueled by pesticides' own effectiveness, is placing an ever-rising burden on environment, health, biodiversity, and even the agro-food sector. Generally, Pesticides are chemicals that have both positive and negative effects on the environment and human health. These effects can be specific or general and can be sensitive to climate change because pest pressure and optimal pesticide application rates vary with weather and climatic conditions (Koleva, *et al.*, 2010).

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. 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 (Ivan, 2015). Healthy environment provide 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.

There are more than 600 weeds and 10,000 insects commonly called pests, which affect human life adversely. They caused reduction in the quality and quantity of food produced, destroy stored produce, compete with man for food and trigger different diseases on humans, including animals and crops (FAO, 2006). Pesticides usage is a control mechanism to secure agricultural production from these various types of pest. It is an economic, labour-saving, and efficient tool for pest management in agricultural activities (Damalas, *et al.*, 2011). Pesticide is produced to improve competitive advantage in agricultural sector. Since, pesticides usage is good for retaining current production outputs, yield levels, and ensuring a high-quality standard of life (Delcour, *et al.*, 2015).

There are several definitions of pesticide in literatures. According to Food and Agriculture Organization (FAO,2006), which defined pesticide as “any chemical substance prepared for controlling, destroying or preventing, all form of pest, including human or animal disease, unwanted plants species causing harm on the production, processing and storage of food. These substances can be used on animals to remove insects and other pests on their bodies. Pesticides are substances or mixtures of substances that are specifically used in crop field and public health protection. Insecticides, fungicides, herbicides, rodenticides, bactericides and plant growth inhibitors are specific examples of pesticide (Alewu, *et al.*, 2011).

The adoption of modern agricultural technologies has increase the use of pesticides tremendously, along with other modern inputs, in most of the developing countries (Rahman, 2013). However, it was undisputed claimed that pesticides are dangerous to health, foods and environment (Hou *et al.*, 2010). The socio-economic and environmental impact of pesticides in the USA alone is USD 10 billion per annum. About 1–5 million people including field workers suffer from pesticides poisoning every year and more than 20,000 people die annually from exposure and contact with pesticides, mostly in developing countries (World Bank, 2018).

Pesticides are very essential to the mix of green revolution technologies by enabling agricultural intensification, boosted agricultural productivity and output. When applied correctly, pesticides are a labor-saving technology that could reduce pest populations and improve yields, quality, and storability of crops (World Bank, 2018). There are many reported cases of food poisoning in Nigeria, which directly related to residual accumulation of pesticide on the food products. Exposure to pesticide is always through skin contact, ingestion, or inhalation. The types of pesticide, duration, mode of exposure, and the health status are determining factors in the health implication. When ingested in human or animal body, pesticides can be metabolized, stored, excreted or bio-accumulated in the body fat (Pirsaheb, *et al.*, 2015). The negative health implications that have been associated with the use of pesticides include; dermatological, neurological, gastrointestinal carcinogenic, reproductive, respiratory and endocrine effects (Thakur, *et al.*, 2014). High occupational, accidental, or deliberate exposure to pesticides can be resulted to hospitalization and death.

## 2. Significance of the Study:

Among various agricultural commodities, Maize is the most important cereal crop and important staple food for more than 180 million people in Nigeria. Nigeria is the largest Maize producer in Africa, with about 8 million tons of Maize on the average annually. The Maize productivity has increased tremendously over the years with average 10.7 million tonnes in 2018 (NBS, 2018). The production of Maize in Nigeria is largely characterized with the use of pesticides as pre-emergence or post-emergence application, and most often as post-harvest control of pests. 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 how to use pesticides to increase yield of crops by lowering infestation of pests in both field and post harvesting handling.

However, pesticides usage raises a number of environmental and human health concerns. Some percentage of applied pesticides can spread beyond their targeted species, by touching non-targeted species, water, air and food. Via spray and vapor drift, runoff and

leaching, pesticides can contaminate other areas. Once sprayed within an environment, pesticides may change the natural biological balances and destroy biodiversity. Since pesticides are designed to be toxic to living species, they may also adversely affect human health. The major concern of this study is to gain more knowledge on the potential threats and contributions of Pesticides usage to environment, food safety, and health of the Maize farmers.

Most pesticide related researches have focused mainly on environmental effects with little focus on the health and food residual effect. Focusing on economic assessment of pesticides usage, its perceived effect on farmers' health, food safety, environment and its relationship with climate change remains the onus of this work. Agriculturally, pesticides usage may be reduced, but their outright elimination is currently not feasible economically. While political leaders, policy makers, citizens, and government officials try to mediate and resolve conflicts between the risks and benefits of pesticides by producing safer chemicals, selective pesticides, better application mode and stronger pesticide admission rules, Climate Change may likely expand the conflicts.

### 3. Review of Related Studies:

There are few past literatures on the general assessment of pesticides usage on agricultural activities especially in Nigeria. Most related works have been conducted in non-Africa nations like USA, Belgium, Egypt etc. For example, pesticides benefits and hazards is a paper review by Ivan, (2015) on scientifically based assessment of positive and negative effects of pesticide application and discuss possible approaches to find balance between them. Mahmood *et al.*, (2016) worked on effects of pesticides on environment of some Asian countries. He opines that several types of pesticides are been used in crop protection. Pesticides benefit the crops but also caused a serious negative alteration on the ecosystem. Continuous use of pesticides will certainly lead to biodiversity destruction.

Also, Impact of climate change on pesticides usage is a reviewed literature by (Ilse *et al.* 2014) where the detailed analysis on the effect of changing climatic variables on pesticide usage was done in Belgium. Koleva, (2010) research provides an integrated economic analysis of United State pesticide applications. The few research works has been focused on climate change impacts on pesticides usage and pest population dynamics. There are few researches on pesticides conducted in Nigeria, these includes among others; Determinants of pesticide usage on crop production in South-Eastern Nigeria, a study by Rahman *et al* (2018). Pesticides use and health in Nigeria is a reviewed paper by Ojo, (2016). He addresses pertinent environmental and health related issues on the pesticides usage, on the farm and general household in Nigeria. This review examines factors responsible for the well-cited data that 99% of the deaths attributed to pesticides usage occur in developing countries like Nigeria, where only 25% of the world's pesticides supply is used. In their paper review, Maton *et al.*, (2016) appraised the pesticides usage on farmlands and stored food crops in Nigeria by reviewing relevant related works. The paper discovered that the simplicity, availability, affordability and effectiveness of pesticides have led to increased usage by farmers to control pests that attack their farm. Babarinsa *et al.*, (2018) opined that pesticides usage poses serious threats to farmers, consumers and the environment. Pests control using pesticides has created many health related issues for the farmers mainly due to mishandling of these toxic chemicals and the inability to use personal protective wears. The indiscriminate disposal of pesticide containers also posed serious environmental implications.

### 4. Objectives of the Study:

The specific objectives are to:

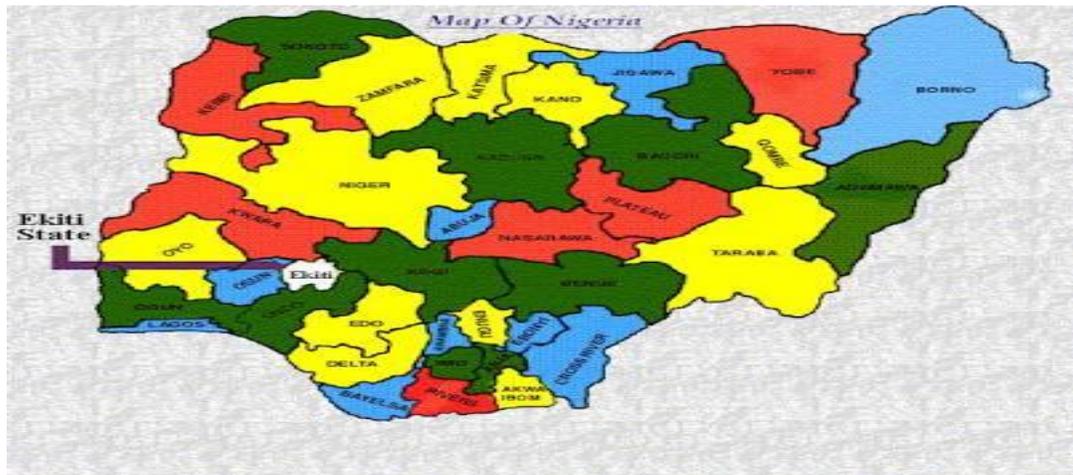
1. Describe the socio-economic characteristics of maize farmers in the study.
2. Estimate the Perceived effect of Pesticide usage on the Environment, Health and Food Safety as well as factors influencing these effects?

### 5. Hypothesis of the Study:

H<sub>0</sub>: Pesticides usage has no significant relationship with the environment, food safety and health of the maize farmers.

### 6. Population and Sample:

The study is carried out in South Western Nigeria. Nigeria is located on the West Coast of Africa, lying 10°North of the Equator and 8°East of the Greenwich Meridian. Her neighbours in the North, East and West are Niger, Republic of Cameroon and Republic of Benin respectively. Nigeria has two distinct seasons the dry and the rainy season. The dry season runs from November to March while the rainy season runs from April to October. The total land area of Nigeria is about 923,763km<sup>2</sup> with population of above 190.9 million (NPC, 2019), and more than 60% of its population being rural.



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

### 6.1 Data collection:

The study used primary data. The primary data were collected through 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 were 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.

## 6.2 Sampling

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. The sampling was justified based on probability proportional size. It is a quotient between the size of the population and the size of the sample (Tedrowos 2017). The formulae bellow was used in estimating the sample size.

$$N = nN_t (PQ)/N_t$$

Where

N = the required Sample Size

n = the number of the targeted maize farmers

N<sub>t</sub> = Total number of the entire population

P = Proportion (0.5), where maximum heterogeneity (50/50)

Q = degree of Precision i.e margin error that is acceptable = 0.5

The sampling frames of maize farmers were obtained from the Ministry of Agriculture of both Ondo and Ekiti State.

## 6.3 Data Analysis and Interpretation:

A combination of various analytical tools was employed in this study. These include Descriptive statistics, Principal Component Analysis (PCA) and Tobit Regression Model.

**Table 1: Socioeconomic Characteristics of Maize Farmers.**

Characteristics	Frequency	Percent	Mean
<b>Sex:</b>			
Male	361	76.81	
Female	109	23.19	
<b>Age:</b>			
< 20	1	0.21	
Between 21 – 40	206	43.74	
Between 41 – 60	226	47.98	
>60	38	8.07	44.5
<b>Marital Status:</b>			
Married	363	77.23	
Single	79	16.81	
Divorced	3	0.64	
Widowed	25	5.32	
<b>Household Size:</b>			
Bellow 5	319	67.87	
Between 5 – 10	143	30.43	
Above 10	8	1.70	4.82
<b>Education Level:</b>			
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	
<b>Farm Size:</b>			
Between 0 – 5	408	86.81	
Between 6 – 10	57	12.13	
Between 11 - 15	5	1.06	3.29
<b>Years of farming Experience:</b>			
Between 1 - 20	414	88.09	
Between 21 – 40	54	11.49	
Above 40 years	2	0.43	11.89
<b>Access to Credit:</b>			
No	352	74.89	
Yes	118	25.11	
<b>Source of Credit:</b>			
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	

**Source:** Data Analysis, (2021).

The results presented in table 1. reveal that majority (76.6%) of the maize farmers in the study area are male 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. 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..

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. Table 1 also shows that 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.

According to their educational levels as shown in Table 1, majority (12.7%, 31.6%, 34.6% 11.3%) of the farmers are 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 implies 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.

On their farming experience, majority (88.1%) of the farmers had less than 20 years farming experience and few (11.9%) others have 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.

The result 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 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%) of the 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%). This results show 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.

#### 6.4 Effect of Pesticides Usage on environment, farmers' health and food safety:

**Table 2. Distribution of Maize Farmers by their perceived effect of pesticides.**

Variables	Frequency	Percent
<b>Environment</b>		
No	158	33.5
Yes	313	66.5
<b>Farmers' Health</b>		
No	114	24.2
Yes	357	75.8
<b>Food Safety</b>		
No	211	44.8
Yes	260	55.2

Source: Data Analysis, (2021).

**Table 3. Tobit Regression Result**

Model	Unrestricted		Restricted	
	(Coefficient)	z-value	(Coefficient)	z-value
Sex	- 0.1692	0.255		
Age	0.00341	0.603		
House Size	- 0.0238	0.399		
Farm Size	- 0.0167	0.561		
Experience	0.0099	0.236		
Education Level	0.0235	0.697		
Farming Practice	-0.1276	0.359		
Type of Pesticides	0.0050	0.957		
Source of Pesticides	-0.2195	0.274		
Total Pesticides used	-0.0016	0.809		
Pesticides Rate of use	-0.0944	0.073	-0.0887***	0.062
Safety Measures Taken	0.1886**	0.022	0.1905**	0.011
Food Safety measure	-0.6728*	0.000	-0.7142*	0.000
Health	0.4173*	0.001	0.4161*	0.001
Livelihood	-0.3985**	0.003	-0.3968**	0.002
Constant	0.9705	0.164	0.3201	0.225
Sigma	0.9102		0.9179	
Log likelihood	-356.360		-370.73	
LR $\chi^2$	81.71***		78.25***	
Pseudo R <sup>2</sup>	0.102		0.096	
Prob> Chi2	0.0000		0.0000	

Statistically significant at the 0.01 (\*\*\*), 0.05 (\*\*), and 0.1 (\*) levels of probability

Source: Data Analysis, 2021.

The perceived effects of pesticides usage is analyzed base on the environment, health of the farmers, and food safety. This objective was analyzed by combination of descriptive analysis, Principal Component Analysis (PCA) and Tobit model. Despite the economic contribution of pesticides usage to maize production in the study area as revealed in the previous analysis, it is well observed that pesticides usage impacts negatively on the environment, health of the farmers and food safety in the study area. This is because; farmers who do not know about the harmful effects of pesticides sometimes overvalue their benefits and use them beyond the private and social optimum levels.

Table 4.4.1 shows the result from the descriptive analysis, where majority (66.5%, 75.8%, and 55.2%) of the farmers claimed to have perceived serious effects of pesticides usage on their environment, health and food safety respectively. Some of the effects on environment include; soil quality reduction, damages to other crops and increase cost of production. Prolonged exposure by farmers to pesticides also caused cardiopulmonary disorders such as difficult breathing, incessant cough etc, body pain and haematological symptoms such as skin rashes or skin diseases. These symptoms can lower productivity because of the farmers' absence on the farm during treatment and recuperation. Also, the residual effects of pesticides usage on food observed by the farmers include; reduced quality of grains, chemical residue in maize, poor taste and alteration of colour.

Principal Component Analysis (PCA) was used to generate an index for the perceived effect of pesticides usage. This index generated was regressed against some explanatory variables to know the factors contributing to the perceived effect of pesticides.

The estimation results of the Tobit models with the index of perceived effects of pesticides usage as dependent variable are reported in Table 3. The result shows that the rate of pesticides usage is significantly ( $P < 0.10$ ) and negatively associated with the environment, health and food safety. This implies that an increase in the rate of pesticides usage will influence negatively the environment, health and food safety, holding other factors constant. The finding that the safety measures tends to decrease the effect of pesticides usage on the environment, health and food safety could indicate that the farmers use adequate safety precautions or use low toxic pesticides, which generally reduce the health impairments, lower food poisoning and overall impact on soil. It could also be that these farmers are able to carefully read label with the minimum treatment possibilities. Among the farmers' socio-economic characteristics variables, that is, age, level of education, experience, household size, farming practice and gender, none had any discernible effect on dependent variables. In addition, farm size though considered as an indicator of wealth does not have a direct effect, though it has the correct sign. Also, there is no significant association between type of pesticides, sources of pesticides and the total number pesticides used with the environment, health and food safety. When the model was re-estimated (restricted) by dropping insignificant variables, the estimates of the coefficients were very robust.

#### Result of the hypothesis test

Variables	Mean	Standard Deviation	t – ratio	p-value
Farm Environment	3425.90	2266.96	32.7	0.000
Food Safety	0.550	0.498	24.0	0.000
Health of farmers	2861.53	1683.002	36.9	0.000

Source: Field Data Analysis, 2021.

It was tested that relationship exists between farm environment, food safety, farmers' health and Pesticides usage in the study area. Table 4 shows that Pesticides usage has significant relationship with environment, food safety and health of the farmers. The sign of this relationship is positive indicating that continuous pesticides usage will adversely impair the health of the farmer as well as the environment and food safety. It implies that, environment, food safety and health of the farmers could be negatively impacted by the increase in the use of pesticides.

#### 7.0 Recommendation:

- Adequate and efficient training on the correct rate of pesticides application by farmers is highly recommended to avoid food poisoning and health implications.

- Production and application of environmental friendly and less toxic pesticides should be encouraged among the pesticides producers and consumers.
- Farmers should ensure adequate and strong adherent to the instructions of the pesticides manufacturers to help in mitigating against the hazard effect of pesticides on farm land, health and foods.
- Government should ban the use of expired and toxic pesticides that can impair the health of the farmers as well as the environment.
- There is need for the global community to increase investment in research, development and demonstration as well as adoption of new technologies to build resilience of local food systems to effects of pesticides usage to avert large-scale of future food shortages, ensuring healthy life, food security and good nutrition for all.

### 8.0 Conclusion:

The study established that, maize farmers were predominantly male, married, physically and economically active in age. They were experienced and educated and depend largely on pesticides usage for their maize production. Pesticides usage though, improves food systems through increased productivity, affects the environment, the health of the farmers and caused loss of wholesomeness of produce and chemical residues. Maize farmers perceived serious effects of pesticides usage on their environment, health and food production. The application rate of pesticides, safety measure, organic farming practices, visitation to health centre and livelihood options were the factors contributing to the effect of pesticides on the maize production.

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