

RESEARCH PAPER

Assessment of Small-Scale Farmers' Knowledge on the Use of Agrochemicals and its Environmental Effects in Izzi Local Government Area Ebonyi State, Nigeria

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ABSTRACT

Environmental effects and proper knowledge on the use of agrochemicals is germane in achieving the 2030 SDG of environmental sustainability and sustainable production. This study assessed small-scale farmers' knowledge on use of agrochemicals and its environmental effects in Izzi LGA, Nigeria. Simple random sampling technique was used to select 120 farmers for the study. Data collected from primary source were analyzed using both descriptive and inferential statistics. The result revealed that majority of the farmers (52.5%) were males with an average age of 37 years. The mean annual farm income was N269, 667, with an average household size of 5 persons and mean farming experience of 8 years. The average farm size was 3 hectares. Result further revealed that the most available agrochemicals in the study area is NPK 25:13:13(69.2%) and most available herbicides was Red force (62.5%). Furthermore, the major insecticides in the area were Laraforce, Rambo and Lindane (58.3%). Again, the most available fungicides was SAAF (63.3%). The farmers level of knowledge on use of agrochemicals was low as farmers lacked knowledge on the duration of the chemical before checking for its effectiveness on crops ($\bar{x} = 2.86$). From the result, farmers were not aware of other environmental effects of use of agrochemicals like its contamination of water bodies. The result of the multiple regression analysis showed high R^2 value of 0.820 indicating that 82% of knowledge on use of agrochemicals and its environmental effects was greatly influenced by the socioeconomic factors. The study identified information, financial, and technical as the major constraints to knowledge on use and environmental effects of agrochemicals and recommends that Knowledge on safety of farmers and the environment should be prioritized by the state government and measures to curb environmental effects of use of agrochemicals introduced.

HIGHLIGHTS

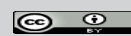
- ① Most available agrochemicals in the study area is NPK 25:13:13 (69.2%).
- ① Most available herbicides was Red force (62.5%).
- ① Major insecticides in the area were Laraforce, Rambo and Lindane (58.3%).
- ① The most available fungicides was SAAF (63.3%).
- ① The farmers level of knowledge on use of agrochemicals was low.
- ① Farmers lacked knowledge on the duration of the chemical before checking for its effectiveness on crops.
- ① Farmers were not aware of other environmental effects of use of agrochemicals.

Keywords: Smallscale, farmers, agrochemicals, environment, Izzi, Ebonyi , Nigeria

Agrochemicals are used in agricultural production to improve the quality and quantity of farm produce. It refers to substances used to help manage agricultural ecosystem or the community of organism in a farming area (Nwakile, Onah, Ekenta, Onah, & Aneke, 2020). Chemicals in

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form of pesticides, herbicide and fertilizers are used to boost agricultural production (Sekhotha, Monyeke & Sibuyi, 2016). These chemicals are important agricultural input useful for sustaining and increasing yields of agricultural products. They are used as soil conditioners, acidifiers, nutrients and are also used to control diseases caused by bacteria, fungi, pests and viruses, enhancing agricultural productivity and safety (Brunelle *et al.* 2024). Agrochemicals vary vastly according to their active ingredients and the purpose for which they are utilized. Examples of agrochemical include fertilizers, pesticides (which include insecticide, fungicide, herbicide and rodenticide) as well as other plant regulators. Generally, they possess various unique attributes that contribute positively to agricultural production thereby increasing farm yield (Ayilara *et al.* 2023). Studie have also shown that factors such as balanced use, optimum dosing, correct application methods and timing help ensure increased agricultural productivity (Bhandari, 2014).

Within the past few decades, the reliance of local farmers on agrochemicals has been on the increase in the Nigerian agricultural sector. This has been attributed to the need for increased and improved farm outputs to cater for the ever-growing human population. These agrochemicals have been utilized tremendously for the various purposes for which they were adopted, although some come with their own shortcomings (Akinola, Akeredolu, Azeez, Adetunji & Ojokunle, 2020). However, according to Akinola *et al.* (2020), the proper use of these chemicals is yet to be sufficiently understood among small scale farmers, in fact, most users (farmers) abuse the usage, all in a bid to improve their farm yield. This naivety can be attributed to lack of adequate knowledge on the dosage of application, especially among rural farmers who are predominantly illiterates. Konradsen (2017) stated that one-half of the human poisonings occur more in less developed countries, even though these places account for only 20% of the world's use of pesticides.

According to Okoffo, Mensah, and Fosu-Mensah (2016), inappropriate use of pesticides to control pests and diseases has major health implications for smallholder farmers and this is now on the global scale, attracting global attention of researchers, policy-makers, and the general public (consumers).

Pesticides and other foreign substances in food products and drinking water along with toxic pollutants in the air pose an immediate threat to human health, whereas other contaminants gradually build up in the environment and in the human body, causing disease long after first exposure (Damalas, & Koutroubas, 2016).

In Nigeria, the agricultural sector is the major supplier of food, raw materials and foreign exchange, with over 70 % of Nigeria's population largely depending on this sector for survival (Apeh, 2018). Due to the country's drive to increase agricultural production and the upsurge of different species of pests that damage and ravage agricultural products in fields and storage, farmers have resorted to the use of agrochemicals as an important control strategy (Maton, Dodo, Nelsla & Ali, 2016). An estimate of 125,000–130,000 metric tonnes of pesticides are used annually (Asogwa & Dongo, 2019). According to Rahman and Chima (2018), 70% of rice and yam farmers apply pesticides, and 41% of farmers apply pesticides to at least one food crop in Nigeria. Hence, the use of agrochemical is now commonly placed among local farmers in most agrarian area like Izzi Local Government Area.

LITERATURE REVIEW

Use of agrochemicals has led to increased food production (Popp, Peto and Nagy, 2013), however, exposures to other organisms during their application, including humans, is poorly controlled especially among uneducated peasant farmers. Their use has significantly increased the concentration of toxic materials in food and the environment, with negative effects on plant and animal health (Tago, Andersson & Treich, 2014). The World Health Organization (WHO, 2010) has estimated that more than three million farmers in developing countries are poisoned by agrochemicals each year.

Apart from inhibiting the soil nutrient by indiscriminate destruction of beneficial soil organisms and increasing soil acidity, causing secondary pest outbreak and developing pesticides resistance pests, various health hazards associated with the improper use of agrochemicals include; abdominal pain, dizziness, headache, nausea, catarrh, vomiting as well as skin and eye problems (Akinola, Akeredolu, Azeez, Adetunji & Ojokunle, 2019). Furthermore, some of the effects of agrochemicals on humans are

damage to the reproductive and nervous systems and other organs, behavioral and developmental abnormalities, interference with hormone function as well as affecting the immunity system. They gather fat deposits in the body where they stay and cause a lot of damage. Most of the infants and young children drinking breast milk ingest herbicides as women who eat fruits and vegetables that have been sprayed with pesticides may pass the chemicals through their breast milk while pregnant women can pass the chemicals unto their foetus (Jurewicz & Hanke, 2018). Agrochemical residues can also enter streams through run-off and pose dangers to fish, birds, wild animals and plants in the aquatic habitat. Excessive use of fertilizers, for example, can lead to the contamination of groundwater with nitrate, rendering it unfit for consumption by humans or livestock (Singh, Walker, Alun, Morgan & Wright, 2014).

Local farmers in Izzi local government area, like others, depend on agrochemicals to improve their farm yield. However, there is increasing concerns about the level of knowledge of these local farmers about the best practices in the usage of agrochemicals to get the desired result on their farms. There is also need to ascertain how the non-literate farmers who cannot interpret the instructions on the labels gain sufficient education or instruction on how to use them and also determine their awareness about the risks associated with the misuse of these chemicals. Hence, this study will help unveil if they are in compliance with the protracted regulations on the use of agrochemicals.

Also, apart from few studies on the topic such as farmers' perception on the use of agrochemicals in crop production in Nsukka, Enugu State, farmers' knowledge, practices and injuries associated with pesticide exposure in rural farming villages, pesticides use and health in Nigeria, and assessment of the use of agrochemicals among small-scale farmers in Esanland, Nigeria (Ojo, 2016; Eifediyi, Omondan, Takim & Animashaun, 2019), there is paucity of literature on the knowledge of proper use of agrochemical among peasant farmers in the study area. Hence, this study is also intended to fill this gap in literature by providing up to date information on the knowledge of use of agrochemicals. The broad objective of this study is to assess small scale farmers' knowledge on the use

of agrochemicals in Izzi Local Government Area of Ebonyi State, Nigeria.

The research hypothesis; Socio-economic characteristics of the small-scale farmers do not have significant effects on their use of agrochemicals in the study area, while the following research questions were formulated to guide this study;

1. What is the Socio-economic Distribution of Respondent?
2. What are the types of agro-chemical you use?
3. How often do you use agrochemicals
4. Do you have adequate knowledge on the proper use of agrochemicals?
5. Are you aware of the adverse health effect of improper use of agrochemicals
6. How does your socio-economic status affect proper use of agrochemicals?
7. What are the major constraints hindering proper use of agrochemicals?

METHODOLOGY

The area under study is Izzi Local Government Area of Ebonyi State. The major economic activity of the population is farming and it is a center of agricultural trade including such products as yams, cassava, rice, and both palm oil and palm kernels. The population of people living within Izzi Local Government Area was 236,679 in 2006 (NPC, 2006). Izzi local government area is lying between latitude 6°29'4.31" N and longitude 8°17'40.85" E of the equator.

The prevailing climatic condition in the area is characterized primarily by two major seasons which are the rainy and dry seasons. The rainy season usually starts in April through October; while the dry season starts from October to February, which is the same throughout southeast Nigeria. Izzi Local Government Area experiences bimodal rainfall pattern with first peak in July and the second in September, and annual rainfall is usually between 1613.8 mm to 2136.27 mm. Dry season begins in November, when the dry continental North-eastern wind blows from the Mediterranean Sea across the Sahara Desert and Samarian desert and down to the southern part of Nigeria. Izzi LGA has a rich agricultural heritage and is known for the cultivation of crops such as yam, rice, cassava, sweet

potato, bambara nut, and cocoyam in substantially large quantities. (Okorie. Njoku, Onweremadu & Iwuji, 2020).

Demographically, Izzi local government area covers a total area of 2,264 square kilometres and has an average temperature of 27 degrees centigrade. The LGA has the guinea savannah vegetation type with an estimated elevation of 140 meters above sea level. Izzi LGA is well forested and has an average humidity level of 70 percent. The area is made up of eight (8) communities including Agbaja, Ezza-Inyimagu, Igbeagu, Mgbalaukwu, Ndieze-enyim, Ndieze-enyim, Ndieze-echi and Ndiebor.



Fig. 1: Map of Ebonyi State showing the Study Area

Sampling Procedure and data analysis

Simple random sampling (SRS) technique was adopted for this study. The list of registered small scale crop farmer from Izzi L.G.A was obtained from Agricultural Development Programme (ADP's) database. From the list, a random sampling of 120 farmers were made from the eight communities in Izzi Local Government Area (including Agbaja, Ezza-Inyimagu, Igbeagu, Mgbala ukwu and Ndieze) and used for this study. The data for this study were collected from primary source. The questionnaire was designed to completely deal with information on the specific objectives of the study. Data were analyzed using relevant analytical techniques such as descriptive and inferential statistics. Descriptive

statistics such as frequency, means and percentages were used to realize objectives i, ii, iii, iv and v while objective vi and vii were actualized using multiple regression analysis and factor analysis respectively. The null hypothesis was tested using F-test at 5% level of significance.

Model Specification

A set of models was used in this study in order to ensure that the set objectives are achieved. The models include; ordinary least squares (multiple regression), factor analysis and Likert type rating scale.

The OLS model

The OLS model will be used to determine the effects of socio-economic characteristics of farmers on the use of agrochemicals.

$$Y = F(X_1, X_2, X_3, X_4, \dots X_9) \quad \dots 1$$

The explicit form is stated below;

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + e_t \quad \dots 2$$

Where;

Y = Use of agrochemicals (number of agrochemicals used)

X_1 = Sex (male=1, female = 2)

X_2 = Age (years)

X_3 = Marital Status (single =1, married = 2, divorced = 3, widowed = 4)

X_4 = Years Spent in Formal Education (Years)

X_5 = Annual Income (Naira)

X_6 = Households size (Number)

X_7 = Farming experience (Years)

X_8 = Farm size (Hectare)

X_9 = Membership of cooperative society (Yes = 1, No = 0)

e_t = stochastic error term

b_0 = Constant

$b_1 - b_9$ = Parameters to be estimated

Likert scale rating technique

A likert scale is a psychometric tonnes scale used in survey research. It was developed in 1932 by Rennis Likert (Johns, 2010). It employs the principles of measuring attitude or opinion by asking people to respond to a series of statement about an issue in terms of extent of their level of agreement or disagreement with the statement. The four point likert scale was used to determine the knowledge of local farmers in Izzi Local Government on proper use of agrochemicals as well as understand the effects of improper use of agrochemicals on the local farmers in the study area. The study adopted: strongly agree (SA), agree (A), disagree (D) and strongly disagree (SD). The values of the four responses will be added and divided by four to obtain mean score of 2.50.

$$\text{i.e., } \frac{4+3+2+1}{4} = 2.5$$

This was regarded as the mean response level. Based on this, any score below 2.50 ($MS < 2.50$) was taken as weak factor and were not considered and vice versa.

Factor Analysis Model

Factor analysis was used to identify the constraints to proper use of agrochemicals among peasant farmers in Izzi Local Government Area of Ebonyi State. Factor analysis is a statistical method used to describe variability among observed, correlated variables in terms of potential lower number of unobserved variables called factors. In order to obtain the factor loadings of each variable necessary for achieving aspects of objectives, it is important to adopt Varimax rotated component matrix statistical tool of using a factor loading of 0.4 and above to rate a factor or to reject any variable that did not load up to 0.4. This method has been adopted severally by many renowned researchers including Nwibo & Okorie (2013), Ezech (2013).

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Small Scale Farmers

This section is based on the examination of the respondents' socio-economic attributes such as sex, age, marital status, educational level, household

size, farm size among others. The result of the analysis was presented in Table 1.

Gender

The sex distribution of the small scale farmers indicated that more males (52.5%) than females (47.5%) were involved in the use of agrochemicals. This may be because of cost of agrochemicals as more men have access to finance and can always use it to purchase agrochemicals for their farm. The finding is in agreement with Nlerum (2012) who noted that farm production in Rivers State, Nigeria was dominated by males and it could be attributed to the energy demanding activities involved in production which require men who are naturally endowed with abundant strength necessary for such jobs.

Table 1: Percentage Distribution of the Small Scale Farmers based on their Socio-economic Characteristics

Variable	Frequency (N=120)	Percentage (%)	Mean ($\bar{x}$)
Gender			
Male	63	52.5	
Female	57	47.5	
Age (Years)			
≤30	42	35.0	
31-40	43	36.0	
41-50	17	14.0	
Above 50	18	15	37
Marital status			
Single	17	14.2	
Married	74	61.7	
Divorced	19	15.8	
Widowed/widow	10	8.3	
Formal Education (Years)			
Yes	87	72.5	
No	33	27.5	
Years Spent in Formal Education (Years)			
1-6	41	34.2	
7-12	45	37.5	
13-16	33	27.5	
Above 16	1	0.8	10
Annual Income (Naira)			
≤200,000	40	33.3	
200,001-300,000	46	38.7	

300,001 – 400,000	30	24.7	
Above 400,000	4	3.3	269,667
Household size (Number)			
1-3	32	26.7	
4-6	62	51.6	
Above 6	26	21.7	5
Farming Experience (Years)			
1-10	99	82.5	
11-20	12	10.0	
21-30	7	5.8	
Above 30	2	1.7	8
Farm Size (Years)			
1-2	54	45.0	
3-4	46	38.3	
Above 4	20	16.7	3
Membership of Cooperative Society			
Yes	47	39.2	
No	73	60.8	

Source: Field Survey, 2023.

Age

The age distribution of the small scale farmers in the study area is presented in Table 1. The result showed that 36.0% of the small scale farmers in the study area were within the ages of 31 – 40 years with a mean age of 37 years. This means that they are still in their active productive ages; an economic active age that can make positive contribution to agricultural production. This finding is similar to the findings of Ugwumba and Omojola, (2012) that the average age of 37 years obtained for farmers in Ipao-Ekiti, Nigeria indicate that they were still in their active productive years.

Marital Status

The result further showed that majority (61.7%) of the small scale farmers' population were married while few (8.3%) were widowed. The findings support the result of Nurudeen (2012) that married farmers tend to have easy access to production variables such as land and large family which are traditionally owned and provided by household heads (husbands) to compliment family labour to enhance production and reduce the cost of hired labour.

Educational Attainment

The result in Table 1 showed that 37.5% of the small scale farmers had spent 7-12 years to acquire secondary education while few (0.8%) had spent above 16 years to acquire tertiary education. However, altogether about 72.5% of the small scale farmers had a formal education. Notably, formal education is an essential tool for the adoption of modern production technologies such as agrochemical use that encourages increase in the productivity of any agricultural venture (Ugwumba and Omojola, 2012). Thus, the high level of literacy in the study area will make small scale farmers to easily adopt new technologies such as use of agrochemicals in their farm which could improve their levels of profits.

Annual Income

Table 1 also showed that about (38.7%) of the small scale farmers in the study area had annual income of between N200,001 – N300,000 while few (3.3%) had above N400,000. This suggests that the farmers are low income earners and this may have negative influence on the use of agrochemicals by the farmers. Their mean annual income was N269,667.00. This support the findings of Onubuogu *et al.* (2016) who reported that farmers with the higher annual income will easily realize more yield than their counterparts who have poor annual income.

Household size

Table 1 showed that majority (57.6%) of the small scale farmers had household size of 4 - 6 persons while least (21.7%) had household of above 6 persons with average household size of 5 persons. The implication of this is that most small scale farmers have large families. Okoye *et al.* (2010) and Udensi *et al.* (2011) reported that a relatively large household size are more likely to provide more labour required for farm operations such as weed control, fertilizer application. Though large household size may not guarantee for increased labour efficiency since family which comprises mostly children of school age are always in school.

Farming experience

The result of the analysis showed that majority (82.5%) of the small scale farmers had 1-10 years

of farming experience while few (1.7%) had farming experience of above 30 years with a mean farming experience of 8 years. This shows that the managerial ability of the farmers can be inferred to be reasonably good. It is of the general opinion that experience farmers would be more efficient, have a better knowledge of climatic conditions and are thus expected to run a more efficient enterprise. This result agrees with the findings of Izeko and Olumeze (2012) that as one gets proficient in the methods of production, optimal allocation of resources is expected to be achieved. The more experienced one is, the lower the inefficiency.

Farm Size

Furthermore, result showed that about (45.0%) of the small scale farmers had farm size of 1- 2 hectare in the area with mean farm size of approximately 3 hectares. This implies that farmers in the study area were mainly small scale farmers operating on less than or equal to 2-3ha. This could be as a result of land tenure system predominant in the area or increasing human population.

Membership of cooperative

The result in Table 1 showed that majority (60.8%) of the small scale farmers do not belong to cooperative association while the least (39.2%) belong to cooperative societies. The effects of this result is that most of the small scale farmers in the study area may not enjoy benefits such as having access to credit, market outlets, marketing information and information on new technologies accrued to co-operative societies through pooling of resources together for a better expansion, efficiency and effective management of resources, and for profit maximization. This finding is in line with Musa *et al.* (2019) that cooperative groups ensure that their members derive benefits from the groups which they could have not derived individually.

Available Agrochemicals and the Usage in the Area

This section analyzes the available agrochemicals and their use in the study area. The result is presented in Table 2.

The result of the analysis shows that the most available fertilizer in the study area was NPK 25

13 13 (69.2%), followed by urea (57.5%), NPK 20 10 10 and NPK 15 15 15 (52.5%) while the most used was NPK 20 10 10 (58.3), followed by NPK 25 13 13 (55.8%), urea (54.2%) and NPK 15 15 15 (51.7%). This implies that most of the fertilizers available the area are also used by the farmers.

Table 2: Percentage Distribution of Respondents based on the Available Agrochemicals and their Use in the Area

Agrochemicals	Available		Use	
	Fre-quency	Percent-age (%)	Fre-quency	Percent-age (%)
Fertilizer				
NPK 20 10 10	63	52.5	70	58.3
NPK 25 13 13	83	69.2	67	55.8
NPK 15 15 15	63	52.5	62	51.7
Urea	69	57.5	65	54.2
Herbicides				
Force-up	63	52.5	66	55.0
Uproot	63	52.5	58	48.3
Slasher	67	55.8	67	55.8
Total control	65	54.2	65	54.2
Red force	75	62.5	59	49.2
Army force	61	50.8	60	50.0
Orizo plus	67	55.8	70	58.3
D.D force	53	44.2	52	43.3
Paraquat	64	53.3	65	54.2
Tackle	66	55.0	60	50.0
General	56	46.7	54	45.0
Insecticides				
Laraforce	70	58.3	67	55.8
Rambo	70	58.3	75	62.5
Organophosphates	53	44.2	52	43.3
Pyrethroids	69	57.5	66	55.0
BHC	66	55.0	65	54.2
Lindane	70	58.3	64	53.3
Fungicides				
Red Force	54	45.0	45	37.5
RIDOMIL GOLD	66	55.0	64	53.3
RIDOMIL GOLD PLUS	48	40.0	54	45.0
SAAF	76	63.3	78	65.0
Agriguard	61	50.8	65	54.2
Z-Force	70	58.3	67	55.8

Source: Field Survey, 2023.

More so, the most available herbicides in the area was red force (62.5%), followed by slasher and orizo plus (55.8%), tackle (55.0%), total control (54.2%),

paraquat (53.3%), force-up and uproot (52.5%) and army force (50.8%). Others were general and D.D force account for 46.7% and 44.2% of the respondents respectively. Meanwhile, the most used herbicides were orizo plus, slasher, force-up, total control, paraquat, army force and tackle which account for 58.3%, 55.8%, 55.0%, 54.2% and 50.0% respectively. This shows that available herbicides are also used in the study area. Furthermore, the major insecticides available in the area were laraforce, Rambo and lindane (58.3%), followed by pyrethroids (57.5%) and BHC (55.0%) while the most used were Rambo (62.5%), laraforce (55.8%), Pyrethroids (55.0%), BHC (54.2%) and lindane (53.3%). Lastly, most available fungicides was SAAF (63.3%), followed by Z-Force (58.3%), RIDOMIL GOLD (55.0%) and Agriguard (50.8%). While the most used herbicides were SAAF (65.0%), followed by Z-force (55.8%), Agriguard (54.2) and RIDOMIL GOLD (53.3%). A study by Nwakile, Onah, Ekenta, Onah and Aneke (2020) revealed that the commonly used agrochemicals in crop production in Nsukka Local Government of Enugu State include Force-up, Uproot, Slasher, Total Control, Red Force, Army Force, D D Force, Punch and N.P.K fertilizer.

Farmers Level of Awareness on the Use of Agrochemicals

Farmers' level of awareness on the use of agrochemicals is shown in Table 3. The results of the analysis in Table 3 revealed that the agrochemicals which the small scale farmers in the study area were very much aware of the use were NPK 15 15 ($\bar{x} = 3.03$) and Rambo ($\bar{x} = 3.00$). Also, the small scale farmers were much aware of the use of NPK 25 13 13 and Pyrethroids ($\bar{x} = 2.98$), force-up ($\bar{x} = 2.96$), general ($\bar{x} = 2.95$), urea ($\bar{x} = 2.90$), uproot and SAAF ($\bar{x} = 2.88$), orizo plus ($\bar{x} = 2.86$), agriguard and Z-force ($\bar{x} = 2.84$), red force ($\bar{x} = 2.83$), army force ($\bar{x} = 2.78$), NPK 20 10 10 ($\bar{x} = 2.77$), paraquat ($\bar{x} = 2.73$), D.D force ($\bar{x} = 2.71$), red force ($\bar{x} = 2.66$), laraforce ($\bar{x} = 2.62$), RIDOMIL GOLD, RIDOMIL GOLD PLUS and total control ($\bar{x} = 2.58$). While the farmers were not aware of the use of some agro-chemicals such as lindane ($\bar{x} = 2.23$), slasher ($\bar{x} = 2.09$) and BHC ($\bar{x} = 2.08$). This implies that the use of NPK 15 15 15, Rambo, NPK 25 13 13, Pyrethroids, force-up, general, urea, uproot and SAAF, orizo plus, agriguard and Z-force, red force, army force, NPK

20 10 10, paraquat, D.D force, red force, laraforce, RIDOMIL GOLD, RIDOMIL GOLD PLUS and total control were known by the farmers in the study. The result agreed with the work of Aviv *et al.* (2015), who reported that farmers in Nigeria are engaged in the cultivation and other agricultural processes such as planting, weeding, and spraying of agrochemicals including pesticides, herbicides, and application of fertilizers/ manure.

Farmers Level of Knowledge on Proper Use of Agrochemicals

The farmers' level of knowledge on proper use of agrochemicals was considered and analyzed in this section. This was done with the help of mean score analysis derived from four point likert type rating scale. The result is as presented in Table 4. Results revealed that the farmers level of knowledge on proper use of agrochemicals was high in the statement being sure of duration of the chemical before checking the effectiveness on crops ($\bar{x} = 2.86$), being sure of proper dosage before application ($\bar{x} = 2.81$) and read the label attached to get the knowledge of use ($\bar{x} = 2.80$). Followed by some chemicals is not allowed to touch the plant ($\bar{x} = 2.79$), some chemicals are applied on the root only ($\bar{x} = 2.73$) and wash hand with soap after applying agrochemicals ($\bar{x} = 2.70$), wearing of safety kits during application ($\bar{x} = 2.66$), some chemicals work some days after application and there is no rain ($\bar{x} = 2.66$), use of modern spraying equipment ($\bar{x} = 2.65$) and apply on the leaves as may be required by the producer ($\bar{x} = 2.62$). Others were some chemicals is plant specific ($\bar{x} = 2.55$) and take shower immediately after applying agrochemicals ($\bar{x} = 2.51$). This implies that the level of knowledge of the farmers on the proper use of agrochemicals in the area was moderate in the study area.

On the level of compliance to regulations on the usage of agrochemicals, Akinola *et al.* (2020) reported that farmers avoids the use of banned agrochemicals (and use the currently approved agrochemicals (92.4%). They also reported that most of their respondents avoid the storage of agrochemicals in family bedroom, and majority dispose the container properly and 90.2% ensured that the containers were not used for domestic purpose. They further showed that the farmer avoided the use of leaking equipment. Hence, they

concluded that the respondents in the study area were complying with regulations on the usage of agrochemicals and are current with its trend. As a consequence, farmers are liable to be selective in their choice and purchase of certain agrochemicals. This according to Asogwa & Dongo (2019) is responsible for the reduced availability of certain agrochemicals in Nigeria market since the marketers are afraid that farmers may not easily accept the newly approved agrochemicals, which may affect patronage. This result agrees with (NPAS, 2012), that also reported positive compliance to regulations on the usage of agrochemicals.

Table 3: Mean Score Distribution on Farmers Level of Awareness on the Use of Agrochemicals

Agrochemicals	Mean ($\bar{x}$)	Decision
Fertilizer		
NPK 20 10 10	2.77	Much aware
NPK 25 13 13	2.98	Much aware
NPK 15 15 15	3.03	Very much aware
Urea	2.90	Much aware
Herbicides		
Force-up	2.96	Much aware
Uproot	2.88	Much aware
Slasher	2.09	Not aware
Total control	2.58	Much aware
Red force	2.83	Much aware
Army force	2.78	Much aware
Orizo plus	2.86	Much aware
D.D force	2.71	Much aware
Paraquat	2.73	Much aware
Tackle	2.88	Much aware
General	2.95	Much aware
Insecticides		
Laraforce	2.62	Much aware
Rambo	3.00	Very much aware
Organophosphates	2.70	Much aware
Pyrethroids	2.98	Much aware
BHC	2.08	Not aware
Lindane	2.23	Not aware
Fungicides		
Red Force	2.66	Much aware
RIDOMIL GOLD	2.58	Much aware
RIDOMIL GOLD PLUS	2.58	Much aware
SAAF	2.88	Much aware
Agri-guard	2.84	Much aware
Z-Force	2.84	Much aware

Source: Field Survey, 2023.

Table 4: Mean Score Distribution of the Farmers Level of Knowledge on Proper Use of Agrochemicals

Proper use of agrochemicals	Mean ($\bar{x}$)	Remark
Read the label attached to get the knowledge of use	2.80	Accepted
Received training on use of agrochemicals from the seller	2.43	Rejected
Check expiring date before application	2.31	Rejected
Wearing of safety kits during application	2.66	Accepted
Being sure of proper dosage before application	2.81	Accepted
Apply on the leaves as may be required by the producer	2.62	Accepted
Some chemicals are applied on the root only	2.73	Accepted
Use of modern spraying equipment	2.65	Accepted
Wash hand with soap after applying agrochemicals	2.70	Accepted
Take shower immediately after applying agrochemicals	2.51	Accepted
Some chemicals is not allowed to touch the plant	2.79	Accepted
Differentiate between total and selective used killer before application	2.43	Rejected
Being sure of duration of the chemical before checking the effectiveness on crops	2.86	Accepted
Some chemicals is plant specific	2.55	Accepted
Some chemicals work some days after application and there is no rain	2.66	Accepted

Source: Field Survey, 2023.

Farmers Awareness Level on Adverse Effects of Improper Use of Agrochemicals

The awareness level of the farmers on adverse effects of improper use of agrochemicals in the study area was examined in this section. The result is presented in Table 5.

Table 5: Mean Score Distribution on Farmers Awareness Level on Adverse Effects of Improper Use of Agrochemicals

Adverse effects	Mean ($\bar{x}$)	Remark
It can cause sickness or ill health	2.87	Much aware
It can kill the crops	2.81	Much aware
Contamination of the produce	2.88	Much aware
It can reduce the lifespan of the crop in storage	2.89	Much aware
It can be washed to the nearest streams	2.81	Much aware



It can denature the soil	2.83	Much aware
It can cause air pollution	2.89	Much aware
It can cause decrease in biodiversity	2.78	Much aware
It can be harmful to non-target organisms (like birds and earthworms)	2.78	Much aware

Source: Field Survey, 2023.

Table 5 revealed that the farmers were much aware of all the adverse effect of improper use of agrochemicals considered. Hence, the farmers are much aware of it can reduce the lifespan of the crop in storage ($\bar{x} = 2.89$), it can cause air pollution ($\bar{x} = 2.89$), contamination of the produce ($\bar{x} = 2.88$), it can cause sickness or ill health ($\bar{x} = 2.87$), it can denature the soil ($\bar{x} = 2.83$), it can kill the crops ($\bar{x} = 2.81$), it can be washed to the nearest streams ($\bar{x} = 2.81$), it can cause decrease in biodiversity ($\bar{x} = 2.78$) and It can be harmful to non-target organisms (like birds and earthworms) ($\bar{x} = 2.78$).

The unsafe use and handling of agrochemicals among Nigerian farmers continues to constitute health hazards and environmental degradation (Asogwu & Dongo, 2019; Ndaghu, 2017). Among the Ethiopian vegetable farmers, Mengistie *et al.* (2017) reported the unsafe use of agrochemicals practices such as unsafe storage facilities, ignoring risks and safety instructions, not using protective devices when applying pesticides, and dispose of containers unsafely. Several studies have reported the high level of indiscriminate/ unsafe use of agrochemicals by farmers in Nigeria. This has been linked to the rising incidence of series of chronic end-points including prostate cancer, endocrine effects and reproductive defects (Govinda, 2014; Rim, 2017).

Effects of Socio-economic Characteristics of Farmers on the Use of Agrochemicals

Multiple regression analysis was used to analyze the effects of socio-economic characteristics of farmers on the use of agrochemicals. The results were presented in Table 6.

The coefficient of multiple determinations (R^2) was found to be 0.820 (82%). This is an indication that 82% of the number of agrochemicals used by farmers was explained by the explanatory variables (socio-economic characteristics of the farmers), while approximately 18% was not accounted-

for due to error term (et). The F-ratio (32.039), which determines the overall significance of the econometric model, is highly significant at 1% level of probability, hence concludes that the socio-economic characteristics of farmers have significant effect on the use of agrochemicals in the study area. Hence, the findings present the marginal effects of the estimated econometric analysis below.

Table 6: Multiple regression analysis on Effects of Socio-economic Characteristics of Farmers on the Use of Agrochemicals

Variables	Coefficient	Standard errors	T-value	Probability level
Constant	3.158	0.718	4.396	0.000
Sex	0.153**	0.237	0.647	0.052
Age	-0.005*	0.018	-0.303	0.076
Marital Status	0.401**	0.177	2.261	0.026
Years spent in formal education	0.003*	0.019	0.018	0.099
Annual income	2.000**	0.000	0.100	0.032
Household size	-0.049**	0.061	-0.791	0.043
Farming Experience	0.012**	0.022	0.566	0.057
Farm size	0.429***	0.128	3.345	0.001
Membership of cooperative society	0.195**	0.233	0.838	0.040
R^2	0.820			
Adjusted R^2	0.813			
F- ratio	32.039			

Source: Field survey, 2023. ***, **, * implies significant at 1%, 5% and 10%.

The socio-economic characteristics considered under the analysis were sex, age, marital status, educational level, annual income, household size, farming experience, farm size and membership of cooperative society. All these variables were found to be significant factors influencing use of agrochemicals in the study area.

The co-efficient of sex was positively signed and statistically significant at 5% level of significance. This is true since male farmers have more access to finance and can encourage the use of agrochemicals. This implies that there is positive relationship existing between gender of the farmers and their use of agrochemicals in the study area. This is in line with the findings of Nmadul and Akinola (2015), that both male and female plays important economic and social roles in any economy.

Age was found to significantly and negatively influence use of agrochemicals at 10% level of significance. This implies that the more aged a farmer is, the lower the propensity to adopt new technologies such as use of agrochemicals. This agrees with Onubuogu *et al.* (2016) whose results showed age to be negatively related to adoption of new technologies.

The coefficient of marital status was positively signed and statistically significant at 5% level of significance. This indicates that there is positive relationship existing between use of agrochemicals and marital status of the farmers. This is because married farmers have more access to asset and credit which should encourage the use of agrochemicals. The findings support the result of Nurudeen (2012) that marital status of is positively related with farming activities.

Furthermore the educational level of the farmers displayed a positive and significant relationship with use of agrochemicals at 10% probability level. This can be adduced to the fact that educated people adopt technologies easily and can easily adopt the use of agrochemicals. This is in line with the result of Ojo *et al.* (2012) who argues that education has a positive relationship with innovation adoption. Through education farmers are able to acquire more information about innovations and how to use them properly. Chikoye (2014) reported that formal education help farmers to understand the usefulness and usage of agrochemicals while Ayeni (2011) observed that higher educational attainment could facilitate the adoption of newer technologies among Nigerian farmers, Michael, Tijani & Eniola (2019) concluded that, higher education attainment has the tendency to enhance the understanding of modern agricultural technology which could translate into large scale farming.

Annual income was found to positively influence use of agrochemicals at 5% probability level. This implies that increase in income of the farmers will likely motivate them to use agrochemicals. This finding corroborates the result of Agbo *et al.* (2015). The authors found that a unit increase in annual income increases the use of farming innovations.

The result also showed that the household size was also positively related to the use of agrochemicals at 5% probability level. This can be explained that larger family size implies more people available as

labourers in application of agrochemicals in farms. Studies by Adekola *et al.* (2013) confirm that the size of the household boost labour availability.

Farming experience was found to positively and significantly influence use of agrochemicals at 5% significance level. This implies that increased farming experience of the farmers connotes increased use of agrochemicals since the farmers must have been enjoying the dividend of using agrochemicals to boost production. This finding corroborates the result of Bender and Bender (2013). The authors found that the farming experience is highly connected to use of certain farm inputs.

The result further showed that farm size was also positively and significantly related to use of agrochemicals at 1% level of significance. This can be explained that increased farm size increases the use of agrochemicals. Studies by Yu *et al.* (2020) confirmed that most farmers that use of agrochemicals have large farm size.

Finally, membership of cooperative society had positive and significant relationship with the use of agrochemicals at 5% probability level. This implies that membership of cooperative society enhances the use of agrochemicals in the area as most of these technologies are introduced and adopted at cooperative level. This is in congruent with Sunder and Kiran, (2016) who reported that most farmers that readily adopt innovations are cooperative farmers.

Constraints to Proper Use of Agro-Chemicals

Factor analysis was used to determine the constraints to proper use of agro-chemicals in the study area. The purpose was to identify new factors and the interpretation boils down to identifying the variable that loaded high under each extracted factor. The result is presented in Table 7.

Table 5 shows the varimax rotated component matrix on constraints to proper use of agro-chemicals in the study area. From the field data collected, four (4) major constraints were extracted based on the responses of the respondents. Only variable with constraints loading of 0.40 and above at 15% overlapping variance were use in naming the constraints. Variable that loaded in more than one constraint were discarded while variables that have constraints loading of less than 0.40 were not used.

Table 7: Varimax Rotated Component Matrix on Constraints to Proper Use of Agro-Chemicals in the Study Area

Constraints	Factor 1	Factor 2	Factor 3	Factor 4
	Information	Financial	Infrastructure	Technical
Lack of education	0.770	-0.091	-0.334	0.243
Lack of information on proper use	0.609	0.327	-0.472	0.323
Lack of finance	-0.524	0.781	0.182	0.301
Size of farm	0.135	0.346	0.776	0.268
Distance of farm from source of chemicals	-0.337	0.313	0.738	0.331
Health hazard associated with misuse	0.601	0.262	0.340	0.717
Poor knowledge of application	0.328	-0.625	0.087	0.649
High cost of procuring agrochemical spraying equipment	-0.303	0.895	-0.356	-0.464
Complexity of user's manual	0.466	0.260	0.280	0.738
Misguiding information from agrochemical dealers	-0.056	-0.502	0.006	0.673
Irritation from agrochemical spills	0.662	0.213	-0.595	0.299
Unpleasant odour of most agrochemicals	0.770	-0.091	-0.334	0.293
Complexity of application equipments	-0.609	0.327	-0.472	0.650
Misconception on the efficacy of agrochemicals	-0.524	0.281	0.182	0.754
Too many expired agrochemicals in the market	0.735	0.346	0.276	0.259
Unavailability of instruments for measuring the quantity of agrochemical used in crop production	-0.337	0.313	0.338	0.691
High cost of chemicals	-0.301	0.662	0.340	0.280
Unaware of some chemicals	0.828	0.325	0.087	-0.019
Unavailability of desired chemicals	0.603	-0.495	-0.356	0.282

Source: Field Survey, 2023.

Factors 1 was considered and named information factors due to variables that loaded high under it. These high loading variables were lack of education (0.770), lack of information on proper use (0.609), irritation from agrochemical spills (0.662), unpleasant odour of most agrochemicals (0.770), too many expired agrochemicals in the market (0.735), unaware of some chemicals (0.828) and unavailability of desired chemicals (0.603). This implies that a positive change of these variables will increase proper use of agro-chemicals while the negative change will decrease the proper use of agro-chemicals in the area since there are information factors. For instance if lack of education, lack of information on proper use and irritation from agrochemical spills decreases on the positive direction the proper use of agro-chemicals will increase and vis versa. This supported the assertion of Aromolaran *et al.* (2013) who affirmed that farm inputs use is influenced by information availability. Moreover, after critical consideration of the constraints, factor 2 was considered and named financial constraints due to the variables that loaded high under it. These high loading variables includes;

lack of finance (0.781), high cost of procuring agrochemical spraying equipment (0.895) and high cost of chemicals (0.662). Farmers are very rational when it comes to judging what benefits they wish to get from buying products or services they pay for (Al-Mamun and Rahman, 2014). However the result agrees with the findings of Komaladewi and Indika (2017) which indicated that most farmers consider finance as an important factor influencing their use of agro-chemical and also similar to the finding of Djatmiko and Pradana (2015) and Termsnguanwong (2015) who reported that most low income earners do not use the required quantity of farm inputs.

Furthermore, factor 3 was considered and named infrastructural factor due to the variables that loaded high under it. These high loading variables includes; size of farm (0.776) and distance of farm from source of chemicals (0.738). This is in line with Omolara *et al.* (2017) who highlighted the major production constraints to be farm size and farm distance in Osun State, Nigeira. Similarly, Ashaye *et al.* (2018) also reported that farm distance and size among others were significant constraints to agricultural production in Kwara State, Nigeria.

Finally, factor 4 was considered and named technical factor. These factors includes Poor knowledge of application (0.649), misguiding information from agrochemical dealers (0.673), complexity of application equipments (0.650), misconception on the efficacy of agrochemicals (0.754) and unavailability of instruments for measuring the quantity of agrochemical used in crop production (0.691). This support the findings of Brown, (2022) which noted that proper use of agrochemicals requires some technicalities.

In conclusion, Nwakile, Onah, Ekenta, Onah & Aneke (2020) revealed that the constraints to the effective utilization of agrochemicals in crop production include; high cost of pesticides, high cost of procuring agrochemical spraying equipment, complexity of user's manual, misguiding information from agrochemical dealers, health hazards associated with misuse, irritation from agrochemical spills, unpleasant odour of most agrochemicals, complexity of application equipments, misconception on the efficacy of agrochemicals, buying of expired agrochemicals and unavailability of instruments for measuring the quantity of agrochemical used in crop production. Also, Jamala, Ari, Tsuda, & Waindu (2013) reported that the major constraints to adoption of agrochemicals is inadequate fund and low competency of farmers in the use of agrochemicals the equipment on their farm.

Hypothesis Testing

Ho: The null hypothesis which stated that the socio-economic characteristics of the small scale farmers do not have significant effects on their use of agrochemicals in the study area was tested using F-test at 5% level of significance and the result showed that F-ratio (32.039) is statistically significant at 1% level of significance, the null hypothesis was rejected and the alternative accepted. This implies that the socio-economic characteristics of the small scale farmers have significant effects on their use of agrochemicals in the study area in the study area.

CONCLUSION

The study revealed that farmers level of knowledge on proper use of agrochemicals was high in the statement being sure of duration of the chemical before checking the effectiveness on crops ($\bar{x} = 2.86$), being sure of proper dosage before application

($\bar{x} = 2.81$) and read the label attached to get the knowledge of use ($\bar{x} = 2.80$) and major constraints to proper use of agro-chemicals in the study area were information, financial, infrastructure and technical constraints.

Based on major findings of the research findings, it is recommended that;

Agricultural extension organizations should carry out improved mobilization and sensitization campaigns to educate farmers on proper use of agrochemicals in order overcome information constraints such as lack of education and lack of information on proper use of agrochemicals.

Safety precautions on mixing, spraying and disposing spoilt and expired chemicals as well as empty agrochemical containers should be prioritized by farmers so as to prevent endangering other persons and children.

Government should make soft loan available and easily accessible to the farmers so as to reduce financial constraints faced by farmers in their use of agrochemicals.

More training on the use of agrochemicals should be given to the farmers by the sellers through extension agents in order to increase their level of knowledge on proper use of agrochemicals to avert technical constraints.

Some desired chemicals should be made available to farmers by the producers through feedback mechanism.

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