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Pesticides knowledge and handling practices of smallholder farmers: A study of farmers in Ogun state, Nigeria.

MASTER'S THESIS

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Declaration

I hereby declare that I have done this thesis entitled **"Pesticides knowledge and handling practices of smallholder farmers: a study of farmers in Ogun state, Nigeria"** independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague, May 2020

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Boluwatife Igbasan

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Abstracts

Nigeria is a country where farmers rely heavily on pesticides usage for productivity but care less about protecting themselves whilst handling pesticides thereby exposing themselves to potential sicknesses and death among farmers because of the toxic nature of the pesticides.

The aim of this research is to assess pesticide knowledge and handling practices among smallholder farmers in Ogun state, Nigeria. Purposive sampling technique was employed in choosing the two local governments which were the study area of the research. Simple random sampling technique was used in selecting the 156 farmers that were interviewed for the purpose of the study.

The questionnaire survey was used in face-to-face interview and focus group discussion was conducted to collect data. The data was analyzed using Multiple Linear Regression and descriptive statistics.

The result of the Multiple Linear Regression shows that an increase in the level of education of farmers, information gotten from other farmers and pesticides label information had positive statistically significant impact on the knowledge and handling practices of farmers which in turn influences their attitude towards usage.

However, trainings given by extension had a negative impact on farmers' knowledge and most farmers will not seek information from them.

Disposal of leftover pesticides, usage of personal protective equipment such as gloves and nose mask were not regularly used by farmers and this can be attributed to lack of proper training and economic factor as most farmers said they couldn't afford personal protective equipment and will rather invest the money on purchasing pesticide for higher crop yield.

The implication of this is that traders of pesticides needs to be properly trained on the kind of pesticides that are not shelve worthy because of their level of toxicity and the danger it poses to the farmers.

Training given to traders of pesticides will help them advice farmers accordingly and this will translate to better handling practices among the farmers. Also, it could avoid the sales of banned pesticides by the traders as most of them have little or no knowledge about pesticides and the danger of its exposure.

Key words: knowledge, pesticides, handling practices and personal protective equipment, farmers

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1 Introduction and Literature review

According to World Health Organization, pesticides are chemical substances used for killing pests including insects, rodents and unwanted weeds that attacks plants and stunt their growth. Although important for the safety and cultivation of plants, its effect on the environment has been seen to be adverse.

Pesticides includes herbicides which are used for attacking weed, insecticides which are used for attacking bugs, grasshoppers, fungicides which is used to fight fungus and rodenticides which is used to fight rodents (Aktar et al. 2009).

Pesticides are widely used by farmers in crop production to prevent or control pests, weeds and other plants pathogens to reduce yield losses and increase productivity. Although pesticides are developed through very strict regulation processes to function with minimal impact on human health and environment, it is difficult to deny the risk it poses to farmers and the environment as a whole (Damalas & Koutroubas 2016).

In Nigeria, pesticides have proven to be indispensable tools in combating damage from pests and ensuring sustainable food production with improved yield and greater availability of food all year round. For example, being a tropical region, without the use of pesticides in rice and cocoa production, about 45 per cent of total production would be lost to pests and diseases Tijani, (2006). It has been estimated that about 125,000-130,000 metric tons of pesticides are applied every year in Nigeria in order to avoid loss of farm products.

Its adverse effect includes the reduction of the aquatic life, pesticides poisoning, wildlife reduction, birth defect, disruption with reproduction, skin irritation, several health impairment and recently suicide (Babarinsa et al. 2018).

This can be attributed to the handling practices of smallholder farmers who lack proper information on the handling practices that are involved in the use of pesticides. The lack of information among handlers has led to poisoning of the environment and themselves (Prieto Garcia et al. 2012).

Despite the toxicity of pesticides, it is beneficial for plants has it helps repel and kill pests that reduces the lifespan of plants which in turn threatens the economy. The growing concern about the effect of its exposure and handling practices among small holder farmers and children has led to

the springing forth of many regularly bodies in Nigeria who ensure that pesticides marketers and farmers are educated on the effect.

Such regulatory bodies include National Agency for Foods and Drugs Control (NAFDAC), Cocoa Research Institute of Nigeria (CRIN), Pest Control Association of Nigeria (PECAN) and the West African Agricultural and Productivity Programme (WAAPP-Nigeria), Integrated Pest Management Plan (IPMP) are all working hard to mitigate the effect of pesticides exposure and ensure better handling practices among farmers (Maitah et al. 2015).

Nigeria is a country that is rich in agriculture and for many years practiced organic farming until 1995 when cocoa farming experienced a serious shift and production had to be done in a large quantity. Cocoa is a crop that is regularly disturbed by pests leading to low productivity

Nigeria's economy is strongly tied to agriculture despite the oil sector being the mainstay of its economy. Agriculture has been responsible for creating primary employment for the population hence the reason for a large part of its population being involved in small scale farming.

The usage of pesticides is not a problem but the handling practices of farmers in Nigeria is worrisome as many of them do not have the adequate knowledge to practices the application of pesticides with safety.

Integrated Pest Management Plan (IPMP) is an organization that ensures pest management and ensures farmers are trained on how to handle pesticides so that it's toxic effect can be mitigated. Also, they ensure that farmer do not make use of pesticides that have been banned for usage by the World Health Organization which they achieve through the extension workers (Ayonmike & Okeke 2016).

Pesticides are widely used by farmers in crop production to prevent or control pests, weeds and other plants pathogens to reduce yield losses and increase productivity. Although pesticides are developed through very strict regulation processes to function with minimal impact on human health and environment, it is difficult to deny the risk it poses to farmers and the environment as a whole (Damalas & Koutroubas 2016).

The hazards of pesticide exposure have been a growing concern globally. It excessive usage by farmers can be attributed to lack of knowledge about the danger it poses to food safety (Okoffo et al. 2016).

Pesticide use is associated with risk and can be hazardous if not properly handled and most farmers in Africa has not learnt proper handling of these pesticides leading them to getting exposed and the risk of being victims of various diseases that accompanies exposure to pesticides (Tijani 2017).

1.1 Literature review

This chapter brings overview of pesticide knowledge and the way it is being handled among smallholder farmers, the root cause of the way pesticide is being handles, the danger they are exposed to base on their practices and their attitude towards safety.

It also discussed the theories guiding their knowledge and attitude toward the usage of pesticides. Finally, this chapter discussed major finding of literature in relation with pesticides knowledge and handling practices among smallholder farmers which were summarized by studying relevant literature sources mainly from scientific articles of electronics resources such as ScienceDirect, Web of Science, Scopus, Research gate, reports from Food and Agricultural Organization (FAO), World Health Organization (WHO)

1.1.1 Overview of pesticide use

The pesticide usage can be traced back to the stone age because man has always had a need to protect his crops from weeds and insects that does great damage to the crops.

However, the men of old relied on natural substance were used for protection of plants which didn't pose any kind of threat to the environment. The birth of synthetic pesticides can be traced back to fifty years ago with the intention of solving World's food and productivity problem.

Since the birth of Dichlorodiphenyltrichloroethane (DDT) which happened fifty years ago, several debate about its toxicity has been put up. Although, it helped in achieving increase in food productivity but the damage and contamination of the environment has been on the rise (Zadoks & Waibel 2000).

Since 1940, the use, production and marketing of pesticides has been on the rise and it doesn't seem to be coming to an end soon. Exposure to pesticide toxicity has been on the rise and has continue to pose imminent danger to lives of those exposed to it as its effect does not appear immediately and could take years before a sign appears (Prieto Garcia et al. 2012).

Pesticides in themselves are not bad but the mishandling practices has succeeded in exposing humans to toxicity which has led to the birth of several diseases and soil degradation, contamination of the aquatic and soil pollution.

Several diseases have been attributes to pesticide exposure and at such can lead to neuritis, psychiatric manifestations, hepatorenal disorders, neurological and neurodegenerative, immune, metabolic and endocrine. Similarly, it has been linked to increased incidence of leukemia and bladder cancer in farmers, following a genotoxic effect of some pesticides and interestingly suicide (Harari et al. 2010).

The groups faced with high-risk exposure to pesticides include production workers, formulators, sprayers, mixers, loaders and agricultural farm workers. In industrial and farm settings, workers are at increased risk since they handle various toxic chemicals including pesticides, raw materials, toxic solvents and inert carriers (Aktar et al. 2009).

Asides being linked to several diseases in the world, it has also been linked to be an instrument of suicide among young people as pesticide poisoning has been recorded to account for one in every five suicide that occurs in the world today which has raised concerned among health practitioners and the World Health Organization (Shankar 2003).

Due to the problem of mishandling, the WHO and FAO developed a code of conduct for that should guide the usage of pesticides. The code of conduct includes responsible and generally accepted practice among traders, it encourages the government of importing and exporting countries of pesticides to create policies that will ensure the management of pesticides whereby it poses minimal risk to health, it encourages government of nations to engage pesticide user in training bringing them abreast with pesticides that have been banned and the reason for their ban, it also encourages government of countries to have regulatory bodies to check that traders and user of pesticides properly handle them. The code of conduct also make provision for shared responsibility among different sectors of the society to ensure the proper usage of pesticides without posing health and environmental risk by ensuring that pesticides are used in the manner that will be sustainable (FAO 2014).

According to Remoundou et al. (2015), there is a distinction what farmers perceive as dangers of pesticides and their actual behavior towards the usage. The author emphasized that many farmers know about the increased deaths cause by the usage of pesticides but has no significant impact in their handling practices such as usage of personal protective equipment.

The benefits of pesticides cannot be put away in a hurry has it has led to increase in yield and increase countries that operate agriculturally dependent economy earn more revenue. In a bid for

a better economy and increased productivity, farmers have resulted in mishandling of pesticides and abuse quantities to be applied to crops.

Bangladesh is an example of a country where heavy application of pesticides is used for crop cultivation and this has exposed many farm workers to the toxicity. Although Bangladesh is gradually moving away from the use of pesticides, the toxic effect remains in the environment (Shammi et al. 2018).

In 2016, the tomato ebola really affected the agricultural sector in Nigeria and was leading to food scarcity safe for the intervention with the use of pesticides. This is one of the many examples of the benefit of pesticides.

1.1.2 Theoretical framework

Theories can be clarified as a group of rules, thoughts standards and methods that apply to a subject particularly when seen as unmistakable from genuine practices. The term hypothesis is characterized as a lot of ideas as well as explanations with of how wonders identify with one another.

The theories can be defined as the basis upon which a research is built. It is the collection of rules, thoughts standards and methods that apply to a subject particularly when seen as unmistakable from real practices. The term hypothesis is characterized as a lot of ideas or potentially articulations with how they identify with each other (Lederman & Lederman 2015).

This research will be premised on the knowledge-gap theory.

1.1.3 Knowledge-gap theory

This is a theory originally formulated by Tichenor (1970) to explain the disparity that occurs in the communication based on society hierarchy. According to Tichenor et.al. (1970) as in Gazino (2016) defined the knowledge gap theory as the mixture of broad communications data into a social framework increments higher financial and higher educational status will in general get information quicker than those with lower financial and educational status in the society.

According to Gazino (2016), knowledge is described as information gotten and recalled through a learning methodology, however information openings are irregularities in data available to be instructed.

The author explained how knowledge can be measured as simple awareness of an issue and as an in-depth information. According to Park (1940) in Gaziano (2016), the author explained that there is a distinction between the “knowledge of” and “knowledge about” a thing.

To further buttress his point, the author explained that a knowledge gap may not exist for the surface knowledge of an issue but may exist for in-depth knowledge on the same issue.

Gaziano (2016) referencing Tichenor et al. (1970) argues data conveyance frameworks had socially stratified structures, especially for science also, open issues news, which would in general be plugged in print media, contrasted and all the more generally got to communicate media, and which could get less reiteration than different themes, in this manner giving less chance to bring down status sections to experience furthermore, recall content.

In explaining the disparity, Le Heron & Sligo (2005) speaks about the distribution of information into a given population. The authors explained that even with the intention of equally distributing information, most times, the outcome is the opposite.

Dervin (1980) as in Le Heron et al. (2005) contradicts the idea that socioeconomic status has an effect on how information is received and processed and it doesn’t determine the ability to learn hence it shouldn’t be considered as a factor that leads to knowledge gap in the society.

Spitzer et al. (1965) as in Le Heron et al. (2005) in agreement with Dervin (1980) argument also postulates that it doesn’t matter the socioeconomic status, simple information is not necessarily retained overtime.

This means that imbalance of information among respondents either may not be decreased or is even intensified by such data, maybe on the grounds that "data rich" (those with better belonging and order of data) all the more effectively access and utilize new data, as opposed to the "data poor" (who may need access to data or the aptitudes to boost its helpfulness).

According to Bonfadelli (2002), believes that the internet might be a tool to further increase the disparity in knowledge among people of the higher status quo and those with lower status quo.

The author based his argument on the assumption of Kubieck et.al. (2000) who believes that those in the society who do not have access to computer will end up not having access to information.

This is to counter Dyson (1997) as in Bonfadelli (2002) who assumes that the coming of the internet will provide information for all.

1.1.4 The effect of pesticides

The essential advantages are the outcomes of the pesticides' impacts and the immediate increases anticipated from their utilization. For instance, the impact of slaughtering caterpillars and weeds benefiting from the crop brings the essential advantage of more significant returns and better nature of crops planted. The optional advantages are the less quick or more subtle advantages that are outcomes from the essential benefits. They might be inconspicuous, less instinctively self-evident, or on the other hand of longer term. It follows that for optional advantages it is along these lines progressively hard to set up circumstances and logical results, yet all things considered they can be ground-breaking legitimizations for pesticide use. For instance, the higher crop yield, the higher the anticipation of extra income that could be put towards kids' education or on the other hand clinical consideration, prompting a more beneficial, better taught populace (Aktar et al. 2009).

Steingrímsdóttir et al. (2018) opines that pesticides when chosen well can be of great advantage. The author stated that certain things must be put into consideration when choosing pesticides such as; pesticides must be user friendly, cost effective, available, personal experience with the pesticide or other people's experience with it. The author cited that some farmers will purchase more expensive pesticides because they believe that it will be more effective than the one that is sold at a cheaper rate.

Pesticides are applied to the earth with the purpose of smothering the impact of plant and animal disturbs and to secure agrarian and mechanical things. When this is done, the pesticides do not only kill the pests but also kill useful organisms and nutrients that are important for the soil (Tukura et al. 2013).

To further explain the risk poses to the environment, Grung et al. (2015) explains that not only is land affected with the usage of pesticides but also the aquatic which translates to the food chain. The author opines that the continuous indiscriminate usage of pesticides leaves its impact on the entire food chain.

The aquatic is the dwelling place of fish which is an animal that makes up for more than 50% of protein in our diets. The indiscriminate usage of pesticide has its effects on the aquatic such as; mortality of fishes, disruption of the normal reproduction (fishes might not be able to produce lots of eggs) which implies scarcity or at worse extinction of the aquatic life and altercation in the

behavioral patterns of fishes. This could pose danger to mankind as fishes could have consumed lots of toxic materials because farmers dispose empty pesticides into the aquatic and washing of their spraying equipment in the river, fishes caught from these kind of rivers could lead to food poisoning (Change 2015).

However, weeds and insects are parasites that heavily damage crops and lead to yield losses in many ways. This is because they compete for nutrients with the crops therefore making it difficult for the crops to absorb enough nutrients needed for their growth.

Insects feed on both the roots and the leaves of plants which affects the growth of these plants which ends up frustrating the farmers (Schroeder et al. 2019).

There are two ways of solving this problem and they are chemical and non-chemical methods. The non-chemical methods are the cultural and physical methods such as uprooting the weeds while the chemical methods are the application of pesticides (Dugje et al. 2008).

Sande et al. (2011) explains that it doesn't matter the chemical components of pesticides, it has been discovered to have adverse effects on the environment based on the amount of pesticides used. This implies that the more pesticides applied on the soil, the higher the damage to the environment.

Mohammed et al. (2018) express concern on the fast rate at which pesticides is endangering human lives and explained that not just those directly in contact with pesticides are endangered. He also explains that pesticide is an industrial pollutant and due to human activities, water has been contaminated due to pesticides.

Indiscriminate usage of pesticides has led to the discovery of residues of pesticides in food and water which was not the case years ago. This is very dangerous and unsafe for mankind because more cases of poisoning are being reported among pesticides users. Unfortunately, in developing countries, most health workers do not have the adequate training to diagnosis pesticide related illness (Okonya & Kroschel 2015).

1.1.5 Handling practices of pesticides among smallholder farmers

Lack of knowledge on handling practices according to many literatures have been blamed. Many farmers refuse to make use of protective clothing because it doesn't provide financial returns so rather than invest in health, they prefer to invest in the crops with the idea of making bigger profit

from it. Some of the farmers attributed not wearing protective clothing to discomfort when they wear them, and they believe that it slows them down (Asogwa & Dongo 2009).

Limited knowledge was also blamed for pesticides mishandling in the findings of Stadlinger et.al. (2011) as the author claims that most farmers do not even know the name of the pesticides which they apply to their crop as most of them buy diluted pesticides which doesn't come with a label that can guide them and many of them re-use these containers when washed.

In the opinion of Salameh et al. (2004), lots of farmers do not know the name of the pesticides they use on their farmland, hence they cannot determine the level of toxicity possessed by a particular pesticide. The author claims that most of the farmers are ignorant of banned pesticides which implies that they could purchase and make use of them due to lack of knowledge about it.

Inhalation and ingestion are the major ones a farmer can be exposed to pesticides. Its effects are also prenatal deaths, miscarriages, dysfunctional birth, premature death of animals and human beings. About only 20.6% of farmers seek medical assistance when ill which majority decide to employ the use of herbal medicine which likely result to death (Gesesew et al. 2016).

In a bid to explain mishandling or misuse of pesticides, Rother (2018) explains that certain factors must be in place such as a label has to be on the container of the pesticides, the label has to be written in the language understood by the end user, the end user must be literate to read and understand what is written on the label and the end user must be able to understand the content of the label which if it' s not the case, then misuse or mishandling is inevitable.

The reason most farmers think pesticides are harmless is because the effect sometimes takes years before it manifest. Most sicknesses attached to pesticides are not known immediately, though most farmers report slight discomfort after spraying pesticides but do not pay attention to these signs until it worsens (Karmacharya 2012).

Delayed diagnosis due to proper health care system make it difficult to diagnose farmer of pesticides poisoning. Also, lots of developing countries do not possess proper health insurance system and getting treatment is costly hence most farmers will resort to self-diagnosis and this often worsen the situation as they face the risk of damaged internal organs due to late diagnosis (Dupas 2011).

Scoy et al. (2015) explains in his findings that most of the pesticides sprayed are not specific to one pest and in a bid for farmers to eliminate from their farmlands, they end up kill organisms that are useful to the land which could lead to damage of the soil and less productivity.

Pesticide use is associated with risk and can be hazardous if not properly handled and most farmers in Africa has not learnt proper handling of these pesticides leading them to getting exposed and the risk of being victims of various diseases that accompanies exposure to pesticides (Tijani 2017).

Farmers' exposure to hazard of pesticide mainly occurs during the preparation and application of the pesticide spray solutions and during the cleaning-up of spraying equipment. Farmers who mix, load, and spray pesticides are at the danger of exposure to these chemicals due to spills and splashes and direct spray contact as a result of faulty or missing protective equipment, or even drift (Spyridon et al. 2016).

Kim et al. (2017) explains that there is a scientific justification for claim that pesticide is linked to occupational hazard as well as hazard on the part of consumers as well as posing risk to the environment and human health.

The hazards of pesticide exposure have been a growing concern globally. Its excessive usage by farmers can be attributed to lack of knowledge about the danger it poses to food safety. Hence, exposing their lives to danger of pesticides toxicity. Also, many of them are seen eating, smoking and drinking while spraying pesticide no matter how toxic the pesticides are (Okoffo et al. 2016).

In the opinion of Vaidya et al. (2017), most farmers are at the risk of exposure to the toxicity of pesticides as this is their biggest occupational hazard. He also explains that the use of pesticides has been linked with ailments such as dizziness, skin irritation, blurry vision and several others among smallholder farmers.

Andrade-Rivas & Rother (2015) in his opinion believes that pesticides risk is increasing especially in Africa though the continent accounts for 2-4% of the global population purchasing pesticides. He attributed this to lack of risk management on the part of pesticides users on the continent that are not paying attention to the use of personal protective equipment.

The unsafe use of pesticides has been identified as a common practice in developing countries as there are no competent authorities to check the activities of farmers and their usage of pesticides. Also, the availability of pesticides have resulted in farmers not taking into consideration the dosage of pesticides before application on the crops (Mengistie et al. 2017)

Alex et al. (2018) in his research explains that farmers directly handling pesticides are mostly at risk of exposure to pesticides due to the residues on treated crops, unsafe handling practices and lack of proper storage and disposal of leftover pesticides and empty containers.

The author further explained that pesticides can be inhaled in the process of mixing the powder before application, burning of empty pesticide containers and spraying of pesticides. The danger which the farmer is being exposed to poisoning as the toxicity gains faster access to the bloodstream.

According to the research done by Shammi et al. (2018), he discovered that 87% of farmers do not use personal protective equipment (PPE) which is meant to protect them from the danger posed by pesticide.

Most farmers believe in the usage of pesticides for high yields. Although, a lot of them purchase pesticide with label but 73% of them do not read the label. The label of pesticides is very important as it gives instructions on the quantity to be used on a crop and the kind of activities that are not to be carried out while spraying pesticides (Damalas & Khan 2016).

They also took a survey of the knowledge of farmers as relating to handling practices and it was discovered that many farmers are not properly educated on the danger that could arise from the excessive usage of pesticides.

Most farmers got their information about pesticides from local vendors of pesticides and not from experienced extension workers. Also, farmers depended on their long-time experience with a pesticide which means they don't even try to find out if the pesticides have been banned from being used if it puts pest away from their products (Oluwole & Cheke 2009a).

The authors also discovered that most of the farmers mixed more than one pesticide together in their bucket before pouring into bottles and then spraying on the field. However, these buckets are the same used in fetching water for having their bathe.

It has been discovered that extension workers do not properly educate the farmers on the usage of pesticides. The author explained that this is a government failure as most extension workers lack support and mobility is also difficult and this has made farmers rely on vendors for advice on the kind of pesticides to use (Asogwa et al. 2009).

Tijani (2017) postulates that most of the farmers do not understand or know how to read the label because the instructions are not written in the farmer's language. This is could be problematic for farmers.

Jallow et al. (2017)discovered that farmers do not have a problem with storing pesticides in the refrigerator with other food items while others prefer to store them in the open fields, cool and dry area meant for pesticides only.

Okoffo et al. (2016) in their findings revealed that most of the farmers leave the empty container of pesticides on the farmland while a handful dig holes in the farm and bury the containers, significant others burn the containers. They also found out some farmers re-use the empty container of pesticides for household purposes such as storage of water, salt, palm oil which they consume. Most of these farmers do not know the extent of danger the usage imposes upon their health.

Based on all the findings from literature, it is obvious that the major issue involved with the use of pesticide and the handling practices can be blamed inadequate information given to the farmers.

Another issue pointed out by several literatures Okoffo et al. (2016), Damalas & Khan (2016), Stadlinger et al. (2011) is the issue of literacy. Most information written on pesticides label are written in foreign languages which is difficult for farmers to comprehend hence they make use of pesticide based on their experiences and how the presume it should be used.

One major factor that has contributed to the continuous usage of pesticides is the ever growing population and the pressure it is mounting on the agricultural sector making it inevitable to apply pesticides to crops to increase productivity which isn't such a bad thing except that farmers have been unable to properly handle pesticides as they ought to. Abuse of quantity applied to the crop becomes inevitable and consumption of such crops could lead to food poisoning (Gereslassie et al. 2019).

This could be harmful to the farmers and the final consumers if the products are purchased from farmers to final consumer and goes through no hazard control or unprocessed. According to Takagai et al. (1997) in Tijani (2006), human exposure to pesticide is an important health and social issue as it usually results in serious health problems such as epilepsy, stroke, respiratory disorders, cancer, leukemia, brain and liver tumors, convulsions etc. Death has been known to occur in some places as a result of exposures to these pesticides.

One of the common illness attributes to the consistent unsafe use of pesticides is musculoskeletal disorders which is common among farmers because of heavy lifting and constant exposure to pesticides. It is a widespread disease in the agricultural sector alongside respiratory diseases that occurs due to exposure to pesticides residues (Benos et al. 2020).

Peng et al. (2020) in his research laid emphasis based on other literatures, the fact that exposure to pesticides have been linked with sicknesses such as brain and prostate cancer. To further explain the level of exposure, the result of his research revealed the level pollution that occurred in his study with residues found in the lady's hair after samples have been collected.

Nguemo et al. (2019) in his findings expressed concerns about the careless disposal of empty pesticides containers and leftover pesticides. The author explained that most farmers method of disposal is dangerous and many of the farmers store leftover pesticides in places like the rooftop of their bedroom which is exposes them to inhaling pesticides which could lead to serious illnesses.

With exposure to hazard on the rise, there is a need for chemical hazard communication to ensure that farmers have enough information to make decision on pesticides and give advice on the right attitude in handling pesticides (Dalvie et al. 2014).

1.1.6 Names of pesticides commonly used by farmers in Nigeria

Identifying pesticides by their names is one of the most difficult tasks as most pesticides have complex names. It is for this reason they are given shorter names which becomes their common name, and this is the name they are sold with at the market. These names are given based on the active ingredients found in them, the active ingredients (abbreviated as a.i.) are the compound used to control the harmful organism. Its ability to kill, harm or prevent certain pests and/or diseases from crops has been proven and its use for this purpose is authorized through a registration process.

Table 1: Common names of some pesticides and the names in which they are sold in Nigeria

Common names	Trade names of pesticides as sold in Nigeria	Uses
Paraquat	Gramoxone, Bret-P, Paraforce, Weedoff, Weedcrusher, Dragon, Dizmaxone, Lasher, Miazone, Weedex, Ravage, etc.	General weed control (by contact) in all crops
Atrazine	Atrazine, Delzine, Atrataf, Atraforce, Xtrazine,	For the control of grass weeds in cereals
Butachlor	Butachlor, Butacrop, Butastar, Butacot, Butaclear, Risene, Teer, Butaforce, Cleweed	For the control of broadleaf and grass weeds in rice, and some legume crops
Propanil	Propanil, Propacare, Propan, Rhonil, Orizo, Propaforce, etc	For post- emergence weed control in rice
Pendimenthalin	Stomp, Pendilin	For pre-emergence weed control in rice, maize and some legume crops
Oxidiaxone	Ronstar, Riceforce, Unicrown	For pre-emergence weed control in rice
Alachlor	Lasso, Alachlor	For pre-emergence weed control in maize and some legume crops
Glyphosate	Roundup, Glycel, Wipeout, Clearweed, Bushfire, Forceup, Sarosate, Rhonasate, Delsate, Glyphosate, Touchdown forte	Systemic herbicide for general weed control before land preparation
2,4-D Amine	Aminoforce, Delmin-forte, 2,4-D-Amine, Select	For pre- and post-emergence control of broadleaf weeds
Lamdacyhalothrin	Karate, Laraforce, Attack, Karto, Zap	Systemic insecticide for many crops

Cypermethrin	Cypermethrin, Suraksha, Superthrin, Best, Cymbush, Cypercot	Contact insecticide for many crops
Dichlovos	Nuvan, Pestoff, Rhonclov, Dash, Smash, Delvap, Wonder, Shooter, Nopest, Clepest, DDforce, VIP	Contact insecticide for the control of insects in storage and in houses. It is combined with Actellic and used to protect grains in storage.
Mancozeb	Z-force, Hi-shield, Mancozeb, Mycotrin	Contact fungicide for disease control in many crop

Source: (Dugje et al. 2008).

In Nigeria, pesticides have proven to be indispensable tools in combating damage from pests and ensuring sustainable food production with improved yield and greater availability of food all year round. For example, being a tropical region, without the use of pesticides in rice and cocoa production, about 45 per cent of total production would be lost to pests and diseases Tijani (2006). It has been estimated that about 125,000-130,000 metric tons of pesticides are applied every year in Nigeria in order to avoid loss of farm products.

This could be harmful to the farmers and the final consumers if the products are purchased from farmers to final consumer and goes through no hazard control or unprocessed. According to Takagai et.al. (1997) in Tijani (2006), human exposure to pesticide is an important health and social issue as it usually results in serious health problems such as epilepsy, stroke, respiratory disorders, cancer, leukemia, brain and liver tumors, convulsions etc. Death has been known to occur in some places as a result of exposures to these pesticides

2 Objectives of the Thesis

2.1 Main objectives

The broad objective of this research assesses the attitude, knowledge of pesticides and handling practices among smallholder farmers

2.2 The specific objectives are as follows

i. Assess the attitude of farmers towards the use of pesticide

ii. Assess their level of knowledge and factors affecting knowledge

iii. To investigate the handling practices of farmers regarding the use of pesticides

2.3 Research questions

i. What is the attitude of farmers towards use of pesticide?

ii. What is their level of knowledge and the factors affecting how much knowledge they have regarding pesticides?

iii. What are their handling practices regarding the usage of pesticides?

2.4 Significance of the study

Over the years, there has been a record of inappropriate handling of pesticides among smallholder farmers especially in Nigeria. This study is significant because it exposes the reason behind the lack of knowledge and proper handling practices among smallholder farmers in Ogun state Nigeria.

The findings in this study will point policymakers to the right direction to be taken on the issue of mishandling of pesticides among smallholder farmers and will help in proffering possible solutions to the problems identified in this study. Also, this study will be a reference point to other student working on similar topic as review for literature pertaining to their study.

3 Methodology

3.1 Study area

Ogun State is a state in southwestern Nigeria with Abeokuta as the capital and largest city in the state. It has a total area of 16,981km^2 and was created February 1976.

It borders Lagos state to the south, Ondo state to the east, Oyo and Osun to the north and Republic of Benin to the west.

It is popular for harboring the highest number of tertiary institutions of learning in the country. Ogun has one Federal University, the Federal University of Agriculture, Abeokuta known as (FUNAAB) and one Federal college of education, FCE Osiele (both at Odeda Local government area), one state government college of education, Tai Solarin College of Education (TASCE), (formerly known as Ogun State College of Education, Ijagun, Ijebu-Ode, one Federal Polytechnic, Ilaro, one state government polytechnic Moshood Abiola Polytechnic (MAPOLY), formerly known as Ogun State Polytechnic, Ojere, Abeokuta, and two state government universities: Olabisi Onabanjo University, Ago Iwoye , and the Tai Solarin University of Education (TASUED) Ijebu Ode. It has five private universities namely Chrisland University, Abeokuta Bells University of Technology in Ota, Covenant University and Babcock University in Ilisan-Remo, which was the first private university in the country.

Agriculture provides 70% of the income for the people of the state as they produce major cash crops such as cocoa, cassava, cotton, kolanut, rice, oil palm(Oppor et al. 2008).

Figure 1: Map of Nigeria showing Ogun State

Figure 2: Map of Ogun State showing the study areas

3.1.1 Pesticide regulation agencies in Nigeria

There are three major agencies in Nigeria in charge of regulating pesticides usage and conducting various research whereby the findings of the research are communicated into workshops where pesticide distributors and farmers are trained. These organizations are:

3.1.1.1 The National environmental standards and regulations enforcement agency (NESREA)

The National Environmental Standards and Regulations Enforcement Agency (NESREA) is a piece of the Federal Ministry of Environment. The Agency was built up by NESREA (Establishment) Act, 2007, accordingly canceling the Federal Environmental Protection Agency Act Cap F10 LFN 2004.

The vision of the Agency is to guarantee that there is a cleaner and more beneficial condition for Nigerians, though its crucial to move and rouse individual and aggregate obligation in building an earth cognizant society for the accomplishment of feasible advancement in Nigeria.

The expansive order of the Agency is to implement every single natural law, rules, arrangements, principles and guidelines in Nigeria; and to disallow forms and the utilization of hardware or innovation that undermine ecological quality. It likewise has duty to implement consistence with arrangements of International understandings, conventions, shows and settlements to which Nigeria is a signatory.

Henceforth, the organization is effectively worried about pesticide utilization and taking care of practices among wholesalers of pesticides and ranchers and it's engaged with workshops that help in making mindfulness among them.

Functions of National environmental standards and regulations enforcement agency (NESRA)

- Development and upkeep of methodologies for powerful natural consistence checking and implementation
- Establishment of a hearty ecological data the executive’s framework including database/databank
- Significantly expanding the degree of ecological mindfulness and making organizations with pertinent partners at both national and worldwide levels

• Carrying out powerful ecological consistence observing and authorization projects to guarantee the reasonable utilization of Nigeria's normal assets, and to secure residents' prosperity and control air, land and water contamination.

• Coordinating and advancing examination and studies, in a joint effort with open and private offices, establishments and associations, on different parts of ecological debasement and contamination including innovative exchange.

3.1.1.2 The National agency for food and drug administration and control (NAFDAC)

The National Agency for Food and Drug Administration and Control (NAFDAC) was established by Decree No. 15 of 1993 as amended by Decree No. 19 of 1999 and now the National Agency for Food and Drug Administration and Control Act Cap N1 Laws of the Federation of Nigeria (LFN) 2004 to regulate and control the manufacture, importation, exportation, distribution, advertisement, sale and use of Food, Drugs, Cosmetics, Medical Devices, Packaged Water, Chemicals and Detergents (collectively known as regulated products). The agency was officially established in October 1992.

Function of National agency for food and drug administration and control (NAFDAC)

- Regulate and control the importation, exportation, manufacture, advertisement, distribution, sale and use of food, drugs, cosmetics, medical devices, bottled water, Chemicals and detergents (Regulated Products)
- Conduct appropriate tests and ensure compliance with standard specifications designated and approved by the Council for effective control of quality of regulated products and their raw materials as well as their production processes in factories and other establishments
- Compile standard specifications regulations and guidelines for the production, importation, exportation, sales, distribution and registration of regulated products
- Issue guidelines, grant approvals and monitor the advertisement of food, drugs, cosmetics, medical devices, bottled water, Chemicals and detergents
- Compile and publish relevant data resulting from the performance of the functions of the Agency or from other sources.
- Sponsor such national and International conferences as may be considered appropriate
- Liaise with relevant establishments within and outside Nigeria in pursuance of its functions and;

- Carry out such activities as are necessary or expedient for the performance of its functions.

3.1.1.3 Cocoa research institute of Nigeria (CRIN)

The Cocoa Research Institute of Nigeria (CRIN) was set up in Ibadan, Oyo State on first December 1964 as a successor independent research association to the Nigerian substation of the outdated West African Cocoa Research Institute (WACRI) (Nigeria Statute, Act No. 6 of 1950 after the foundation in 1944 of the base camp of the said WACRI at Tafo, Ghana with duty to lead research to encourage improved creation of malady free, or sickness safe cocoa.

By prudence of the Nigerian Research Institutes Act No. 33 of 1964, the extent of CRIN was extended past that of WACRI which remember look into for kola and espresso notwithstanding cocoa. In 1975, by the Agricultural Research Institutes (Establishments, and so forth), the extent of CRIN examine exercises was additionally expanded to incorporate cashew and tea. Thusly, CRIN today has command to direct research on five yields, to be specific, Cocoa, Kola, Espresso, Cashew and Tea all through the nation. In like manner to the previously mentioned empowering Decree the communicated destinations of CRIN command on these five harvests are:

(i) Improvement of the hereditary potential, agronomic and cultivation works on, including handling and capacity of the harvests.

(ii) Identification of the biology and strategies for control of vermin and infections influencing the crops.

(iii) Investigating the successful use of the harvests and their results, and the attainability of little scope creation of such end-use items.

(iv) Integration of the development of the order crops into editing frameworks where each crop is developed by ranchers.

(v) Translation of research results and improved innovations into training among ranchers furthermore, makers to improve creation and financial existence of the individuals (“Cocoa Research Institute of Nigeria (CRIN) - Home” n.d 2020.)

3.2 Sampling techniques and study design

The study was conducted in the country Nigeria and it covered the population in Abeokuta North and Ifo local government respectively. These local governments are well known for their farming activities and reliance on pesticides.

Five communities each were visited in each of the local governments targeting the head of households which are smallholder farmers comprising of both male and female respectively.

A total of 156 respondents were randomly selected and interviewed.

3.3 Data collection

Data was collected using face - to - face interview and focus group discussion with the farmers.

Farmers were interviewed using open ended and semi-structured questionnaires to determine their knowledge of pesticides and handling practices.

The questionnaire was used after a pre-test survey was carried out with 20 farmers which makes up 13% of the total respondents and the questions amended. It was divided into four sections which are as follows:

Household characteristics: age, gender and education, household size and total hectares of land, Farmer's knowledge about pesticides usage, Attitude of farmers regarding usage of pesticide, Handling practices of farmers.

The researcher conducted the interview most often in Yoruba which is the native language of the respondents in the study area and the questionnaires were translated back to English on the spot.

About 5% of the interview were conducted in English. The interviews and focus group discussions lasted between 30-45minutes and data was collected from December 2019 till January 2020.

With respect to pesticides knowledge, farmers were asked to give their opinion as regards to their use of pesticides, coding 0 for being unaware and 1 for their awareness.

A knowledge index as calculated by Damalas & Khan (2016) was used. Farmers were also asked about crops cultivated, brand of pesticides used, number of times applied in farming season and most dangerous pest.

3.4 Data analysis

Descriptive and inferential statistics were used for analyzing the data collected from the field. Descriptive statistics in form of arithmetic mean, mode, percentages and standard deviation were used to describe all the collected data.

Inferential statistics in form Multiple Linear Regression was used to describe the second objective which is to assess the level of knowledge farmers have and factors affecting knowledge using IBM SPSS Statistics 25.

3.4.1 Multiple linear regression

Multiple linear regression was used to determine the influence of socio-economic characteristics and sources of information that affects the level of knowledge farmers have about pesticides as described in table 1.

Below is the model specification:

$$Y = b0 + b1X1 + b2X2 + \ldots + bnXn + e \quad \ldots (2)$$

Where:

Y= Dependent variable *(*level of knowledge about pesticides, ranging from 0-15

b0-bn= Regression coefficients

X1-Xn= Independent variables (socio-economic variables and food handling information sources) and ***e=*** Error term.

Table 2: Description of the variables used in the multiple linear regression model, 2019.

Variable name	Description	Source
Knowledge	Knowledge of farmers 0-15 (correct answers = 1, no=0, I don't know=0)	(Damalas & Khan 2016)
Gender	Measured using dummy variable, 0 is given to male and 1 to female.	(Negatu et al. 2016)
Age	The age of the responded, measured as a continuous variable.	
Education	A total number of years that the respondent has spent in school, measured as a continuous variable.	(Dibb & Fitzpatrick 2014)
Farming experience	A total number of farming experience, measured as a continuous variable	(Babarinsa et al. 2018)
Household size	The number of members per household, measured as a continuous variable	(Koyi et al. 2017)
Hectares of farmland	The total hectares of farmland, measured as a continuous variable	(Rijal et al. 2018)
Extension workers train on pesticide usage	Training given by extension workers to farmers on pesticide usage, measured as ordinal	(Asogwa & Dongo 2009)

Trainings on danger of pesticides is important	The importance of training on the danger of pesticides, measured as dummy variable where 0 is assigned to no while 1 assigned to yes	(Ojo 2016)
Distributor of pesticides	Distributor of pesticides as a source of information on pesticides important to farmers before purchasing pesticides	(Babarinsa et al. 2018)
Government agencies	Government agencies as a source of information on pesticides important to farmers before purchasing pesticides, measured as continuous variable	(Oluwole & Cheke 2009a)
Other farmers	Other farmers as a source of information on pesticides important to farmers before purchasing pesticides, measured as a continuous variable	(Oluwole & Cheke 2009a)
Label of pesticides	Label of pesticides as a source of information on pesticide important to farmers before purchasing pesticides, measured as a continuous variable	(Sharifzadeh et al. 2017)
Previous knowledge	Previous knowledge as a source of information on pesticide important to farmers before purchasing pesticides, measured as a continuous variable	(Tijani 2017)

4 Results and Discussion

4.1 Sample socio-economic description

Majority (76.9%) of farmers in the study are male Table 2, this is attributed to the fact that the farming is regarded as a hard job which is more suitable for male than their female counterparts who are more interested in small businesses.

Table 3: Socio-economic distribution of farmers (N=156), 2019

Variable	Items	Frequency	%
Sex	Male	120	76.9
	Female	36	23.1
Age	<29	12	7.7
	30-39	30	19.2
	40-49	55	35.3
	50-59	56	35.9
	≥60	3	1.9
Edu.level	None formally	56	35.9
	Primary	33	21.2
	Secondary	27	17.3
	Diploma ND/HND	27	17.3
	NCE	9	5.8
	Bachelors	4	2.6
Years of experience	<5	15	10.6
	5-10	53	37.5
	12-17	31	21.9
	18-25	39	27.6
	27-40	18	12.7
Household size	<5	10	6.41
	5-10	114	73.1
	11-15	32	20.5
Total hectares of land	1	2	1.3
	2	43	27.6
	3	59	37.8
	4	32	20.5
	5	13	8.3
	6	6	3.8
	10	1	0.6

This is in agreement with the findings of Mukasa et al. (2015), explaining the low representation of women in agriculture in Nigeria when compared to their counterparts. The age bracket of 50-59 years accounted for 35.9% of the sample population which agrees with the finding of Koyi et al. (2017) who reported that most farmers mean age was 52 years.

35.9% of the sample size had no formal education which means they cannot read or write while a total of 46.6% have received some level of formal education and are able to read as well as write this corroborated the finding of Damalas & Khan (2016). This high percentage of illiteracy among farmers is a contributing factor to their low level of knowledge regarding pesticides

Farmers with more than 5 years' experience accounted for 37.5% while 12.7% had over 20years of farming experience which corroborated the findings of Babarinsa et al. (2018) which also recorded a similar result. This reveals that majority of the farmers possess adequate experience in cultivation of crops.

73.1% has a household size of 5-10 persons, 20.5% has a household size of 11-15 persons while 6% has a household size of <5 which implies that most farmers have a large household sizes which may affect how pesticides is being handled and mounts pressure on the farm produce.

37.8% of the farmers own 3 hectares of land which signifies that most of the farmers are smallholder farmers. This corroborates the findings of Tijani (2017) and Babarinsa et al. (2018) who had similar results.

4.1.1 The attitude of farmers towards the usage of pesticides

According to Figure 3, majority of the farmers do not concern themselves with the price at which pesticides are being sold as 32.7% are neutral about the price at which it is sold which implies that the price at which it is being sold is not a determining factor in their decision of purchasing pesticides as they are concerned with purchasing and applying it to their crop at all cost not minding if it is expensive or not. However, the price is important to 30.1% of the total respondent and very important to 23.1% of the total respondent. This implies that majority of the farmers will overlook the price at which pesticides are being sold in the market in order to apply them on crops.

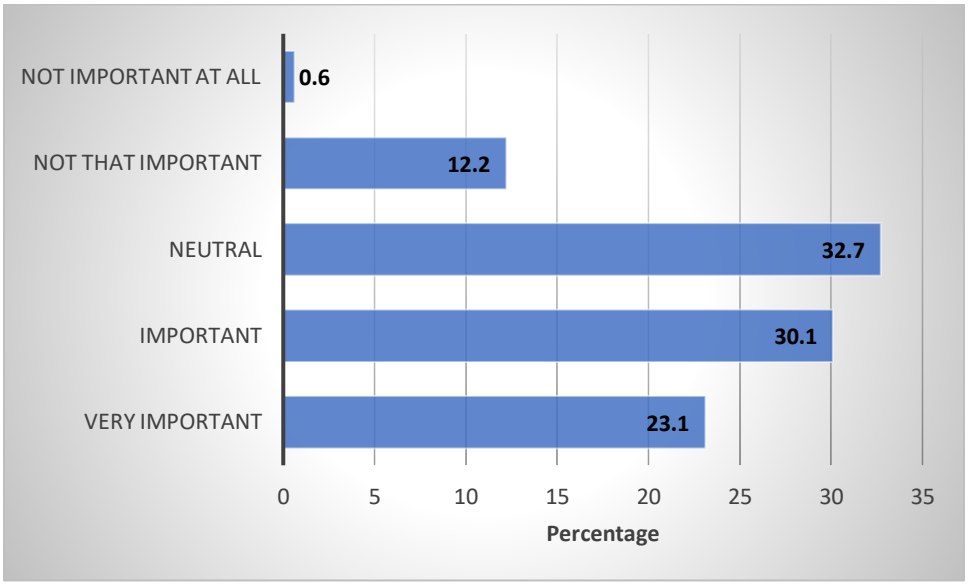

Figure 3: How important is price for your decision to select pesticides?

Most farmers are of the believe that without the application of pesticides on crops, it is impossible to have a tangible harvest let alone experiencing high crop yield. As shown in Figure 4, 82.1% of respondent agreed to the fact that pesticides are indispensable for high crop yield even when they complained about how expensive it. This reveals their attitude towards the price of pesticides and their willingness to purchase it at all cost. This is in agreement with the findings of Tijani (2017) explaining that most crops cannot survive without the use of pesticides as there is a huge possibility of losing 45% of the crops but the problem with this is most farmers do not know how to apply pesticides with moderation.

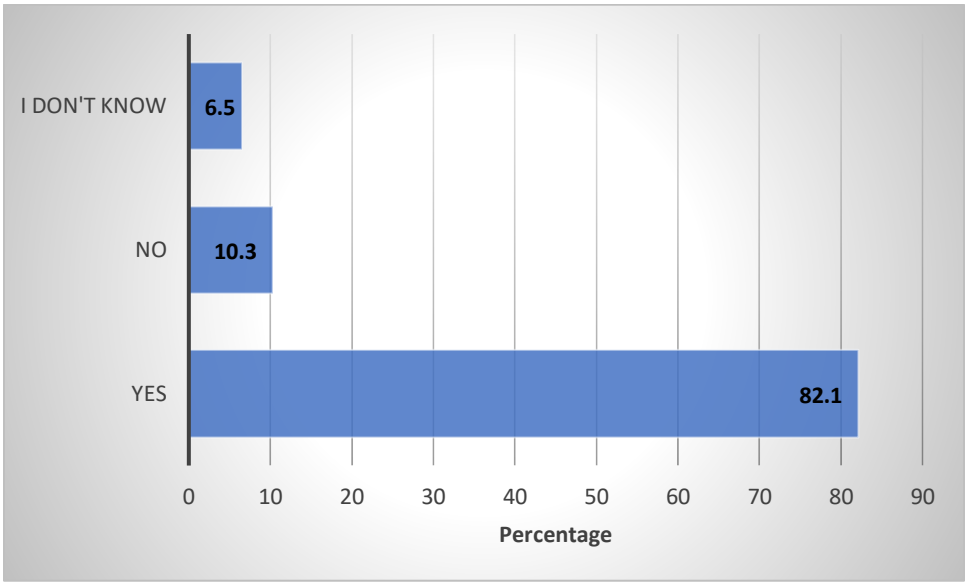

Figure 4: Do you think pesticides are indispensable for high crop yield?

The result in Figure 5 shows that 95% of the farmers prefer to make use of pesticides with labels not because they can read them but they belief when a pesticide has label then it is original.

However, they do not read nor understand what is written on the labels hence, they cannot comply by the instructions on it.

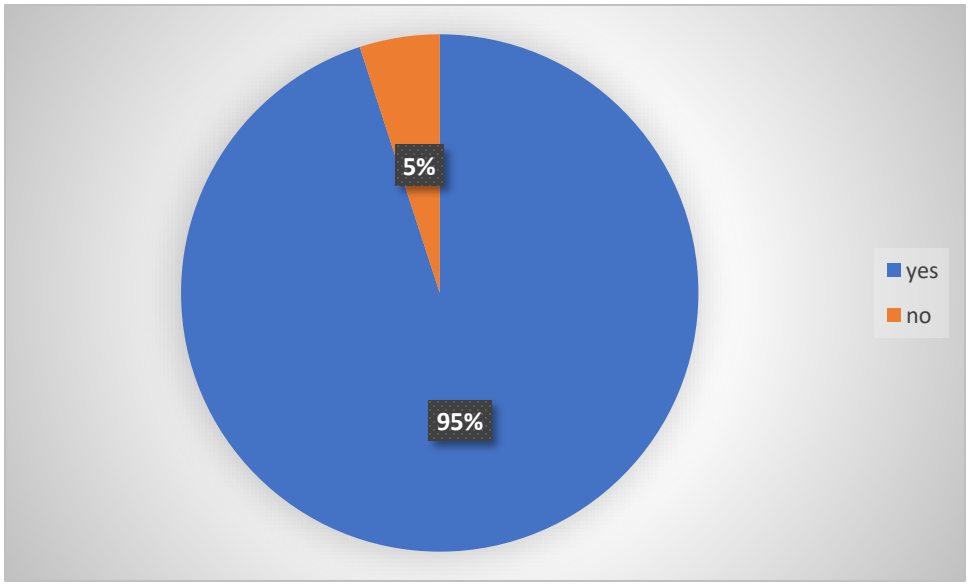

Figure 5: Do you prefer pesticides with labels or without labels?

This is in agreement with the findings of Damalas & Khan (2016) that explains that majority of farmers purchased pesticides with their original containers that has the label written with instruction on how to apply pesticides to the crops but lack of ability to read the instructions has led many farmers to misuse or overspray pesticides on crops.

4.2 Pesticides knowledge description

According to the result in Table 4, respondents are more knowledgeable with questions pertaining to i: eating while spraying pesticide is not a problem (85.9%); ii: there is no problem with children spraying pesticides (70.5%); iii: washing hands immediately after spraying is important (94.2%) iv: some pesticides are extremely dangerous to the health (73.7%); v: inhaling pesticides could lead to sickness (89.1%) vi: stirring of pesticides with bare hands could lead to skin irritation (80.1%) vii: showering immediately after spraying pesticide is necessary (90.4%); viii: blowing sprayer nozzle with the mouth is not a problem (72.4%). The farmers have relatively low knowledge in i: empty bottles of pesticides can be used for storage of drinking water (48.7%); ii: the direction of the wind whilst spraying is not important (46.2%); iii: the dosage of pesticides

must be precisely calculated (44.9%); iv: pesticides may be stored at the rooftop of the house (34.6%);

v: excessive use of pesticides can cause damage to the soil (44.2%); vi: buckets used for bathing can also be used in mixing pesticides (34%).

It is interesting that farmers possess knowledge pertaining to the question "following instruction written on labels is important" (55.8%) but majority of the respondent cannot read the instructions written on the label and therefore cannot follow them.

Table 4: Descriptive result of pesticide knowledge (N=156), 2019.

Question	Correct (%)
Eating while spraying pesticides is not a problem	85.9
Empty bottles of pesticides can be used for storage of drinking water	48.7
There is no problem with children spraying pesticides	70.5
Washing hands after spraying is important	94.2
The direction of the wind whilst spraying is not important	46.2
Following the instruction written on labels is important	55.8
Some pesticides are extremely dangerous to health	73.7
The dosage of pesticides must be precisely calculated	44.9
Inhaling pesticides could lead to sickness	89.1
Pesticides may be stored in the rooftop of the bedroom	34.6
Excessive use of pesticides can cause damage to the soil	44.2
Stirring of pesticides with bare hands could lead to skin irritation	80.1
Blowing sprayer nozzle with the mouth is not a problem	72.4
Showering immediately after spraying pesticide is necessary	34.0

4.2.1 Socio-demographic and source of information about pesticides used in regression model

The variables used in the Linear regression model shows that the minimum score for knowledge of pesticides among respondents is 3 while the maximum score is 14 with mean of 9.35 and a standard deviation of 2.86. The minimum age is 29 while the maximum age is 60 with mean of 2.41 and standard deviation of 1.35.

The minimum household size is 1 while the maximum household size is 1 while the maximum household size is 15 with a mean of 8.40 and standard deviation of 2.61. The minimum level of education is 1 while the maximum is 6 with a mean of 2.44 and standard deviation of 1.41.

The minimum years of experience among respondents is 2 while the maximum is 40 with the mean of 14.62 and standard deviation of 8.72. The minimum hectares of land among respondents is 1 while the maximum is 10 with mean of 3.23 and standard deviation of 1.22.

Farmers who are trained by extension workers on pesticides usage had their minimum at 1 and their maximum at 3 with the mean of 1.71 and standard deviation of 0.858. Furthermore, the minimum of farmers who believes that training on danger of pesticides is important is 0 while the maximum is 3 with mean 1.17 and standard deviation of 0.49. The minimum of respondents that got their source of information from extension officers is 0 while the maximum is 3 with mean of 2.29 and standard deviation of 0.85.

Respondents who relied on distributor (sellers) of pesticides as information source were 0 at minimum while the maximum is 3 with mean of 2.03 and standard deviation of 0.73. The minimum of farmers who got their information from other farmers is 0 and the maximum is 3 with a mean of 2.78 and standard deviation of 0.57. Those who relied on government agencies have their minimum at 0 while the maximum is 3 with mean of 1.82 and standard deviation of 0.774. Those who relied on previous knowledge as a source of information have their minimum at 1 and their maximum at 3 with a mean of 2.83 and standard deviation of 0.46.

The minimum of respondent using the mass-media as a source of information is 0 while the maximum is 3 with a mean of 2.46 and a standard deviation of 0.67. The minimum of respondents that relied on the label of pesticides for information is 0 and the maximum is 3 with a mean of 2.12 and standard deviation of 0.83.

4.2.2 Pesticides commonly used by respondents

According to the result shown in Figure 6, 55.13% of the respondents prefers the pesticide DDForce which accounted for the most used pesticides among the respondents interviewed.

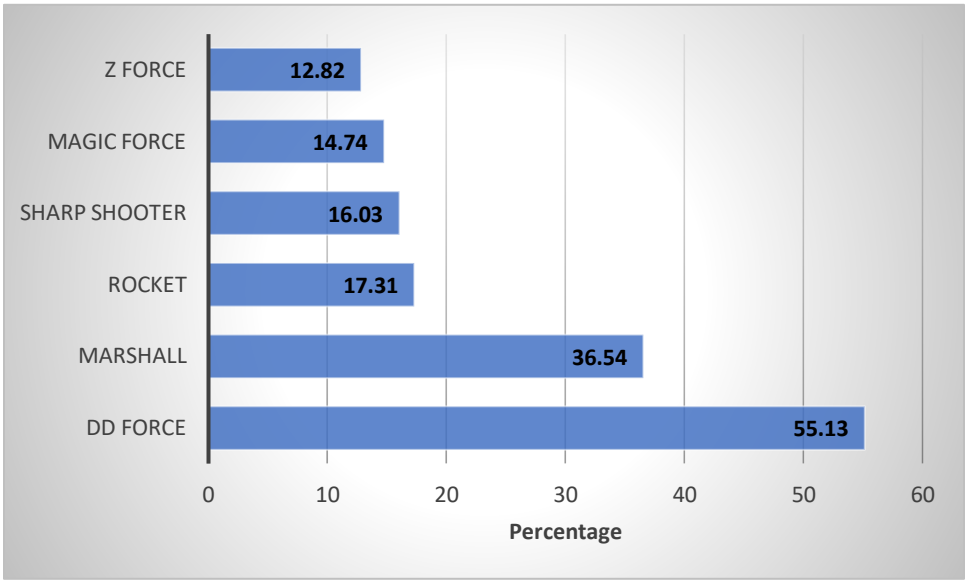

Figure 6: Share user of brand of pesticides used

Marshall accounted for 36.54% of the pesticides commonly used among pesticides for crop yield, 17.31 of the respondents prefer to make use of the pesticides called rocket while 12.82% of the respondents preferred to make use of Z-force.

55.8% of the respondents apply pesticides 1-3 times within a growing season, 39.1% of the respondents apply pesticides 4-6 times within a growing season while 4.5% of the respondents apply pesticides 4-6 times within a growing season. This agrees with the findings of Oesterlund et al. (2014) whose result revealed 1-7 times as the average spraying time of pesticides by farmers.

However, majority of the farmers could not differentiate between herbicides, fungicides, rodenticides and insecticides which made them apply them to crops inappropriately.

It is quite interesting to find out that 60.9% of the respondents do not know that some pesticides are banned for use which put them at the risk of purchasing those pesticides hence exposing themselves to the danger that accompanies the toxicity. This agrees with the finding of Koyi et al. (2017) and Jallow et al. (2017) who explained that most farmers do not know that certain pesticides have been banned for use but unfortunately, they still have access to it in the market.

4.3 Level of knowledge and factors affecting knowledge

The result of Multiple Linear Regression Table 5 shows that the level of education of a farmer has a statistically significant impact on the education of the respondent. The positive regression coefficient of 1.127 implies if a farmer attains a level higher in education, then there will be a significant increase in the knowledge of pesticides.

Table 5: Multiple linear regression result

Variable	Coefficient	Std.Err.	t-test	p-value
Gender	-0.472	0.386	-1.224	0.233
Age	0.505	0.067	0.473	0.659
Educational level	1.127	0.157	7.158	**0.000**
Years of experience	-0.003	0.021	-0.148	0.883
Total hectares of land	0.013	0.137	0.096	0.924
Total household size	-0.023	0.068	-0.337	0.737
Extension workers	-0.504	0.208	-2.422	**0.017**
Distributor of pesticides	0.295	0.248	1.191	0.236
Government agencies	0.242	0.234	1.036	0.302
Other farmers	0.678	0.316	2.146	**0.034**
Label of Pesticides	0.062	0.214	2.903	**0.004**
The media	0.006	0.278	0.020	0.984
Previous knowledge	-1.161	0.388	-2.994	**0.003**
Constant	7.150	1.738	4.115	**0.000**
F-value	15.432			
R^2	0.592			

****= significant at p<0.05 and ***= significant at p<0.01**

This corroborated the finding of Bagheri et al. (2019) explaining that the knowledge of farmers is the most significant factor which affects their attitudes towards the usage of pesticides. Also Mubushar et al. (2019) explains that literate farmers have better understanding and knowledge about pesticides compared to the illiterate farmers.

The result in Table 5 shows a negative coefficient of -0.504 at a $p<0.05$ which means an increase in the trainings given by the extension workers to the farmers, the less receptive they are to acquiring knowledge. This is quite interesting because trainings with the extension workers is supposed to increase their knowledge about pesticides. This could be attributed to the fact that most are unhappy with the government and since most of the extension workers are from the government, they become less receptive to adopting new techniques as well as turning to them as a source of information.

This corroborated the findings of Rahman & Chima (2018) who explains that farmers exposure to trainings by the extension workers have no significant impact in increasing the knowledge of pesticides and help them have with improved handling practices. Furthermore, the findings of Rijal et al. (2018) that was carried out in Nepal revealed that most farmers chose to depend on other sources of information like the Agro-vets who did not have sufficient knowledge of pesticides rather than the extension workers provided by the government.

As revealed in Table 5, government agencies as a source of information has no statistically significant impact on the knowledge farmers as most farmers had lost faith in the government and are reluctant to receiving advise from anyone from the government. However, they prefer to turn to other farmers for information on pesticides to be used. According to the result in Table 5, other farmers as a source of information is significant at $p<0.05$. This corroborated the findings of Wang et al. (2018) explaining in his result that about 57% of respondents strongly agreed that they trust and help each other which means that whenever any of the farmers seek information about pesticides from his/her neighbor, they trust that their information is valid.

It is interesting that though farmers do not understand what they read on labels of pesticides; they still believe it is a good source of information for them as it has a statistically significant impact on the knowledge of farmers with a positive coefficient of 0.062 at a $p<0.05$. The media as an information had no statistically significant impact on the regarding pesticides knowledge of farmers. This contradicts the findings of Yang et al. (2014) whose results revealed that farmers learned about pesticides through the media which had a statistically significant on their knowledge of pesticides.

The result in Table 5 shows a negative coefficient of -1.161 at $p<0.05$ which implies that the more farmers rely on their previous knowledge of pesticides, the less they know because most of these pesticides may have been banned for usage. Also, it implies that farmers need to get themselves updated about pesticides.

4.4 Handling practices of farmers regarding usage of pesticides

According to the result shown in Figure 7, 56.1 of the respondents applies leftover (mixed, diluted) pesticides on other crops, 28.1% of the respondents disposed pesticides in the field , 4.1% disposed pesticides in sewer while 2.3% of the respondents disposed pesticides in hazardous waste site.

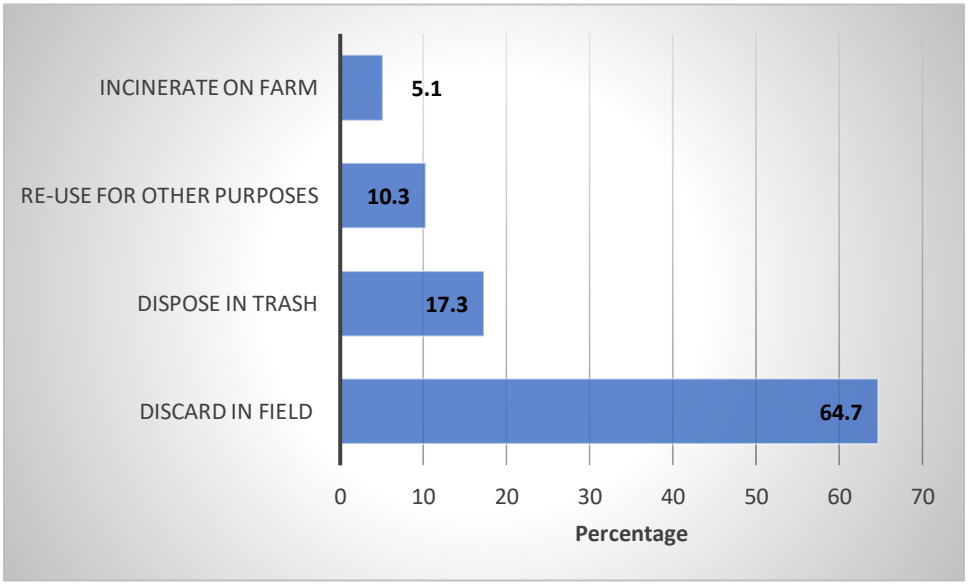

Figure 7: What do you do with leftover (mixed, diluted) pesticides?

This result agrees with the findings of Mohanty et al. (2013) who revealed that one-third of the respondents, disposed their leftover pesticides in the field. The danger of this attitude among farmers is that applying leftover pesticides to others crops could be exposing the consumers to poisoning neither is disposing them on the field a good practice as children could face the risk of exposure as well as the farmers because it exposes them to toxicity which could translate to health problems as many literatures have revealed.

Figure 8 reveals that 64.7% of the respondents discards empty containers of pesticides on their farmland, 17.3% of the respondents dispose the empty containers of pesticides in trash containers, 10.3% of the respondents re-use the empty containers for other purposes such as drinking water and 5.1% of the respondents incinerate the empty containers on the farm.

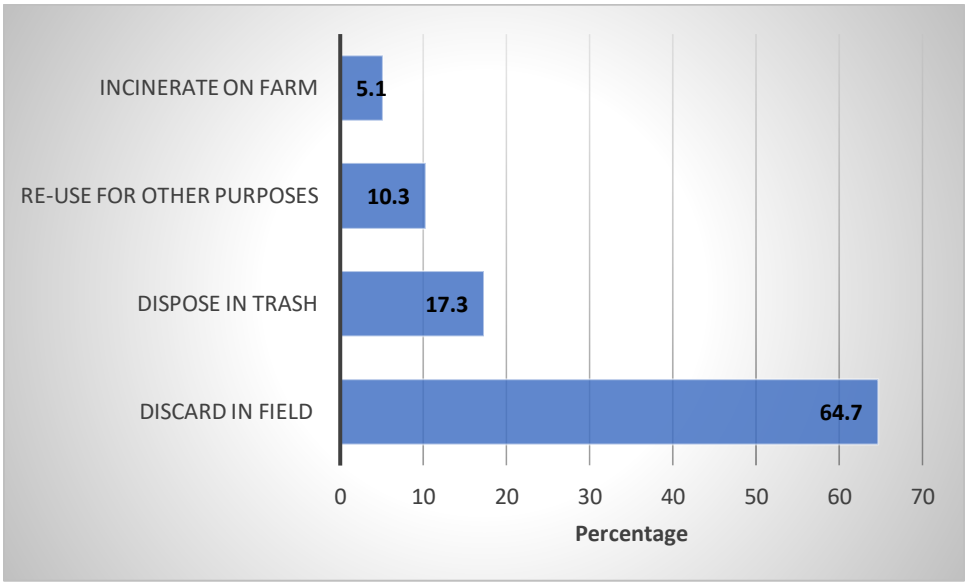

Figure 8: What do you do with empty pesticides containers?

This result contradicts the findings of Damalas & Koutroubas (2017)who in his results revealed that most of the respondents disposed empty containers of pesticides following the guidelines of disposal written on labels as only a few disposed the empty containers wrongly.

In the result as shown in Figure 8, majority of the farmers disposed the empty containers wrongly. Discarding empty bottles of pesticides on farmland could be dangerous especially in the study area whereby children always accompanied their parents to the farm. A child could pick the empty container laying on the farm and use it to fetch drinking water which endangers the child and put the child at risk.

Empty bottles of pesticides are not to be re-use for other purposes. Although, only 10.3% of the respondents admitted to re-use of empty containers as compared to the findings of Oluwole & Cheke (2009a) who revealed that 74.7% of the respondents re-use empty pesticides containers.

The result in Figure 9 that 48% of the respondents never make use of coverall while spraying pesticides, 40% of the respondents sometimes make use of coverall while spraying and just 12% of the respondents make use of coverall while spraying pesticides.

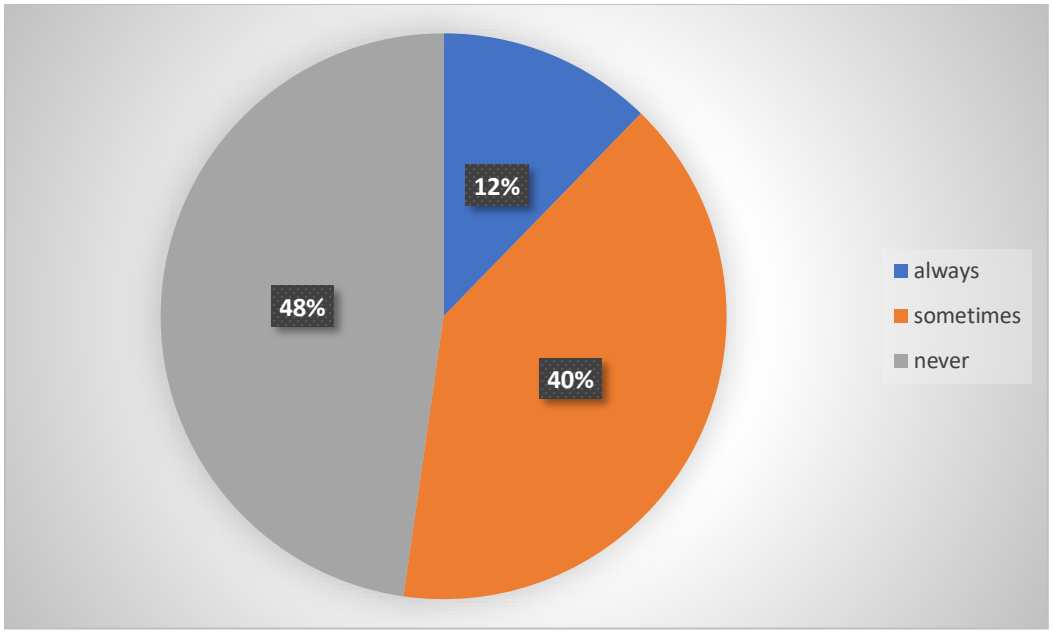

Figure 9: How often do you use personal protective equipment? (Coverall)

This is quite unfortunate because farmers who do not use coverall while spraying are at higher risk of skin problems due to the toxic nature of pesticides. Yarpuz-Bozdogan (2018) explained in his research the importance of wearing coverall while farmers spray pesticides and recommended that farmers should purchase re-usable coverall which are cost effective.

The result shown in Figure 10 reveals that 17% of the respondents always make use of gloves while mixing and spraying pesticides, 24% of the respondents never make use of pesticides while mixing or spraying pesticides while 59% of the respondents sometimes make use of pesticides while mixing or spraying pesticides.

This result corroborated the findings of Ndayambaje et al. (2019) when he carried out a similar research in Rwanda. According to the result of his findings, 92.7% of respondents mixed pesticides with their bare hands and do not make use of glove while spraying pesticides.

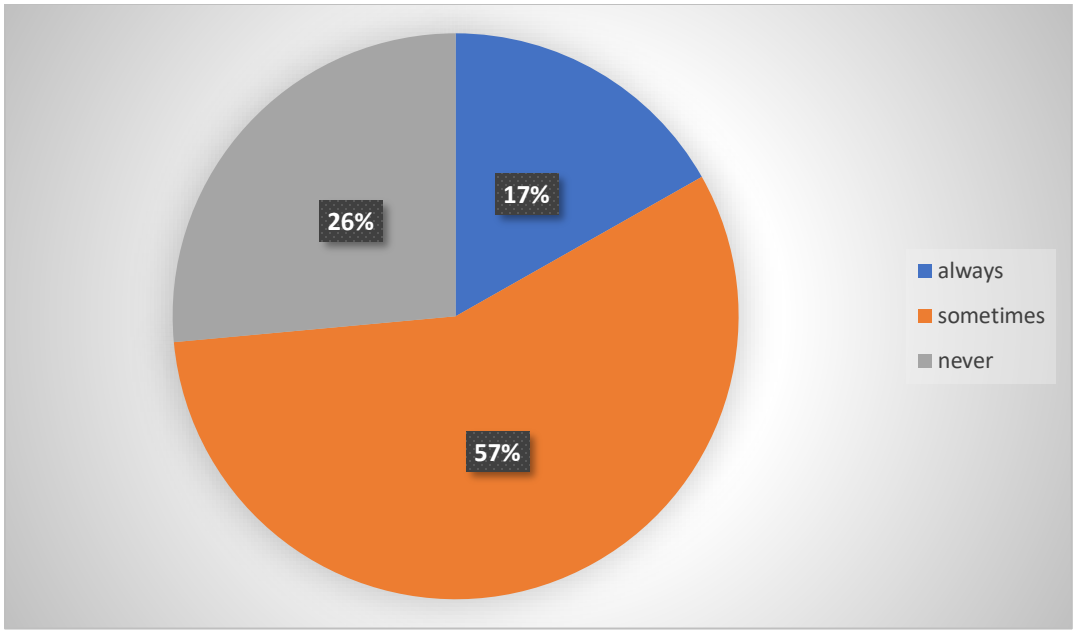

Figure 10:How often do you use personal protective equipment? (Gloves)

The implication of this practice is high possibility of skin irritation and poisoning as there could be retention of pesticides residuals even after washing of hands since eating with the bare hands is a common habit in the study area.

According to the result in Figure 11, it is revealed that only 17% of the respondents always make use of nose mask while spraying pesticides, 26% of the respondents never make use of nose mask while spraying pesticides while 57% of the respondents sometimes make use of pesticides while spraying.

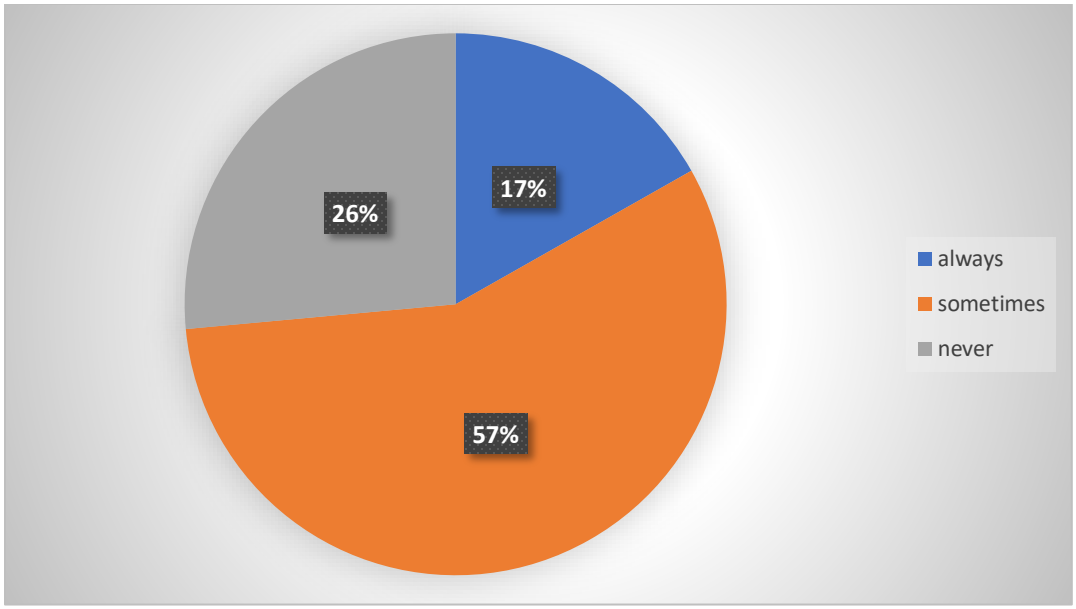

Figure 11:How often do you use personal protective equipment? (Nose mask)

This corroborated the findings of Oesterlund et al. (2014) who conducted a similar research in Uganda. According to the results of her findings, she explained that only 39% of the total respondents make use of nose mask while spraying pesticides. The implication is that most farmers are at the risk of inhaling pesticides which is toxic to the system and hence lead to dizziness, vomiting and respiratory difficulties as recorded is several literatures.

According to the result in Figure 12, 57% of the respondents do not wear boots while spraying pesticides, 36% wear boots while spraying sometimes while only 7% wear boots always whilst spraying.

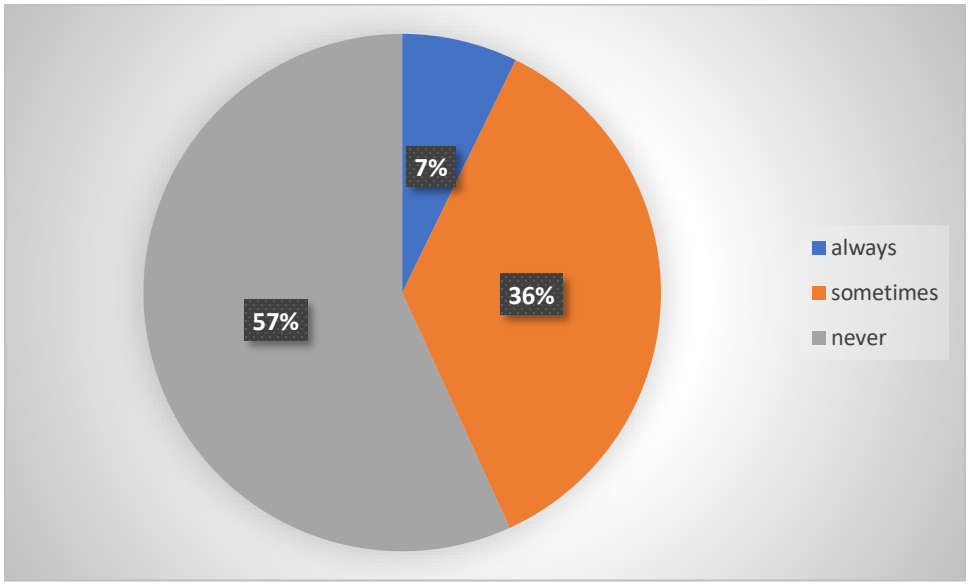

Figure 12:How often do you use personal protective equipment? (boots)

This result agrees with the findings of Tambe et al. (2019) conducted in Cameroon and the author's result revealed that majority of the respondents do not make use of personal protective equipment whilst spraying pesticides. Based on the author's findings, only 12.5% of the respondents interviewed used safety boots whilst spraying pesticides.

This result also agrees with the findings of Nguemo et al. (2019) that conducted a similar research In Cameroon and cited 10.8% of the respondent interviewed wore safety boots while spraying pesticides on their farmland.

This result contradicts the findings of Rijal et al. (2018) conducted in Nepal and revealed that 52% of the respondent used personal protective equipment such as safety boots while spraying pesticides.

It is worthy of note that some farmers in Nigeria make use of slip-on whilst spraying thereby exposing their skin to toxicity which translates to skin irritation due to the harsh nature of pesticides.

Under no circumstances should a farmer expose any body part whilst spraying pesticide because it will not only affect their skin, but internal organs could also be damaged in the process.

The result in Table 6 reveals the reason most farmers do not make use of personal protective equipment. Most of the farmers blamed it on their economic situation as 59% of the respondents termed being expensive as their most important reason for not making use of personal protective equipment.

Table 6: Reason for not using personal protective equipment

Reason	Very important reason (%)	Most important reason (%)	Less important reason (%)
Uncomfortable	3.8	34	5.8
Heavy	1.3	17.3	16
Expensive	5.1	59	5.8
Not necessary	3.2	41	12.8

41% of the respondents believe it is not necessary to make use of personal protective equipment while 34% of the respondents refuse to make use of it because it makes them uncomfortable and hinders their productivity.

This result corroborated the findings of Ajayi et al. (2007) conducted in Côte d'Ivoire. The author's result revealed that most farmers blamed their lack of money for their inability to purchase personal protective equipment. They also blamed the hot weather as they get uncomfortable in the personal protective equipment when working. It also agrees with the findings of Mohammed et al. (2018) that conducted a similar study and the result of his study revealed that almost 60% of the farmers believe it is unnecessary to wear protective gears whilst spraying pesticides.

The findings of Damalas et al. (2019), explained that there is a distinction between farmer's perception of safety and safety behavior. This implies that farmers may have the knowledge of the danger that might occur from exposure but still not practices safety measures whilst spraying pesticides.

This result is quite unfortunate because farmers will choose to purchase pesticides than protect themselves from it using protective gears. They will choose productivity over protection which costs them more than they even know.

However, most farmers do not know is they are exposed to different ailments that will incapacitate them from productivity in the long run because once a farmer is sick, he or she cannot work on the farm land which end up affecting food supply for their family and eventually the whole of the agricultural sector.

4.5 Limitation of the study

This research was conducted on smallholder farmers in Ogun state, Nigeria, in local government areas of the state, therefore it cannot represent other smallholder farmers in the rest of the world or used to make generalization of other local government areas in the rest of the state.

It is worthy of note that result is prone to unavoidable bias as data was collected through self-reporting by smallholder farmers.

5 Conclusion

The result of the socio-economic characteristics of the smallholder farmers revealed the level of education of farmers has a statically significant impact on the knowledge of pesticides and the handling practices while gender, age, total hectares of land, years of experience and total household size had no statistically significant impact on the knowledge of smallholder farmers and their handling practices.

The sources of information used by farmers according to the results of the regression has a statistically significant impact on the knowledge and handling practices of smallholder farmers. One of the most unexpected results of this findings is that the trainings given by the extension workers has a negative impact on the knowledge of farmers and farmers refuse to turn to them for advice on the kind of pesticides to use.

Based on the interview conducted for the findings, most farmers spoke about how they have lost fate in the government and everything that has to do with it because of the promise and fail syndrome. Also, many farmers are unresponsive to changes and when advised differently from what they have been used to, they almost refuse it or not accept it at all.

As compared to other studies, distributors of pesticide (sellers of pesticides) have not significant impact as most of the respondents termed them as not being helpful with information at the time of purchase.

However, other farmers had a statistically significant positive impact in the knowledge of pesticides as most smallholder farmers believes in the advice a fellow farmer gives. This could be attributed to the trust and community cooperation among farmers.

Another interesting result is the fact that the media has no statistically significant impact on the knowledge of pesticide as many of the farmers are rural dwellers who might not have access to electricity in order to listen or watch what is going on the media. This is different from other studies where mass-media has an impact on the knowledge of pesticides among smallholder farmers.

The label of pesticides interestingly has a statistically significant positive impact on knowledge and handling practices of smallholder farmers. Although, most of the farmers cannot read and understand the words written on the labels but understand the symbols like danger symbol represented with the skull which explains that it is a harmful product.

Perceived previous knowledge has a negative impact on the knowledge of pesticides and handling practices among smallholder farmers. One explanation can be that several pesticides that might have been banned that are still being used by the farmers. This can be attributed to the farmers' attitude of being unresponsive to change which is not helpful.

In a bid to improve pesticides knowledge and handling practices among smallholder farmers, we will recommend that farmers should be encouraged to form cooperative and farmers who have better knowledge of pesticides should be encouraged to train other farmers on how to better handle pesticides.

It is important to train farmers about the adverse effect pesticides have on the soil. In order to increase productivity, majority of the farmers do not bother about the dosage of pesticides to be applied to the crop, in fact many of the apply pesticides to the crop 4-6 times before harvest.

The effect this has on the soil is that it kills the organisms that are essential for the crops to grow and it also weakens the soil. A weak soil will produce less which translates to less productivity that could result in food scarcity.

Also, the government or the pesticides producing and selling companies should assist farmers with personal protective equipment and credit that will give most farmers the opportunity to protect themselves from exposure to the toxicity that accompanies pesticides usage.

It is important for government agencies such as NAFDAC to ensure that pesticides that are banned shouldn't be sold in retail shops and see to it that distributors (sellers) are properly trained and up to date with the pesticides that cannot make it to their shelves. It is important to make them understand the implication of selling pesticides that have been banned as they could lead to food poisoning when applied on the crops not only for the farmer but also for consumers.

Another reason for proper training of sellers of pesticides is, it will give them the opportunity of assisting farmers whilst they purchase pesticides as it will have a better impact on the farmers and improved attitude because they will be given proper advice on the kind of pesticide to purchase and the one to avoid rather than purchasing based on past experiences which might no longer be relevant.

Since most of the label on pesticides containers come in English, we will recommend that on importation, they should be repackaged with the three major languages in the country so that

farmers can easily understand what is written on the containers and will have adequate knowledge which will translate to better handling practices among them. The pictogram of illiterate farmers also needs to be used.

Farmers should also be trained on the level of harm lack of protective gear could cost them. Not only could it harm them physically, their internal organs are also at risk of damage due to continuous inhaling of pesticides.

We will also recommend that the mass media should be used as a medium of communication by encouraging farmers to tune into radio stations with their mobile phones where educative and informative program will be done in the native languages spoken by farmers explaining the importance of personal protective equipment and interpreting labels written in English language to their native languages.

In further studies, it would be relevant to compare the level of knowledge of pesticides among farmers with higher knowledge of pesticides with actual application of the knowledge they have acquired and the influence they have on other farmers that have less knowledge about pesticides.

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Appendices

List of the Appendices:

Appendix 1: Description of the dependent (Knowledge) and independent variables imported into the multiple linear regression model (N=156), Ogun state, Nigeria, 2019.

Dimension	Description	Min	Max	Mean/SD
Knowledge	Knowledge of farmers	3.00	14.00	9.35(±2.86)
Independent variables				
Gender	Measured using dummy variable, 0 is given to male and 1 to female.	0	1	0.23(±0.42)
Age	The age of the responded, measured as a continuous variable.	1	5	2.41(±1.35)
Education	A total number of years that the respondent has spent in school, measured as a continuous variable.	1	6	2.44 (±1.41)
Farming experience	A total number of farming experience, measured as a continuous variable	2	40	14.62 (±8.716)
Household size	The number of members per household, measured as a	1	15	8.40 (±2.61)

	continuous variable			
Total hectares of land	The total hectares of farmland, measured as a continuous variable	1	10	3.23 (±1.22)
Extension workers train on pesticide usage	Training given by extension workers to farmers on pesticide usage, measured as ordinal	1	3	1.71 (±0.86)
Trainings on danger of pesticides is important	The importance of training on the danger of pesticides, measured as dummy variable where 0 is assigned to no while 1 assigned to yes	0	3	1.17 (±0.49)
Distributor of pesticides	Distributor of pesticides as a source of information on pesticides important to farmers before purchasing pesticides	0	3	2.05 (±0.73)
	Government agencies as a source of	0	3	1.82 (±0.77)

Government agencies	information on pesticides important to farmers before purchasing pesticides, measured as continuous variable			
Other farmers	Other farmers as a source of information on pesticides important to farmers before purchasing pesticides, measured as a continuous variable	0	3	2.78 (±0.57)
Label of pesticides	Label of pesticides as a source of information on pesticide important to farmers before purchasing pesticides, measured as a continuous variable	0	3	2.12 (±0.83)

Previous knowledge	Previous knowledge as a source of information on pesticide important to farmers before purchasing pesticides, measured as a continuous variable	0	3	2.83 (±2.83)

Appendix 2: Descriptive result of personal protective equipment

Item	Mean	SD
Coverall	2.08	0.94
Respirator	2.63	0.74
Nose mask	1.66	0.85
Gloves	1.70	0.86
Hat	2.31	0.89
Boots	2.21	0.94

Appendix 3: Descriptive result of reason for not wearing personal protective equipment

Item	Mean	SD
It makes me uncomfortable	1.35	0.71
It is too heavy	1.96	0.99
It is too expensive	1.24	0.95
It is not important	1.51	0.84

Appendix 4: Descriptive result of attitude of farmers towards usage of pesticides measured as continuous variable

Item	Mean	SD
Do you think pesticide is indispensable for high crop yield?	1.25	0.599
How many types of pesticides have you apply on your farmland within the last two years?	2.01	0.71
Do you read and understand instruction written on labels?	1.65	0.65
Do you think spraying of pesticides has an adverse effect on soil and water	1.67	0.702
Do you think trainings on the danger of pesticides is important?	1.17	0.493
Do you prefer to make use of labelled pesticides instead of those without the label?	1.05	0.221
Have the instructions written on the label been helpful?	2.01	0.902
Are you aware that some pesticides are banned for use?	1.64	0.51
How important is price for your decision to select pesticides?	2.67	0.991

Appendix 5: Study Questionnaire

Czech University of Life Sciences Prague
Faculty of Tropical AgriSciences

INTRODUCTION

Dear Sir/Madam,

I would like to ask you to fill in the following questionnaire. I am a student at the Czech University of Life Science in Prague, and I am conducting this study to learn more about the ***pesticides handling knowledge and practices of smallholder farmers in Ogun state, Nigeria***.

All the data are collected anonymously. The filling would only take a few minutes. I would appreciate very much if you would fill in and help me to conduct this research.

Thank You!

Name of LGA ……

Name of Community ……..

SECTION A: HOUSEHOLD HEADS SOCIO-DEMOGRAPHIC AND FARM CHARACTERISTICS

1. Gender
   (a) Male (b) Female
2. Age

(a) < 29 (b) 30-39 (c) 40-49(d) 50-59(e) ≥60

3. Educational level
   (a) None formally (b) Primary (c) Secondary (d) Diploma ND/HND (e) NCE (f) Bsc (g) Post-graduate
4. How many years of farming experience do you have? _____

5. What is your household size?

Children >15 years	Adults (16-59) years	Retired (60+) years	Total

6. How many hectares is your farmland? _____
7. Did you receive governmental support in the last five years? (a) Yes (b) No
8. How often do you get credit? (a) Never (b) Seldom (c) Sometimes (d) Very often
9. Do you make use of pesticides? _____ (a) Never (b) Rarely (c) often (d) very often
10. If you make use of pesticides, what is the quantity you apply? (a) small quantity (b) medium quantity (c) large quantity
11. In what quantity do you purchase pesticides? (a) In large quantity for future use (b) I only purchase what I need
12. Has the government provided you with free pesticides in the last five years? (a) Yes (b) No
13. Please answer the following questions if you make use of pesticides.

Crops cultivated		Number of times applied in farming season				Brand of Pesticide used	Most dangerous pest
		Seldom (1-3 times in a month)	Sometimes (1-2 days in a week)	Often (3-6 days in a week			
Fruits							
Vegetables							
Cocoa							
Kolanut							
Maize							
Others							

14. Do you prefer to make use of labelled pesticides instead of those without the label? (a) Yes (b) No

SECTION B: USE OF PESTICIDES

Please tick the correct answer according to your opinion

	Agree	Disagree	I don't know
Eating while spraying pesticide is not a problem			
Empty bottles of pesticides can be used for storage of drinking water			
There is no problem with children spraying pesticides			
Washing hands after spraying is important			
The direction of the wind whilst spraying is not important			
Following the instructions written on labels is important			
Some pesticides are extremely dangerous to health			
The dosage of pesticides must be precisely calculated before application			
Inhaling pesticides could lead to sickness			
Pesticides may be stored in the rooftop of the bedroom			
Excessive use of pesticides can cause damage to the soil			
Stirring of pesticides with bare hands could lead to skin irritation			
Blowing sprayer nozzle with the mouth is not a problem			
Showering immediately after spraying pesticide is necessary			
Buckets used for bathing can also be used in mixing pesticides			

SECTION C: INFORMATION OF FARMERS REGARDING USAGE OF PESTICIDE

1. Are you aware that some pesticides are banned for use? (a) Yes (b) No
2. Do you think pesticide is indispensable for high crop yield? (a) Yes (b) No (c) I don't know
3. How many types of pesticides have you apply on your farmland within the last two years? _____
4. Do you read and understand instruction written on labels (a) Yes (b) No (c) Sometimes
5. Have the instructions written on the label been helpful? (a) Yes (b) No
6. Do extension workers train you on pesticides usage? (a) Often (b) Rarely (c) Never
7. Do you think trainings on the danger of pesticides is important? (a) Yes (b) No
8. Which of sources of information about pesticides are important to you?

	Not important	Less important	Neutral	Very important	Very important
Extension officers/workers					
Distributor of pesticides					
Government agencies					
Other farmers					
The label of pesticides					
The media (radio, television, internet)					
Previous knowledge					
Others please specify					

9. Do you think spraying of pesticides has an adverse effect on soil and water (a) agree (b) disagree (c) I don't know

SECTION D: HANDLING PRACTICES OF FARMERS

Where did you store pesticides?

Living area within reach of children	
Living area without reach of children	
Open shed just with pesticides	
Refrigerator with other food items	
Refrigerator without other food items	
Animal house	

Others please specify _____

What do you do with empty pesticides containers?

Discard on-farm	
Dispose in trash containers	
Re-use for other purposes	
Incinerate on farm	
Bring to hazardous waste collection sites	
Selling of empty containers	

Others please specify _____

What do you do with unused leftover (mixed, diluted) pesticides if you have some?

Dispose in the field	
Apply on other crops	
Dispose in sewer	
Bring to hazardous waste collection sites	

Please tick the correct boxes

How often do you use personal protective equipment?

Protective Equipment	**Always**	**Sometimes**	**Never**
Coverall			
Respirators			
Nose mask			
Gloves			
Hats			
Boots			

Others please specify _____

If you do not use, what is the reason?

Reasons	Very important reason	Most important reason	Less important reason
It makes me uncomfortable			
It is too heavy			
It is too expensive			
It is not important			

Appendix 6: Photo documentation of interview conducted