UNIVERSITY FOR DEVELOPMENT STUDIES

ASSESSMENT OF THE USE OF AGRO-CHEMICALS BY SMALLHOLDER FARMERS IN THE NADOWLI-KALEO DISTRICT

APPIAH-KUBI, KWAME DAVID SEREBOUR

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BY

APPIAH-KUBI, K. D. SEREBOUR

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[THESIS SUBMITTED TO THE DEPARTMENT OF ENVIRONMENT AND RESOURCE STUDIES, FACULTY OF INTEGRATED DEVELOPMENT STUDIES, UNIVERSITY FOR DEVELOPMENT STUDIES, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN ENVIRONMENT AND RESOURCE MANAGEMENT]

JANUARY, 2019

DECLARATION

Candidate's declaration

I Appiah-Kubi K.D.Serebour hereby declared that this thesis is my own work and a result of my own investigation. All the sources that I have used or quoted have been indicated and acknowledged by means of complete references. To the best of my knowledge, this work has not been submitted before for any degree in this University or elsewhere:

Candidate's Signature: …….. Date: ……..

Name: Appiah-Kubi K. D. Serebour

Supervisor's declaration

I hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines on supervision of dissertation/thesis laid down by the University for Development Studies.

Supervisor's Signature: ……. Date: …….

Name: Dr. Kenneth Peprah

DEDICATION

This thesis is dedicated to my lovely mother Madam Yaa Ameyaa and my brother Pastor Anim Addo for their care, love and financial support throughout my education.

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ABSTRACT

Agriculture serves as a valuable source of income, contributing to poverty reduction. The study set out to assess the use of agro-chemicals by smallholder farmers in the Nadowli-Kaleo District in the Upper West Region of Ghana. The study utilized the Expected Utility Theory (EUT), Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB) and the Rational Choice theory (RCT). The study adopted mixed method design. Primary data were collected through questionnaire, interview guide, Focus Group Discussions and Observation guide. In all a total of 187 participants from 3 communities and 4 officials were interviewed. Data collected were processed and analysed with the Statistical Package for Social Scientists (Descriptive Statistics and Crosstabs). The findings of the study present, the type of chemicals used has a direct linkage with the type of crops cultivated by farmers. Farmers in the District only use fertilizers, pesticides and weedicides on large scales which is attributed to the type of crops farmers cultivate in the District. Additionally, the findings show that respondents use agro chemicals because it improves crop yield. Farm size was a major reason why farmers used agro-chemicals. However, high costs of labour, duration of raining season, non-availability of household labour were some of the reasons most farmers do not utilize agro-chemical. It was observed that some of the high crop yield was found to be highly perceived and observed to have impact on agro-chemical usage. Also, it was found that farmers use disposal methods such as; burning, burying, and dumping in the farm, throwing them in the bush, returning them to chemical dealers and keeping them at home. The study concluded that agro-chemical use has impacted positively on crop yield. It is however recommended that the Ministry of food and Agriculture (MOFA) should send more extension officers to the District to aid farmers. The Environmental Protection Agency (EPA) should also regulate agro-chemicals sellers.

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LIST OF ABBREVIATIONS

AEAs	Agricultural Extension Agents
AU	African Union
DDT	Dichloro Diphenyl Trichloroethane
EKC	Environmental Kuznets Curves
EUT	Expected Utility Theory
FAO	Food and Agriculture Organisation
FFTC	Food and Fertilizer Technology Center
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
GSS	Ghana Statistical Service
IEEP	International Environmental Education Program
IFAD	International Fund for Agricultural Development
KII	Key Informants Interview
MOFA	Ministry Of Food and Agriculture
NKDA	Nadowli-Kaleo District Assembly
PHC	Population and Housing Census
PNDC	Provisional National Defense Council
RCT	Rational Choice Theory
SEM	Structural Equation Modelling
SRID	Statistics, Research and Information Directorate

TRA	Theory of Reasoned Action
TPB	Theory of Planned Behavior
UN	United Nations
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Global agricultural production has kept pace with population growth over the past 50 years, mainly due to intensification associated with the 'green revolution' (Royal Society, 2009) and expansion into previously uncultivated areas (Green et al. 2005; Ramankutty et al. 2008). Despite global gains in production, access to food remains unevenly distributed. As a result, 870 million people remain food insecure, with many more suffering from 'hidden hunger' caused by micronutrient or protein deficiencies (Graham et al. 2007; Keatinge et al. 2011; FAO 2011; Khush et al. 2012).

Agriculture serves as a valuable source of income, contributing to poverty reduction. This is as a result of the employment that it offers. Seventy-five per cent of people live in rural areas of developing countries, especially sub-Saharan Africa and southern Asia (UN 2011; IFAD 2011). Agriculture depends on the environment for land, water, sunlight, and even biological agents. The increasing world population has been the driving force to promote intensive land use, agrochemical use, irrigation and disease and pest-resistant varieties to boost agricultural production. Agricultural development policies in many developing countries emphasize external inputs such as machinery, fertilizers and other agro-chemicals as means of increasing food production, and this has led to a growth in the use of synthetic agro-chemicals instead of biological, cultural, and mechanical methods for boosting production, controlling pests, weeds and diseases (Ngowi, 2003).

Agro-chemical is any chemical used in agriculture to improve productivity, control pests, and treat or control diseases. It encompasses fertilizers and agricultural pesticides: insecticides, fungicides, rodenticides, acaricides, molluscides, and herbicides; and plant regulators (Tekwa et al., 2010).

Though the benefits are substantial, studies have associated the use of certain agro-chemicals with some important environmental and health damages (Clarke et al., 1997; WHO, 1997; Krebs et al., 1999; Greenpeace, 2008).

Agro-chemical mishandling constitutes one of the most several farm operation hazards confronting farmers, their produce, and the environment. Wrong application time and dosage, mishandling, ignorance of safety precautions, and the use of adulterated or expired agro-chemicals in circulation have been shown to impact both aquatic and terrestrial ecosystems and degrade the quality of groundwater destined for human consumption (Nikolaidis et al., 2007; Tekwa et al., 2010). The run-off of agricultural fertilizers into surface water bodies can cause an increased productivity of those aquatic ecosystems leading to eutrophication (Chapman, 1996). Nitrate concentrations in groundwater have been found to be higher shortly after the farming periods (Akoto and Adiyiah, 2008).

In addition, some types of agro-chemicals known as organochlorines are persistent. They tend to stay longer in the environment and accumulate in aquatic food chains and cause effects on the health of top predators (Pearce, 1998). For example, dichlorodiphenyltrichloroethane (DDT) in avian bodies interferes with calcium metabolism and makes it impossible for birds to produce eggs with sufficiently thick shells to withstand incubation (Baird, 1999; Pollock, 2001; Tanabe, 2002). Long-term exposure to pesticides can increase the risk of developmental and reproductive disorders, immune-system disruption, endocrine disruption, impaired nervous-system function, and development of certain cancers (Parthasarathy et al. 2008). Ngowi (2003) noted that while industrialized countries have been taking significant steps to reduce agro-chemicals, particularly pesticide, the use in developing nations is on the increase. To reduce the use of agro-chemicals for agricultural activities and hence reduce their associated effects on the environment and human

health, there is the need for all stakeholders to be abreast with the fates and effects of the chemicals. Farmers need to understand that their continuous reliance of agro-chemicals, though beneficial, have long term effects on the environment that provide other inputs for their production.

Most countries in Sub-Saharan Africa heavily depend on agriculture that is dominated by subsistence smallholder farmers (World Bank, 2000). Farming is a major source of income for many people in developing countries. It also contributes to economic growth and employs over 30% of the labor force. However, the performance of the African agricultural sector has been disappointing over many decades (Wayo, S., Monty, J., Emmanuel, T., and Gbadebo, O., 2011). The performance of agriculture in this region has not lived up to expectations as it is characterized by decades of ups and downs. Its low level of productivity is emphasized by the statistics that while the sector employs about 67 percent of labor force, it contributes only about 17 percent of the total gross domestic product (World Bank 2000).

Sub-Saharan Africa is also reported as the only region in which per capita agricultural value added has not seen a substantial increase, rather a declining trend on average over the last three decades since 1961 with considerable variation over time and across countries (FAO, 2008). This declining per capita food production has resulted in increasing rural poverty, rising food prices, widespread famines and increasing food imports. It is frustrating to note that the Green Revolution, which has saved many lives in Asia and South America, has bypassed Africa and hunger still prevails on the continent despite the past research and development efforts. Some of the factors hindering agricultural development in Africa include, inadequate investment in agriculture, limited access to credit by smallholder farmers, high cost and unavailability of inputs such as fertilizers and improved seeds, inadequate use of modern technologies, inefficient agricultural input markets, and the absence of a conducive policy environment.

Africa's consumption of modern inputs, particularly agro-chemicals, is comparatively very low. FAO (as reported in Wayo et al. 2011), projected that the situation was not going to change much in the short run as Africa was expected to account for less than 3% of world agro-chemical consumption by the end of 2012 especially fertilizer. The use of improved agricultural inputs in Africa is very low and has remained largely static over the last 25 years; lower input usage are in smallholder food crop and livestock production systems.

Efficient input markets are also crucially important in order to deliver the right product, at the right time, in the right amounts, at a convenient place, and for an affordable price. According to Salami et al. (2010) access to input and output markets are a key precondition for the transformation of the agricultural sector from subsistence to commercial production. Smallholder farmers must be able to benefit more from efficient markets and local-level value- addition, and be more exposed to competition. Salami et al. (2010) reported that more than half of the population in most East African countries lives five hours or more from a market center. As a result of market access problem input use is generally low. Wiggins and Jonathan (2010) indicated that the average application rates of fertilizer for arable crops in East African countries are estimated to be below 30 kg/ha/year which is far less than the world average of 100kg/ha/year.

In response to this low agricultural input use, African Union (AU) member states passed the Abuja declaration with resolutions to increase timely access and raise fertilizer use by farmers to an average of 50 kg/ha by 2015. The declaration intended to increase fertilizer access and usage through elimination of barriers to fertilizer access such as tariffs on agro-chemical and agro-chemical raw materials. Increased agro-chemical use is ought to increase productivity, reduce food insecurity and poverty levels among smallholder farmers (Aloyce at el., 2014).

The low use of agro-chemicals in Africa can be explained by demand side as well as supply-side factors. Demand for agro-chemical is often weak in Africa because incentives to use agro-chemical are undermined by the low level and high variability of crop yields on the one hand and the high level of fertilizer prices relative to crop prices on the other (Aloyce et al., 2013). Increased use of inputs (seeds, fertilizers and chemicals) alongside organic soil fertility enhancing practices is crucial in addressing the technical change needed for sustainable smallholder agricultural growth in Africa.

Agriculture is predominantly on a smallholder basis in Ghana. About 90% of farm holdings are less than 2 hectares in size, although there are some large farms and plantations, particularly for rubber, oil palm and coconut and to a lesser extent, rice, maize and pineapples. Main system of farming is traditional. The hoe and cutlass are the main farming tools. There is little mechanized farming, but bullock farming is practiced in some places, especially in the North. Agricultural production varies with the amount and distribution of rainfall. Soil factors are also important. Most food crop farms are intercropped. Mono cropping is mostly associated with larger-scale commercial farms (SRID AUGUST, 2013).

In Ghana agriculture represents 36 percent of the country's GDP and is the main source of income for 60 percent of the population (GSS, 2012). Agricultural production depends on a number of factors including economic, political, technological, as well as factors such as disease, fires, and certainly weather. Rainfall and temperature have a significant effect on agriculture, especially crops. Although every part of the world has its own weather patterns, and managing the risks associated with these patterns has always been a part of life as a farmer, recent changes in weather cycles resulting from increasing climate change have increased the risk profile for farming.

Agriculture for many years has been the mainstay of the economy of the country and contributed more than 22.7 percent of gross domestic product (GDP) (GSS, 2012). In Nadowli-kaleo District, agriculture is the mainstay of the people. It engages about 85% of the active population. Food crop production in the District is largely on subsistence basis. It is characterized by low output levels. The main food and cash crops produced are maize, millet, sorghum, rice, groundnuts and soya beans. Tree cropping is also done particularly mangoes and cashew. The sector is estimated to be growing at 2.1% per annum, which is below the national target of 6% per annum (NKDA, 2013). Development efforts in this sector are geared towards modernizing agriculture as the path out of poverty in the District. The economy of the Nadowli-Kaleo is mainly agrarian, with the people engaged in the cultivation of food crops (2010 PHC).

1.2 Statement of the Problem

Even though many evidences show that agro-chemical adoption and usage by smallholder farmers contribute to high crops yield in many developing countries, there still exit some level of knowledge gap as to the factors that influence farmers' decision to use agro-chemicals on one hand and the perceived and observed effects of these agro-chemical on the other hand. A plethora of theoretical and empirical literature also suffices (Yuan et al., 2010; Kelly, 2006; Assa et al., 2014) explaining the factors influencing usage of agro-chemical, however many of these studies concentrate only on fertilizer usage among smallholder farmers. It is therefore worthy to note that most studies have been skewed towards fertilizer usage rather than all types of agro-chemicals. Again many of these studies were conducted outside the shores of Ghana and only few can be identified with Ghana (Anang and Amikuzuno, 2015) conducted in the northern region of Ghana. It is against this background that this study brings into a clear perspective of the types of agro-chemicals farmers use and the factors that influence the usage of these agro-chemicals. Also the

study seeks to examine the observed and perceived effects of the use of agro-chemicals on the health of farmers, their crops and on the environment in general. Again the study will examine the safety measures and precautions farmers adhere to before, during and after application of agro-chemicals in the Nadowli-Kaleo District.

It is therefore hoped that the findings of the study will stimulate research interest into the farmers' use of agro-chemicals and have practical use for people directly engaged in the agricultural sector in the developing world including Ghana.

1.3 Research Questions

The general research question is "what are the effects and factors influencing the use of agro-chemicals by smallholder farmers in the Nadowli-Kaleo District in the Upper West region of Ghana? The specific research questions include;

i. What types of agro-chemicals do small holder farmers use in Nadowli-Kaleo District?

ii. What factors influence the use of agro-chemicals by smallholder farmers in the Nadowli-Kaleo District?

iii. What are the perceived and observed effects of agro-chemical usage by smallholder farmers in the Nadowli-Kaleo District?

iv. What safety measures and precautions do smallholder farmers adhere to before, during and after application of agrochemicals in the Nadowli-Kaleo District?

1.4 Objectives of the study

The general objective of this study is to assess the use of agro-chemicals by smallholder farmers in the Nadowli-Kaleo District in the Upper West region of Ghana. The specific objectives are;

i. To identify the types and sources of agro-chemicals small holder farmers use in Nadowli-Kaleo District.

ii. To examine the factors influencing the use of agro-chemicals by smallholder farmers in the Nadowli-Kaleo District.

iii. To assess the observed and perceived effects of agro-chemical usage among smallholder farmers in the Nadowli-Kaleo District.

iv. To examine the safety measures and precautions smallholder farmers adhere to before, during and after application of agrochemicals in the Nadowli-Kaleo District.

1.5 Operational Terms

Agro-chemical

Agrochemicals refers to the broad range of pesticides including insecticides, fertilizers, hormones, herbicides, fungicides, and other growth chemicals and concentrated stores of raw animal manure (cow dung and poultry droppings). Globally, agro-chemicals (agrichemicals) are used for improving soil fertility and productivity. These methods of farming have been used in agriculture especially cropping system. The old civilization used organic manure (cow dung and poultry dropping) as means of providing nutrients to the crops for a long period with consistent yield (Albert, 1989)

Agro-chemical encompasses fertilizers and agricultural pesticides: insecticides, fungicides, rodenticides, acaricides, molluscides, and herbicides; and plant regulators (Tekwa et al., 2010). Though the benefits are substantial, studies have associated the use of certain agro-chemicals with some important environmental and health damages (Clarke et al., 1997; WHO, 1997; Krebs et al., 1999; Greenpeace, 2008).

Agrochemical could also be defined as a generic term for the various chemical products used in agriculture. And in most cases refers to the broad range of pesticides including insecticides, herbicides, rodenticides, molluscicides, fungicides and nematicides. It may also include synthetic

fertilizers, hormones and other chemical growth agents, and concentrated stores of raw animal manure.

Smallholder farmer

This is a subsistence farmer, generally somebody with less than 2 hectares of land, usually with poor access to inputs, technology, extension, and credit facilities.

1.6 Scope of the study

This thesis was restricted to the Nadowli Kaleo-District of the Upper West Region. Nadowli-Kaleo District is centrally located in the Upper West region of Ghana. The location of the District promotes inter-District trade and international trade with Burkina Faso on the Western Corridor. The study will cover the 2016 farming season and will assess the following main areas; the safety measures and directives smallholder farmers adhere to when dealing with agrochemicals, the factors influencing the use of agro-chemicals by smallholder farmers, the type and sources of agro-chemicals smallholder farmers use and the perceived and observed effects of the use of agro-chemicals. Data collection was undertaken between January and February, 2017. The thesis was submitted in January, 2018.

1.7 Ethical Consideration

Before the research was undertaken, a letter of introduction was requested from the Department of Environment and Resource Studies for official sourcing of relevant information. With the help of the introductory letter and a student identity card, community entry was done in the selected communities from the three zones, through the representatives of the farming groups in the selected communities. Introductory letters were written to the Department of Food and Agriculture to solicit services of some key officers for purely academic research work. The agro-chemical dealers were also given the letters and shown identity card to source information for academic work only. They

were all assured that any information given was purely for academic purpose and that their confidentiality was highly guaranteed.

During the Focus group discussion with farming groups in both communities, it was made known to discussants that it was purely for academic work. Consent of respondents was also sought in the questionnaire and they were assured that any information given was purely for academic purpose and that their confidentiality was highly guaranteed.

Ethical issues such as community entry protocols, adherence to confidentiality, privacy and avoidance of harm to respondents were assured. The respondents were well informed about the objectives of the study and their participation in the study were purely voluntary and as such they could choose to partake or not. Their withdrawal from the study would be voluntary and confidentiality of respondents were also ensured. Information provided by respondents were not to be given out to third party without prior approval of respondents.

1.8 Organization of the thesis

The thesis is organized into five chapters. Chapter one gives the general introduction of the research work, which comprises the background of the study, problem statement, research questions, research objectives, and the theoretical framework. Chapter two is the review of relevant literature which deals with definition of theoretical concepts and review of empirical literature about the thesis topic. Chapter three discusses the study area, sites selections and offers an outline of the different methodologies employed in this research. This chapter delves into the methodology employed in the study, it contains sub-topics like research design, population, sampling technique, and sample size. It also discusses the instruments to be used. Chapter four includes data analysis, presentation and discussion of major findings. This also will discuss findings against the evidence

presented in the empirical literature. Chapter five concludes on the summary of major findings, conclusion and recommendations on the major findings.

1.9 Significance of the Study

The significances of the study arose from the fact that little is known about how farmers handle agro-chemicals and it subsequent effects on the environment and the fact that global agriculture has caught pace with technology which has resulted every farmer into applying one form of agro-chemical in his or her farm or the other and this is no exception in the Nadowli-Kaleo Sistrict of the upper west region. Many research projects have actually been conducted on farmers' use of agro-chemicals, but majority of these studies focus on fertilizer usage by farmers and not looking at the various ranges of agro-chemicals that farmers use and the factors that influence farmers use of agrochemicals. This study is to assess the use of agro-chemicals by smallholder farmers in the Nadowli-Kaleo District in the Upper West region of Ghana.

Also only a few of such studies have been conducted in the northern part of Ghana and none in the Nadowli-Kaleo District the study area of this research. In addition, despite several studies, there is no evidence that any research on the assessment of the use of agro-chemicals by smallholder farmers has been conducted in the study area. The study will measure the benefits of environmental changes in a large amount of situations. This study is also important since it can also aid public decision making by better understanding the effects of agro-chemical use and farmers' preferences for it.

The results of the study will bring the attention of government and other development partners to the problems and challenges facing farmers with regards to the use of agrochemicals in the Nadowli-Kaleo District of the Upper West Region. Finally, the study will contribute to the stock

of knowledge on the assessment of the use of agro-chemicals by smallholder farmers and serve as useful literature for others who want to work in related disciplines.

1.10 Research Challenges/Mitigation Measures

The researcher faced some challenges during the study. Prominent among them included the following: Firstly, covering 27 selected communities within the Nadowli-Kaleo District came with some financial implications since the research work was self-sponsored. Transportation, feeding, stationery such as papers for printing and photocopying questionnaires, files, pens etc. were all provided by the researcher. However, this challenge was resolved through the researchers' personal savings and support from family members to fund the budget of the research work.

Also, some respondents within some sampled communities were unwilling to participate in the research work. their reason was that earlier researchers failed to fulfil promises made to them. Some NGO's promised financial assistance to purchase agro-chemicals and to provide agricultural implements to help expand farms and to improve farming activities. This challenge was resolved amicably through education. Respondents were made to know that the research work was purely academic and that their concerns would be communicated to the appropriate authorities.

Another significant challenge was language barrier. Most of the respondents who could not speak or understand English, which was the only medium of conducting this research was fraught with difficulties in responding to the questionnaire. However, this was again resolved with the involvement of translators to translate the questionnaire to them for a better understanding before they responded.

Again, some originally sampled respondents were not available, some respondents too had gone to the farm, market and funeral grounds during the data collection. This made data collection difficult considering the number of selected communities. However, with regards to respondents

who were not available in a particular community simple random sampling was done again to select new respondent to replace the unavailable respondent and those who had gone to farm and other social grounds were traced to get their data taken.

Lastly, three Agricultural extension officers were earmarked for the key informant interview for three zones but only one was available as I was told they were understaffed. This made the interview difficult. But the quantity and quality of information needed for this research was not compromised as the only extension officer supervising the three zones in the whole District was always available to provide all the necessary information needed.

In conclusion, amidst these challenges the quality of data collected was not compromised.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter assesses agro-chemical use by smallholder farmers. The first part is made up of theoretical literature which gives an overview of definition of basic concepts and theories underpinning the research such as; agro-chemical, smallholder farmer, expected utility theory (EUT), theory of reasoned action (TRA), theory of planned behavior (TPB), and rational choice theory (RCT). The second part deals with relevant empirical literature espoused by competent authorities and scholars in academia. The last part looks at the gaps in the literature discussed and lessons learned.

2.2 Agro-chemical

Agro-chemical is any chemical in agriculture to improve productivity, control pests, and treat or control diseases. It encompasses fertilizers and agricultural pesticides: insecticides, fungicides, rodenticides, acaricides, molluscides, and herbicides; and plant regulators (Tekwa et al., 2010). Though the benefits are substantial, studies have associated the use of certain agro-chemicals with some important environmental and health damages (Clarke et al., 1997; WHO, 1997; Krebs et al., 1999; Greenpeace, 2008).

Agro-chemical could also be defined as a generic term for the various chemical products used in agriculture. And in most cases refers to the broad range of pesticides including insecticides, herbicides, rodenticides, molluscicides, fungicides and nematicides. It may also include synthetic fertilizers, hormones and other chemical growth agents, and concentrated stores of raw animal manure.

2.3 Expected Utility Theory (EUT)

The Expected Utility Theory (EUT) purports to explain how innovation is accepted and utilized among farmers. It states that a farmer compares an innovation with the traditional technology and adopts the former if the expected utility from adopting the innovation exceeds the expected utility of the traditional technology (Batz et al., 1999). Despite the fact that the utility function is unobserved, the linkage between the expected utility corresponding to each alternative is assumed to be a function of the vector of observed variables and an error term (Adesina & Zinnah, 1993; Batz et al., 1999).

The theory seeks to determine a series of principles on which the behavior of a rational individual is based – that of a decision maker. The theory purports that an individual's aspiration lessens or avoid losses, that is to enlarge their gains (been material, emotional or any other) is implied in that individual's goals, while at the same time maximizing the personal welfare or benefit is the guiding principle in making a choice between varying alternatives (Pavličić, 2014). With regard to utilization of agrochemicals, farmers as well will consider the merits and demerits of applying agro-chemicals and decide whether to use or otherwise in order to boost productivity.

2.4 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) was developed by Ajzen and Fishbein (1980) out of social–psychological research on attitudes and the attitude–behavior relationship. The model presumes that most behaviors of social relevance are under volitional control, and that a person's intention to perform a behavior is both the immediate determinant and the single best predictor of that behavior. To them intention in turn is held to be a function of two basic determinants: attitude towards the behavior (the person's overall evaluation of performing the behavior) and subjective norm (the perceived expectations of significant others with regard to the individual performing the

behavior). Generally speaking, people will have strong intentions to perform a given action if they evaluate it positively and are also convinced that significant others think they should perform it. The relative importance of the two factors may vary across behaviors and populations. TRA also specifies the determinants of attitude and subjective norm. They posits that attitude is held to reflect a person's salient behavioral beliefs concerning the possible personal consequences of the action (Ajzen & Fishbein, 2010). For instance, a person who believes that performing a given behavior will usually lead to positive personal consequences will hold a favorable attitude towards the behavior. Specifically, attitude is held to be a function of the sum of the person's salient behavioral beliefs concerning the outcome of the action each weighed by their evaluation of that outcome.

An indirect, belief-based, measure of attitude can be created by multiplying each behavioral belief by its corresponding outcome evaluation and then summing over outcomes. In a similar way, subjective norm is a function of the person's beliefs that specific individuals or groups think he or she should, or should not, perform the behavior (Fishbein & Ajzen, 2010). A person who believes that most significant referents think he or she should perform the behavior will perceive social pressure to do so. Specifically, subjective norm is held to be a function of the person's salient normative beliefs with respect to each referent, each weighted by their motivation to comply with that referent (Fishbein & Ajzen, 2010). An indirect measure of subjective norm can be created by multiplying each normative belief by its corresponding motivation to comply and then summing over referents.

2.5 Theory of Planned Behaviour (TPB)

Theory of Planned Behaviour (TPB) is one special case of a multi-equation model that attempts to portray people's cognitive processes. According to Ajzen (1991), this theory assumes that people behave in a responsible way, taking into account available information and evaluating the results

of their actions. The theory also postulates that a person's intention to perform (or not to perform) a behaviour is the most important immediate determinant of that action (Fishbein & Ajzen, 2010). Moreover, it acknowledges and incorporates other determinants of behaviour in the conceptual model to account for attitudes, social influences and perceptions over control. These determinants are attitudes toward the behaviour, subjective norm and perceived behavioural control. They impact to a greater or lesser extent on behaviour, depending on the circumstances under analysis.

Therefore, the TPB provides a framework to explain the relationships between decision variables, including latent ones and behaviour. By means of structural equation modelling (SEM), TPB incorporates economic, socioeconomic, socio-cultural and psychological aspects in behavioural analysis (Burton, 2004). According to Fishbein & Ajzen (2010), the model specification assumes that people assign probabilities of occurrence of each outcome associated with behaviour and whether these outcomes are positive or negative. How much they believe in such an association determines the belief strength.

Within agricultural studies, the Theory of Planned Behaviour has been applied to research on farmers' technology adoption and other issues of public interest, such as animal welfare (Edwards-Jones, 2006) and conservation behaviour (Beedell & Rehman, 2000). However, a major emphasis on attitudes towards behaviour has resulted in some criticisms to TPB. Burton (2004), for instance, drew attention to this tendency of behavioural analysis focusing on attitudinal aspects at the cost of the other elements of the TPB model. That is the subjective norm and perceived behavioural control. According to Edwards-Jones (2006), the challenges involved in estimating these two elements of TPB explain the lack of emphasis on them. Beedell and Rehman (2000) also made some criticisms to TPB, including the possibility of acquiescence biases since behavioural measures are estimated by the farmers themselves and the difficulty of interviewees to understand

and cope with the TPB procedures, which follow a standardised method that is time consuming and monotonous.

2.6 Rational Choice theory (RCT)

Rational Choice Theory (RCT) is used to explain the manner in which human beings/actors make decisions in various contexts, with the main aim to derive the most rewarding result through maximisation of any cost-benefit balance (Denzin, 1990; Boudon, 1998). While the theory is interdisciplinary, two general perspectives have been presented: a sociological and an economic version. Denzin (1990) critically analysed how emotionality is interpreted and represented in the theory. He initially utilizes the work of various authors to outline the main assumptions of the theory, which first presupposes a human being to be "egotistical, hedonistic, asocial, rational and purposive in his or her actions" (Denzin, 1990, p174). This rational human or actor, when faced with options, decides on those actions which are most rewarding. To achieve this, the actor is equipped with all information of the situation he or she faces and aware of all possible choices, and outcomes. He or she is capable of recalling stored information without forgetting or misinterpreting. The actor's choice is therefore a reflection of careful assessment, based on having all the knowledge concerning the situation, with an aim for the most rewarding result he or she seeks. In the event that human being adheres to emotions and sentiments in making choices, these are considered irrational or socially conditioned choices.

Although a number of theories have been reviewed, the Rational Choice Theory will be adopted for the study. The is because just as the theory purports that human beings/actors make decisions in various contexts, with the main aim to derive the most rewarding results, in this current study the theory will best aid in understanding why a farmer will decide to use a particular agro-chemical or otherwise. As rational human beings, it more likely that the ultimate motivation to apply any

particular agro-chemical will rest upon a critical analysis of the merits and demerits thereof such as the cost, impact on productivity and easy/difficult access to that particular agro-chemical. The farmer is more probable to adopt the agro-chemical if the advantages outweigh the disadvantages in terms of some of the parameters raised, however, if the disadvantages exceed the advantages then he is more probable to ignore the agro-chemical. The theory will therefore offer a clear lens through which agro-chemical usage can be assessed among farmers in order to offer more insights for further studies and improvement in the agricultural sector. With the Rational Choice theory, the researcher is optimistic that the study will yield its intended objective of assessment on the use of agro-chemicals by smallholder farmers in the Nadowli-kaleo District.

2.7 Overview of Agro-chemical industry and use among farmers in Ghana

Agriculture constitutes the most important sector in Ghana's economy, in terms of contribution to the nation's Gross Domestic Product (GDP) (FAO, 2005). Out of the country's total land area (238.854km2) only 57% is suitable for agricultural production. At the same time, 6,331,000 hectares of the arable land are infertile and as a result they are only productive with proper management and good agricultural practice (FA0, 2005; Ministry of Food and Agriculture (MOFA), 2007). As a result of this and the need to increase food supply, the use of various agrochemicals as well as increased area of agriculture land appears the simplest way to obtain better yield. Agrochemical use is generally recognized as a significant factor in enhancing the ability to meet Ghana's need for sufficient, safe and affordable food and fiber.

In Ghana, agro-chemicals are extensively utilised in oil palm, cocoa, cola nut, coffee and cotton farms, vegetable (such as tomato, eggplant, onion, pepper, okra, cabbage, lettuce and carrot) and fruit production (including papaya, citrus, avocado, mango, cashew and pineapple) (Fianko, Donkor, Lowor & Yeboah, 2011). It is also widely used in mixed-crop farming systems involving

cereals (e.g. maize, millet, sorghum and rice), tuber crops (e.g. yam, cassava, cocoyam and sweet potato) and legumes (e.g. cowpea, bambara nut, groundnut and soybean) (Essumang, Togoh & Chokky, 2009).

Typically, the use of chemical fertilizers has rose tremendously and is largely responsible for the green "revolution", that is the massive increase in production obtained from the same surface of land with the help of mineral fertilizers (nitrogen, phosphorus, potassium) and intensive irrigation (Carvalho, 2006). At present, Ghana does not manufacture fertilizers, as such all fertilizers used in the country are imported. The consumption of fertilizers fell substantially in the early 1980s due to adverse economic conditions; nonetheless, it increased in the second half of the 1990s following an improvement in the national economy, ever since it has been steady (Carvalho, 2006).

Ever since the inception of agrochemicals in Ghana, its application to protect crops from diseases and pests has significantly reduced losses and enhanced the yield of crops such as cereals, vegetables, fruits and other crops (Fianko, Donkor, Lowor & Yeboah, 2011). Ghana thus, has known a continuous growth of agro-chemical usage, both in number of chemicals and quantities because of the expansion of area under cultivation for food, vegetables and cash crops (Ministry of Food and Agriculture (MOFA), 2007). Agro-chemical application in Ghana is more concentrated in cocoa, oil palm, cereals, vegetables and fruits sectors.

Although purchased physical agro-chemicals represent less than 30% of the total cost of crop production, it use is becoming more widespread. For instance, between 1995 and 2000, about 21 different kinds of pesticides were imported into the country for agricultural purposes (FAO, 2005). Its use has been embraced by local communities that are making a living from sale of vegetables and other cash crops. There is ample evidence that these products especially tomatoes are always

sprayed and sold immediately after maturity for consumption (FAO, 2005; Ntow, Gijzen, Kelderman & Drechsel, 2006).

This inevitably puts a high risk on consumers who always get their supply directly from the farmers. It is estimated that 87% of farmers in the country who use agro-chemicals apply any of the following or a combination of pyrethroids, organophosphates, carbamates, organochlorines on vegetables (FAO, 2005). Lindane was widely used in Ghana on cocoa plantations, vegetable farms, and for the control of stem borers in maize (Ntow, Gijzen, Kelderman & Drechsel, 2006). Endosulfan is popularly applied in cotton growing areas, vegetables farms, and coffee plantations in some parts Ghana. Some agro-chemicals used particularly DDT and lindane which are no longer registered for any use in the country were once employed to control ecto-parasites of farm animals and pets in Ghana (FAO, 2005). Agro-chemicals mostly used to control foliar pests of pineapple in Ghana include chlorpyrifos, dimethoate, diazinon, cymethoate and fenitrothion whereas the fungicides maneb, carbendazim, imazil, copper hydroxide are used for post-harvest treatment (Glover-Amengor & Tetteh, 2008).

2.8 Types of Agro-chemicals

- **Fertilizer**

Several studies have suggested that large increases in fertilizer usage is necessary to correct the massive nutrient losses of much of the arable land in sub-Saharan Africa (Morris et al., 2007; Crawford et al., 2005; Heisey and Mwangi, 1997; Wallace and Knausenberger, 1997). Currently, sub-Saharan Africa has the lowest fertilizer application rates of any region, with application rates around 10 kg/Ha. Africa contains 25 percent of the world's arable land, yet represents less than 1 percent of global fertilizer consumption (Kariuki, 2011; Morris et al., 2007). As of 2010, fertilizer use in Ghana was well below the average in SSA at less than 6 kg/Ha (FAO, 2014). Historically,

Ghana has seen some fluctuations in fertilizer usage, but the rates have always remained relatively low (FAO, 2005).

Fertilizer is a type of agro-chemical used in Ghana. However, average fertilizer application rates in Ghana are still below the average of Africa overall. Fertilizer application rates are relatively low for all crops, but the rates average slightly higher on maize fields which is a common crop; application rates average around 14 kg/Ha on maize fields, accounting for about 64 percent of total fertilizer use (Heisey and Mwangi, 1997; Kherallah et al., 2002).

Kherallah et al. (2002) give some potential reasons for the low fertilizer use rates in Africa as: (1) high fertilizer costs, (2) lack of irrigation systems, (3) the prevalence of traditional crop varieties that are less responsive to fertilizer, and (4) low incentives to invest in land-saving technologies. Other factors that may impact fertilizer use include availability of information on correct usage, information on the effects of fertilizer use on yields and profits, and the effectiveness of fertilizer on a particular field. Among these potential reasons for low fertilizer use in Africa, high fertilizer costs and the lack of irrigation systems are the most apparent in Ghana.

In 2008, Ghana's fertilizer subsidy reduced the price of fertilizer by one half, yet even at those prices some farmers claimed that the subsidized fertilizer was not affordable (Yawson et al., 2010). Farmers who did not use fertilizer or used it at less than recommended rates stated they did so because of the high prices of the product (Banful, 2009). The lack of irrigation systems in Ghana is another potential deterrent of fertilizer use, since only 0.4 percent of the area under cultivation is under irrigation (MoFA, 2010). Notwithstanding, Kherallah et al. (2002) did not find any significant indication of the last two reasons for low fertilizer use as suggested by above. The main crops produced in Ghana are maize, cassava, and cocoa, so the prevalence of crops that are unresponsive to fertilizer is unlikely to explain the low fertilizer usage (Braimoh and Vlek, 2006;

Ruf and Bini, 2011; Olasantan et al., 1997). Since population density in Ghana is low outside the southern regions, there may be reduced incentive to invest in agrochemical use.

These potential determinants of fertilizer use as agro-chemical only begin to explain the low application rates in Ghana; the literature suggests many other factors that may affect fertilizer application. Neighbours or "information neighbours" have been found to contribute to the farmer's knowledge of fertilizer profitability and management (Conley and Udry, 2010; Duflo et al., 2006; Foster and Rosenzweig, 1995; Munshi, 2004). Lack of access to credit markets has been found to reduce farmers' ability to afford fertilizer at planting season (Ouma et al., 2006). A farmer's perception of their risk may alter their fertilizer-use decision (Reardon et al., 1999). Finally, poor road infrastructure, distance from the market, and lack of suitable transportation can cause the farmer difficulty in physically accessing fertilizer (Fufa and Hassan, 2006).

- **Pesticide**

Food and Agricultural Organization (FAO) has defined pesticide as any substance intended for preventing, destroying or controlling pests. This include vectors of human or animal disease, unwanted species of plants or animals causing harm or interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs. The term include substances intended for use as a plant growth regulator, defoliant, desiccant or agent for thinning fruit or preventing the premature fall of fruit and substances applied to crops either before or after harvest to protect the commodities from deteriorating during storage and transport (WHO/FAO, 2005).

Pesticides can be classified in so many ways. Pesticides can be classified by target organism, chemical structure and physical state. Pesticide can also be classified as inorganic (Synthetic) or organic (Biological). Biopesticides includes microbial pesticides and biochemical pesticides.

Plant- derived pesticides or botanicals have been developing rapidly. These include pyrethroids, rotenoids, and nicotinods. Pesticides can be grouped into the chemical families. Prominent among these are organochlorines, organophosphates and carbamates. However, four main types used in Ghana are Organochlorines, Carbamates, organophosphates and Pyrethroids.

Pesticides can be classified based upon their biological activity, function or application method. Pesticides move inside plant following absorption by the plant and this movement is outward. Another means of classifying pesticides is the mode of action. This includes stomach poisons (they have to be eaten), contact poisons (they work via the skins), and fumigants (they produce vapour that kills the organism).

Again, pesticides are classified based on the target range: Broad spectrum pesticides (chemicals that kill a wide range of pests) Selective pesticides (chemicals that kill only a specific pest or group of pests). Another means of classifying pesticides is based on how it is formulated. This includes: liquid, powders, granules, baits, dust, smoke, generators, and ultra-low volume (ulv) liquids. Pesticides are also classified based on the toxicity class it belongs. They may be classified according to the type of pests they destroy, how hazardous they are and their mode of action or chemical properties.

Pests include insects, plants, pathogens, weeds, molluscs, birds, mammals, fish, nematodes, (roundworms) and microbes that destroy property, spread disease or are vector for disease or cause nuisance (FAO/WHO 1998). Pests have been a threat to humans because of their destructive activities and the economic damage they cause to agricultural products before and after harvesting. The pathogens they transmit and the parasitic mode of life, some of them live infect human beings with diseases. Widespread use of pesticide is therefore due to the advantages they offer. They are effective and reliable in keeping crops healthy and prevent them from being destroyed by pests

infestation. They work fast in emergency situations especially when crops are under immediate threat of infestation.

It is estimated that about one thousand four hundred (1400) pesticide ingredients are used in the agricultural sector (Kolpin et al., 1998). Ghana currently consumes about 25% of these pesticides produced (Ntow, 2005). Notwithstanding the beneficial effects of pesticides, their adverse effects on environmental quality and health have been well documented worldwide and constitute a major issue that gives rise to concerns at local, regional, national, and global scales (Planas et al., 1997, Ntow, 2001, Kidd et al., 2001, Huber et al., 2000, Cerejeira et al., 2003). Residues of pesticide contaminate soils and water, persist in the crops, enter the food chain and are finally ingested by humans with foodstuffs and water.

Furthermore, pesticides can be held responsible for contributing to biodiversity losses and deterioration of natural habitat (Sattler et al., 2006). There have been reported instances of pest resurgence, development of resistance to pesticides, secondary pest outbreaks and destruction of non-target species. Despite the fact that pesticides are also applied in other sectors, agriculture can undoubtedly be seen as the most important source of pesticide discharge into the ecosystem (Hoyer and Kratz, 2001 cited in Sattler et al., 2006). Tomato, eggplant, pepper and onion are grown in all ten regions in Ghana. However, some regions are more efficient and specialized in the production of only one or two of the above four crops. One of the biggest problems confronting vegetable farmers in Ghana is diseases and pests which ravage their crops. Vegetables generally attract a wide range of pests and diseases and can require intensive pest management (Dinham, 2003).

The improper pests control practices in vegetable production in Ghana include application of highly toxic pesticides which are most of the time misapplied and which results in pesticide contamination of the produce itself as well as the environment. While Ghana's elite is becoming

increasingly concerned about the adverse effect of pesticide on the environment and the health of the country resources, little scientific research has been done to address the issue (Ntow, 2001). Within the context of efforts to achieve safe, sound and sustainable production of vegetables, safe pesticide management plays a crucial role. Pesticide management includes all aspects of the safe, efficient and economic use in handling of pesticides (Bull, 1982). Proper use of pesticides as an agrochemical in Ghana means taking into account the health, social and economic realities of life. It implies using pesticides which can safely be applied and only when necessary in the appropriate health, social and environmental context. (Osafo and Frempong, 1998)

2.9 Pesticide Use in Ghana

As a developing and agro-based country, Ghana is experiencing economic growth and subsequently uses pesticides for national development, notwithstanding its effects on humans and the environment. Pesticide use in Ghana has increased in number of chemicals and quantities coupled with the increase in crop yield; a response to increase in demand. Areas of application of pesticides in Ghana is concentrated in vegetable and fruits sectors, cocoa, oil palm and the cereal sectors. Apart from physical inputs in crop production, which form less than 30%, the use/ application of pesticides is now widespread (Ntow et al, 2009). According to Ntow and co-workers, 21 different kinds of pesticides were imported into the country between 1995 and 2000. Furthermore, 87% of farmers used one or a combination of more than one pesticide on a crop, due to their cost effectiveness. Lindane, an OC, is widely used on cocoa, vegetable and maize plantations; whilst Endosulfan is mostly used on cotton, vegetables and coffee. Ultimately Lindane and DDT use have been banned in Ghana (EPA Ghana)

Pesticides mostly used to control foliar pests of pineapple in Ghana include chlorpyrifos, dimethoate, diazinon, cymethoate and fenitrothion while the fungicides maneb, carbendazim,

imazil, copper hydroxide are used for post-harvest treatment. Lambda-cyhalothrin cypermethrin, dimethoate and endosulfan are also used by vegetable growers in tomato, pepper, okra, egg-plant, cabbage and lettuce farms. Glyphosate, fluazifopbutyl, ametryne, diuron or bromacil are normally employed in land clearing. Nonetheless, the most extensively used pesticides in the pepper, tomato, groundnut and beans cultivation are karate, cymbush, thiodine, diathane, lubillite and kocide. Eighty-seven per cent (87%) of farmers in Ghana use chemical pesticides to control pests and diseases on vegetables and fruits, with proportions of pesticides used popularly on vegetable farms as herbicides (44%), fungicides (23%) and insecticides (33%).

In a study encompassing 30 organized farms and 110 kraals distributed throughout the 10 regions of Ghana, it was found that 20 different pesticides were in use with the organochlorine -lindane being the most widely distributed and used pesticides, accounting for 35% of those applied on farms. Of the 20 pesticides, 45% were organophosphates, 30% were Pyrethroids, 15% were carbamates and 10% were organochlorines. (Ntow et al., 2009) Analysis of pesticide trade flow patterns, recorded by Ghana‟s Statistical Service, in 1993 indicated that a total of 3,854,126 kg of pesticides were imported, besides, a survey conducted between 1992 and 1994 in the Ashanti, Brong Ahafo, Eastern and Western Regions of Ghana revealed that the most broadly used pesticides by farmers are copper (II) hydroxide (29.0%), mancozeb (11.0%), fenitrothion (6.0%), dimethoate (11.0%), pirimiphos methyl (11.0%), λ-cyhalothrin (22.0%), and endosulfan (10.0%) (EPA, Ghana, 2008). Moreover, it was established that insecticides constituted about 67% of pesticides employed by farmers while fungicides were about 30% and herbicides and other pesticides types form 3% of the total use.

On the other hand, it is on record that between 1995 and 2000, an average of 814 tons of pesticides was imported into the country annually, the greatest quantity (70%) being insecticides, The amount

of pesticides imported into the country from 2002 to 2006 increased. "Agro-chemicals and the Ghanaian Environment", an updated register of pesticides from the Environmental Protection Agency in Ghana in 2008 indicated that about 141 different types of pesticide products have been registered in the country under the Part II of the Environmental Protection Agency Act, 1994 (Act 490). These consist of insecticides (41.84%), fungicides (16.31%), herbicides (0.43%) and others (0.01%), (Ntow et al 2006). Articles reviewed during this study have not showed any concrete amount of pesticides used in Offinso north.

2.9.1 Pests and their control

Pests are unwanted plants or animals (which could be microbes) that are detrimental to humans or human concerns such as in agriculture or livestock production. They interfere with human activities, and cause nuisance and epidemics associated with high mortality. They could be found in homes, industrial settings and farms. Mechanical control methods of pest control include picking of pests or their larvae by the hand, removing the part or whole plant that is affected, using traps or catching them with the help of nets. Physical control methods are by heat (high temperature kills pests), low temperature and by X-rays or Gamma rays.

Cultural methods include crop rotation, deep ploughing, clean cultivation, proper use of fertilizers and water, growing pest resistant varieties of plants, timely or late sowing and proper harvesting. Predators such as parasites, birds, animals and micro-organisms e.g., Chilonus, Crysopa, Tricogama, copidosoma, bacillus thuringenesis are used to control pests biologically. Chemical methods involve the use of chemicals (pesticides) on a large scale to mitigate pests. It is effective and faster compared to other methods but is also the most hazardous to humans and the environment. Their improper use can result in resistance among various pests which could lead to extensive outbreaks resulting in cost increase of cultivation and losses. Many farms are pestered

by pests. Pests are annoying and bothersome. The effective control of pests such as weeds, insects and disease is critical to ensuring healthy crops and enhance agricultural productivity (Mah, et al., 2001)

Various pests control methods have been adopted. One is the use of chemical pesticides which is still the most common method in many countries (Hussein, 1999). This is because it is cheap and often very effective (Mobbd Narow, et. al., 2002). The effective use of chemical pesticides in protecting crops, however, has masked the negative impacts associated with their use. For farmers, the most serious issue is the development of resistance by pest to the chemicals, secondary pest outbreak and health hazards associated with the application of chemicals (Magnaye, 2006). For consumers, the main problems are pesticide residues in food and environmental degradation (Persley, 1999).

Because of such concerns, there is a great deal of interest in applying non-chemical pest control methods. Non-chemical pest control methods have many advantages compared to chemical treatments. They are generally effective for longer periods of time (Lingappa, 2001). They are less likely to create hardy pest population that develop the ability to resist pesticides and can be used with fewer safeguards, because they are generally thought to pose virtually no hazards to human health or environment (Lenne, 2000). Chemical methods are not necessarily the best method of pest control (Pearce, 2002).

A number of different approaches are available and have been used and proved efficacious in some countries worldwide (Waterhouse, 1992). These include biological control, mechanical and cultural practices. Ecobichon (2001) argues that pressure on developing countries to intensify production of non-traditional agricultural products for the global market has led to increased dependence on chemical pesticides in those countries. Moreover, farmers in these countries are

more likely to use older, non-patented, toxic chemicals because they are inexpensive, readily available (partly due to restrictions on distribution in developed countries), and farmers lack information about their harmful effects (Echobichon, 2001; Weir & Schapiro, 1981). The health effects of pesticides have been widely explored in terms of risks for farmers who apply the chemicals.

Studies have also found that farmer families are at risk for harmful effects of pesticides due to residues, water and soil contamination, the reuse of chemical containers for food, and exposure to residues on clothing or equipment brought home (Ecobichon, 2001; Garcia, 2003). Men and women may be affected by pesticides in different ways. Studies have documented women who were exposed to pesticides having deficiencies in reproductive functions or increased numbers of birth defects in children (Garcia, 2003), while men who handled dibromochloropropane (DBCP) experienced low sperm counts or complete sterility (Babich, Davis and Stotzky, 1981). Traces of organochlorine pesticides have been found in breast milk among women in Ghana (Ntow, 2001), signalling the potential for negative effects of pesticides on both women and nursing children who consume the breast milk. Women may also be more susceptible than men to certain cancers because many of the chemicals in pesticides act as endocrine disrupters, leading to hormone-related cancers that affect women more than men (Garcia, 2003).

Studies also show that knowledge, perceptions, and practices of pesticide use differ by gender. In some cases, women have significantly lower literacy rates than men, decreasing their ability to read warning labels; they also have lower rates of knowledge of the risks of pesticides and are less likely to use protective clothing (Atreya, 2007; Garcia, 2003). In other contexts, women's concern for the health of family members may actually increase their awareness of the risks of pesticides. Research in the Ecuadorian Andes demonstrates an association between households where women

and men have more equal participation in decision-making and roles, productive and household, with lower use of hazardous pesticides, particularly on non-commercial farms (Cole et al., 2011). It is therefore imperative to understand gender differences in knowledge, practices, and perceptions of pesticides in order to better address the risks of pesticide use for women and men.

In addition to the dangers of pesticides to humans, insects and plant pathogens can develop resistance to these chemicals. This leads to increased levels of pesticide use in response to increased pests, and keeps farmers locked into a "pesticide treadmill" (PANNA, 2012). Moreover, research suggests that pesticide use leads to pesticide resistance in addition to the weakening of the plants themselves. In one study, plants treated with pesticides experienced twice as much disease as plants treated with water (Gips, 1987).

2.9.2 Pest Management in Ghana

Pesticide use on crops is common in Ghana. Rates of insecticide, herbicide, and fungicide use have increased significantly since the 1960s (Ntow, 2001). Among Ghanaian farmers' expenditures for crop inputs, nearly 16% went to pesticides (insecticides and herbicides) (GSS, 2008). While the Pesticides Control and Management Act of 1996 outlines registration requirements for pesticides and pesticide distributers as well as classifications and restrictions of pesticides, there is extensive evidence of the use of restricted chemicals and misuse or repackaging of hazardous chemicals on crops for which they are not intended (Danquah, Ekor, and Asuming-Brempong, 2009; Ntow, 2001; Obiri-Danso, Adonadage, and Hogarh, 2011).

As demand for vegetables grows in Ghana, farmers have had to develop ways to address the major pest problems to which vegetable production is susceptible. Chemical pesticides are often perceived to be the best, and sometimes only, solution (Danquah et al., 2009; Marfo, 2006; Ntow, Gijzen, Kelderman, and Drechsel, 2006). Studies of vegetable producers in Ghana have found that

most farmers use a variety of insecticides, some of which are not recommended for use on vegetables, and spray several applications which could lead to the build-up of residues or pesticide resistance (Danquah et al., 2009; Ntow et al., 2006). In some cases, farmers report getting information on insecticides from a source other than the agricultural extension agent, specifically agro-chemical sellers and other farmers (Danquah et al., 2009), while farmers in other contexts rely primarily on extension agents for information (Ntow et al., 2006). This can have implications for the kind of information farmers receive since agrochemical vendors have little interest in promoting methods of pest management that would decrease business at their stores, such as non-pesticide methods.

Farmers in Ghana use a variety of methods, recommended and not, to measure and apply pesticides (Ntow et al., 2006). Few wear protective clothing (Marfo, 2006; Ntow et al., 2006), and one study found that 80% of farmers surveyed reported experiencing illness due to pesticide exposure (Ntow et al., 2006). Farmers dispose of pesticide containers by leaving them in the field or throwing or burying them nearby (Marfo, 2006; Ntow et al., 2006). High demands for produce and low perceptions of risks or residues of pesticides in food lead some farmers in Ghana to harvest prematurely (Darko and Akoto, 2008), increasing the likelihood of residues and potential harmful effects for both harvesting farmers and consumers.

Studies have found evidence of pesticide residues in blood and breast milk (Ntow, 2011), surface and groundwater (Obiri-Danso and Adonadaga, 2011), and tomatoes to an extent that could cause health risks such as cancer (Darko and Akoto, 2008; Essumang et al., 2008). Extensive use of fertilizer in tomato production in Ghana has also been linked to significant greenhouse gas emissions (Eshun, Apori, and Oppong-Anane, 2011). Nearly all of the studies reviewed, examining both pesticide use and residues in Ghana, recommend training and education for farmers and

pesticide distributors as a means of reducing indiscriminate use of hazardous chemicals and increasing awareness of the risks of pesticide use.

Application of pesticides varies by crop and other factors such as gender or wealth. Dagomba women in northern Ghana prefer to cultivate local varieties of cowpea because they do not require agro-chemicals to grow well, in contrast to improved and introduced varieties that do (Padmanabhan, 2007). Padmanabhan found that this preference is associated with the perception among Dagomba people that insecticides are "medicine"; since the diagnoses of problems and handling of medicine is considered the domain of men, and taboo for women, pesticides have been constructed as a gendered technology. In contrast, the application of fertilizer is considered part of sowing, which is considered female work in this context. This case demonstrates the importance of considering the cultural context and constructions of gender in a particular place because these factors will give meaning to and affect the way new technologies are introduced to and adopted by a community.

2.9.3 Effects of Pesticides on Humans and the Environment

The use of pesticide is a threat to human health and the environment. Their effects of long term work; related exposure at low amounts are problematic to detect since they include transitory and non-specific health repercussions. It may also hinge on the pesticide used, means of exposure and regularity of exposure, period and application approaches, not forgetting personal protective equipment use (Garcia-Garcia et al, 2015). Negative health consequences that occur due to exposure to pesticides differ according to the pesticide involved and the means of exposure, with the dermal route being the utmost, especially for sprinklers or applicators, (MacFarlane et al., 2013). Due to their wide-ranging and well-known use in agronomy and in the home setting,

pesticide exposure occurs chiefly through the oral (ingestion), dermal, the eyes and nasal (inhalation); through food or from the environment.

Contact with pesticides has been connected with numerous health effects such as malignancies, neurodegenerative conditions and reproductive disarrays (Ghisan et al., 2015). Sosan and his colleagues, found that almost all the farmers in their study confirmed typical symptoms of insecticide poisoning after each spraying task (Sosan et al., 2012). These symptoms comprised severe headache (66%), dizziness (58%), body weakness or being unusually tired (55%), nausea (53%), restlessness (37%), excessive sweating (41.3%), etc. In a study to review the effects of Neurotoxic pesticides on hearing loss, Gatto et al. (2014) found that results from human studies suggest that exposure to neurotoxic pesticides can induce damage to the central auditory system. Pesticide sprayers report greater signs and symptoms of exposure such as skin irritations, stomach poisoning and eye irritations than other farm workers (Atreya, 2008).

A study conducted on 268 married male farmers in Iran showed that 68% of participants reported to their general practitioners of suffering from burning and skin irritations, eye burn, headaches, vertigo, nausea and vomiting during spraying; about 6.3% had offspring with congenital malformations, 7% showed impaired (fecundity) fertility rates after working for over 10 years as sprayers. Still births among farmers‟ wives were greater than that of the average population (Neghab et al, 2014). Chronic disease such as diabetes, Cardiovascular diseases (Hypertension), Chronic Respiratory diseases (e.g. asthma), Chronic Fatigue Syndrome, Systemic lupus erythematosus, rheumatoid arthritis, malignancies of all types, Alzheimer's, reproductive disorders, parkinsonism, nephropathy congenital anomalies etc. are key conditions affecting health of the public after exposure to pesticides, in the 21st century (Moustafalou and Abdollahi, 2013).

One of the causes of infertility is occupational exposures to harmful environmental factors where the decreased fertility rate in some occupations is much more significant than in the general population. There is also evidence linking reduced amount of semen to exposure to pesticides including damage to spermatogenesis (Mehrpour et al., 2014). Also, male reproductive activity is highly sensitive to many man- made physical and chemical agents produced by agricultural and industrial activities. Formulations of pesticides differ in absorption ability e.g. emulsifiers are more readily absorbed than others. Hence rate of dermal absorption differs depending on the part of the body involved, e.g. rates of absorption are greater around the genitals (12 times faster) than in the fore arms. The fact that neurons cannot regenerate makes neurotoxicity of the neurological system cause irreversible effects in an organism due cell death and loss of neurons. Due to the subtle affect and slow development of neurological signs and symptoms, most conditions are not recorded or observed.

Relating to the Environment, each type of pesticide is pest specific. In other words they are intentionally released into the environment to mitigate certain targeted pests. Yet, a large amount of it enters water bodies, air, sediments or food. These occur as a result of run-off after rains, escape tanks or spray drift i.e. the airborne movement of agrochemicals onto non-target areas at or shortly after application either by air or ground level; with the potential of injury or damage to humans, animals, plants or the environment (National Pesticide Information Center, NPIC, U.S.A. 2015). Pesticide deposits in air, water and foods have serious health repercussions for the general public. Pesticides have been found in the air long even after use, leading to effect on humans, wildlife and biodiversity; they mount up and travel worldwide. “Pesticide use has caused domestic animal poisonings, the death of useful predators and parasites, residues in air, fishery and aquatic

body losses, the damage of flora and fauna, unintentional crop exposures, death of birds and honeybees and undesirable residue in food items have all credited to pesticides.

It has been recognized that the chemical pesticide residues are the key contributor to the destruction threats facing many endangered species" (Khan, 2012) Haarstad reported in 2008 that a landfill comprising mainly of biological waste from a tree nursery and containing an estimated 900 kg of DDT was monitored since 1994. Later, downstream ground water was sampled from four wells. More than 10 years of monitoring of two of the wells in addition to sampling of the waste was carried out. A total of seven pesticides were detected in the ground water. In addition to DDT, there were two other insecticides and four fungicides occurring in the ground water downstream of the landfill (Haarstad, 2008).

2.9.4 Pesticides Application and Application Equipment

This refers to the practical ways where pesticides are delivered to their biological targets such as pests, crops or other plants. The effects of pesticides on humans and the environment, in recent times has necessitated their efficient use in order to minimize environmental and human exposures (i.e. operators, bystanders, produce consumers). The pest management practice of pesticide application considers seed treatment, spray application methods and techniques, weather conditions and application equipment (USA/CDC, 2000) Pesticides can be applied to seeds prior to planting i.e. seed treatment or coating. This protects the seed/plant against soil-borne threats. The role of pesticides in pest management cannot be over emphasized, hence the equipment and the techniques used in their application are important to the success of pest control and ultimately better crop yield. Pesticide application is not limited to only the operation of the application equipment but is coupled with a thorough knowledge of the pest management, in order to cover the target crop with maximum efficiency, minimum efforts and minimum contamination of non-

target crops, to keep the pest under control. A good pesticide application technique becomes paramount. It must be remembered that all pesticides are poisonous and can cause harm to living things and must thus be used meticulously; the most reason why application must be target-oriented to guarantee the safety of non-targets and the environment. This therefore calls for the proper selection of application equipment, knowledge of pest behavior, skillful dispersal methods and knowledge of the most susceptible stage of the pest, helps determine the time of pesticide application (Pal and Gupta, 1996).

It is also aimed at avoiding pollution. The success of controlling pest therefore depends on the quality of pesticide, timing of application and quality of application and coverage, proper dosage being applied evenly, ensuring the toxicant reaches the target, applying the proper droplet size and density and its target. Pesticides are dispersed by different methods like spraying or dusting. Most pesticides are applied as sprays, in liquid formulation (dilution), with water or oil being the diluent Spraying may be done in high, low or ultra-low volumes. One of the most common forms of pesticide application is the use of mechanical sprayers. These may be operated manually or powered. Manual sprayers include syringes/slide pump, stirrup pumps, knap sack/shoulders hump (lever operated; piston pump, diaphragm pump, compression sprayer and the stationary type (Pal and Gupta, 1996). Most pesticides are diluted from concentrates with water applied by forcing the liquid through a very small opening in a nozzle to form a spray that is targeted at the intended surface", (Matthews, 2015).

The original knapsack sprayer was a hand operated pump which was part of a small tank carried on the users back. The knapsack sprayer is the most widely used, is lever - operated and designed to spray liquid rather air. It is suitable for small farm and areas that are inaccessible to vehicles and are designed to meet international standards of the FAO. The sprayer is mounted on the back of

operator with help of a pair of mounting straps. The pump of the sprayer is activated by working a hand lever up and down by one hand of the operator while the other hand holds the cut off device for spraying purpose. It consists of liquid tank, hydraulic pump, operating lever, pressure chamber, agitator, delivery hose, spray lance and nozzle. A plastic tank of 14-16 litres capacity is commonly used. It is essential to operate the hand lever constantly at the rate of 15-20 strokes per minute.

2.9.5 Disposal and Transportation of Pesticides

Health hazards such as empty pesticides containers pose a threat to environmental contamination. A study in Greece found a common practice of dumping empty pesticide containers by fields, near, or into irrigation streams and canals, burning in open fire are well known practices of disposal farmers are involved in, coupled with using them for fuel storage, water and food storage (Haylamicheal and Dalvie, 2009). Accidental and intentional poisonings have been encouraged by the presence of undesirable and outdated pesticides. These undesirable pesticides hence contribute to unsafe disposal of pesticides.

According to the FAO, pesticides accumulate in the system as a result of storage beyond shelf-life, banning, inappropriate formulations, and poor assessment of required quantities, poor pest outbreak forecasting, substandard containers, excessive donation, poor storage systems, defective distribution or poor marketing strategies (Dalvie, Africa and London, 2009). The above-mentioned problems tend to increase obsolete pesticides in developing countries, making their disposal another concern for Regulatory bodies. Most farmers burn pesticide containers. Some countries have initiated disposal awareness by re-calling all obsolete pesticides and send them to treatment and disposal sites in developed countries. E.g. Ethiopia sends its obsolete pesticides to Finland for combustion and disposal. In Africa lack of national capacity and farm worker training lead to unsafe practices (Dalvie, Africa and London, 2006).

Another study in rural Greece reported that farmers re-sprayed excess pesticide until their tanks were void, or sprayed it on any other crop itemized on the container. Some farmers confessed releasing left over into nearby streams and irrigation canal. After rinsing they poured the water into nearby uncultivated lands. Most containers were dumped on rubbish dumps or burned (Damalas, Telidis and Thanos, 2008). Re-spraying surplus mixtures have been said to be risky as it doubles the recommend dosages on the crops leading to toxicity, residues in soil and harvested crops. This also includes the disposal of leftovers on uncultivated lands. The best way recommended to dispose of left-over is to find other similar farms that will need application of the same chemical.

Dalmalas, Telidis and Thano (2008) thought that disposal of containers onto nearby fields, streams, canals is unsafe practice totally; burning will undoubtedly release other chemicals into our atmosphere and should be discouraged. Pesticide wastes should be buried; the site must be chosen carefully to prevent contamination of surface water, runoff or groundwater. Pesticide wastes should be buried under at least 1/2 m of soil mixed with lime to enhance degradation. To begin with, the pit should be creased with 5-10 cm of clay and glazed with 2-3 cm of lime. Wastes should be added to the pit in layers not more than 10-15 cm deep and inter- mixed with lime and bio-degradable household waste, to assist in biological degradation (Matthews, 2015)

When transporting pesticides, there is the need to keep them in their original containers with the labels securely attached. They should be placed in such a way to prevent spillage or leakage, in a plastic material to hold the spillage in case of an accident. If transporting in the rear of a car or an open trunk they should be secured and the whole load covered. Passengers must also not share any compartment of the vehicle with pesticides, likewise groceries and food for animals.

2.9.6 Storage of Pesticides and Equipment

Unsafe practices are prevalent among farmers and operators in developing countries e.g. In Egypt, almost all farmers stored pesticides in bedrooms; likewise, in Kenya and Palestine (Remoundou, 2014). A study on the occupational insecticide exposure and perception of safety measures among cocoa farmers in south western Nigeria showed that about 61% of the farmers stored pesticides in their homes, 31% had a separate store for pesticides, and 8% kept them on the farm.

However only a few correctly disposed of empty containers (i.e. burn, destroy, bury). Almost half washed the containers and put them into various uses such as for storing palm oil and kerosene, with some throwing them away anywhere including places to which children had access. A few resold the containers to buyers. Almost all the farmers cleaned up their spraying equipment after use. Leftover spray mixture was sometimes used to spray already sprayed cacao trees or was emptied into streams or near a well at the village (Sosan and Akingbohungbe, 2009).

In order to protect the content of pesticide, containers are made of materials that have the capacity to withstand the chemical. These containers are to be stored with their original labelling including directions on application and disposal, names of the components, emergency information in case of spillage or exposure. It also includes temperatures at which the pesticides should be stored, since extremes of temperatures can change the chemical structures of the product or damage the container. For safety reasons, it is best to keep the pesticide inventory to the lowest, i.e. buying only what you need per season and mixing only what you will use in a day. It is not advisable to store pesticides in food and drink containers for the safety of especially children. If a spill is anticipated, bottled pesticides are to be stored in a larger container and tightly covered. Equipment are supposed to be stored separately away from chemicals.

In the developed countries, they are stored in well lit, ventilated and fire resistant buildings. They are to be inspected annually, must be sited away from flood prone areas, wells, drains, ground and surface water. The building must be dry, with appropriate signs for warning, secured under lock and key against theft and with suitable exits routes. Personal protective equipment must be kept and washed daily, separately from other clothes; work clothes must not be considered as PPEs. Clean water must be available /accessible for eye flushing/irrigation in case of splashes on the face (National Pesticide Information Center, NPIC, U.S.A. 2015).

2.10 Empirical Literature Review

Various studies have investigated farmers' agro-chemical use in general (Gollin et al, 2005; Isin & Yildirim, 2007). The studies that will be reviewed for this thesis will be of variable scope; investigating from one to several aspects of farmers' agrochemical use. While investigations employed methodologies which comprised varying methods, most studies used a combination of quantitative and qualitative measures; the latter being significant for developing causal linkages or reasons and suggesting policy recommendations.

The importance of agro-chemical application has extensively been documented. For instance, some studies investigating changes in technological application in agriculture in general attribute increased agricultural productivity to the use of technology packages encompassing MVs, agricultural chemicals such as, fertilizers, herbicides, and relevant machinery (Golin et al, 2005; Keshavarz, Karami & Kamgare-Haghighi, 2010). However, a couple of quantitative based studies and systematic reviews have indicated that acquisition of relevant knowledge is required if much benefit would evolve if not side effects are more probable to outweigh the benefits (Scott, 2005; Fianko, Donkor, Lowor & Yeboah, 2011). With this, they noted that proper information utilisation

in conjunction with appropriate management skills culminates in increment in the efficiency of inputs which in turn contributes to the sustainable use of resources (Scott, 2005).

Although these studies have revealed the justification for agro-chemical utilisation, they were skewed towards quantitative approach thereby rendering shallow generalisation of results. Despite the fact that some merits or justifications have been advanced, a qualitative inquiry into this phenomenon might be necessary in gain in-depth understanding of the need for farmers to apply various agro-chemicals.

Despite the enormous benefits of agro-chemical application, sufficient evidence exist to contend that adverse implications are associated with usage. Aneani, Anchirinah, Owusu-Ansah & Asamoah (2012) reported that intensive utilization of technology and agro-chemicals for usually results into water pollution, land degradation, compromised human health, increased cost due to cost incurred in addressing adverse effects such as pollution as well as destruction of livelihoods and social systems inherent in those livelihoods (Aneani, Anchirinah, Owusu-Ansah & Asamoah, 2012). Their study involved a qualitative study of formal socio-economic sample survey of 300 cocoa farmers selected randomly, by a multi-stage sampling technique, from all the cocoa growing regions of Ghana. Typically, fertiliser and pesticide use are some of the widely discussed implications of agro-chemical application. Essentially, it is reported that these adverse implications result from their inappropriate use as opposed to the mere application. For instance, both IEEP (2003) and Scott (2005) indicate that fertilisers and pesticides are aligned with water and soil pollution. Excessive fertilizer application has again been linked with water contamination, health hazards particularly on infants, denitrification and various cancers (Scott, 2005; Wipatayotin, 2007; FFTC, 2009).

Also in Guyana, research indicates that occurrences of agro-chemical misuse such as overuse, have been reported with similar concerns (Chandran, 2006; Spiller & Aleguas, 2007). The historical evolution of the agricultural sector in Guyana reveals traces of technology adoption, which includes the use of agro-chemicals from colonial times (Spiller & Aleguas, 2007). At the same time, varying rates of technology adoption, including agro-chemical use are reflected across traditional and non-traditional agricultural sub-sectors (Danso-Abbeam, 2014).

Similarly, Roca (2011) noted that adverse implications of fertilizer application include but not limited to decline in productivity, acidification and losses in soil organic matter. Although misapplication of agro-chemicals constitutes a global concern, developing world and communities with low economic standing have been noted to as areas where this phenomenon is rampant. Among the major concerns of this practice are negative residual effects including environmental pollution (PRB, 2011).

Waichman, Eve & Nina, (2007) added a new dimension of adverse effects of agro chemical application by indicating that although high fertilization rates lead to faster and higher productivity which is positive for farmers, its implications for agro-biodiversity is adverse. With this he noted that, for instance, higher and faster production of grass results in frequent and faster mowing leaving no food for grassland birds (Waichman, Eve & Nina, 2007). Again, excessive fertilization causes eutrophication and consequently the death of more terrestrial and aquatic systems. In 2007 the surplus on the soil surface balance in agriculture declined by 68% for nitrogen (N) and by 95 % for phosphorus (P) compared to 1990 and this was induced by increased manure processing, decline in usage of fertilisers (Roca, 2011).

Literature substantiate environmental pollution based on principles of the Environmental Kuznets Curve (EKC), which assumes a relationship between per capita income and environmental

degradation and pollution (Richmond & Zencey, 2007). The principle of the EKC posits that during low income levels of environmental degradation is low at low income levels and increase as income increases. However, the reverse will occur beyond turning point where environmental degradation and pollution will decline with increased income. This principle may account for why over-usage of agro-chemicals and its associated pollution seem to dominate in developing countries (Richmond & Zencey, 2007).

Scott (2005) observed that the concerns of an agricultural official was suspicion of pesticides in the agricultural products sold on the Guyana's market. Also, in the works of Spiller and Aleguas (2007) to investigate agricultural chemical exposure in small vegetable farms they noted common occurrences of morbidity arising from agricultural chemical exposure among farmers.

A cross-country study (Benin, Ethiopia, Ghana and Senegal) investigating into cultivation of cotton, vegetables, pineapple, cowpea, and mixed cereals and legumes, for export and local markets revealed that bioaccumulation and biomagnification usually occurs as the pesticides travel higher up the food chain usually occurs as the pesticides travel higher up the food chain with detrimental effects on higher humans (Williamson, Ball & Jules, 2008). The study utilized both quantitative and qualitative methods to examine pesticide use and handling, costs and access and health, welfare and sustainability issues. They further noted that the effect on man is compounded by the fact that drinking water is usually taken directly from streams, rivers and lakes instead of ground water. Through a systematic inquiry into pesticide packaging contamination of vegetables in Ghanaian urban markets, Amoah, Drechsel, Abaidoo and Ntow (2006) observed that presence of pesticides in soil can alter the composition and circulation of nutrient (Amoah, Drechsel, Abaidoo & Ntow, 2006). It may also exert subtle effects on the organism's activities. This may

degrade soil fertility, ultimately producing an essentially biological sterile soil (Barriada-Pereira, Gonzalez, Muniteque-Lorento & Fernandez, 2005).

Most prior studies on agro-chemical usage by economists presumed that farmers' decision to utilize agro-chemicals was based on maximization of utility, meanwhile, in recent times social scientists have contended that farmers' independent assessment of agricultural technology in general are of utmost importance and induces their adoption decision. This reflects in the works of Amurazi & Albarus (2008) where they realized that farmers' perceptions are of extreme relevance in adoption of modern crop varieties in several regions in Africa.

In Ghana, Danso-Abbeam, Setsoafia & Ansah (2014) noted that although large proportion of farmers they interacted with use agrochemicals, the intensity and amount spent to purchase these inputs were minimal. They assessed the effects of the determinants of farmer's adoption of and investment in agrochemicals by recruiting 156 cocoa farmers in the Sefwi-Wiawso Municipality. Upon analysis with descriptive statistical technique to analyse demographic and farm-specific characteristics together with adoption rage and expenditure on agro-chemicals, they realised that generally the sex of farmers, their age, household size, attainment, mean age of cocoa farms, farm size and farmers previous output were all important variables in explaining farmers decision to invest in agrochemicals (Danso-Abbeam, Setsoafia & Ansah, 2014).

An investigation into factors affecting farmers' decision on fertilizer application in Northern China revealed that many of the subjective factors induced farmers' decision to use agro-chemicals (Zhou, Yang & Mosler, 2010). The study was based on a survey of 349 farm households taking into consideration both farm and farmer specific characteristics and farmers' subjective evaluations of factors shaping their decisions. Regression models were employed in examining the determinants of fertilizer use intensity across farm households and investigation into the factors

influencing overuse of nitrogen. They again observed that irrigation, gains in crop yield and higher earning goals were positively correlated with fertilizer use intensity, while farm size, manure application, soil fertility and distance to fertilizer markets were negatively correlated. Further inquiry into the problem of overuse showed that higher education level significantly reduces the possibility of over-fertilization (Zhou, Yang and Mosler, 2010).

Evidence from Nigeria indicates that subsidization of agro-chemicals especially fertilizer occupies a central role in the policy tool kits of the government and as a result the federal, state, and local governments have all been involved in the procurement, distribution and price determination of fertilizer at various times (Obisesan, Akinlade and Fajimi, 2013). Upon employing a cross-sectional data from 110 smallholder food crop farmers in Ondo State Nigeria, both descriptive statistics and Tobit regression revealed that years of education, distance to market, membership of farmers' group, farm size, access to credit and fertilizer price were significant factors in the use of fertilizers. This is more probable to serve a motivating factor to induce more farmers in utilizing agro-chemicals. Their findings presupposed that farmers with higher level of education were more likely to apply fertilizer than those with lower level of education. They acknowledged that this may be as a result of the fact that more educated farmers are enlightened on the benefits of using improved farm inputs such as fertilizer on crop production. Again, their study illustrated that the longer the distance, the less the probability of fertilizer use (Obisesan, Akinlade and Fajimi, 2013).

Through a quantitative survey involving sixty smallholder farmers sampled using a two-stage sampling technique and Probit model, Alabi, Lawal, Coker & Awoyinka (n.d.) realised that decision making on agro-chemical use was dependent on farmers' age, farm size, level of education, extension services, access to credit, farming experience and off-farm revenue. They however stressed that information plays a critical role in one's decision to utilize agro-chemical

inputs. Sources of such information included print media, government extension agents, print media and other farmers (Raufu, 2010). They therefore stressed that information dissemination through print media such as farmers' magazines and newspapers could be utilized and distributed intermittently to farmers as reference materials in order to enhance their knowledge base about agro-chemicals (Alabi, Lawal, Coker & Awoyinka, n.d.).

According to Nwanze (2011) there are about 500 million smallholder farms globally offering livelihoods for more than 2 billion people. These small farms produce about 80% of the food consumed in Asia and sub-Saharan Africa, indicating the importance of the small farm sector to agricultural and economic development in many developing countries. Similarly, smallholder farms account for 80% of Ghana's agricultural output with 2.74 million households involved in farming (MOFA 2008; Namara, 2010).

In Ghana, the smallholder farming industry is undermined by a number of obstacles such as difficulty in accessing micro-credit. In Northern Ghana, an investigation by Anang, Sipiläinen, Bäckman & Kola (2015) revealed that gender, household income, farm capital, improved technology adoption, contact with extension, the location of the farm, and awareness of lending institutions were the key factors inducing access to agricultural micro-credit. They employed a multi-stage stratified random sampling technique and recruited 300 smallholder rice farmers from three irrigation schemes in Northern Ghana who were interviewed using a semi-structured questionnaire.

In Upper West region, Musah (2013) noted that more smallholder farmers gain access to market information (77.3%) and this market information comprised market prices and where readily available market exists. The various means of gaining information were through friends/relatives, market women, radio, combined sources of friends/relatives, market women and radio (Musah,

2013). Market participation of smallholder farmers in Ghana are dependent on diverse factors. Some studies have indicated that this is induced by age of the household head, educational status of the household head, household size, and membership in farmer based organization, farm size, annual household income, proportion of off-farm income in total annual household income, output of maize and access to credit (Musah, 2013).

Also, in Ghana, growth in the cocoa production has been increasing at an increasing rate with a record-breaking of about 1,000,000 tons in 2012 cocoa season. It is believed that this increase in output is attributed to a number of interventions including the cocoa Hi-Tech programme popularly known as "Mass Spraying Exercise". In spite of this tremendous increase in production, average yields per hectare is still below the potential estimated average of about 1000kg/ha. Ghana's yield/ha is about 400kg which is substantially lower than those observed in some of the cocoa producing countries such as Malaysia (1800kg/ha) and Cote d'Ivoire (800kg/ha) (Binamet al., 2008; Barrietoset al., 2008).

The low productivity of crop such as cocoa is partially attributed to the depleting of soil nutrient, farmers inability to control pests and diseases as well as escalating cost of inputs in recent years. The cost of factor inputs results in farmers reducing the quantity of inputs use on their farms. The most important of these inputs are labour, fertilizer (to improve soil fertility), insecticides and fungicides (for controlling pests and diseases). The use of agro-chemicals to provide nutrients for soil and pests and diseases control is an important issue under investigations in the Ghanaian cocoa industry. It has become a well-known fact that, one of the measures to increase cocoa productivity is through fertilization and control of pest and diseases. Appiahet al., (1997) reported a doubling of cocoa yields over a four-year period after the application of 4.94 bags of triple super phosphate and 2.49 bags of muriate of potash per hectare on on-farm trials in Ghana.

The most damaging disease attacking cocoa is the fungal disease called "black pod". This disease is caused by two main species namely pytophthora megakarya and pytophthora palmivora which are of economic significance. The black pod disease is reported to be responsible for an estimated yearly loss of about 44% of the total global cocoa production (Nkamleuet al., 2007). Insect pest, cocoa capsids or mirids (Distanthiella theobromae and Salbegella singularis) are widely perceived to be one of the serious constraints to cocoa production. Outbreaks of these pests and disease could cause up to about 75% loss of output especially in areas where trees have been neglected (Nkamleuet al., 2007). A parasitic plant called mistletoe is also another serious problem in cocoa production. It usually occurs in newly established cocoa farms after the primary forest has been cleared. Other insect pests are mealybugs (planococcus and stictococcus species) and nematode parasites (meliodogyne). These are most significant species because of the extent of damages they cause and their widespread occurrence in cocoa growing regions.

In an attempt to mitigate the challenges of low productivity level, the Ghana COCOBOD introduced a technology package which includes cocoa diseases and pests control programme (CODAPEC or mass spraying of cocoa farms) and Cocoa High Technology programmes, which provides free inputs and labour for the control of capsids and black pod as well fertilizer to cocoa farmers on credit. This is because the spraying frequency of the "mass spraying exercise" is not adequate and cocoa farmers are expected to do additional spraying. For effective and sustainable control of pest and diseases, one of the components of the technology is the requirement that cocoa farmers spray their farms with insecticides four times per cocoa year. Spraying is done from the month of August to December, leaving out November for harvesting and to ensure that treatment

coincides with the main period of capsid or mirid population increase which usually occurs between August and November (ICCO, 2008; Adu-Acheamponget al., 2007).

The recommended chemicals used in controlling capsid in Ghana include Confidor 200SL and Cocostar EC. The application is done by the use of motorized mix-blower machine. Moreover, spraying against black pod is done nine times per year starting from the month of March and continuing every two to three weeks whilst fertilizer is applied once every year with three bags of fertilizer per hectare. Dormonet al., (2007) reported that the use of chemical in controlling pests, though effective, comes with its own challenges regarding its applications and adoption.

Furthermore, vegetable farming is highly practiced by small scale farmers in the region who frequently use pesticide without knowing their impact on human health and the environment (Ngowi, 200; Ngowi et al., 2007). Furthermore, poor soil fertility as drawback to production has also been previously reported in areas with intensive unsustainable agriculture whereby farmers are necessitated to use organic and inorganic fertilizers (Mati, 2005; Salami et al., 2010). However, average rate of fertilizer use in Tanzania is significantly below consumption rates (about 10 kg ha-1) as opposed to 18kg in Africa and 94 kgin the world (World Bank, 2000).

Fertilizer consumption rate in Tanzania increased significantly from 83,392 metric tons in 2003/2004 to 146,000 in 2006/2007 while the supply increased from 112,000 metric tons in 2003/04 to 287,763 metric tons in 2006/2007 (Shetto et al., 2007). Of particular concern, the use of commercial fertilizer is done without proper advice from agricultural officers (Isham, 2002; Mati, 2005). Misuse including over- and under-dosing, mixing of different fertilizers may have impacts to the crop production and environment at large.

Because of its soil fertility and arable irrigatable land Lake Manyara basin in particular Mto wa Mbu ward at the foot of the Rift Valley escarpment has recently attracted many immigrants from

all parts of Tanzania (Rohde and Hilhorst, 2001). The estimated Lake Manyara basin immigration rate is 4.5% (Norconsult, 2001). Land use has been intensified and irrigated farming is adversely practiced in the area. The irrigated lands are located at the interface between pastoral and agricultural societies which results to conflicts between cultivators and livestock keepers over pasture-land and water resources.

On the one hand, agricultural practices and overgrazing on the plateau have a direct bearing on soil fertility and the hydrological regime which supports this intensive irrigated agriculture at the escarpment foot. Unfortunately, factors creating environmental problems are the same as those required for growth in agricultural production. While increased agriculture and agro-chemical uses are generally considered a panacea for farmers' to increased Nonga et al. 2217 production; farming practices, use of the agrochemicals and possible environmental pollution from agriculture in Manyara basin has not been investigated. The current study was conducted to assess the smallholder farming practices, usage of agro-chemicals and their possible pollutions to the environment. It is envisaged that information presented in this study will contribute to our understanding of agricultural situation in Lake Manyara basin and the possible types of agrochemical pollutions released to the environment. This may be useful as baseline information for sustainable agriculture, identify specific constraints and opportunities for appropriate and sustainable agriculture in the basin aimed at increased production, and safeguard the public health and conservation of fragile Lake Manyara ecosystem

To attain the goals of increasing productivity, farmers in Ghana need to be encouraged to use agro-chemicals as reported in the aforementioned works. To design such strategies, information is needed about farmers' current use of agrochemical inputs and the factors that shape the adoption of these and the intensity with which they are used.

2.11 Food Safety Issues on the use of Pesticides

The view to regulate pesticides residue to safer levels was originally initiated by the joint Food and Agriculture Organization and the world Health Organization (FAO/WHO) expert committee on food safety and they defined food safety as "all conditions necessary during production, processing, distribution, storage and during the preparation of food to ensure it is safe, wholesome, sound and fit for human consumption (Codex, 1995). To facilitate the implementation, the joint FAO/WHO food standards programmes, Codex Alimentarius Commission, comprising 120 member states, was established in 1964. The Codex Committee on Pesticide Residue (CCPR) is a subsidiary body on the Codex Alimentarius commission that advises on all issues relating to pesticide residues. The main objective was to come out with Maximum Residue Limits (MRLs) to protect consumers and foster international trade to avoid, for example, according to the Ghanaian Statesman (2006), a consignment of 2,000 metric tonnes of Cocoa beans from Ghana rejected by Japan as a result of excessive levels of pesticide residue in the beans. According to Ntow (1998), monitoring of pesticide residue on food is virtually non-existent in Ghana and this is so because the analysis is too expensive for public authorities (Clark et al., 1997).

Unsafe food from any part of the world causes devastating health, economic and political consequences. According to DeWaal and Nadine (2005), contaminated food contributes to 1.5 billion cases of diarrhoea in children each year, resulting in more than three million premature deaths. The World Health Organization (WHO) (1999) revealed that, both developed and developing nations share those deaths and illnesses. According to Masud and Hassan (1992), pesticide residues were found in fruits been sold in markets which indicates the indiscriminate, wrongful and careless use of pesticides by farmers.

On-farm food safety related issues and quality assurance initiatives according to Ontario Ministry of Food and Rural Affairs (OMAFRA) (2004) are as a result of changing paradigm faced by the agricultural food system. Some decade ago, farmers produce was freely marketed without strings attached. But of late, the reality is that farm produce production is shifted to the dictates of market requirements. Consumers now expect their food meets safety standards and increasingly, they want assurances of how their food is produced in addition to assurances of produce quality and safety (OMAFRA, 2004).

Whitehead and Field (2002) have classified food hazard into three categories: physical, chemical and biological. Physical hazards (e.g. Stones in grains. Bone pieces and others like metal chips in meat products) are most likely to be understood by people but far more complex and less understood are the nature of the impact or consequences of chemical which if misapplied or not recommended can lead to the contamination of crop lands, water sources and more importantly result in the accumulation of pesticides residues in crops especially crops that are eaten in the raw state as well as biological hazards on human health related issues because of the nature of complexities. For instance, the level of pesticide residue, which is capable of causing harm to an individual, can only be determined through laboratory analysis.

Sefa-Dedeh (2006) reported of the high expectation of consumers for food safety but the challenge has been on maximum residue compliance and residue testing. The horticultural industry of Ghana has developed the manpower needs in producing and maintaining quality management standards to assure safe produce deliverance. Sefa-Dedeh (2006) stated the horticultural sector's strategies for establishing quality assurance and food safety as part of the operational management plan of the various actors. The GhanaGAP concept is been initiated in establishing a national quality management assurance management system. The initiative is a gradual mainstreaming of good

agricultural practices that seeks to raise standards in the horticultural sector and to also facilitate produce quality, safety and traceability. This can help prevent farmers from mixing cocktails of various pesticides with the aim to increase their potency (Danso et al., 2002).

- Institutions and Agencies Involved in food Safety and Regulation in Ghana

  Sefa-Dedeh (2009) listed the key actors in Ghana's food safety sectors to include: 1) Ghana government being responsible for setting regulatory standard, certification, policies, enabling environment, 2) Ghana government in partnership with development partners, 3) Private Sector which involves the farmers, market intervention both local and export sectors, processors, distributors and consumers, 4) Public- private initiatives such as the National Codex Committee and the Horticultural Task Force.

Food safety involves several interrelated activities which cut across multi disciplines that need collaborated efforts from the government ministries, agencies, organizations and ministries while parliament enacts regulation to provide main corpus of food law. A comprehensive food system needs a dynamic interdependency of a number of factors such as the farmers, marketers, the private sector, consumers, governmental bodies, researchers and educational organizations (FAO, 2002). A frame work system is needed to harmonize the various actors' roles to enhance a collaborative interdependency, cohesiveness and effective communication between the major actors. In Ghana, the Ghana Standard Board and the Food and Drugs Board are the major regulatory institutions mandate in ensuring the safety and quality standards of all consumables besides other governmental institutions.

2.11.1 Status of Food Safety and Legislation

Safa-Dedeh (2009) reported of the formation of institutions with specific mandates derived from various enacted legislative instrument such as the Legislation on Food and Drugs: Food and Drugs

(Amendment) Act, 1996 (Act 523) Article 5. Section 7 of PNDCL 305B amended by renumbering and insertion of the following new subsection (2) "Foods shall be stored and conveyed in such a manner as to preserve its composition, quality and purity and to minimize the dissipation of its nutritive properties from climatic and other deteriorating conditions", Legislation on the Environment: Environmental Protection Agency Act, 1994 (Act 490), Pesticides Management and Export Control Act, 1996 (Act 528), Standards Decree, 1967 (NLCD 199), superseded by the Standards Decree, 1973 (NRCD 173), Ghana Standards (Certification Marks) Rules, 1970 (LI662), Ghana Standards (Certification Marks) (Amendment) Rules, 1970 (LI 664), Standards (Amendment) Decree, 1979 (AFRCD 44), Ghana Standards Board (Food, Drugs and other goods) general Labelling Rules, 1992 (LI 154).

2.12 Identified Gaps in the Literature Reviewed

Based upon the literature reviewed, there are a number of gaps identified which the thesis will take consideration in enriching the literature on assessing the use of agrochemical by smallholder farmers in the Nadowli-Kaleo District of the upper west region, Ghana. The literature reviewed on assessing the use of agrochemicals by smallholder farmers in the Nadowli-Kaloe District of the upper west region has no study area located in the region. The only literature reviewed on smallholder farmers was conducted by Musah, (2013) on Market participation of smallholder farmers in the Upper West region of Ghana.

It was also realized from the literature reviewed that most of the studies conducted concentrated on the use of fertilizers, the percentage of farmers using fertilizers. The problem of the perceived and observed effects of continual use of agro-chemicals and precautionary measures farmers adhere to when dealing with agrochemicals were not examined by various authors in the literature reviewed, which revealed a shortfall in the literature on assessing the use of agro-chemicals by

smallholder farmers. The literature also depicted that less of the Rational Choice Theory (RCT) was employed to elicit information on farmers' use of agrochemicals.

Many of the studies conducted did not show how research bias was tackled in the process of soliciting information in the research work to minimize the incidence's research bias. And some of the studies conducted have small sample size. However, this study employed the Rational Choice Theory (RCT) through which the stated preference approach will be used to elicit information on assessing the use of agro-chemicals by small holder farmers in the Nadowli-Kaleo District.

2.13 The conceptual framework for the study

A farmer is driven by two main characteristics that influence him or her to use or not use agro-chemical in farming, these characteristics are farm characteristics (farm size, type of crop cultivated, nature of farm land) and farmer characteristics (age of farmer, income status of farmer, experience of farmer). In spite of these characteristics, a farmer is also faced with opportunities such as adequate rainfall, machinery, agro-chemicals and threats such as rain failure, pest and disease infestation. A farmer's decision to use or not to use agrochemical largely depends on farm/farmer characteristics, opportunities and threats to the farmer. In spite of these factors, a farmer can decide to use or not to use agro-chemical and make losses or make gains with regards to crop yield. A farmer as rational as he/she may be will weigh the losses and gains if the gains outweigh the losses the farmer will continue and will always use the agro-chemicals. This is presented in the framework in figure 2.1 below.

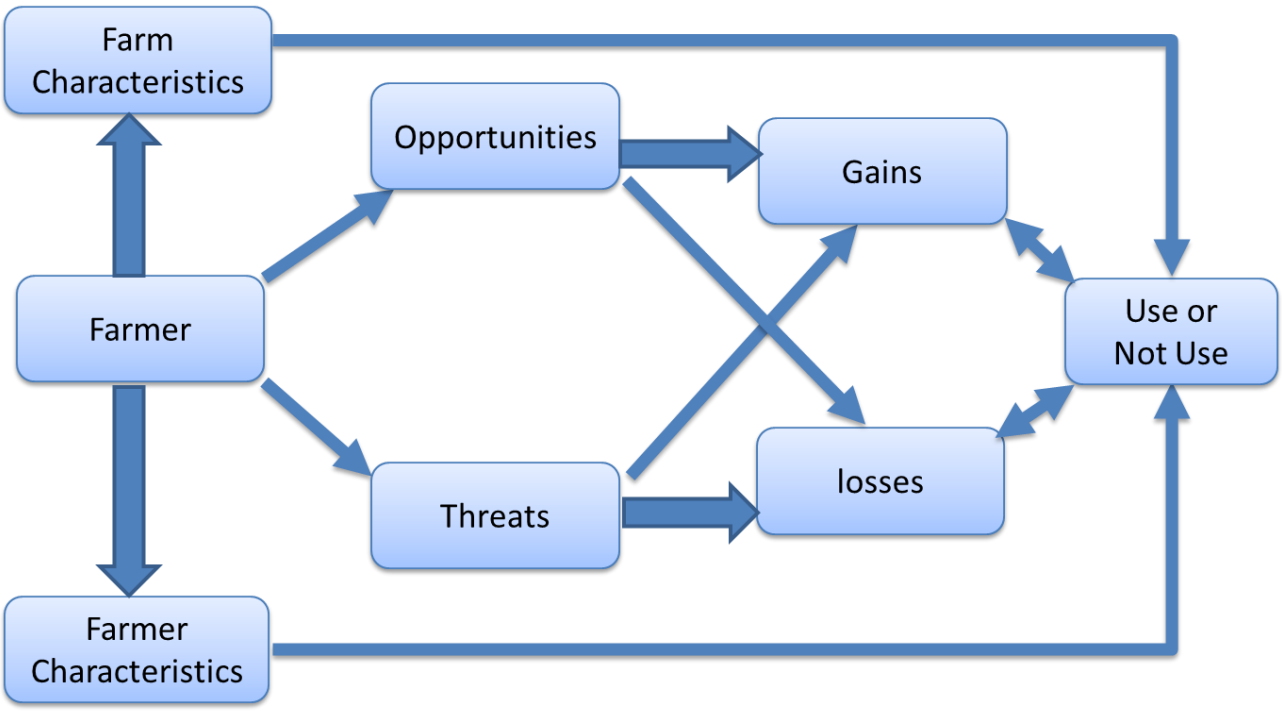

Figure 2.1: Conceptual framework for the study

Source: Author's Construct 2017

2.14 Conclusions

Literature reviewed on assessment of agrochemical use by smallholder farmers revealed major lessons and information to complement the thesis. Knowledge gained from the literature reviewed will serve as a bench mark for the research work. The general approach in the research work involves; research design, data collection tools, data analysis, and presentation. Questionnaire designing and administration is another lesson learned from the literature reviewed, the segmentation of the questionnaire in order to obtain relevant information on farmers use of agrochemicals.

Research work is prone to bias as a result of questionnaire administration, which plays a key role in eliciting information from respondents. Thomson (1991) described how he was able to minimize the risk of strategy bias in his work, while Barnes (1997) considered how to minimize the risk of

various forms of bias such as; compliance bias, starting point bias, range bias, relational bias and positional bias. Few of the studies such as Shang et al. (2011) carried out pretest study to reduce bias, such as sequencing and strategic bias which might affect the respondents to express agro-chemical usage assessment. It is noted from the review of the empirical literature that, little or no study has been done on assessment of the use of agro-chemicals by smallholder farmers in upper west region and in Nadowli-Kaleo District respectively. This therefore necessitated the current study to fill this gap.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the various methods and procedures employed in the study. The methodology includes the study area, and population and sampling techniques. It also discusses the various types and sources of data, methods of data collection, as well as the type of research instruments used. It again features prominently the type of data analysis adopted for the study.

3.2 Area of Study

The Nadowli-Kaleo District Assembly was established in 1988 under the Local Government Law 1988 (PNDC Law 207). The assembly is empowered as the highest political and administrative body in the District charged with the responsibility of facilitating the implementation of national policies. Under section 10 of the Local Government Act 1993 (Act 426), the Assembly exercises deliberative, legislative and executive functions in the District. By this act, the Assembly is responsible for the overall development of the District through the preparation of development plans and budgets and other development initiatives. The development of the District shall be on a satisfaction of essential needs of the people, equitable access to education and reduction of illiteracy and creation of an enabling environment for the private sector participation in development activities so as to achieve poverty reduction in the District.

The Nadowli-Kaleo District Assembly exists to improve the living standard of the people through the efficient, effective mobilization and utilization of resources with the participation of the people in a friendly environment and on sustainable basis. Nadowli-Kaleo District is centrally located in the Upper West Region of Ghana. It lies between latitude 11’ 30’ and 10’ 20’ north and longitude 3’ 10’ and 2’10’ west. It is bordered to the south by Wa Municipal, west by Burkina Faso, north

by Jirapa/Lambussie District and to the east by the Daffiama-Bussie-Issah District. It covers a total land area of 2,742.50km2 and extends from the Billi Bridge (4km from Wa) to the Dapuori Bridge (almost 12km from Jirapa) on the Nadowli-Kaleo District Assembly, main Wa – Jirapa Hamile road. From West to east, it extends from the Black Volta to Daffiama. The distance between the District and the regional capital covers about 41 km. The location of the District promotes inter-District trade and international trade with Burkina Faso on the Western Corridor. The administrative responsibility of the District rests with the District Assembly. The District Assembly is made up of the General Assembly/Secretariat, the highest decision making body, Department of the Assembly, Area Councils and Unit Committees. There are 7 Area Councils. The District Assembly is composed of the General Assembly and departments of the Assembly. The General; Assembly is made up of the District Chief Executive, the Members of Parliament and Assembly members.

There are 49 Assembly members, 69.39% of which were elected from the various electoral areas in the District by universal adult suffrage and the remaining 31.61% appointed by government in consultation with the traditional leaders and interest groups in the District. The Assembly has a Presiding Member, elected by 2/3 of its members in line with the Local Government Act. The District Chief Executive is a government appointee approved by 2/3 members of the assembly. Traditionally, there are 4 pronounces in charge of traditional administration. These are Kaleo, Takpo, Cherikpong and Nadowli.

According to the 2010 population census, the District has a total population of 94,388. This population compared with the 2000 census figure of 82,716 indicates a growth rate of 1.9% per annum.The growth rate needs to be checked. Out of the current estimated total population of

94,388, the males are 44,724 and females 49,664. The male/female ratio is 47:53. The male/female ratio amplifies the need to mainstream gender in the pursuance of development in the District.

The District depicts a typical rural economy dominated by the agriculture sector followed by the commerce and industrial sectors. Agriculture alone accounts for about 85% of the labour force while commerce/service and industry account for 14% and 1% respectively. Agriculture is the mainstay of the people in the District. It engages about 85% of the active population. Food crop production in the District is largely on subsistence basis. It is characterized by low output levels. The main food and cash crops produced are maize, millet, sorghum, rice, groundnuts and soya beans. Tree cropping is also done particularly mangoes and cashew. Livestock production is also done on subsistence basis and as a complement to crop production. The sector is estimated to be growing at 2.1% per annum, which is below the national target of 6% per annum. Development efforts in this sector are gear towards modernizing agriculture as the path out of poverty in the District. The commerce/service sector is the second largest employer of the District's labour force after agriculture. It encapsulates a wide range of tertiary activities. These include retailing and petty trading, transport and financial services and services provided by civil servants.

The sector is dominated by informal small scale trading, especially in agricultural produce and limited modern consumer products. It is characterized by family ownership. The District has three (3) major periodic markets. These markets centres are located in Sankana, Nadowli and Tangasia. However, these markets are not so brisk, as revealed by the volume of endogenous and exogenous inflows of goods to and from the markets. Nadowli, the District capital is the main commercial center in the District and most of the settlements in the District depend on it for their shopping needs. Apart from being a source of livelihood, the trading activities in the District particularly in the periodic market centres form one of the major sources of revenue to the District Assembly.

Thus the improvement of market infrastructure is key in the development agenda of the District Assemble.

The transport sector plays a crucial role in the District's economy with regard to getting the produce to the market as well as supplying inputs and other needs of the people in the District. Nevertheless, the sub-sector is poorly developed. Poor condition of the roads and lack of access roads to communities hinders production in the District. There is only one financial institution in the District. That is the Sonzelle Rural Bank Agency in Nadowli. It focuses on mobilizing savings of individuals and enterprises. Therefore, access to credit and financial information is remote in the District and is a serious constraint to businesses in the District. Though individuals' income is low but puts together, it constitutes the large market potential to attract development oriented financial institutions.

The industry sector is characterized by small-scale activities and the use of labour intensive production technology. These include basketry, cloth/smock weaving, blacksmithing, pito brewing, pottery and shea butter extraction. With training and credit interventions from the District Assembly, National Board for Small Scale Industries and some NGOs, small scale industrial activities have stepped up in the District. Nevertheless, inadequate financial management skills, inadequate credit facilities, low level of technology and inadequate socioeconomic infrastructure stand as teething issues militating against the development of this sector of the District's economy.

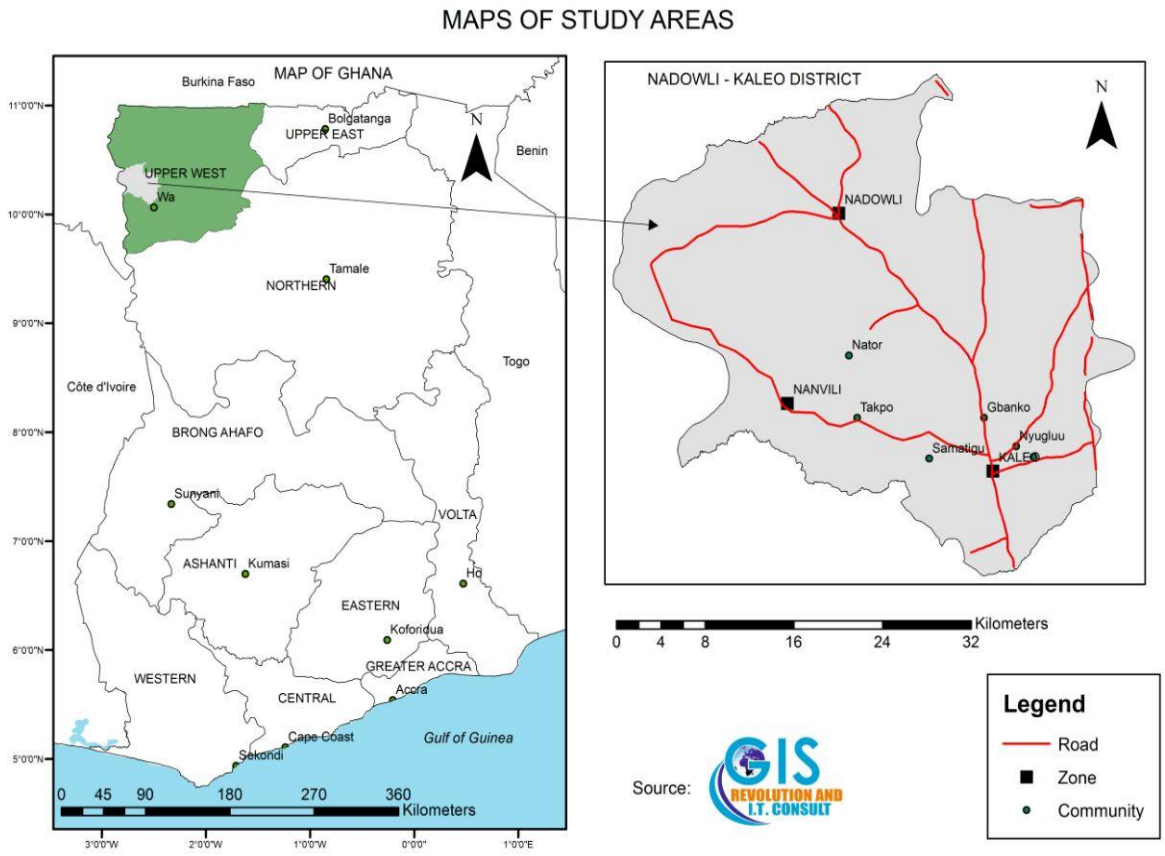

Figure 3.1: Map of Study Area

3.3 Research design

The research design is the mixed method. The purposeful collection of data which constitutes evidence is important to research. Different research techniques or methods are associated with different research designs. The research design of this study comprises of a mixture of both quantitative and qualitative aspects, formulated for the purposes of generalising with respect to a larger population, in a limited manner, but more designed to establish motivational relationships and understanding agents' behaviour in specific contexts.

The quantitative aspect of this research will utilised a cross-sectional design, which involves data collection on variables of interest, from a number of farming groups (cases); each case supplying

data in a single encounter (Bryman, 2004). The cross-sectional design that was used in this study is associated with quantitative research, but also employed in qualitative research through the use of semi-structured and unstructured interviews and Focus Group Discussion (FGDs).

May (2012) indicates that the aim of social research is not simply to collect observations but to examine these within a theoretical framework for underlying mechanisms. The author points out that: "Examining and explaining underlying mechanisms cannot use the methods of empiricism as these simply reflect the everyday world, not the conditions which make it possible". It is due to the limitation of the quantitative strategy that this investigation utilized the strengths of the qualitative strategy through the use of FGDs and semi-structured interviews, to obtain farmers discourses which comprised explanatory or descriptive data concerning their agro-chemical use practices and the effects of these agro-chemicals.

Photographs were taken where possible to complement data which will be generated by the other techniques and were attached in the appendix. Various methods therefore be combined in this study for their capacity to complement each other in expounding the dynamics surrounding agro-chemical use by smallholder farmers; demonstrating the use of triangulation for understanding; as exemplified in other studies.

This is appropriate because it employs quantitative measurement and use of statistical analysis to generate results. The quantitative study mainly from the structured questionnaire was used to estimate the types of agro-chemicals farmers' use and the factors that influence the usage of these agro-chemicals. Also the study estimated the observed and perceived effects of the agro-chemical on the health of farmers, their crops and on the environment in general. However, interviews with key informants such as Agricultural Extension Agents (AEAs) and inputs dealers is important for

corroboration of contingent and support factors that were identified by farmers and also for identifying contextual situations which will be tangential to farmers' use of agro-chemicals.

A Focus Group Discussion (FGD) were conducted with two farming group in two communities on the agro-chemicals use, why they use these agro-chemicals and to elicit from the farmers observed and perceived effects of agro-chemical use. Findings from both key informant interview and Focus Group Discussion was transcribed and presented as qualitative analysis of the data to complement the quantitative data from the questionnaires. Field visits were also conducted to obtain information on agro-chemical use.

3.4 Sampling Procedures

A simple random sampling technique was used to select the respondents for the study. In view of this, both probability and non-probability sampling techniques were employed. The use of both probability and non-probability sampling techniques was meant to improve representativeness of the sample and also reduce bias in the selection processes. The formula $n = N/1+N(e)^2$ by Yamane (1967)

Where:

n = sample size

N = sample frame

(e) = margin of error

With the sample frame (N) of seven hundred and forty-two (742) who belonged to farmer based organizations (FBOs) and margin of error (e) of 0.07.

$742/1+742(0.07)^2$ =160.0587 approximately a total number of one hundred and sixty (160) sample size was generated.

Table 3.1: Sample Distribution

Zones	Number of Communities	Number of FBOs	Number of Farmers
Nadowli	10	14	262
Nanvilli	7	9	314
Kaleo	10	18	166
	Total=27	Total=41	Total=742

Source: MOFA (NKD)

The sample size of 160 was divided by the total number of communities 27 to get the number of farmers in each community.

Sample size/No. of communities = 160/27 = 6.

The second stage then involved the random selection of six (6) farmers from each community. In the third stage of the sampling, twenty-seven (27) respondents (farmers) who do not belong to any farmer based organizations (FBOs) were purposively selected from the twenty-seven communities, one farmer from each community. This was done to compare some the responses of respondents/farmers who belonged to FBOs and had direct technical assistance from agricultural extension officers to those farmers who did not belong to any FBOs and had no direct technical assistance from agricultural extension officers.

In all a total of 187 farmers/respondents were administered a questionnaire each. Each farmer/respondents provided data regarding their socioeconomic and demographic profile, expenditures, return, types of agro-chemicals used, reasons for using agro-chemicals, effects of using agro-chemicals, and precautionary measures adhered to before, during and after agrochemical use. Finally, stakeholders in agro-chemical use in the Nadowli-Kaleo District were

also purposively sampled, notably; agriculture extension officers and agro-chemical dealers in the District.

3.5 Sources of Data

This thesis employed primary data as the main data for the purposes of the analysis of the research questions. Data were therefore generated from respondents (farmers), those in farmers' groups (FBO) who had technical assistance from agricultural extension officers and those who did not have direct technical assistance from agricultural extension officers in the selected communities. Secondary data were also obtained from published articles, thesis and journals about agrochemical.

3.6 Data Gathering Methods

The choice of data collection method was principally informed by the nature of the respondents and the objectives of the study. Hence, this study used the close- ended-questionnaire, structured face- to- face interviews, FGDs and KII in collecting data for the research, using interview guides. It was envisaged that, most of the respondents were illiterates or were unable to understand or speak the English Language. For sake of respondents who did not understand English language, the study resorted to the use of interpreters, to translate the questionnaire into Dagaare to obtain better responses from the respondents.

The study also sought the assistance of three research assistants, two females and one male who were deployed to administer the questionnaire. The research assistants were provided with training on the questionnaire designed to elicit farmers' preference and use of agro-chemicals. They also helped in the distribution of questionnaires, assisted respondents where necessary, especially where there was language barrier, and collected completed questionnaires.

3.7 Questionnaire

A questionnaire was designed to elicit information about the types of agro-chemicals farmers use, factors influencing farmers' use of agro-chemicals, observed effects of the use of agro-chemicals, and precautionary measures adhered to in handling agro-chemicals. A pre-test was conducted with the questionnaire at the Kaleo zone to ensure consistency and reliability of data. For the two categories of farmers; that is, farmers' groups (FBO) who had technical assistance from agricultural extension officers and farmers who did not belong to any farmers' groups and had no technical assistance from agricultural extension officers, including two agricultural extension officers and two agro-chemical dealers a total of 187 questionnaires were administered. Some 160 farmers/respondents belonged to FBOs and 27 farmers/respondents who did not.

3.7.1 Interviews

Key informant interviews was conducted involving one agricultural extension officers (this was due to the fact that only one agricultural extension officer was responsible for the three zones in the District). Three (3) agro-chemical dealers in the District were also interviewed one from each zone in relation to agro-chemical use in the District. One environmental expect and one opinion leader were also interviewed. In all, four (4) key informant were interviewed. An interview guide was designed and used to elicit information on: types of agro-chemicals sold, prices of agro-chemicals, how often farmers buy agro-chemicals, why farmers resort agro-chemical use, observed effects of the use of agro-chemical, precautionary measures when dealing with agro-chemicals, and challenges affecting the efficient use of agro-chemicals in the District.

3.7.2 Focus Group Discussions

Focus Group Discussions were also conducted involving three farming groups in three communities, one from each zone on agro-chemical use. The communities were the FDGs were

conducted were Takpo, Goliyiri and Zambogu. A focus group discussion guide was also designed and used to solicit information on: the types of agro-chemical they use, the factors that in influence the choice of agro-chemicals, observed effects of agrochemicals use, precautionary measures adhered to when dealing with agro-chemicals and how beneficially the use of agro-chemicals to them. Two focus group discussions were conducted with eight (8) farmers from each of the communities. Membership to these groups was based on association to farmers' groups.

3.7.3 Observation

Personal observation was employed in the three zones (Kaleo Nanvili and Nadowli zones) on the physical environment. A transect walk through some of the communities was employed to observe how farmers handle or deal with empty agro-chemical containers. Some farms were also selected and visited, here, observations were made on how farmers apply agro-chemicals and also the effects of agro-chemical usage. In Goliyiri in Nandowli zone, a farmer took us around his farm to observe the devastating effects of army worm infestation in the 2017 farm season, one of the reasons why they use agro-chemicals more often. Agro-chemical shops were also visited and observations were made to ascertain whether the dealers were following the rules and regulations of the environmental protection agency (EPA). Some few homes in some of the communities were also visited to observe whether empty agro-chemical containers were reused at homes. Photography on the devastating effects of army worm was also undertaken.

3.8 Techniques of Data Analysis and Presentation

For the purpose of addressing the research questions and based on the nature of the data that was collected, only descriptive statistics and cross-tabulations were employed. Data was presented using frequency tables, bar graphs and pie charts. The quantitative analysis was supported by the qualitative data from the FGDs and interviews through transcription, direct quotations and

interpretation. The study dwelled mainly on the Rational Choice Theory (RCT) to elicit information from the respondents on agro-chemical use and its effects. The data was edited, coded and inputted into a statistical software package called SPSS (Descriptive statistics and crosstabs), Microsoft excel was also used to present the tables and figures generated from the SPSS.

3.9 Outline of the Research Process

The research design that was used in the study was mixed method, the qualitative aspect was concentrated on Observation, Focus Group Discussion (FGD) and Key Informant Interview (KII) on agro-chemical use by farmers in the Nadowli-Kaleo District. The quantitative aspect of data was also generated from the questionnaire designed to examine farmers' use of agro-chemicals in the Nadowli-Kaleo District.

Yamane 1967 formula $n = N/1+N(e)^2$ was used to generate the sample size of 160 respondents from a sample frame of 742 members. Additional 27 respondents who were not members of FBOs were conveniently selected, one respondent from each of the 27 communities. Purposive sampling was also used to select the agricultural extension officers in charge of the three zones. Three leading agro-chemical dealers in Nadowli-Kaleo District were also purposively selected for the questionnaire interview.

The source of data collection was mainly from primary source, notwithstanding some secondary sources of data were also collected where it was necessary. The primary data was generated from the farmers' questionnaire administered, FGDs, and KII. These were transcribed and presented in the analysis while quantitative data are presented in table and figures. Secondary data sources was obtained from published and unpublished documents. The main data gathering methods the study employed was the use of closed- ended- questionnaire, structured face- to- face interviews, interview guides on key informant interview, and focus group discussion. The study also made use

of SPSS software (version 21) and Microsoft excel to generate and present data for discussion. The chapter three comprising of the research design, target population, sources of data, data collection instruments, sample size and sampling techniques and data analysis and presentation is summarized in the figure 3.2 below.

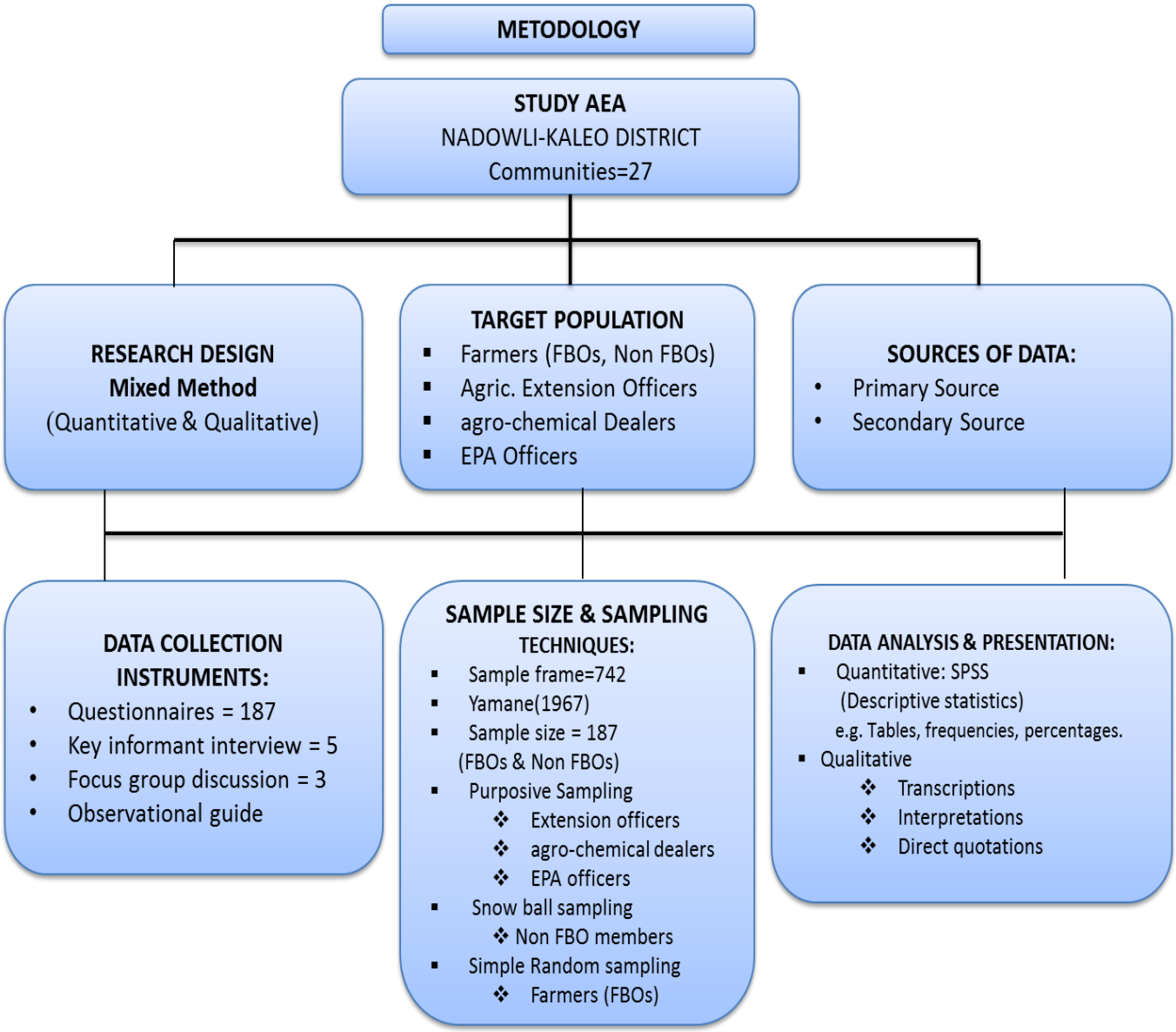

Figure 3.2 Summary of Methodology

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF FINDINGS

4.1 Introduction

This chapter is devoted to the results and discussions of the data obtained from the field. The findings were obtained through direct interview and the use of questionnaire. They are based on demographic characteristics and the study objectives; types and sources of agro-chemicals small holder farmers use in Nadowli-kaleo District; factors influencing the use of agro-chemicals by smallholder farmers in the Nadowli-kaleo District; observed and perceived effects of agro-chemical usage among smallholder farmers in the Nadowli-kaleo District; and safety measures and precautions smallholder farmers adhere to before, during and after application of agro-chemicals in the Nadowli-kaleo District.

4.2 Demographic Characteristics

Research by Danso-Abbeam, Setsoafia & Ansah (2014), (Alabi, Lawal, Coker & Awoyinka, n.d.) and Musah (2013) emphasized on the influence of demographic factors on agro-chemical usage by small holder farmers. Therefore, it was imperative to investigate demographic characteristics such as gender, marital status, religious status, farmers' age and educational status, duration of farming, source of income, estimated income as well as remittances. The results are shown in Table 4.1. About 187 farmers were sampled by the researcher, of this, majority (70.6%) were males while females formed 29.4% of respondents. This agrees with Danso-Abbeam and Musah (2013) assertion that majority of farmers in the study area are males.

Table 4.1: Demographic characteristics

Variable	Description	Responses	
		Freq. (f)	Percent
Gender	Male	132	70.6
	Female	55	29.4
Marital Status	Single	14	7.5
	Married	158	84.5
	Divorced	4	2.1
	Others	11	5.9
Religious Status	Christian	132	70.6
	Muslim	48	25.6
	Traditionalist	7	3.7
Farmer's Age	15-25 years	15	8.0
	26-36 years	55	29.4
	37-50 years	76	40.7
	Above 50 years	41	22
Farmer's Educational Status	No Formal Education	104	55.7
	Primary	35	18.7
	J.H.S/ J.H.S	34	18.1
	S.H.S/Voc./ Tech.	12	6.4
	Tertiary	2	1
No. of Years in Farming	1-5 years	25	13.4
	6-11 years	31	16.5
	12-25 years	91	48.7
	26-36 years	23	16.6
	Above 26 years	9	4.8
Farmer's Source of Income	On-Farm	115	61.5
	Off-Farm	6	3.2
	Both	66	35.3
Est. Income from On-Farm Prod.	GH¢0- GH¢200	39	20.8
	GH¢201-GH¢300	12	6.4
	GH¢-301-GH¢400	23	12.3

	GH¢401-GH¢500	17	9.1
	Above GH¢500	96	51.3
Beneficiary of Remittance	Yes	39	20.9
	No	148	79.1
Kind of Remittance	Cash	15	38.5
	Kind (Material)	22	56.4
	Both	2	5.1

Source: Field Survey, 2017

Respondents who were single and divorced constituted 7.5% and 2.1% of total participants respectively. Those who were married constituted 84.5%. For those who were married, their family's income needs to also cover the purchase of agro-chemicals. This is necessary because of the nature of the extended family system that exists in these areas. It was observed that respondents who were Christians formed 70.6%, followed by approximately 25.6% of respondents who were Muslims. The implication of this is that, the practice of using agro-chemicals including community workshops on use of agro-chemicals are likely to be influence by beliefs of these farmers. For instance, some farmers who are traditionalist depend more on weather and beliefs of smaller gods for good yield rather than agro-chemical usage in these areas.

Also, respondents aged 37 to 50 formed 40.7% of total respondents, respondents aged 26 to 36 formed 29.4% of the total sample. Respondents aged above 50 formed 22% of the total sample while respondents who were between 15 to 25 years formed 8% of the total sample. The study found that since most of the farmers are between 37 to 50 years, their understanding in the use of agro chemicals was good due to their individual experiences. These findings are consistent with that of Danso-Abbeam, Setsoafia & Ansah, (2014) and Alabi, Lawal, Coker & Awoyinka, (n.d.) that farmers' age is a critical factor in determining whether to utilize agro-chemicals.

Out of 187 sample size, 104 individuals/respondents have never had any formal education constituted 55.7%, this clearly suggests that the use of agro-chemical in farming is not limited to the educational status or level of the farmer. About 18.7% of respondents had primary education followed by 18.1% of respondents have had Junior High School training. Respondents who have experience Senior High School education constituted 6.4% of respondents. Just two respondents had acquired tertiary education. Although this finding corroborate Danso-Abbeam, Setsoafia and Ansah, (2014) and Alabi, Lawal, Coker & Awoyinka, (n.d.) assertion on the linkage between educational background and use of agro chemicals, the study found that, training and other sensitization workshops that are undertaken in these areas are also affected. Conversely, it contradicts report by Obisesan, Akinlade & Fajimi (2013) that more educated farmers are enlightened on the benefits of using improved farm inputs such as fertilizer on crop production. This is mainly because educating farmers with no formal education requires more efforts than those with formal education.

Furthermore, the researcher sought to measure the experience accumulated by respondents in farming and it was observed that 48.7% of respondents have been farming for about 12-25 years, this clearly shows that most farmers have being farming throughout their most productive part of their lives. About 16.5% have been farming for 6 to 11 years. Respondents who have been farming for 1-5 years; and 26-36 years accounted for 13.4% and 16.6%. Hence, this study considered farmers in the selected areas as farmers with much experience due to their level of knowledge in chemical use over the years.

Again, the study sought to determine the major sources of income for respondents. This was necessary to determine whether these sources are sustainable and also whether farmers engage in other occupations aside farming. In response, 61.5% of respondents gained their income from on-

farm activities, this clearly shows that farming is the major occupation for respondents in the Nadowli-Kaleo District, followed by 35.3% who received their income from both on-farm and off-farm activities. Few respondents (3.2%) relied on solely off-farm activities. This the study considers partially sustainable owing to the nature of rainfall patterns as well as other critical factors as indicated by Bäckman & Kola (2015) that affect both members and non-members on income of farmers.

The study further investigated about the level of income generated solely from on-farm activities. This was necessary to determine whether these farmers can purchase agro-chemicals in addition to large family expenditures. Majority of respondents earned more than GH¢500 from on-farm activities (51.3%). Respondents were also asked whether they received any beneficiary remittances, majority (79.1%) of them who have not received any remittance, this shows that majority of farmers only rely on the income from the farming activities for survival, 20.9% of respondents have received remittances. It was observed that majority of remittances came in kind (56.4%) like products and about 38.5% of remittances came in cash (Mostly above GH¢100). These had implications on the intensity and amount of money invested in agro-chemicals. This finding is contrary to report by Danso-Abbeam, Setsoafia & Ansah (2014) who noted that although large proportion of farmers they interacted with use agro-chemicals, the intensity and amount spent to purchase these inputs were minimal.

4.3 Farm Characteristics

The study investigated farm characteristics such as methods employed in ploughing farms, major crops cultivated, total land size cultivated, farm animals reared, household members involvement in farming, farmer turner status, source of credits, major constraints farmers face as well as constraints in accessing credit. This investigation was necessary in order to place the current study

within the right context of farm related issues and their linkages with agro-chemical utilization. Figure 4.1 illustrates findings on the methods that farmers (members and non-members of FBOs) use for ploughing their farms.

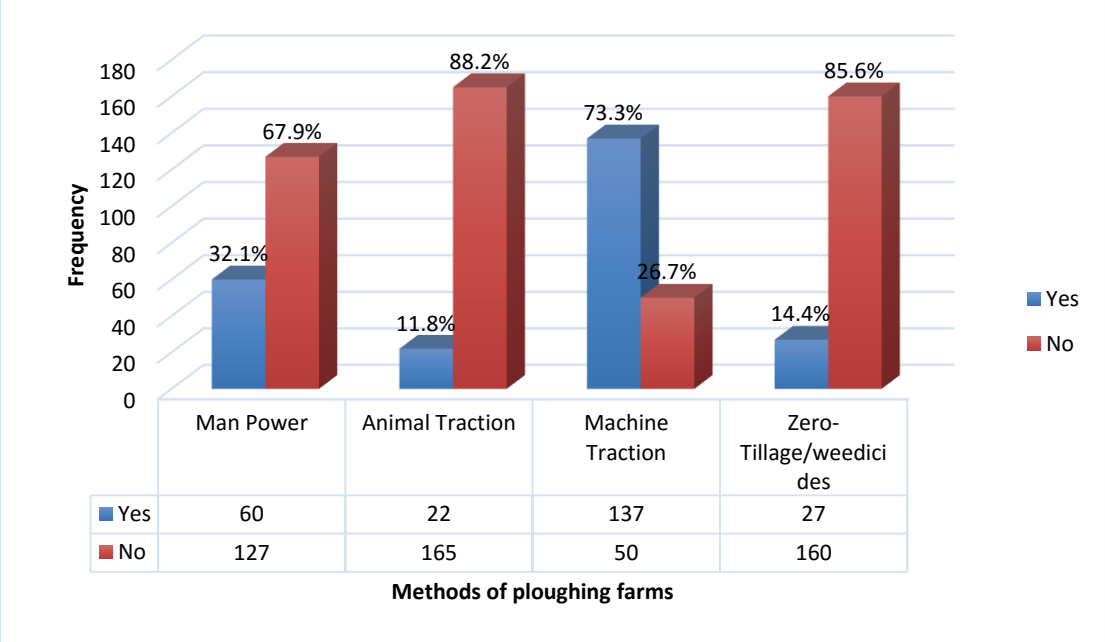

Figure 4.1: Methods of Ploughing Farm

Source: Field Survey, 2017

The various methods of ploughing employed by farmers in the Nadowli-Kaleo District clearly show that farmers use multiple methods for preparing land for cultivation. Notwithstanding, it was observed that majority (57.8%) of respondents were using machines for ploughing. They were more engaged in mechanized farming, using tractors and other machines to enhance the farming process. About 33.8% of respondents did not plough or till the land in any way (zero tillage). They resorted to the use of weedicides and other chemicals to prepare the land for sowing. Information from some farmers show that those who are non-members of FBOs use less of these methods. This can be attributed to their non-affiliation to Farmer Based Organizations in the District.

As part of the research, farmers were asked to state the types of crops commonly cultivated in the area, which are represented in table 4.2. This was necessary because, agro-chemical usage is dependent on the type of crops cultivated as espoused by Amurazi & Albarus (2008).

Table 4.2: Major Crops Cultivated by Farmers

Major Crops Cultivated	Yes		No	
	f	%	*f*	%
Maize	172	92	15	8
Groundnut	177	94.7	10	53
Cowpea/beans	169	90.4	18	9.6
Sorghum	35	18.7	152	81.3
Millet	83	44.4	104	55.6
Rice	77	41.2	110	58.8
Tigernut	4	2.1	183	97.8
Bambara Groundnuts	5	2.7	181	97.3

Source: Field Survey, 2017

It was observed that maize, groundnut and beans were the most commonly cultivated crop among farmers in the Nadowli-Kaleo District with a percentage of 92%, 94.7%, 90.4% respectively, out of the total number of farmers, this has called for the high usage of fertilizer by maize farmers in the District and until this 2017 farming season the onset of army worm infestation in the country including the Nadowli-Kaleo District has also called for maize farmers high use of pesticides. As indicated by a key informant in an interview that, “most of us here cultivate groundnut and beans during the farming season”. Beans was recorded among the most commonly cultivated crop among farmers 90.4%.

Farmers asserted that due to some insects that feed on the flowers and leaves of the beans plants if one does not spray with pesticide one will barely harvest. Groundnut was the highest cultivated

crop among farmers with 94.7% but farmers asserted that due to the nature of groundnut (it is not attacked by any insect and it can also fix nutrient into the soil) no agro-chemical is used during its cultivation. Sorghum, Millet and rice were moderately cultivated crops with 18.7%, 44.4% and 41.2% respectively. While the least cultivated crops were tigernuts and Bambara beans with percentages 2.1% and 2.7% respectively. According to farmers most of these crops do not need agro-chemicals in their cultivation in the District. Hence, future education on agro-chemicals must target the cultivation of these crops for high yield.

The total land size cultivated by farmers in the Nadowli Kaleo District was essential to the study since it helped to assess the capacity of the farmers in terms of the quantum of chemical to be applied. Table 4.3 revealed that most of the respondents were peasant farmers cultivating 5 acres and below.

Table 4.3: Total Land Size Cultivated

		Freq.	Percent
Total Land Size Cultivated	Below one acre	3	1.6%
	1 to 2 acres	29	15.5%
	3 to 4 acres	67	35.8%
	5 acres and above	88	47.1%
	Total	187	100%

Source: Field Survey, 2017

However, it was gathered from the research that farm size was not the main driving force with regards to farmers' use of agro-chemical but rather the type of crop cultivated by farmers. The study found that majority of the respondents, cultivated lands measuring 5 acres and above, followed by those whose total land size ranged from 3 acres to 4 acres. The remaining respondents had total land size measuring 2 acres and below. Again, this justifies the choice of Nadowi-Kaleo

District as study area for such a study because of the large land sizes cultivated by farmers. Stakeholders who visit the selected communities must consider the land sizes in educating farmers on the use of agro- chemicals. Additionally, the researcher asked whether farmers engage in animal farming aside their crop farming. Results of this are presented in Figure 4.2 which reveals that 89% of farmers engage in animal rearing aside their normal crop farming while 11% were solely into crop farming.

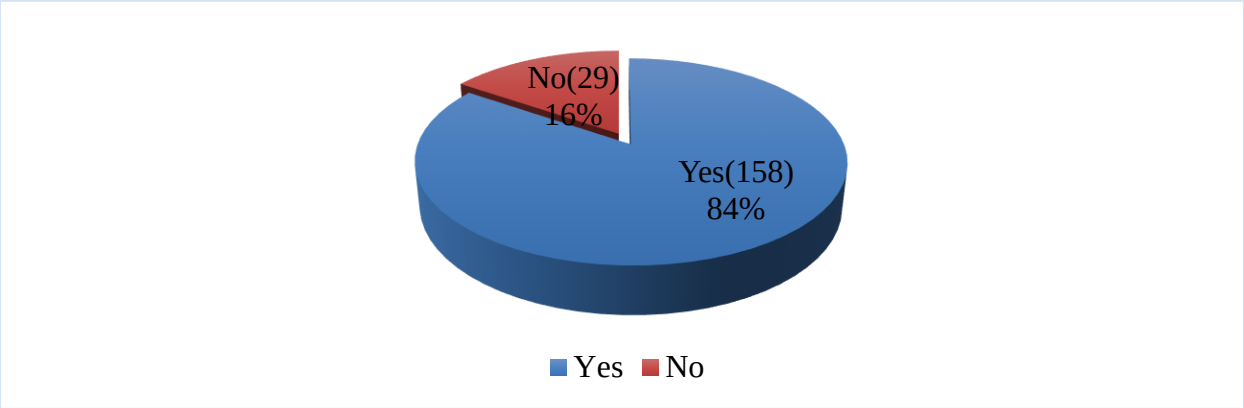

Figure 4.2: Whether farmers engage in animal farming aside their crop farming

Source: Field Survey, 2017

This was necessary to ascertain whether farmers could resort to alternative forms of increasing the fertility of the soil using organic components. An example is animal droppings through the practice of mixed farming and also to know whether farmers have appreciable alternative source of income aside their crop farming but this was not a reality because animals were reared on a very small scale basis as a hobby and their droppings could not be used to improve the fertility their large farms. This calls for more education as farmers can improve the fertility of their farms as well as increasing their off farm income to improve their living conditions. It also agrees with Amurazi & Albarus (2008) assertion on animal rearing.

The study further revealed in table 4.4 that, respondents were mostly into goat rearing and poultry farming as they accounted for almost 82.3% and 87.3.8% respectively each of the total respondents indicated.

Table 4.4: Farm animals reared by farmers

Animals reared by farmers	Yes		No	
	f	%	*f*	%
Goat	130	82.3	28	17.7
Sheep	59	37.3	99	62.7
Poultry	138	87.3	20	12.7
Cattle	21	13.3	137	86.7
Pigs	54	34.2	105	66.5

Source: Field Survey, 2017

Few members of respondents were also into sheep rearing 37.3%, pig was among the least reared animals in the District this was partly due to the fact that some of the respondents were Muslims who also form majority. The least reared animal was cattle with a percentage of 13.3% of the total respondent. These were all done on a small scale basis. Some of the respondents interviewed recommended that they should be educated on the importance of rearing farm animals to encourage more farmers to go into animal rearing. It was evident from the research that respondents involved their household members in the various farming activities.

For this reason, the research sought to find out the number of household members engaged in their farming activities and whether this could be a driving factor determining farmers' use of agro-chemicals. The study gathered in table 4.5 that majority of respondents representing 77.0.0% had about 1- 4 individuals from their households helping the respondents in the farming activities, followed by those with 5-9 members with a percentage 17.6% with their household members helping them in their farming activities.

Table 4.5: Household members involved in farming

Household members engaged in farming	Frequency	Percentage
None	4	2.1
1-4 Member	144	77.0
5-9 Members	33	17.6
10 members and above	6	3.2
Total	187	100.0

Source: Field Survey, 2017

The remaining percentages 2.1% and 3.2% were for respondents who had no household member helping in farming activities and respondents who had more than 10 members engaged in farming activities respectively. On the average 3 (Mean = 3.41) household members from the farming households assist in various farming activities.

The implication of this is that cost in acquiring labour for work on the farms was reduced. These extra monies can be saved and channeled for the acquisition of agro-chemicals for the crops as espoused by Aneani, Anchirinah, Owusu-Ansah and Asamoah (2012). But the number of household members engaged in farming does not prevent one from using agro-chemical or reduce the quantum of agro-chemical to be applied or used.

Anang, Sipiläinen, Bäckman & Kola (2015) revealed that farmer's tenure status was relevant in farm operations. In relation to this, it was necessary to examine farmer's tenure status whether farm operations are solely by the owner, family, or farmer is just a squatter. Figure 4.3 illustrates the results. There are various forms of land ownership available to farmers in the Nadowli Kaleo District. The nature of the study made it relevant to consider such forms of land ownership and tenure systems common to the farmers.

The study revealed in figure 4.3 that, majority of the respondents (59.0%) were cultivating on lands collectively owned by their families, followed by (39.0%) of respondents who were farming on lands that they owned. Only three respondents constituting 2.0% of the total respondents were found cultivating on a rented piece of land.

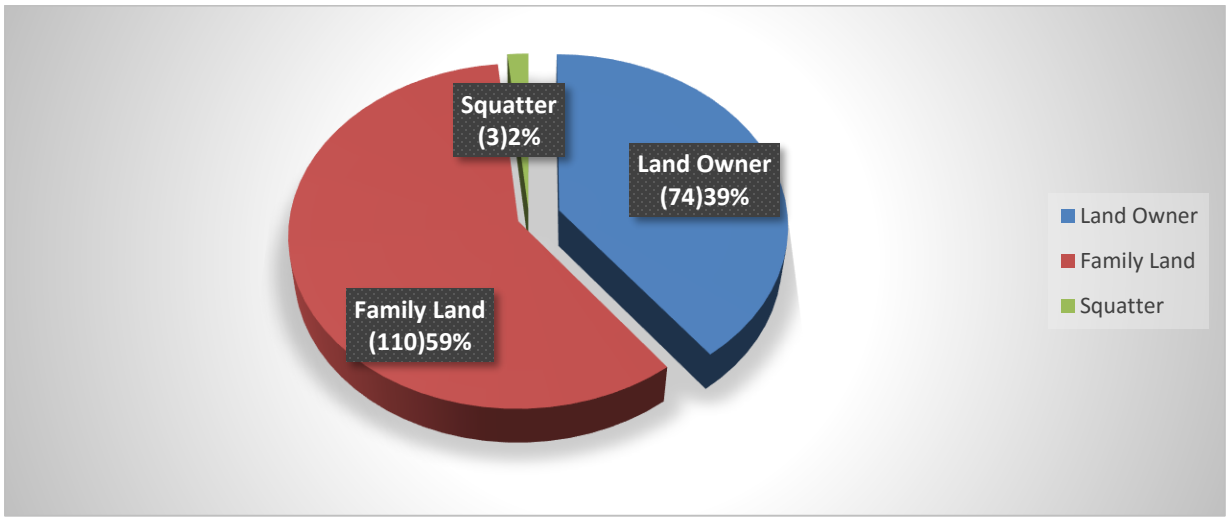

Figure 4.3: Farmer's Land Tenure Status

Source: Field Survey, 2017

This finding corroborates assertion by Anang, Sipiläinen, Bäckman and Kola (2015) that farm capital such as labour plays significant role in farm operations particularly on finance needed.

As part of this study, the author asked whether farmers took credit to finance their farming activities since every business venture relied on capital. This view is further advanced by Anang, Sipiläinen, Bäckman & Kola (2015) and Obisesan, Akinlade & Fajimi, (2013) who reported that capital in a form of micro-credit is essential for farm operations. The study revealed in figure 4.4 below that, 70% of respondents did not take loan to finance their activities, 30% of respondents relied on credit facilities to finance their farming activities.

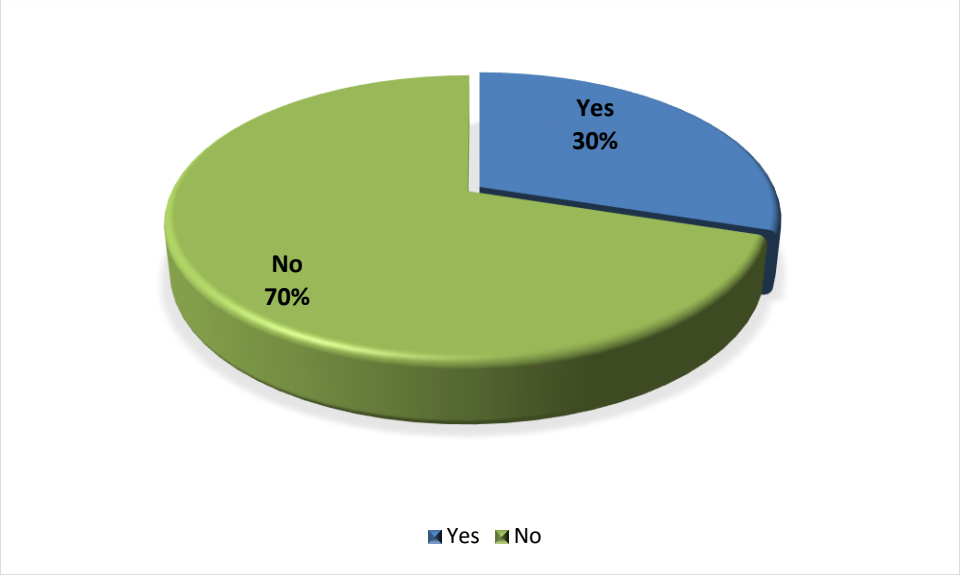

Figure 4.4: Accessibility to Financial Support or Loan

Source: Field Survey, 2017

It was found that membership status to FBOs is not a guarantee for access to loan for farming. Even though some farmers are affiliated to FBOs, more than half do not take loan for farming activities. Based on this finding, it was imperative to find the source of financial assistance for these farmers.

Figure 4.5 illustrates results on the various sources of financial assistance available to farmers. The findings revealed that majority of farmers engaged in informal ways of acquiring loans like dealing with Village Savings and Loans Associations (VLSA) with a percentage of 80.4% from the total number of respondents who take loan for farming activities. Also, 14.3% of respondents relied on FBOs for loan to finance their farming activities. Few farmers/respondents with a percentage of 3.6% each relied on their family/relatives and banks for loan facilities. The VSLA is a group or association that supports people, particularly, farmers with loans.

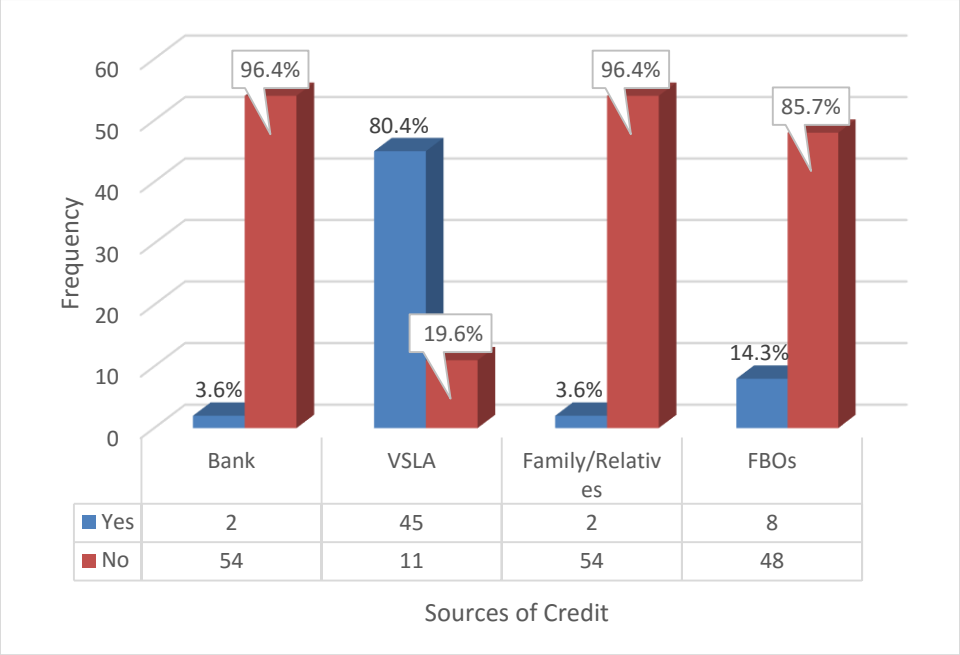

Figure 4.5: Source of Financial Assistance for farming activities

Source: Field Survey, 2017

It was implemented by Plan Ghana and Barclays bank with funding from CARE international (International Non-Governmental Organization). Even though the VSLA was found to be in operation, most farmers resort to other sources for financial assistance. This may be attributed in bureaucratic process and cost (payment of dues) involved on joining such associations. This reveals the difficulty or obstacles that farmers face in accessing credit in Ghana as opined by Obisesan, Akinlade and Fajimi (2013).

The author asked respondents who rely on loan facilities as a way of financing their farming activities to state various challenges they face in acquiring loan facilities. Table 4.6 indicates that majority of respondents (71.1%) stated that interest rates charged were too high and therefore made payments difficult. About 6.7% of respondents described their proximity to banks and financial institution as a major hindrance in accessing financial assistance.

Table 4.6: Major Constraints Faced by farmers in accessing credit

Constraints to Credit access	Yes		No	
	f	%	*f*	%
Distance to bank	3	6.7	42	93.3
No Collateral	5	11.1	40	88.9
High interest rate	32	71.1	13	28.9
Not a member of FBO	5	11.1	40	88.9
Time to repay loan	8	18.2	36	81.8

Source: Field Survey, 2017

The second major constrain to farmers' inability to assess loans for farming was time to repay loan with a percentage of 18.2% with this the respondents said was always too short. The remaining respondents complained about lack of collateral and the fact that some of them were not members of FBOs and VSLAs as a major setback in acquiring loan for farming activities with each having a percentage of 11.1%. This finding agrees with Obisesan et al., (2013) report that interest rates and distance to banks as well as markets are major constraints that farmers face.

Figure 4.6 seeks to establish farmers' use of agro chemicals. Overwhelming 98% of respondents use agro-chemicals while only 2% of the respondents indicated they don't use agro-chemicals. This means majority of the respondents who were interviewed use agro- chemicals in farming. This also clearly shows that being a member of an FBO has no significance influence on farmers' use of agro-chemicals.

This finding corroborates report Danso-Abbeam et al., (2014) that large proportions of farmers in northern Ghana use agro- chemicals.

However, for those who do not use agro-chemicals, the author asked them to indicate their reason(s).

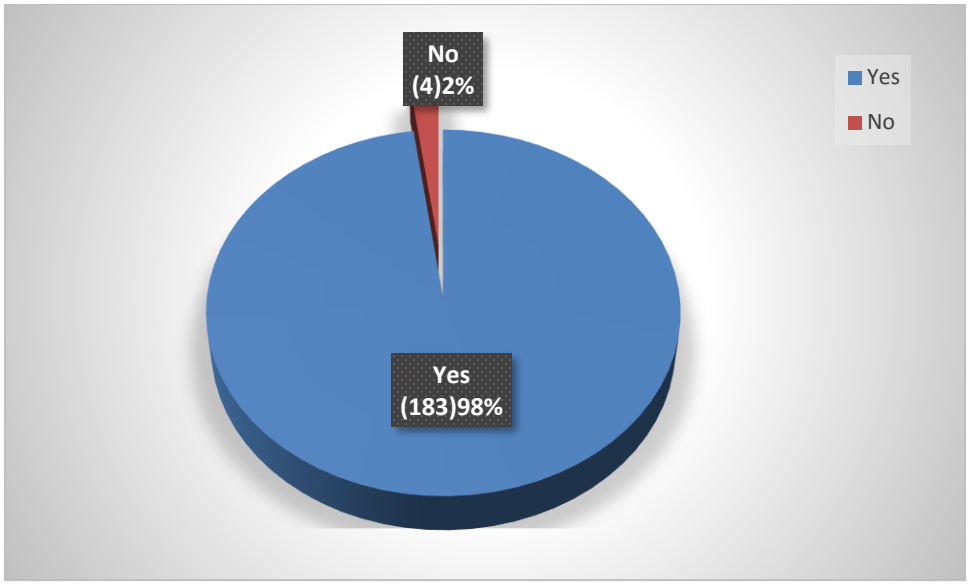

Figure 4.6: Agro-chemical usage by farmers

Source: Field Survey, 2017

The study revealed that four respondents do not use agro-chemicals when farming. Three of them were members of FBOs and the other one was a non-member of FBOs. Table 4.7 reveals reasons why some respondents do not use agro-chemicals. 50% of the respondents stated lack of funds as their main reason, 25% 0f the respondents said they had available alternatives to fertilizers and pesticides. 25% of the respondents also stated that the agro-chemicals were expensive.

For members of FBOs alternative for fertilizers and pesticides was paramount, for instance, a farmer asserted that instead of using inorganic fertilizer to improve the soil fertility of his farm, he uses his farm animals' droppings to improve the soil fertility. On the aspect of pesticide usage, the farmers maintained that he uses extract from Nim tree to control pest in his farm.

Table 4.7: Reasons for not using Agro-Chemicals

Reasons for not using agro-chemicals	*f*	%
Agro-chemicals are expensive	1	25
No Money to purchase	2	50
Available Alternative to agro-chemical	1	25
Total	4	100

Source: Field Survey, 2017

While for the non-member the study found that it was due to the fact that they were very expensive. This finding is inconsistent with findings of Golin et al. (2005) and Aneani, et al. (2012) who maintained that intensive utilization of agro-chemicals, usually, results into increased cost due to cost incurred in addressing adverse effects. With regards to alternatives to the use of agro-chemicals in farming in the Nadowli-Kaleo District, the only agricultural extension officer in the District said. *"...the alternative way of farming rather than the continues use of agro-chemicals by farmers is the method called the integrated pest management practice where farmers employ biological (use of animals to feed on insects that destroy crops), cultural (farm hygiene) and chemical (organic chemicals eg. extract from neem tree) approaches in conducting their farming activities".*

Again, for those respondents who indicated that they use agro-chemicals, there was the need to assess the types of agro-chemicals respondents use when farming.

Figure 4.7 shows that majority of the respondents use pesticides (91.9%), followed by fertilizer users with a percentage of 86.1%, and the least used agro-chemical by respondents in the Nadowli-Kaleo District was weedicides, with a percentage of (75.4%) of the total respondents, this was probably due to the alternatives farmers had in controlling weeds in their farms as indicated. The type of chemicals used also has a direct linkage with the type of crops cultivated by farmers.

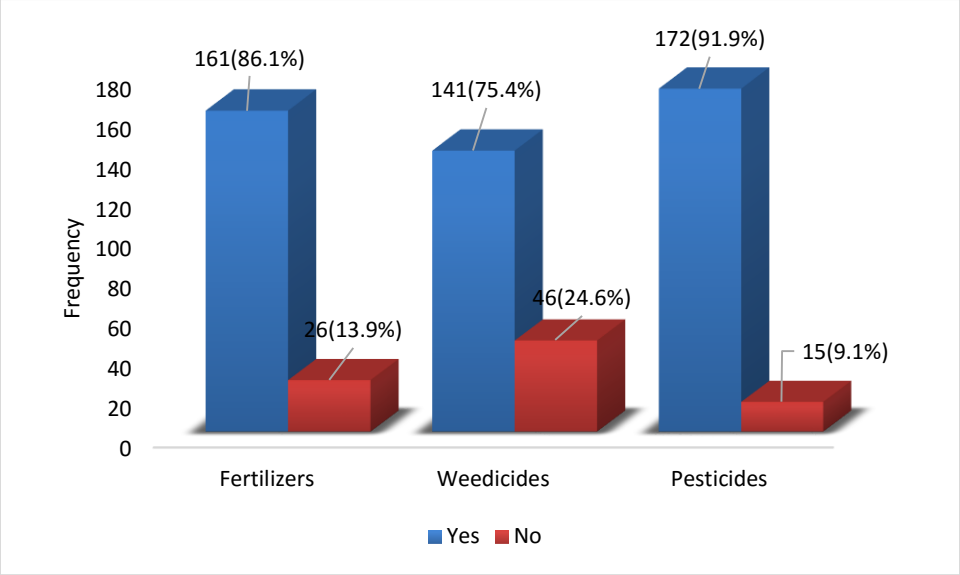

Figure 4.7: Types of Agro-Chemicals used by Farmers

Source: Field Survey, 2017

Even though there are many forms or types of agro-chemicals as agreed with (Tekwa et al., 2010) who maintained that agro-chemical encompasses fertilizers and agricultural pesticides: insecticides, fungicides, rodenticides, acaricides, molluscides, and herbicides; and plant regulators. Farmers in the District only use fertilizers, pesticides and weedicides on large scales in farming, this is attributed to the type of crops farmers cultivate in the District.

Although some respondents disclosed of some adverse implications while using agro chemicals, the larger participants indicated otherwise. This view is contrary to observation that most farmers who apply agro-chemicals in Northern Ghana experience gruesome consequences.

However, the author asked respondents to indicate where they get these agro-chemicals used in farming from. The study sought to find out the various sources of agro-chemicals to farmers in the Nadowli Kaleo District. The responses are presented in Table 4.8. It was observed that majority (96.2%) of respondents purchased agro chemicals from the local agro-chemical dealers. About 2.7% of respondents received agro-chemicals from friends and family members.

Table 4.8: Sources of Agro-chemicals

Sources of Agro-chemicals for farmers	Yes		No	
	f	%	*f*	%
Friends/Family	5	2.7	178	97.3
Agro-Chemical dealers	176	96.2	7	3.8
Extension officers	2	1.1	181	98.9
FBO	0	0.0	183	100

Source: Field Survey, 2017

The remaining respondents (1.1%) usually received agro-chemicals from extension officers, no respondent (0.0%) receives agro-chemical from farmer based organizations whether members or non-members of FBOs. It can also be concluded here that farmers even receive agro-chemicals from family and friends than from extension officers, this attest that fact lamented by farmers that agricultural extension officers are insufficient in the District and that farmers hardly get access to their services. It was there the author found that some farmers do not even get the product all. This is what one respondent from Kaleo said; *"…urh…we don't get the chemicals sometimes, we don't get regular assistance from officers, we need high yielding seeds"*

The study sought to investigate the source of knowledge or information on agro-chemicals. The results shown in Figure 4.8 reveals that, respondents who gained information on agro-chemicals from fellow farmers formed 36.8% of total respondents. Farmers who first acquired knowledge about agro-chemicals from the media (TV/Radio) formed 32.8%. Farmers who first acquired knowledge about agro-chemicals from either extension officers or family/friends accounted for 16.9% and 14.2% of total respondents respectively.

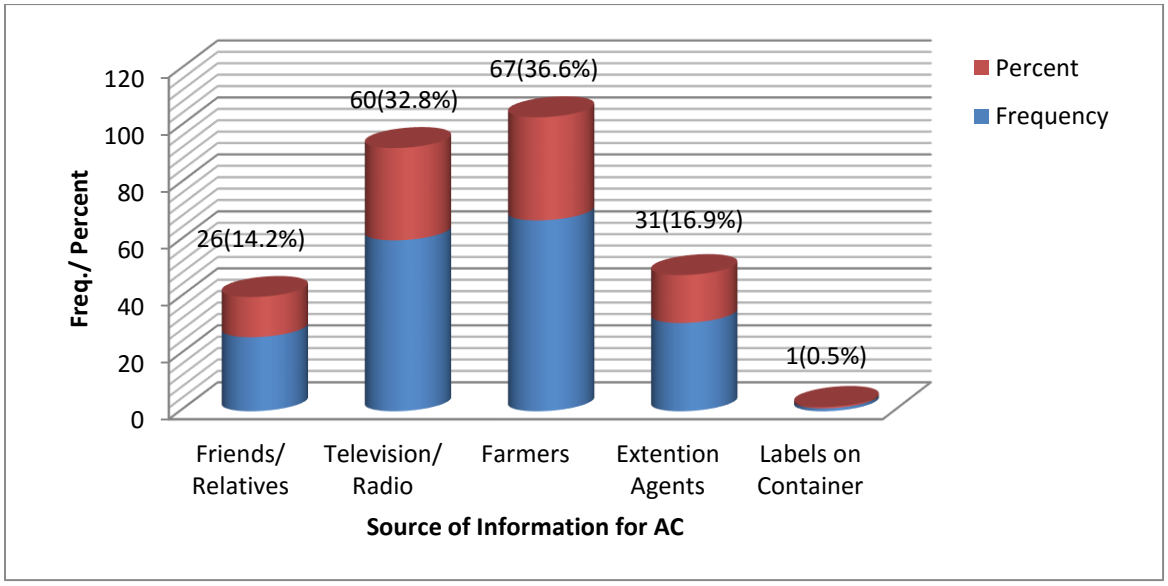

Figure 4.8: Source of first Knowledge/ Information of Agro-chemicals

Source: Field Survey, 2017

Most of the farmers expressed the significant role that information play in using and accessing agro chemicals. As indicated by Raufu (2010) and Scott (2005) on the efficacy of information in enhancing the knowledge of farmers for using agro-chemicals. Moreso, findings from the selected communities are consistent to report by Musah (2013) that the various means of gaining information were through friends/relatives, market women, radio, combined sources of friends/relatives, market women and radio.

The researcher asked respondents to indicate whether or not they are able to access agro- chemicals for their farming activities. Table 4.9 shows that majority of respondents (60.1%) reported that agro chemicals were "Accessible". About 19.7% of respondents also maintained that agro chemicals were "Very Accessible", while 16.9% of the respondents indicated that agro-chemicals were "Fairy accessible". The remaining few respondents with a percentage of 3.3% asserted that agro- chemicals were "Not Accessible".

Table 4.9: Accessibility of Agro-chemicals

Description		Frequency	Percentage
Accessibility of Agrochemicals	Not Accessible	6	3.3%
	Fairly Accessible	31	16.9%
	Accessible	110	60.1%
	Very Accessible	36	19.7%
Total		183	100.0%

Source: Field Survey, 2017

This means that regardless of farmers' membership status to FBOs or experience, a farmer can access agro chemical in the District. However, it was found that membership to FBOs makes it easier to access agro-chemicals. This is mainly due to subsidization by these organizations. As indicated by Obisesan, et al. (2013) that subsidization of agro-chemicals especially fertilizer enhances access to the products. The easy access of agro-chemicals in the District, was due to the fact that there is no regulations and proper supervision on those selling the agro-chemicals, this has led to many people venturing into the sale of agro-chemicals especially during the farming season. The study also sought to investigate estimated income of farmers and access to agro-chemicals.

Findings revealed that majority of farmers (95) earn above GH¢500. Out of this, 49 of them representing 26.25% indicated that they can access agro-chemicals. Following this are those that earn GH¢200 and below. About 14% of them espoused that they are able to access agro-chemical. However, only 4(2.1%) of respondents reported that they cannot access agro-chemical.

Table 4.10: Crosstab on Estimated Income from On-Farm Production and Accessibility of Agro-chemicals

			Accessibility of Agro-chemicals					
			Not Accessible	Fairly Accessible	Accessible	Very accessible	No Response	Total
Estimated Income from On-Farm Production	¢0-¢200	f(%)	1(0.5%)	1(0.5%)	26(13.9%)	11(5.9%)	0(0.0%)	39(20.9%)
	¢201-¢300	f(%)	0(0.0%)	1(0.5%)	9(4.8%)	2(1.1%)	0(0.0%)	12(6.4%)
	¢301- ¢400	f(%)	0(0.0%)	3(1.6%)	18(9.6%)	3(1.6%)	0(0.0%)	24(12.8%)
	¢401-¢500	f(%)	0(0.0%)	5(2.7%)	11(5.9%)	1(0.5%)	0(0.0%)	17(9.1%)
	Above ¢500	f(%)	3(1.6%)	22(11.8%)	49(26.25)	19(10.2%)	2(1.1%)	95(50.8%)
	Total	f(%)	4(2.1%)	32(17.1%)	113(60.4%)	36(19.3%)	2(1.1%)	187(100.0)

Source: Field Survey, 2017

With this an agro-chemical seller interviewed in Nadowli had this to say. "…*we face challenges in this business because others are selling agrochemicals without license, training and knowledge on the chemicals they are selling. No regulations and supervisions on those selling the chemicals by the appropriate authorities. So everybody is selling the chemicals everywhere*". Inappropriate and Illegal sales point of agrochemicals in the Nadowli-Kaleo District. The chart below shows shop where both provisions and agro-chemicals are sold.

Figure 4.9: A provision seller also engaging in selling agro-chemical

Source: Field survey, 2017

Source of Specific Information on Agro-chemicals

The study sought to explore where respondents gained specific information concerning agro-chemicals. The table 4.10 illustrates that respondents who gained specific information on agro-chemicals usage from fellow farmers formed 22.4% of the total respondents. Farmers who acquired specific information about agro-chemicals from agro-chemical dealers formed 71.6% of the total respondents. While farmers acquired specific information about agro-chemicals usage

from extension officers accounted for 35.0% of the total respondents. Only 7.1% of the total respondents read from labels on agro-chemical containers. Attesting to the fact that majority of the farmers in the District are illiterates only few had formal education and therefore could read. This can make the use of agro-chemicals not realize its intended purpose fully. As indicated by Scott (2005) and Fianko et al. (2011) that acquisition of relevant knowledge is required if much benefit is desired in using Agro-chemicals.

Table 4.11: Source of Specific Information on Agro-chemicals (Main Information Source)

Sources of specific information about Agro-chemicals	Yes		No	
	f	%	*f*	%
Extension Officers	64	35.0	119	65.0
Agro-Chemical dealers	131	71.6	52	28.4
Labels on Agro-chemical containers	13	7.1	170	92.9
Other Farmers	41	22.4	142	77.6

Source: Field Survey, 2017

This finding is consistent with Musah (2013) who found that more smallholder farmers gain access to market information (77.3%) through farmers and other sources. Based on this the author further asked respondents as to how easy it is to get information on Agro-chemicals. The findings are presented in Figure 4.9 which tasked farmers to rank how easy or difficult it was for them to acquire information on agro-chemicals. Majority (57.9%) of the respondents ranked they obtain information on agro-chemicals as “Easy”.

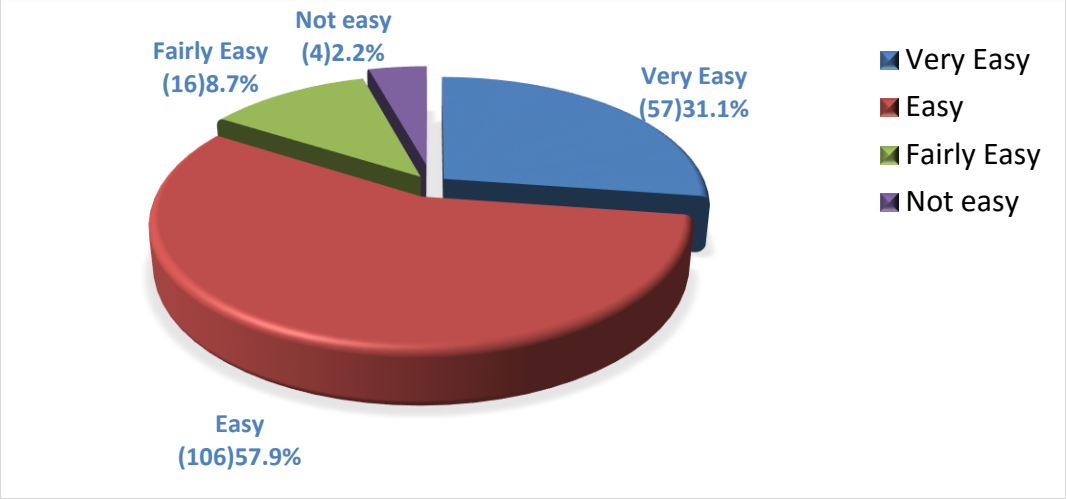

Figure 4.10: How easy it is to get information on Agro-chemicals
Source: Field Survey, 2017

About 31.1% of respondents say obtaining information on agro-chemicals was "Very easy". About 8.7% of the respondents said obtaining information on agro-chemicals was "Fairly Easy" while the remaining 2.2% of the respondents reported obtaining information on agro-chemicals was "Not easy". This means that information on the use of agro-chemicals abound in the study areas. This is because majority of farmers obtain this information from the chemical dealers and the study revealed that so many people engaged in agro-chemical trade. The extension officer in the Nadowli District had this to say. "…every farmer is now an agro-chemical dealer selling agro-chemicals without any knowledge, because over reliance on the chemicals is too much."

Therefore, it was necessary to find out how relevant this information is to farmers. Results on this are presented in Figure 4.10 which reveals that majority of respondents (50.8%) ranked the pertinence of information obtained on agro-chemicals as "Relevant".

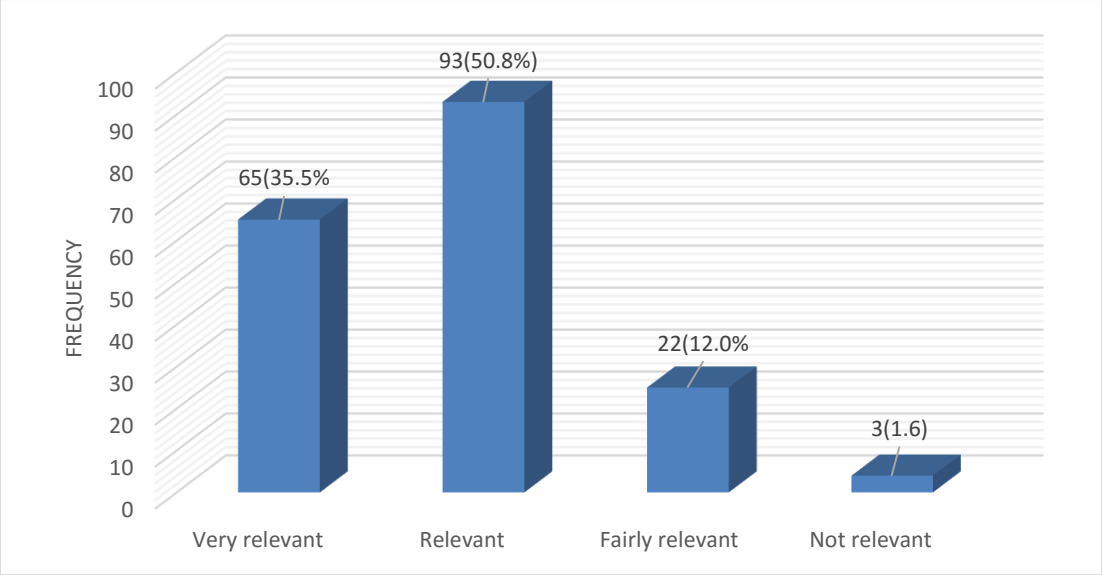

Figure 4.11: Relevance of Information on Agro-chemical use
Source: Field Survey, 2017

While three (3) respondents, representing 1.6% of the total respondents indicated that the pertinence of information obtained on agro-chemicals was "Not relevant". This can be attributed to the high crop yield and the outcome of their harvest that these farmers' experience. With regards to how relevance information concerning agro-chemical are to farmers, this was what a farmer from Kaleo had to say. …. "it is very relevant because an agro-chemical dealer once gave me a non-selective weedicide for selective, when I sprayed my farm with it the following day all my crops were dead including the weeds" The nature of the study deemed it necessary to obtain information regarding the factors influencing the use of agro-chemicals by smallholder famers. Table 4.11 below presents views on whether these factors influence the use of agro-chemicals by smallholder farmers. It was revealed that, majority (97.3%) of the respondents used agro-chemicals because it improves crop yield;

Table 4.12: Views on whether these factors influence the use of agro-chemicals by smallholder farmers

Reasons for Agro-Chemicals use	Yes		No	
	f	%	F	%
Farm Size	105	57.3	78	42.6
Type of Crop	125	68.3	58	31.7
High Cost of farm Labour	72	39.3	111	60.7
Soil Fertility	152	83.1	31	16.9
Duration of the raining season	47	25.7	136	74.3
Pest and Diseases incidence	177	96.7	6	3.3
Non-availability of household labour	48	26.2	135	73.8
improve crop yield or avoid crop failure	178	97.3	5	2.7
Faster crop growth	153	83.6	30	16.4

Source: Field Survey, 2017

96.7% of the respondents asserted that they used agro-chemicals because of pest and diseases which most of the times put most farmers into debt at the end of the farming season. About 83.6% of the respondents used agro-chemicals for faster growth of their crops. Soil fertility and crop type cultivated by farmers also constituted one of the major reasons farmers used agro-chemicals with the percentages of 83.1% and 68.3% of respondents respectively. Farm size (57.3%) was a major concern why farmers used agro-chemicals since it was difficult to use manpower on such farms. High cost of labour (39.3%), duration of raining season (25.7%), non-availability of household labour (26.2%) were some of the reasons most farmers did not deem them important when it comes to agrochemical use in farming. However, farmers who were interviewed did not indicate adverse effects as espoused by Aneani et al. (2012). A farmer from Kaleo had this to say .... *"if you farm*

without using agro-chemicals you will not get anything; our land is not good it can no more support our crops even this year it might be worse with these caterpillars".

In relation to factors that influence farmers' decision on the use of Agro-chemicals, difference in the indicators such as age, gender, experience, education, income, membership status, farm size, household labour, access to credit, price of chemicals and understanding of the chemical usage were observed.

The study revealed in table 4.12 the most important driving force influencing farmers' decision to use agro-chemical were income level of farmers (64.5%) and price of agrochemicals (67.8%). With the exception of price of chemicals (67.8%) and income level of farmers (64.5%), which were found to be very important when it comes to deciding on agro-chemical use, understanding the use of agro-chemicals and farming experience were the other factors that were found to be important with the percentages of 48.1% and 58.5% respectively.

However, farmers deemed age (78.7%), gender (71.6%), level of education (67.2%), being a member of FBO (79.8%), and household size (63.4%) 'Not important' factors that influence farmers decisions to use agrochemical. Hence, it can be concluded that although other factors influence farmers decision on the use of agro-chemicals, income and price of chemicals are critical.

Factors that influence farmers' decision on the use of Agro-chemicals

Table 4.13: Factors that influence farmers' decision on the use of Agro-chemicals

Factors helping farmers decision to use Agro-chemical use	Very Important		Important		Not Important	
	f	%	*f*	%	*f*	%
Age	16	8.7	23	12.6	144	78.7
Gender	11	6.0	41	22.4	131	71.6
Level of Education	22	12.0	38	20.8	123	67.2
farming experience	24	13.1	107	58.5	52	28.4
Income level	118	64.5	57	31.1	8	4.4
Being a member of FBO	2	1.1	35	19.1	146	79.8
Farm size	47	25.7	60	32.8	76	41.5
Household size	24	13.1	43	23.5	116	63.4
Access to Credit	55	30.1	72	39.3	56	30.6
Price of Agro-chemicals	124	67.8	55	20.1	4	2.2
Understand the use of Chemicals	31	17.0	88	48.1	64	35.0

Source: Field Survey, 2017

These findings are contrary with Zhou et al. (2010) assertion on factors that induce farmers to use agro chemicals. A farmer from Nadowli said. .... *"it is only poor people who don't use agro-chemicals in this community".*

4.4 Relationship between socio-demographic characteristics of farmers and use of Agro-chemicals by type

Pearson chi-square test statistic was use to test the significance of the relationship between socio-demographic characteristics of small holder farmers and the three main ranges of agro-chemical type used in the District namely fertilizer, weedicide and pesticide

Table 4.14 shows the relationship between farm size measured in acres and its fertilizer use. The Pearson chi-square value 20.4848 with the corresponding probability value of 0.000 indicates that there is significant relationship between farm size and use of fertilizer. This implies that the larger the farm size the more likely the farmer will use fertilizer.

Table 4.14 Relationship between Farm size and Fertilizer use

Farm size	Yes		No		Total	
	f	%	*f*	%	*f*	%
1 - 2.5 acres	19	63.3	11	36.7	30	100
3 - 4.5 acres	61	88.4	8	11.6	69	100
5 - 6 acres	40	87	6	13	46	100
Above 6 acres	41	100	0	0	41	100
Total	161	86.6	25	13.4	186	100

Pearson chi-square (3) = 20.4848 Pr = 0.000

Table 4.15 also shows the relationship between farm size measured in acres and its weedicide use.

Table 4.15 Relationship between Farm size and Weedicides use

Farm size	Yes		No		Total	
	f	%	*f*	%	*f*	%
1 - 2.5 acres	17	56.7	13	43.3	30	100
3 - 4.5 acres	52	75.4	17	24.6	69	100
5 - 6 acres	38	82.6	8	17.4	46	100
Above 6 acres	34	82.9	7	17.1	41	100
Total	141	75.8	45	24.2	186	100

Pearson chi-square (3) = 8.2936 Pr = 0.040

The Pearson chi-square value 8.2936 with the corresponding probability value of 0.040 indicates that there is significant relationship between farm size and use of weedicide. Also, this implies that when the farm size is increased there is greater likelihood that the farmer will use weedicide.

Table 4.16 also shows the relationship between farm size measured in acres and its corresponding pesticide use. The Pearson chi-square value 12.8517 with the corresponding probability value of 0.005 indicates that there is significant relationship between farm size and use of pesticide. Again, this implies that when the farm size is increased there is greater likelihood that the farmer will use pesticide.

Table 4.16 Association between Farm size and Pesticide use

Farm size	Yes		No		Total	
	f	%	*f*	%	*f*	%
1 - 2.5 acres	23	76.7	7	23.3	30	100
3 - 4.5 acres	66	95.7	3	4.3	69	100
5 - 6 acres	44	95.7	2	4.3	46	100
Above 6 acres	39	95.1	2	4.9	41	100
Total	172	92.5	14	7.5	186	100

Pearson chi-square (3) = 12.8517 Pr = 0.005

The results from the Pearson chi-square test statistics showed that the age of farmer, number of household farm labour did not have significant relationship with the use of pesticides, weedicides and fertilizers (refer to appendix E)

Again sex of the farmer was significant in explaining only fertilizer use indicating that male farmers are more likely to use fertilizers relative to female farmers in Nadowli-Kaleo District. This could be because male farmers are more likely to be financially sound relative to their female counterparts and also this could be because most females depend on their husbands financially in the District. The sex of the farmer could not significantly account for the differences in weedicide and pesticide use among smallholder farmers in the District.

Also farmers experience measured by the number of years into farming was significant in explaining fertilizer and weedicide use but not pesticides (see appendix E). This implies that more experienced farmers are more likely to use fertilizers and weedicides relative to less experienced farmers.

4.5 Effects of agro-chemical usage among smallholder farmers

Table 4.13 illustrate findings on perceived and observed effects of agro-chemical usage among smallholder farmers. Among the effects, high crop yield (100%) was found to be unanimously highly perceived and observed to have impact on agro-chemical usage.

Table 4.17: Observed/ Perceived effects of agro-chemical usage among smallholder farmers

Effects of agro-chemicals	Perceived				Observed			
	Yes		No		Yes		No	
	F	%	*f*	%	*f*	%	*F*	%
High Crop yield	183	100	0	0.0	183	100	0	0.0
Faster crops growth	181	98.9	2	1.1	180	98.4	3	1.6
Quality of crops	171	93.4	13	7.1	177	96.7	6	3.3
Higher market value	167	91.3	16	8.7	168	91.8	15	8.2
Water Pollution	160	87.4	23	12.6	156	85.2	27	14.8
Sickness to human	174	95.1	9	4.9	169	92.3	14	7.7
Diseases/mortality of livestock	164	89.6	19	10.4	147	80.3	36	19.7
Soil infertility	90	49.2	93	50.8	96	52.5	87	47.5
Tasty/Nutritious	52	28.4	131	71.6	63	34.4	120	65.6

Source: Field Survey, 2017

This means perception and observation of the farmers on effects of agro-chemicals is highly informed by crop yield in the District, this buttresses the assertion by a farmer in Takpo that, *"If you don't use agro-chemical, you will not harvest anything".*

While faster crop growth (98.9%), quality of crops (93.4%), higher market value (91.3%), disease to human (95.1%) and disease/mortality of animals (89.6%) were all found to be highly perceived and observed to have effect on agro-chemical usage. Water pollution accounted for 87.4% and 85.2% of respondents who perceived and observed it. This collaborated with the run-off of agricultural fertilizers into surface water bodies can cause an increased productivity of those aquatic ecosystems leading to eutrophication (Chapman, 1996). Nitrate concentrations in groundwater have been found to be higher shortly after the farming periods (Akoto and Adiyiah, 2008).

Though the benefits are substantial, studies have associated the use of certain agrochemicals with some important environmental and health damages (Clarke et al., 1997; WHO, 1997; Krebs et al., 1999; Greenpeace, 2008). This was revealed in the study as famers in a focus group in Goliyiri discussion said: "*We are usually affected with so many problems including skin rashes, waist pains, loss of eye sight and even our reproductive organ weakens*"

Additionally, farmers who were interviewed revealed that there are certain adverse effects on the use of agro-chemicals while some also indicated that most at times they mis-apply the chemical as indicated by Roca (2011). An extension officer at Nadowli also had this to say:

"*Farmers encounter a lot of health threatening consequences and even death due to inappropriate handling of agro-chemicals but these cases are not reported only one man reported he fainted during application of a chemical in a work shop*".

An agro-chemical dealer in Takpo also explained that, "*A farmer's son trying to commit suicide drunk a chemical kept at home by the father and died. Animals die or run diarrhoea if they feed on crops or grass immediately after spraying"*

However, tasty and nutritious produce was also found to be less perceived and observed as the impact of agro-chemicals on the crops compared to the other factors. The study has revealed that, after applying agro-chemicals farmers experience high crop yield, faster crop growth and high quality farm produce. Contrarily, most respondents (65.6%) indicated they do not experience tasty and nutritious farm produce after the application.

The study also revealed that most farmers have observed that agro-chemicals usage also causes soil infertility. Evidently, one respondent in a Focus Group Discussion at Goliyiri asserted that, "when you use weedicides on a particular land for some time it spoils the land and if you don't use fertilizer you cannot harvest anything from there again".

4.6 Safety measures and precautions smallholder farmers adhere to before, during and after application of agro-chemicals

Table 4.14 presents findings on safety measures and precautions smallholder farmers adhere to before, during and after application of agrochemicals. Most of them indicated that they buy the agro chemicals themselves all the time about 87.9% and (73.1%) of members and non-members respectively of the respondents indicated on the affirmative as a safety measure. One agro-chemical dealer in Zambogu had this to say; "I sell all forms of agro-chemicals: Fertilizer, weedicide, pesticides. I don't sell to children or under age due to the harmful effect of the chemicals. Farmers come with their own prescription. Farmers prefer systematic chemicals to contact chemicals. Sulphates of ammonia continues usage kills soil nutrient". The study again revealed that, majority of the farmers apply the chemical on the farm themselves and decide on the quantity to use themselves both members and non-members of FBO with each having a percentage of respondents of 90%.

Table 4.18: Safety Activities

Safety measures for Agro-Chemicals usage	FBOs Member			Non-members of FBOs		
	Yes		No	Yes		No
	F	S	NA	F	S	NA
	f(%)	f(%)	f(%)	f(%)	f(%)	f(%)
Buy/purchace AC yourself	139(87.9)	17(10.8)	2(1.3)	19(73.1)	3(11.5)	4(15.4)
Apply AC on Farm yourself	127(80.9)	24(15.3)	6(3.8)	19(73.1)	5(19.2)	2(7.7)
Decide on Qty of use yourself	110 (70.1)	35(22.3)	12(7.6)	10(38.5)	9(34.6)	7(26.9)
Have Protective Clothes	18(11.5)	25(15.9)	114(72.6)	0(0.0)	3(11.6)	23(88.5)
Wear Protective clothes when applying AC	20(12.7)	49(31.2)	88(56.1)	1(3.8)	3(11.6)	22(84.6)

Ever applied AC without putting on Protective clothes	92(58.6)	49(31.2)	16(10.2)	18(69.2)	6(23.1)	2(7.7)
Use AC container to Drink water	1(0.6)	7(4.5))	149(94.9)	0(0.0)	4(15.4)	22(84.6)
Use AC container to store ingredients	2(1.3)	8(5.1)	147(93.6)	1(3.8)	4(15.4)	21(80.8)
see others use AC container to serve other purposes	26(16.5)	81(51.6)	50(31.9)	3(11.6)	14(53.8)	9(34.6)

Source: Field Survey, 2017

What is worrying is that majority of these farmers are illiterates who cannot read. However, majority of the farmers were also found not to have any form of protective clothing at all constituting 72.6% and 88.5% of members and non-members of FBO respectively. Those farmers who don't wear any form of protective clothing when applying agro-chemicals on their farms also accounted for 56.1% and 84.6 % members and non-members respectively of respondents. Here it was understood that some appreciable number of farmers who belonged to FBOs were sensitized and therefore adhered to some form of precaution when applying the chemicals. When asked, the extension officer in Nadowli asserted that, "…*most farmers do not adhere to safety measures due to Ignorance. There are no regulatory systems for chemicals, sellers of chemical are not educated, and farmers don't come for sensitisation meetings, because there is no incentive. Sellers also recommend wrong chemical for farmers, staffing, no resource for supervision and that affect product safety".*

Also, from the study it was noted that even though majority of farmers 94.9% and 84.6% of members and non-members of FBOs respectively explained that they don't use empty agro-chemical containers in any form to serve any purpose, majority agreed that they see others all the

time or sometimes use the containers to serve other purposes. The researchers realized that the respondents were unwilling to openly indicate that they themselves were using the containers to serve other purposes because of the guilt in using the containers in inappropriate ways.

Figure 4.11 shows some inappropriate ways farmers use empty agro-chemical containers, here the figure was seen been used as drinking cup in one of the communities visited in the Nadowli-Kaleo District during an observational tour.

Figure 4.12: Agro-chemical container used as a drinking cup

Source: Field Survey, 2017

Figure 4.12 presents findings on disposal methods that are used by farmers for agro- chemical containers. Findings from the field indicate that farmers use the following main methods in disposing agro-chemical containers: burning, burying, dumping in the farm, throwing them in the

bush, returning them to chemical dealers and keeping them at home. It was found that most farmers preferred burning the agro-chemical containers (71.0%) as a disposable measure.

Evidently, a respondent from Takpo said "…*we burn and dump them in the bush after we are done using it".*

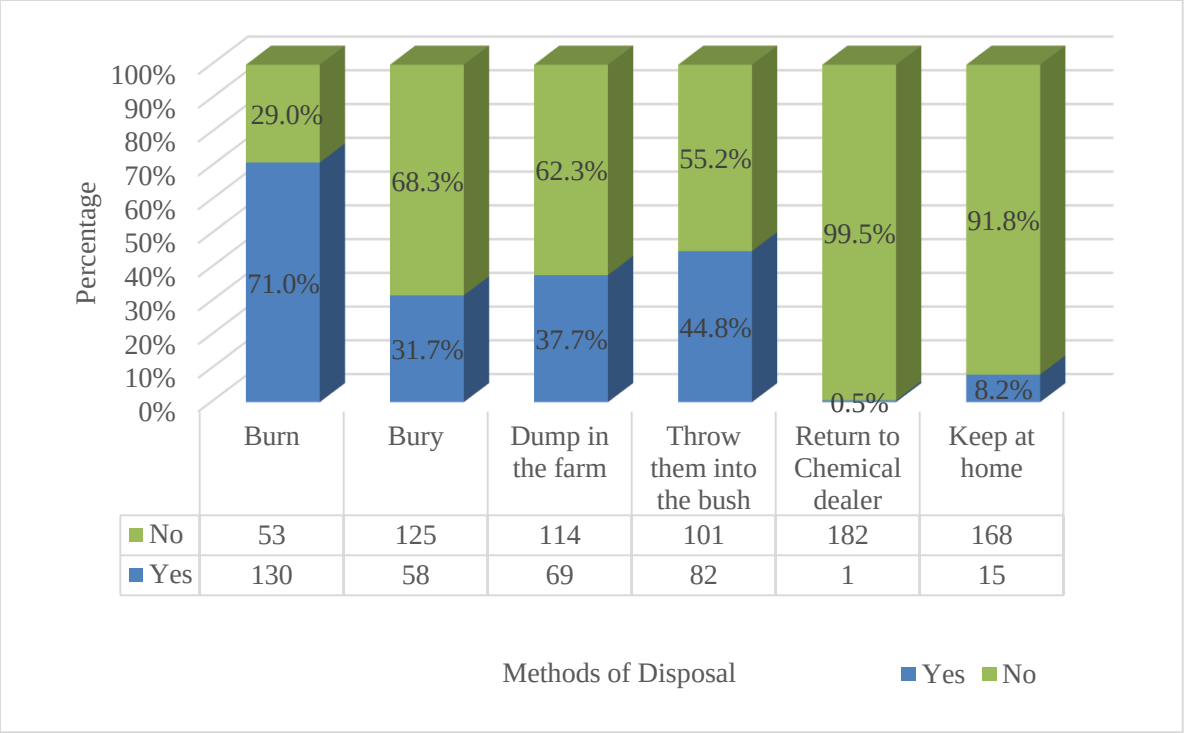

Figure 4.13: Disposal Methods
Source: Field Survey, 2017

It was also realized that appreciable number of the farmers employed throwing the containers in the farm or bush (44.8%) as the preferred mode of disposing empty agro-chemical containers. With this method of disposal, it collaborated with the claim of the extension officer in Nadowli that…."*most of the farmers just throw the empty containers in the farm, you always see them lying in the farm when we go for supervision"*

Again it was found from the study that 31.7% of the respondents buried the containers and 8.2% of the respondents return the containers home as way of disposing them. Here a traditional ruler and an environmental expect interviewed from Nadowli said that:

…. "*burying containers is never a good and environmentally friendly way of disposing empty containers. This is because some left over chemicals in the containers can stay in the soil for a long time which kills the micro-organism in the soil. These organisms help improve the soil fertility and the containers are also made of rubbers which are not biodegradable and can be in the soil for so many years"*

However, it was observed that the most approved method of disposing empty agro-chemical containers endorsed by extension officer, EPA and an environmental expert interviewed is the return of the containers to the agro-chemical dealers, unfortunately only one (1) respondent representing 0.5% of the total number of respondents interviewed was found to comply with this appropriate method of disposal. The extension officer from Nadowli emphasized that, *"There should be a disposal plant for all containers. So farmers are supposed to bring all empty containers to the dealers for onwards transmission to the disposal plant for appropriate disposal".*

4.7 Conclusion

Results from the field are presented in this chapter. They are tailored on types and sources of agro-chemicals smallholder farmers use in Nadowli-kaleo District; factors influencing the use of agro-chemicals by smallholder farmers in the Nadowli-kaleo District; observed and perceived effects of agro-chemical usage among smallholder farmers in the Nadowli-kaleo District; and safety measures and precautions smallholder farmers adhere to before, during and after application of agro-chemicals in the Nadowli-Kaleo District. The following chapter presents summary of findings, conclusions and recommendations.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary and conclusions on the research findings and recommendations that would help address the problems identified.

5.2 Summary of Findings

The study assessed the use of agro-chemicals by smallholder farmers in the Nadowli-Kaleo District in the Upper West Region of Ghana. Having reviewed related literature, the methodology was linked to the empirical literature which is hinged on use of agro-chemicals by smallholder farmers. Participants were selected through purposive and simple random sampling procedure. The data were collected through the use of questionnaire, as well as interview, Focus Group Discussion and observational guides. Analysis was done with the aid of transcription and interpretations in relation to qualitative data. The data were presented in tables and figures, whiles cross-tabulations were used to present quantitative data with the aid of the Statistical Package for Social Sciences (SPSS v. 20.0). This section presents summaries of main findings based on the research objectives.

5.2.1 Types and sources of agro-chemicals small holder Farmers use in Nadowli-Kaleo District

Majority of the respondents use pesticides, followed by fertilizer users, and the least used agrochemical by farmers in the Nadowli-Kaleo District was weedicides with a percentage of (75.4%) of the total respondents, this was probably due to the alternatives farmers had in controlling weeds in their farms. The high percentages chopped by the chemicals used by the respondents was an indication that the three chemicals were used by most farmers in the District.

The study found that, the type of chemicals used has a direct linkage with the type of crops cultivated by farmers. Farmers in the District only use fertilizers, pesticides and weedicides on large scales in farming, this is attributed to the types of crops farmers cultivate in the District. Although some respondents revealed adverse implications in using agrochemicals, most respondents indicated otherwise as most purchased agro-chemicals from the local agro-chemical dealers. None of the respondents received agro-chemical from farmer based organizations whether members or non-members of FBOs. While some farmers confirmed that they do not get the products, others indicated that they received agro-chemicals from family and friends than from extension officers.

5.2.2 Factors influencing the use of agro-chemicals by smallholder farmers

On factors that influence the use of agro-chemicals, 97.3% of the respondents reported that they use agro chemicals because it improves crop yield. Soil fertility and crop type cultivated by farmers also constituted one of the major reasons why farmers used agrochemicals with the percentages of 83.1% and 68.3% of respondents respectively. Farm size was a major concern why farmers used agrochemicals since it was difficult to use manpower on such farms. High cost of labour, duration of raining season, non-availability of household labour were some of the reasons most farmers did not consider them important when it comes to agrochemical use in farming.

The study also revealed the most important driving force influencing farmers' decision to use agrochemical were income level of farmers and price of agrochemicals. With the exception of price of chemicals and income level of farmers, which were found to be very important when it comes to deciding on agrochemical use.

5.2.3 Observed and perceived effects of agro-chemical usage among smallholder farmers

Regarding the observed and perceived effects of agrochemical usage, high crop yield was found to be highly perceived and observed to have impact on agrochemical usage. While faster crop growth, quality of crops, higher market value, disease to human, and disease/mortality of animals were all found to be highly perceived and observed to have effect on agrochemical usage. Additionally, farmers revealed that there are adverse effects on the use of agro-chemicals while some also indicated that most at times they misapply the chemical.

5.2.4 Safety measures and precautions smallholder farmers adhere to before, during and after application of agrochemicals

The fourth objective was to examine safety and precautionary measures that smallholder farmers adhere to before, during and after application of agro-chemicals. It was found that, most of them indicated that they buy the agro-chemicals themselves all the time. The study again revealed that, majority of the farmers apply the chemicals on the farm themselves and decide on the quantity to use themselves both members and non-members of FBO with each having a percentage of respondents above 90%.

Those farmers who don't wear any form of protective clothing when applying agro-chemicals on their farms also accounted for 56.1% and 84.6 % members and non-members of FBOs. Also respondents reported that they don't use empty agro-chemical containers in any form to serve any purpose, majority agreed that they see others all the time or sometimes use the containers to serve other purposes. Findings from the field indicate that farmers use burning, burying, dumping in the farm, throwing them in the bush, returning them to chemical dealers and keeping them at home as methods of disposal. It was found that most farmers preferred burning the agro-chemical containers as a disposable measure.

5.3 Conclusion

The study set out to assess the use of agro-chemicals by smallholder farmers in the Nadowli-kaleo District in the Upper West region of Ghana. Even though the study employed the Expected Utility Theory (EUT), Theory of Reasoned Action (TRA), and Theory of Planned Behaviour (TPB) but it dwelled largely on the Rational Choice theory (RCT). The study concludes that,

The type of chemicals used has a direct linkage with the type of crops cultivated by farmers. Farmers in the District only use fertilizers, pesticides and weedicides on large scales which is attributed to the type of crops farmers cultivate in the District.

It can also be concluded that respondents use agro chemicals because it improves crop yield. Farm size was a major another major concern why farmers used agro-chemicals. However, high cost of labour, duration of raining season, non-availability of household labour were some of the reasons most farmers do not utilize agro-chemical.

High crop yield was found to be highly perceived and observed to have impact on agro-chemical usage. It was also revealed that some farmers don't wear any form of protective clothing when applying agro-chemicals on their farms. Farmers in the District use burning, burying, dumping in the farm, throwing them in the bush, returning them to chemical dealers and keeping them at home as methods of disposal for agrochemical containers.

The study conclude that agro-chemical use have impacted positively on crop yield.

5.4 Recommendations

From the findings of this study the following recommendations are proffered:

The Ministry of food and Agriculture (MOFA) should send more extension officers to the District since the findings revealed that the District was supposed to be supervised by three extension

officers but only one extension officer supervises the three zones. This has made extension officer to farmer ratio very less and hence, does not make supervision effective.

The Environmental Protection Agency (EPA) should regulate agro-chemicals sellers in the District by issuing sellers with licence and also monitoring them all the time. This will prevent illegal sales of agro-chemical and streamline inappropriate sales point of agro-chemical.

Extension officers should sensitize farmers to employ alternative ways of ploughing, increasing the fertility of the soil and controlling of pest and diseases without using agro-chemicals this will help reduce the excessive use of agrochemicals by farmers.

The Environmental Protection Agency (EPA) together with Agricultural Extension Officers should enforce the use of protective clothing by farmers in the District. There is the need for the EPA to establish a law enforcing all farmers who deal with agrochemicals or apply agrochemical to put on protective clothing before application. This will help prevent some of the diseases farmers' contract through agrochemical use.

The Environmental Protection Agency (EPA) in collaboration with extension officers should educate farmers on the effects of agro-chemicals on the environment, animals and humans as well. This will help farmers to adhere to safety precautions when using agrochemicals and to prevent the harmful effects of agro-chemicals on the body.

Extension officers should assist farmers with high yielding and diseases resistance crops. This will help farmers reduce the excessive use of agro-chemicals.

The Ministry of Food and Agriculture through the Environmental Protection Agency (EPA) should established recycling plant within the District where all empty agro-chemical containers will be brought for appropriate disposal. This will eliminate the inappropriate methods employed by farmers to dispose agro-chemical containers.

The study covered 3 communities within the Nadowli Kaleo District of the Upper West Region of Ghana. The author recommends that a research on the following areas is critical. Future researchers should examine the abuse of agro-chemicals by farmers in the District

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APPENDIX A

UNIVERSITY FOR DEVELOPMENT STUDIES

FACULTY OF INTEGRATED DEVELOPMENT STUDIES

(GRADUATE SCHOOL)

SURVEY QUETIONNAIRE

Survey Questionnaire for assessing Farmers use of agro-chemicals

Introduction:

This study is being conducted for my MPhil thesis and assesses farmers' use of agrochemical in the Nadowli-Kaleo District. As a farmer you would know that you do lots of things in farming; like preparing the land before planting and adding different types of substances to help the plants grow and prevent diseases. These things that you do are what my study seeks to assess. I would like to find out more about some of the practices you do; like what type of fertiliser or manure you use, what you use to keep off pests and prevent diseases and other questions like these. I am very interested in knowing how and why you choose these kinds of practices and will also ask you some questions about yourself; which will help me to understand the choices you make. You are free to tell me anything else about how you use agrochemical in farming. The information you give to me will not be shared with anyone else. You are free to take part or not, but am hoping that you will do so, since this is a very important study which can provide both of us with much information on farming; especially in understanding the choices you make. If you wish, at the end of the study I can tell you what I found.

Is there anything else you would like to know about this study?.....

.....

Are you willing to take part in this survey/interview?.....

Date: ...../...../.....

SECTION A
FARMER/RESPONDENT BACKGROUND CHARACTERISTICS

2. Community: .....zone.....

3. Gender: Male..... Female: .....

4. Marital status [ ] single [ ] married [ ] divorced

5. Religion [ ] Christian [ ] Muslim [ ] Traditionalist [ ] other ……

6. Farmer's Age……..

7. Farmer's Education: (Education Level) [ ] No Formal Education, [ ] Primary

[ ] JHS/JSS, [ ] SHS/Voc./Tech, [ ] Tertiary.

8. Farmer's Experience: (Number of years involved in farming): ……

9. What is/are your source(s) of income? [ ] On Farm, [ ] off Farm, [ ] Both.

10. What is your estimated amount of income from on farm production? GH₵ ([ ] 0−200,

[ ] 201−300, [ ] 301−400, [ ] 401−500, [ ] Above 500)

9. Do you receive remittances from relatives or friends? [ ] Yes, [ ] No.

10. If yes, what kind of remittances? [ ] Cash, [ ] Kind, [ ] Both.

11. Are you a member of any farmers' organization or group? [ ] Yes, [ ] No.

SECTION B:
FARM CHARACTERISTICS

13. How do you plough your farm [ ] Manual/Manpower, [ ] Animal traction, [ ] Machine,

[ ] Zero Tillage/weedicide.

14. What major crops do you cultivate?

CROP	TICK
Maize	
Groundnut	
Beans	
Sorghum	
Millet	
Rice	

15. Area Cultivated: Total Farm land size (acres) under cultivation: ……

16. Do you rare any farm animal? [ ] Yes [ ] No

17. If Yes,

Farm Animal	TICK
Goat	
Sheep	
Poultry	
Cattle	
Pigs	
Others	

18. How many of your household members are actively involved in farming activities ……..

20. Farmer's Tenure Status:

SOURCE	TICK
Owner	

Family	
Rent	
Squatter	

21. Do you take credit to conduct farming activities? [ ] Yes, [ ] No.

24. If yes - Where do you access credit from?

SOURCE	TICK
Bank	
VSLA	
Relatives	
FBOs	
Others	

25. Do you face constraints in accessing credit? [ ] Yes [ ] No

26. If yes, what major constraints do you face in accessing credit?

Constrains	Tick
Distance to Bank	
No collateral	
High interest rate	
Not a member of FBOs/VSLAs	
Other (specify)	

SECTION C:
INFORMATION CONCERNING AGROCHEMICALS, TYPES AND SOURCES

1. Do you use agrochemicals? [ ] Yes [ ] No.

2. If no why? .....

2. If Yes which type?

Chemical	Tick	Frequency
Fertilizers		
Weedicides		
Pesticides		

3. If yes, where do you get your agrochemical from?

SOURCE	**TICK**
Friends/Relatives	
Agrochemical dealers	
Extension officers	
Farmer Based Organization	

4. Where did you first get to know the agrochemical you are using?

SOURCE OF INFORMATION	**TICK**
From friends / From relatives	
From television/radio	
From other farmers	
From Extension Agents	
Labels on Container	
Other source (specify)	

5. How accessible are agrochemicals to you? (Ease of Access):

ACCESSIBILITY	TICK
Not Accessible	
Fairly Accessible	
Accessible	
Very Accessible	

6. Where do you get specific information concerning agrochemicals? (Main Information Source):

SOURCE	TICK
Extension agent	
Pesticide Dealer/Seller	
Label/ instructions on containers	
Farmers' Organization/Group	
Other Farmers	
Other Source (Specify)	

7. How easy is it to get information concerning agrochemicals?

[ ] Very Easy, [ ] Easy, [ ] Fairly, [ ] Not Easy.

How relevant do you think this information is assisting you to understand agrochemicals and their use? (Relevance):

RELEVANCE	TICK
Very Relevant	
Relevant	
Fairly Relevant	

Not Relevant	

SECTION D:
FACTORS INFLUENCING FARMERS USE OF AGROCHEMICALS

1. Why do you use agrochemicals?

REASON(s)	Tick
Farm size	
Crop types	
Cost of labour	
Nature/ fertility of the soil	
Duration of raining season	
Pest and disease	
Non availability of household labour	
Improve crop yield/avoid crop failure	
Faster crop growth	

2. Why don't you use agrochemicals?

REASON(s)	TICK
High cost of agrochemicals	
Not readily accessible	
No know-how	
Have no information	
Alternative to agrochemicals	
Others (Specified)	

3. Which of the following factors help(s) you to decide to use agrochemicals?

Using the scale: Very Important = [1], Important = [2], Not Important = [3]

FACTORS	VERY IMPORTANT	IMPORTANT	NOT IMPORTANT
Age			
Gender			
Education			
Experience			
Income			
Member FBO			
Farm Size			
Household labour			
Access to credit			
Price of chemical			
Understanding the use of chemicals			

SECTION E:
EFFECTS OF AGROCHEMICHALS

Do you think that, the use of agrochemicals can result in the following?

EFFECTS	YES	NO
High crop yield		
Faster crop growth		
High quality of farm produce		
High market value/attractive		
Water pollution		
Sick/ disease to human		
Sickness/disease and mortality of livestock		
Soil infertility		
Tasty and Nutritious farm produce		

Death of humans and other organisms		

Which of the following have you seen/ observed /experienced as a result of agrochemical use.

EFFECTS	YES	NO	Evidence/example
High crop yield			
Faster crop growth			
High quality of farm produce			
High market value/attractive			
Water pollution			
Sick/ disease to human			
Disease and mortality of animals			
Soil infertility			
Tasty and Nutritious farm produce			

SECTION F
SAFETY MEASURES CONCERNING AGROCHEMICAL USE

Which of the following do you do with regards to agrochemicals use

ACTIVITY	**YES**		**NO**
	FREQUENTLY	**SOMETIMES**	**NOT AT ALL**
Buy/purchase agrochemical yourself			
Apply agrochemical on farm yourself			

Decide on the quantity to use yourself			
Have protective cloths			
Wear protective cloths when applying agrochemicals			
Ever applied agrochemicals without putting on protective cloths			
Use agro chemical container to drink water			
Use agrochemical container to store ingredients			
See others use chemical containers to serve other purposes			

How do you dispose used agrochemical containers?

DISPOSAL METHOD	**YES**	**NO**
Burn		
Bury		
Dump in the farm		
Throw them in the bush		
Return them to chemical dealer		
Keep at home		

Do you use agrochemical containers to serve any of the following purposes?

	YES	**NO**

USAGE	FREQUENTLY	SOMETIMES	NOT AT ALL
As drinking cup			
To perform abolition			
To store ingredients			
As container for water storage			
Other(s) specify			

Do you have any question or issue you want to share with me?.....

APPENDIX B

FOCUS GROUP DISCUSSION GUIDE TO FARMER GROUPS USE OF AGROCHEMICALS.

This focus group discussion is part of a survey being conducted in partial fulfillment of an MPhil in Environment and Resource Management degree from University for Development Studies on the topic "Assessment of the use of agrochemicals by smallholder farmers in the Nadowli-Kaleo District of the upper west region". This information is purely for academic purpose; therefore, its confidentiality is highly guaranteed. You are kindly requested to provide accurate answers to the stated questions. Your co-operation and support is appreciated.

1. Do you use agrochemicals?

2. Where do you purchase your agrochemicals from?

3. How did you first get information about agrochemicals use?

4. What type of agrochemicals do you use?

5. What factors have influenced your continual usage of agrochemicals over the years?

6. Is there any alternative you think you can employ in farming and derive the same benefits as agrochemicals?

7. What benefits do you get when you use agrochemicals as a farmer? Or how has agrochemicals helped you in your farming activities?

8. Have you had any diseases or health related problems as a results of using agrochemicals?

9. Have you seen or do you know any one has had some diseases or health problems as a results of using agrochemicals?

10. state these diseases or health related problems encounted.

11. Has the use of agrochemicals caused any changes in the environment including water bodies?
12. What changes have occurred in water bodies and the environment?
13. Do you purchase agrochemicals yourself?
14. If you don't to question 15, then who purchases them for you and why?
15. Do you receive information about how to use agrochemicals?
16. How often do you receive these information?
17. Do you apply agrochemicals to your crops yourself?
18. Do you have protective cloths?
19. How often do you use them?
20. What other purposes do you use empty agrochemical containers to serve?
21. How do you dispose empty agrochemical containers?
22. What challenge or problem do you face with regard to agrochemical usage?

APPENDIX C

KEY INFORMANT INTERVIEW GUIDE TO AGRICULTURAL EXTENSION OFFICERS ON AGROCHEMICAL USE BY FARMERS.

This key informant interview is part of a survey being conducted in partial fulfillment of an MPhil in Environment and Resource Management degree from University for Development Studies on the topic "Assessment of the use of agrochemicals by smallholder farmers in the Nadowli-Kaleo District of the upper west region''. This information is purely for academic purpose and therefore its confidentiality is highly guaranteed. You are kindly requested to provide accurate answers to the stated questions. Your co-operation and support is appreciated.

1. How long have you been working in the study area?

2. What are the types of crops farmers cultivate in this study area?

3. What are the types of agrochemicals farmers use in the study area?

4. What are the reasons why farmers use agrochemicals?

5. Is there any alternative way you think farmers can adopt to derive the same benefit as agrochemical?

6. Do some farmers use ban agrochemical?

7. What do you do when such information come to your notice?

8. Can farmers in these study area cultivate crops without applying agrochemicals?

9. Has the use of agrochemicals by farmers had some consequential effects on the environment including water bodies, animals and plants?

10. What are these effects?

11. Has any farmer within the study area had health problems/diseases or even died as a results of agrochemical use?

12. If yes what are these health problems/diseases?

13. Do farmers purchase and prescribe agrochemicals themselves?

14. Do farmers apply agrochemicals themselves?

15. Do you supervise farmers when they are applying agrochemicals?

16. Do farmers have protective cloths?

17. How often do farmers use protective cloths when applying agrochemicals?

18. Do farmers use empty agrochemical containers to serve some purposes?

19. What purposes do these farmers use empty agrochemical containers to serve?

20. How do farmers dispose empty agrochemical containers?

21. How should farmers dispose empty agrochemical containers to protect the environment?

22. What challenge do farmers in the study area face with regards to agrochemical use?

23. What challenge do you face with regards to supervising farmers usage of agrochemicals in the study area?

APPENDIX D

KEY INFORMANT INTERVIEW GUIDE TO AGROCHEMICAL DEALERS ON AGROCHEMICAL ACQUISITION AND USAGE BY FARMERS.

This key informant interview is part of a survey being conducted in partial fulfillment of an MPhil in Environment and Resource Management degree from University for Development Studies on the topic "Assessment of the use of agrochemicals by smallholder farmers in the Nadowli-Kaleo District of the upper west region''. This information is purely for academic purpose and therefore its confidentiality is highly guaranteed. You are kindly requested to provide accurate answers to the stated questions. Your co-operation and support is appreciated.

1. How long have you been in this business?
2. What types of agrochemicals do you sell?
3. What purposes do these agrochemicals serve?
4. Do farmers come themselves to purchase agrochemicals?
5. What types of agrochemicals do farmers purchase mostly?
6. How do you think agrochemical is helping farmers improve their activities?
8. Have you heard of disease or death humans/animals suffer as a results of agrochemicals usage?
9. If yes, what are some diseases and deaths?
10. I have learnt that some farmers convert empty agrochemical containers to serve some purposes, has this come to your notice?
11. If yes, can you mention some of these purposes farmers convert empty agrochemical containers to serve?

12. How do you think farmers dispose empty agrochemical containers? Or how do farmers dispose empty agrochemical containers?

13. What efforts have you put in place to promote save and clean environment with regards to farmers' disposal of empty agrochemical containers?

14. What challenge do you face with regards to your work as agrochemical dealer?

APPENDIX E

Association between socio-demographic characteristics of farmers and use of agro-chemical by type

Association between age of farmers and fertilizer use

Age category	Yes		No		Total	
	f	%	*f*	%	*f*	%
18-29years	29	85.3	5	14.7	34	100
30-39 years	49	86	8	14	57	100
40-49 years	43	86	7	14	50	100
50 years and above	40	88.9	5	11.1	45	100
Total	161	86.6	25	13.4	186	100

Pearson chi square (3) = 0.2874 Pr = 0.962

Not significant

Association between age of farmers and weedicide use

Age category	Yes		No		Total	
	f	%	*f*	%	*f*	%
18-29years	24	70.6	10	14.7	29.4	100
30-39 years	41	71.9	16	14	28.1	100
40-49 years	41	82	9	14	18	100
50 years and above	35	77.8	10	11.1	22.2	100
Total	141	75.8	45	13.4	24.2	100

Pearson chi square (3) = 2.1130 Pr = 0.549

Not significant

Association between age of farmers and pesticide use

Age category	Yes		No		Total	
	f	%	*f*	%	*f*	%
18-29years	30	88.2	4	11.8	34	100
30-39 years	54	94.7	3	5.3	57	100
40-49 years	46	92	4	8	50	100
50 years and above	42	93.3	3	6.7	45	100
Total	172	92.5	14	7.5	186	100

Pearson chi-square (3) = 1.3608 Pr = 0.715

Not significant

Relationship between sex of farmer and Pesticides use –

Sex	Yes		No		Total	
	F	%	*f*	%	*f*	%
Male	125	94.7	7	5.3	132	100
Female	47	87	7	113	54	100
Total	172	92.5	14	7.5	186	100

Pearson chi-square (1) = 3.2305 Pr = 0.072

Relationship between sex and fertilizer use -

Sex	Yes		No		Total	
	F	%	*f*	%	*f*	%
Male	119	90.1	13	9.9	132	100
Female	42	77.8	12	22.2	54	100
Total	161	86.6	25	13.4	186	100

Pearson chi-square (1) = 5.0433 Pr = 0.025

Relationship between sex of farmer and Weedicides use

Sex	Yes		No		Total	
	F	%	*f*	%	*f*	%
Male	101	76.5	31	23.5	132	100
Female	40	74.1	14	25.9	54	100
Total	141	75.8	45	24.2	186	100

Pearson chi-square (1) = 0.1245 Pr = 0.724

Relationship between household farm labour and fertilizer use

Number of household farm labour	Yes		No		Total	
	f	%	*f*	%	*f*	%
1 farm labourer	15	88.2	2	11.8	17	100
2 farm labourers	41	78.9	11	21.1	52	100
3 farm labourers	43	91.5	4	8.5	47	100
4 farm labourers	29	96.7	1	3.3	30	100
5 and above labourers	32	82.1	7	17.9	39	100
Total	160	86.5	25	13.5	185	100

Pearson chi-square (4) = 6.9649 Pr = 0.138

Relationship between household farm labour and weedicides use

Number of household farm labour	Yes		No		Total	
	f	%	*f*	%	*f*	%
1 labourer	9	52.9	8	47.1	17	100
2 farm labourers	40	76.9	12	23.1	52	100
3 farm labourers	38	80.1	9	19.2	47	100
4 farm labourers	26	86.7	4	13.3	30	100
5 and above labourers	27	69.2	12	30.8	39	100
Total	140	75.7	45	24.3	185	100

Pearson chi-square (4) = 8.3500 Pr = 0.080

Relationship between household farm labour and Pesticides use

Number of household farm labour	Yes		No		Total	
	f	%	*f*	%	*f*	%
1 labourer	16	94.1	1	5.9	17	100
2 house farm labourers	46	88.5	6	11.5	52	100
3 farm labourers	43	91.5	4	8.5	47	100
4 farm labourers	29	96.7	1	3.3	30	100
5 and above	37	94.9	2	5.1	39	100
Total	171	92.4	14	7.6	185	100

Pearson chi-square (4) = 2.4017 Pr = 0.662

Relationship between farmer's experience and fertilizer use

Number of years in farming	Yes		No		Total	
	f	%	*f*	%	*f*	%
2-5years	17	65.3	9	34.6	26	100
6-10years	24	92.3	2	7.7	26	100
11-20years	64	87.7	9	12.3	73	100
21years and above	56	91.8	5	8.2	61	100
Total	161	86.6	25	13.4	186	100

Pearson chi-square (3) = 12.2778 Pr = 0.006

Relationship between farmer's experience and weedicides use

Number of years in farming	Yes		No		Total	
	f	%	*f*	%	*f*	%
2-5years	20	76.9	6	23.1	26	100
6-10years	14	53.8	12	46.2	26	100
11-20years	58	79.5	15	20.5	73	100
21years and above	49	80.3	12	19.7	61	100
Total	141	75.8	45	24.2	186	100

Pearson chi-square (3) = 8.0633 Pr = 0.045

Relationship between farmer's experience and pesticides use

Number of years in farming	Yes		No		Total	
	f	%	*f*	%	*f*	%
2-5years	23	88.5	3	11.5	26	100
6-10years	23	88.5	3	11.5	26	100
11-20years	68	93.2	5	6.8	73	100
21years and above	58	95.1	3	4.9	61	100
Total	172	92.5	14	7.5	186	100

Pearson chi-square (3) = 1.8469 Pr = 0.605