ANALYSIS OF ADOPTION OF RECOMMENDED AGROCHEMICAL PRACTICES AMONG CROP FARMERS IN KADUNA AND ONDO STATES OF NIGERIA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY (ABU), ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF DOCTOR OF PHILOSOPHY IN AGRICULTURAL EXTENSION AND RURAL SOCIOLOGY

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AHMADU BELLO UNIVERSITY
ZARIA, KADUNA STATE
NIGERIA

OCTOBER, 2016

DECLARATION

I hereby declare that this thesisentitled **“Analysis of Adoption of Recommended Agrochemical Practices among Crop Farmers in Kaduna and Ondo States of Nigeria”** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another Degree or Diploma in this or any other institution. All borrowed information have been duly acknowledged in the text and a list of references provided.

Fadlullah Olayiwola ISSA	**Date**
Student	

CERTIFICATION

This thesis entitled **"Analysis of Adoption of Recommended Agrochemical Practices among Crop Farmers in Kaduna and Ondo States of Nigeria"** by Fadlullah Olayiwola **ISSA** meets the regulations governing the award of the Degree of Doctor of Philosophy in Agricultural Extension and Rural Sociology of the Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

To my late father, Alhaji Issa Sodiq and mother, Alhaja Amanatallah Adetutu. My darling wife Muslimah Ashani and children: Sumayyah, Ibrahim and Sofiyyah.

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TABLE OF CONTENTS

Content **Page**

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Appendix **Page**

LIST OF ABBREVIATIONS USED IN THIS TEXT

Abbreviations	**Full Meaning**
ADPs	Agricultural Development Programmes
CPCs	Crop Protection Chemicals
EPA	Environmental Protection Agency
FEPA	Federal Environmental Protection Agency
FDAE	Federal Department of Agricultural Extension
FMARD	Federal Ministry of Agriculture and Rural Development
FNTs	Fortnightly Trainings
IAR	Institute for Agricultural Research
ICCM	International Conference on Chemical Management
IPM	Integrated Pest Management
LIFDCs	Low Income Food Deficit Countries
MRLs	Maximum Residual Levels
NAERLS	National Agricultural Extension and Research Liaison Services
NAFDAC	National Agency for Food, Drugs Administration and Control
NAPRI	National Animal Production Research Institute
NGOs	Non-Governmental Organizations
NPAFS	National Programme on Agriculture and Food Security
NPC	National Population Commission
PPE	Personal Protective Equipment
RAPs	Recommended Agrochemical Practices
RBDAs	River Basin Development Authorities
SEPA	State Environmental Protection Agency
SAICM	Strategic Approach to International Chemical Management
UNICEF	United Nations Children Emergency Fund
VEAs	Village Extension Agents
WHO	World Health Organization

ABSTRACT

This study analysed the adoption of recommended agrochemical practices (RAPs) among crop farmers in Kaduna and Ondo States of Nigeria. A total of 260 crop farmers who had sustained the use of agrochemicals for at least five years were selected for the study by using a multi-stage sampling technique. Data were collected by using a structured, pretested interview schedule. Descriptive statistics (mean and percentages) and inferential statistics (Multiple regression and Z-test) were used for data analysis. Findings revealed that majority (93%) of the crop farmers were male with about 25 years of farming experience, and belonged to more than one association. The mean age of crop farmers was 44 (for Kaduna) and 51 (for Ondo), while the mean farm size was 3.01 and 4.08, respectively. Extension visit to crop farmers recorded a mean of 9 and 12 per annum in Kaduna and Ondo States, respectively. Also, majority (62.7%) of the crop farmers perceived that the efficacy of agrochemical was fair. Similarly, many (43.5%) perceived agrochemical as inaccessible. The results obtained revealed that crop farmers had high level of knowledge (M=2.12 and 2.16 in Kaduna and Ondo State, respectively) of RAPs while the level of adoption was low (M=1.43 and 1.66 in Kaduna and Ondo State, respectively).Non-adoption of RAPs had negative consequences on human safety (53.5%), and the environment (84.2%) of respondents in the two States. The most statistically influential socio-economic variables on adoption of RAPs in order of importance were level of education (0.058, $P<0.05$), farming experience (0.017, $P<0.05$), social participation (0.806, $P<0.10$) and cosmopoliteness (0.057, $P<0.10$) in Kaduna State. For Ondo State, the variables were level of education (0.015, $P<0.01$), farming experience (0.032, $P<0.05$), social participation (0.300, $P<0.01$), and cosmopoliteness (0.004, $P<0.05$). The most important institutional factors on adoption of RAPs were access to training (0.103, $P<0.01$) and accessibility of agrochemicals (0.113, $P<0.10$) in Kaduna State. Similarly, in Ondo State, the variables were access to training (0.113, $P<0.05$) and accessibility of agrochemicals (0.022, $P<0.05$).The most important technological factors on adoption of RAPs were observability (0.081, $P<0.1$), complexity ((-0.043, $P<0.05$) and compatibility (0.060, $P<0.05$) in Kaduna State. For Ondo State, the variables were observability (0.092, $P<0.01$), complexity (-0.043, $P<0.05$), and compatibility (0.004, $P<0.05$).There were significant differences in the yield, output as well as income, and adoption of RAPs between the two States. Most serious constraints to adoption of RAPs were adulteration (94.2%) high cost of agrochemicals (93.1%), and inadequate technical know-how (91.2%). This study concluded that despite high level of knowledge of RAPs, there was low level of adoption among farmers, which was caused by inadequate skill and nonchalant attitude about the health implications of no-adoption of RAPs. This study therefore, recommends that regular training on the use of agrochemicals should be organized for farmers by extension agencies in collaboration with relevant stakeholders. Public orientation using the media and other public enlightenment strategies in order to engender attitudinal change among crop farmers should be pursued by extension agencies. In order to prevent adulteration, fake and banned agrochemicals, the regulatory policies should be revised and adequately enforced.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Promoting agricultural development requires the introduction of innovations that rely on a reasonable use of science and technology embodied in crop protection chemicals (CPCs) for improved crop production. The introduction of these innovations into the agricultural economy of any nation holds the key to the development of the sector. The ability of small-scale farmers to adopt these innovations becomes very crucial if the sector must continue to contribute to national earnings. However, the adoption of agrochemicals is one issue; adopting the recommended practices is another, while availability of the chemicals at the right time, in the right quantity and quality and at affordable prices is also another issue. However, it is important to note that different types of technologies have both hardware and softwarecomponents (Swanson, 1997). For example, a new crop variety, as a type of material technology, cannot be fully exploited without having a complementary set of agronomic or crop management practices, including pest management. Likewise, the use of agrochemicals generally requires some practices embodied in a package of recommendations. Therefore, the functional relationship or linkage between the hardware and software must be carefully examined and followed in order to realize the full advantage inherent in the adoption of such technology/practices.

While population is rising and creating the need for more food, many diseases, pests and other inhibitors of crop growth contribute to reducing crop production. However, many types of chemicals have been developed to fight these plant diseases and pests and manage the effects of inhibitors in crop production. The introduction of these chemicals is, therefore, an important farm innovation which when used by farmers can significantly improve crop production. The CPCs particularly useful to farmers consist of different types of insecticides, fungicides, herbicides, rodenticides and nematicides available in the market. The other group consists of growth regulators, which are mainly chemicals that eliminate the effect of inhibitors. In Nigeria, the strategy has always been to encourage the establishment of private agrochemical plants in the country or the importation of the chemicals by interested investors. However, the existing plants only re-formulate and package CPCs for sale.

The use of agrochemicals is very beneficial in crop production. According to Lomborg (2001),the lives to be saved if pesticides were abolished, would be outnumbered by a factor of around 1000 by the lives lost due to poorer diets to be caused by the associated poor crop yields. The secondary penalties would be massive environmental damage due to the land needs of less productive farming, and a financial cost of around 20 billion US Dollars. Denis Avery (1999),who was Director of the Centre for Global Food Issues at the Hudson Institute in the US wrote in the Wall Street Journal that “Humanity in the 21st century can banish hunger, end nutritional deficits in its children, and save virtually all of the remaining wild lands in the process. But there are only two ways to do it: either murder four billion people, or use chemicals and biotechnology to maintain and increase yields on land already under farming”.

Agrochemicals are important agricultural inputs to protect crops from diseases, pests and weeds. The use of agrochemicals contributes not only to healthy growth of crops and animals but also to improve farm work efficiency and stable supply of agricultural produce (Kughur (2012). Though 75% of all herbicides in the World are used in developed countries however, their use in developing countries is on the increase (Nyatuame and Ampiaw, 2015).

Pests cost developing countries billions of dollars in national income (Food and Agriculture Organization [FAO], 2004) and farm and post-harvest losses contribute to hunger and malnutrition. Malnutrition kills between 12 million (United Nations Children Emmergency Fund [UNICEF], undated) and 15 million children annually (Think Quest, 2005). According to Carol Bellamy, the Executive Director of UNICEF, malnutrition is largely a silent and invisible emergency, exacting a terrible toll on children and their families. It would neither be logical nor ethical to expect poor people to forego the benefits of technologies used in the richer countries to grow and protect crops.

Nigerian agriculture is still characterized by continuing underdevelopment beset by low productivity of resource inputs, low aggregate output, and a large population of stagnant, conservative, traditional small-holder farmers. The technology still remains the traditional hoe-culture coupled with the age-long unproductive farming practices. These culminate in small volume of trade (limited purchases of products outside the agricultural sector and limited sales to the other sector). Therefore the issue of food shortage has expectedly become the biggest challenge facing the nation today as a result of poor quality rather than quantity involvement in the agricultural production process. That Nigeria is still listed among the Low Income Food Deficit Countries (LIFDCs) is evidence.It is an irony indeed that Nigeria, a vast agricultural country endowed with substantial natural resources which include: 68 million hectares of arable land; fresh water resources covering about 12 million hectares, 960 kilometers of coastline and an ecological diversity which enables the country to produce a wide variety of crops and livestock, forestry and fisheries products (Shaib*et al.*, 1997) should find itself in the group of 43 LIFDCs in Africa (FAO, 1997).

With its vast human and natural resources complemented by perhaps, the largest National Agricultural Research and Extension System (NARES) in sub-Saharan Africa comprising of: 17 Commodity-based Research Institutes, a specialized National Agricultural Extension Institute, 18 Faculties of Agriculture in regular Federal Universities; 3 specialized Universities of Agriculture and one International Agricultural Research Centre (IARC i.e. IITA), 11 River Basin Development Authorities (RBDAs), 37 States (including FCT Abuja) Agricultural Development Projects (ADPs) (Arokoyo, 1998) Nigeria has no excuse to be in the company of food-deficit or food insecured nations in Africa.

Nigeria has an estimated total land area of 98.3 million hectares, 74% or 72.7 million hectares of which were certified cultivable. However, less than 50% of this is actually under cultivation. This picture depicts that Nigeria has a very good potential for large agricultural output with only the right combination of resources. Increase in food production is not proportionate with population growth. The rather unimpressive performance of the agricultural sector especially since the oil boom of the 1970s as occasioned by the high local food prices and skyrocketing food import bills of N24 trillion annually, has no doubt been due to lack of a well-articulated, functional agricultural policy instrument which could engender the use of science and technology in crop protection for improved crop production.

1.2Statement of the Problem

There is widespread recognition that farmers misuse agrochemicals while protecting crops from incidences of pests and diseases. The high reports of pesticide failure and unprecedented level of pesticide-related accidents and their attendant consequences on the health of people is quite alarming (FAO, 1998). Exposure to agrochemicals poses an increasing health risk in agricultural work especially as pesticide sale and use have continued to rise over the years, thereby increasing farmers' risks due to the increasing use of more toxic chemicals. The International Labour Organization (ILO) and FAO (2012) asserted that 170,000 of the 335,000 fatal workplace yearly accidents that occur worldwide involved agricultural workers, thereby making agriculture one of the three most dangerous sectors to work, along with construction and mining.

Furthermore, available literature as well as field experiences from various practitioners indicate a demand-supply system that just emerged by chance, which is hence not perfect but characterized by adulteration, use of expired chemicals as well as inefficiency in usage, improper storage, bad (high) retailing prices, and lack of safety measures (FAO, 1998). In attempt to tackle these problems, useful efforts has been done by research institutes and extension agencies in providing information on research-based Recommended Agrochemical Practices (RAPs) (Laary, 2012; Zyoud*et al.*, 2010; Asogwa and Dango, 2009; Kishi, 2005; and Kishi *et al.,* 2005).

Despite these efforts, recommended agrochemical practices have been poorly adopted thus resulting in environmental and health hazards.The wrong use of chemicals on farms exposes farmers and the environment to some risks due to the hazardous effects of these chemicals. The residual effect of the chemicals on crops also constitutes concern if the chemicals are not properly handled. According to Atu (1990), pesticides are toxic and can have serious health hazards on human beings. To guard against these dangerous effects, Idowu (1996) recommended precautionary measures in chemical application. These include; wearing of nose shield to avoid inhalation; putting on protective clothing, rubber gloves and boots; refraining from smoking, eating and drinking, and covering of food and water to avoid contamination. However, the adoption of the recommended practices has been generally low as indicated by persistent incidences of agrochemical-related accidents (Abdullahi, 2008). Importantly, data on how recommended agrochemical practices are being adopted by farmers in Nigeria is very scanty. Some of the past studies on agrochemical practices also lacked the detailed analysis that isrequired to understand the practices better.

Safety and health in the use of agrochemicals has been one of the primary concerns of international organizations and of many government administrations for over two decades. With thisbackground therefore, the need for a systematic analysis of the adoption of available recommended agrochemical practices and the problems associated with their adoption has become imperative (Abdullahi, 2008). This therefore, raises fundamental research questions concerning recommended agrochemicalpractices in Nigeria, namely:

i. What are the socio-economic characteristics of farmers in the study area?

ii. What are the farmers' perception of efficacy and accessibility of agrochemicals?

iii. What is the level ofknowledge of RAPs among farmers?

iv. What isthe level of adoption of RAPs by the farmers?

v. What factors influence the adoption of RAPs by the farmers?

vi. What is thefarmers' knowledge of the consequences of non-adoption of recommended agrochemical practices on human and environmentalsafety?

vii. What are the constraints to adoption of RAPsby farmers in the two States of Nigeria?

1.3 Objectives of the Study

The broad objective of this study was to analyse the adoption of recommended agrochemical practices among crop farmers in Kaduna and Ondo Statesof Nigeria. Specific objectives of the study were to:

i. describe the socio-economic characteristics of farmers in the study area;

ii. assess the farmers' perception of efficacy and accessibility of agrochemicals;

iii. determine the farmers' level of knowledge of RAPs;

iv. estimate the level of adoption of RAPsby the farmers;

v. determine the socio-economic,technological and institutional factors influencing adoption of RAPs by the farmers;

vi. analyze farmers' knowledge of the consequences of non-adoption of recommended agrochemical practices onhuman andenvironmental safety, and

vii. identify constraints to adoption of RAPs by farmers in the two States of Nigeria.

1.4 Justification of the Study

Extensionists, economists and sociologists have made extensive contributions to the literature on adoption and diffusion of innovations in agriculture. Such contributions typically focus on the long-term extent of adoption, rate of adoption and the factors that influence the adoption decision. However, the analysis of adoption of agrochemicals should go beyond just measuring the adoption of a particular agrochemical for whatever purpose. Hence, studies should go further to investigate the extent to which recommended practices are being adhered to in the use of such agrochemicals.

Some studies have been conducted on the adoption of plant protection measures against pests and diseases of different fruit trees, yet some others have been carried out on the use of pesticide spray. Most other studies are limited to just the adoption of agrochemicals. But little specific work has been carried out on the adoption of the recommended practices on the use of agrochemicals and its socio-economic correlates.

In recent decades, there has been a steady increase in the amount of pesticides marketed for argicultural use. In the European Union alone, more than 200,000 tonnes of pesticides (active ingredients) are used annually (Eurostat statistical Books, 2007). Between 2005 and 2010, the total volume of global sales rose from US$ 31 billion to US$ 38 billion (CropLife International, 2006 and 2010). The amount of pesticides used internationally has risen fifty-fold since 1950and 2.3 million tonnes of industrial pesticides are now used each year (Ecobichon, 2001; Miller , 2002.). China is now the country that uses and produces the largest amounts of pesticides (Pesticide Action Network(PAN), 2010).

In developing countries, the effects of acute poisoning due to exposure to dangerous levels of pesticides in food are apparently more severe than in industrialized countries. Two examples from Africa: in 2008 Nigeria reported that 112 people had been poisoned by pesticide-contaminated food, and two children died as a result. Another report from Nigeria recorded 120 cases of poisoning of students who had eaten beans contaminated with lindane (Organic Consumer Association (OCA), 2008, Integrated Regional Information Network(IRIN), (2008). Some pesticides that are restricted and banned in industrialized countries are used in many third-world countries (Wesseling*et al.*, 1997).

Among the pesticides that are frequently associated with documented cases of poisoning are carbamates and organophosphates, which are in World Health Organization (WHO) class I, endosulfan, which the Stockholm Convention has earmarked to be phased out worldwide, and paraquat (Kishi, 2005; Secretariat of the Rotterdam Convention, 2010). According to Vaagt (2005) these pesticides are often freely available in the markets in developing countries or smuggled in for use or sale.

Illegal trade in pesticides is a significant global problem. In developing countries, as much as 30% of the pesticides do not meet internationally recognized safety standards (Vaagt, 2005). In India, for example, the Ministry of Agriculture has determined that one-third of the pesticide samples examined do not comply with official standards (WHO, 2002).

The most striking significance of this study is therefore, that, an x-ray of literature (FAO, 1998; Meijden, 1998; Udoh, 2009; Ecobichon, 2001; Dugje *et al.*, 2008; Asogwa and Dango, 2009; Mokwunye *et al.*, 2012) on the use of crop protection chemicals in

Nigeria indicated thatvery few studies have evaluated how recommended agrochemical practices were adopted by farmers. Essentially, the data to be generated through this study would serve as a basis for understanding how recommended agrochemical practices are being adopted in the country. This can then be used for making appropriate policy.

Stakeholders in agrochemical use and handling stand to benefit a lot from this study. To policy makers, result of this study can guide policy directions geared towards local production and enforcement of regulatory rules particularly with respect to importation, sales (including price) and distribution of agrochemicals. The research institutes can be able to pick up the challenges posed to farmers in using spraying apparels and equipment. The knowledge of the factors influencing adoption of RAPs can be useful to modify and improve extension especially in providing effective training and supervision for farmers and to properly re-orientate them on the use of safety/protective devices. NGOs and private organizations too can leverage on the findings of this study to address some of the constraints to adoption of RAPs as exposed by this study. The knowledge of the consequences of non-adoption of RAPs can also assist the farmers to create a change of mind by endorsing the recommended practices and use them efficiently to promote their personal safety, guard failure and protect the environment. As for the Nigerian public, the benefit of this study can be safety of health resulting from consumption of non-contaminated fresh food from the farm.

1.5 Hypotheses of the Study

The null hypotheses set for this study were:

H_{01} There is no significant relationship between farmers' socio-economic characteristics and adoption of RAPs.

H_{02} There is no significant difference between the technological attributes of RAPs and adoption of RAPs among farmers in Kaduna and Ondo States.

H_{03} There is no significant difference between the institutional variables and adoption of RAPs among farmers in Kaduna and Ondo States.

1.6 Scope and Limitations of the Study

This study covered crop farmers in Kaduna and Ondo States (in the North-west and South-west agroecological zones, respectively) in Nigeria. Crop farmers were specifically covered by the study. Also, the study covered agrochemicals that were used both on the field as well as those used for storage.

Many of the respondents do not keep records of their farm operations and activities, therefore, their memories were relied upon in supplying certain information, for example, number of years respondents have been using a particular agrochemical, cost of agrochemical in the past years and hecterage of farmland sprayed. Some of the farmers also were not be able to recall certain information at all. These limitations were addressed by assembling the containers of most of the agrochemicals used in the past 5 years. This was achieved by getting the catalogue of agrochemicals produced by various agrochemical industries especially the old and popular ones, as well as input agencies. The catalogue made it easy for farmers to identify the types of agrochemicals used.

1.7 Basic Assumptions of the Study

The following assumptions were made for the study:

i. That the action and inaction of farmers with respect to agrochemical usage has a direct consequence on the result (yield) to be obtained, the farmers' health and safety, environmental safety, as well as agrochemical failure.

ii. That those farmers' characteristics which enhance adoption of agrochemicals make greater impact and influence on how the farmers comply with the accompanying recommended practices. For example, that a poor and illiterate farmer is more likely to misuse agrochemicals compared to a rich and literate one.

1.8 Definition of Terms

Adoption: The decision of farmers to make full use (application) of specific agrochemical on continuous basis as the best course of action available.

Recommended practices: This can be described as the process of carrying out an activity in a worthwhile manner as suggested by relevant authority.

Recommended agrochemical practices: This can be described as the process of using (applying) agrochemicals in a worthwhile (efficient and effective) manner as suggested by relevant authority.

Application knowledge: The knowledge necessary for the proper and successful application and incorporation of agrochemical recommended practices.

Agrochemicals: Agrochemicals encompass fertilizers and agricultural pesticides, insecticides, fungicides, rodenticides, acaricides, molluscides, nematicides, algicides, herbicides, and plant regulators (Ayoola and Idachaba, 1990) used by farmers on the field or in storage for the purpose of improving optimum crop yield.

NOTE: For the purpose of this study, only herbicide, insecticide, and fungicide were considered. Also, only agrochemicals used both on the field and for storage were considered.

Pesticides: Pesticides are types of agrochemicals that are intended to prevent, destroy, repel or kill any animal pest or disease caused by microorganisms, as well as unwanted weeds for the purpose of crop protection in the field and store.

Insecticides: Insecticides are chemical substances used for killing insects in different crops.

Herbicides: Herbicides are chemical substances used for killing weeds for the purpose of preventing their (weeds) competition with different crops.

CHAPTER TWO

LITERATURE REVIEW

2.1 Socio-economic Characteristics of Adopters of Recommended Practices

Rashid (1980) cited in Tijani and Nurudeen (2012) studied some personal and socio-economic factors associated with adoption of recommended agricultural practices in rural Egypt. He reported that education and income were associated with use of pesticide.However, age of farmers was not related to the said use. Ahmad (1992) conducted a study on the adoption of plant protection measures by citrus growers and found that there was a positive relationship between age group, educational level, social status, size of holding, size of orchard and adoption of plant protection measures. Yasin*et al.* (2003) found a strong and negative relationship between farming experience and adoption of insecticide spray. Size of holding however, had no effect on usage of citrus spray, while in the case of social status; farmers with higher social status used more spray (Bonabana-Wabbi, 2002).

Furthermore, according to Adesope*et al.*(2012), marital status and farming experience of farmers were negatively correlated with adoption of organic farming practices. This is in consonance with the findings of Edeoghon (2008) who reported that farmers usually are more involved in practices that they are more familiar with than other practices. According to Baral*et al.* (2006), neighbors and relatives were valuable sources of information in India, but extension agents and radio broadcasts were not. This situation is identical to what is happening in neighboring Bangladesh (Rashid *et al.*, 2003) and in other States of India (Alam*et al.*, 2006).

Farmers' age had negative and strong correlation with pesticide usage (Bonabana-Wabbi, 2002). Tijani and Nurudeen (2012) also found same. A positive and strong correlation was also found between education and adoption. Educated farmers used more sprays than those with little education or uneducated. Size of holding had no effect on usage of citrus spray, while in the case of social status; farmers with higher social status used spray. Farmers' exposure to education increases their ability to obtain, process and utilize information relevant to the adoption of IPM technologies (Bonabana-Wabbi, 2002).

In the same vein, Abdullahi (2012) found in Paikoro LGA of Niger State that the adopters of an improved rice variety were relatively younger and were more likely to try new technology.This is in line with findings of Obeta and Nwagbo (1999) who also noted that younger farmers are more amenable to new ideas and risk; they are expected to adopt innovations more readily than older ones thereby becoming more efficient in production. Abdullahi (2012) also found that majority of the farmers who adopted improved rice variety were male. He argued that adoption of innovations could be as a result of enlightenment campaigns by extension agents and that the low adoption rate among female farmers may be as a result of domestic activities which keep them indoors, thus inhibiting their contact with extension personnel. Also, in line with Rogers and Shoemaker (2001) who observed that education is not only an important determinant of adoption of innovations but also an instrument for successful implementation of innovations for profitability; Abdullahi (2012) found formal education as a major socio-economic characteristic affecting adoption of innovation. The use of recommended practices in agrochemical requires some level of education to be able to use them efficiently and effectively. Farm size and farm income were also found by Abdullahi (2012) as positive correlates of adoption of innovation, thus confirming the findings of Alamu *et al.* (2002) that farmers with more resources including land area are more likely to take advantage of a new technology.

2.2 Accessibility of Agrochemicals to Farmers

The source of cocoa pesticides used by the farmers includes agrochemicals retailers, Cocoa traders, Cocoa Association of Nigeria (CAN), and Agricultural Development Programme (ADP) (Mokwunye *et al.*, 2012).Farmers in Nigeria use different strategies to source agricultural raw materials. These are direct purchase from the market, use of buying agents, direct purchase from farmers or producers. A survey by the Nigerian Institute of Social and Economic Research (NISER) (1999) on the strategies used by agribusiness firms suggests that the use of buying agents and direct purchase from the open market are quite popular amongst agribusiness firms.

2.2.1Types of agrochemicals used by farmers

It has been estimated that about 125,000 - 130,000 metric tons of pesticides are applied every year in Nigeria (Asogwa and Dongo, 2009). Pesticide application equipment has been introduced into the Nigerian farming system, together with the pesticides to be applied, ever since they were used in the industrialized world. Practically, all the different techniques available have, at a given time, been introduced more or less successfully.The mandate to screen and recommend potential crop pesticides and spraying equipment lies with the designated research institutes. However, the effect of the new European Union Legislation on Maximum Residue Levels (MRLs) since the regulation came into effect since September 1, 2006 is yet to be substantially ascertained.Chemicals are essential requirements of modern society that need to be managed properly in order to achieve a sustainable level of agricultural and industrial development, and a high level of environmental and human health protection.

The major types of chemicals used in Nigeria are imported. Some formulations are however undertaken, often without adequate consideration for human health and the environment during their handling, storage, use and disposal.Although national legislative instruments and policies are in place; implementation and enforcement are inadequate due to limited national infrastructure and capacity to manage chemicals. At the international level, considerable attention has been given to the sound management of chemicals. Since the late 1980s, several international policy instruments have been adopted; the most recent being the adoption of the strategic approach to international chemicals management (SAICM) by the International Conference on Chemicals Management (ICCM) in Dubai, United Arab Emirates in February 2006.

Subsequently, the Basel Convention Regional Centre (BCRC)in Pretoria, the Secretariat of the Basel Convention and the Swedish Chemicals Agency (KemI) planned a regional cooperation in Anglophone Africa to enhance chemicals management through the implementation of the Strategic Approach towards International Chemicals Management (SAICM), the Stockholm, Rotterdam the Basel Conventions.The project, in which Nigeria was identified as one of the pilot countries, is funded under a project of the Secretariat of the Basel Convention (SBC) and the Swedish Chemicals Agency (KemI), with the aim of establishing key baseline data on national chemicals and waste (Anyadiegwa, 2007).

2.2.2Production, import-export and use of chemicals

Only very few chemicals are produced in the country with about 90% of chemicals in use in the country imported. Nigeria's trading partners/principal sources for these chemicals are European and Asian countries. The only chemicals formulated or produced in the country are those for use in agriculture e.g. fertilizers and other agrochemicals; and industrial chemicals such as sulphuric acid, alum, linear alkyl, benzene, industrial solvents, carbon black and propylene. Crude oil dominates exports, accounting for 95.7% of all exports, while agricultural products account for only 2.6%. The country generates a significant quantity of hazardous wastes from the various industrial sectors such as tanneries, textiles, refineries, etc. An estimated 30 MT of agrochemicals are wasted per annum (Akunyili and Ivbijaro, 2006; NAFDAC, 1996).There are only few companies in the country that formulate and package agrochemicals such as gammalin 20 (Lindane) and Butachlor and other insecticides, rodenticides, etc. The active ingredients of these formulations are however imported.

2.2.3 Banned pesticides in Nigeria

A banned pesticide is that, for which all registered uses have been prohibited by final government regulation action or for which all requests for registration or equivalent action for all uses for health or environmental uses have not been granted. The Nigeria Committee on PIC (Prior Informed Consent) procedure usually takes final decision on pesticides to be banned in the country and their decision is informed by actions taken under the Rotterdam Convention for International Control of Pesticides and other Hazardous Chemicals.

The use of the following pesticides has been banned in Nigeria (Ezie, 2008): Aldrin, chlordane, lindane, DDT (Dichlorodiphenyl Trichloroethane), toxaphene, endrin, heptachlor, flouroacetamide, captafol, mirex, methyl parathion, parathion, chlorodimeform, pentachlorophenol, methamidophos, dinoseb and dinoseb salts, chlorobenzilate, phosphamidon, monocroptophos, ethylene oxide, ethylene dichloride, EDB(1,2,dibromoethane), hexachlorobenzene (BHC), binapacryl, dieldrin. Others are DDD (Dichlorodiphenyl dichloroethane, 2,4,5 trichlorophenoxy acetic acid and HCF/BHC-1,2,3,4,5,6Hexachlorocyclohexane. However, it is not clear that some of these products are completely absent in the Nigerian markets. The porous nature of Nigerian borders as well as numerous illegal borders worsens the situation.

2.3 Farmers' KnowledgeofRecommended Agrochemical Practices

The cultivation of crops and vegetables requires the application of agrochemicals. Farmers are increasingly relying on inorganic agriculture mainly because, the soils are poor, and indigenous crop varieties have almost been replaced by improved high-yielding varieties which are heavy nutrient miners. The crops are also quite susceptible to many insect species, which may not only feed but also reproduce on them. So the farmer seems to have no choice but to treat crops and protect them against insects and diseases by using agrochemicals. Agrochemicals are crop protection products or agents used to control plants or weeds, diseases, insects or animals that are undesirable or harmful to man, and/or also to promote the growth and development of crops. The commonly used agrochemicals in Nigeria are insecticides, herbicides, fungicides, fumigants, fertilizers and growth regulators.

Most agrochemicals are toxic and can pose some dangers to human health (WHO, 2008); hence, their use is highly regulated internationally, nationally and regionally, with regulations and conventions (PAR, 2000; FAO/WHO, 2001). As a result of dangers associated with agrochemicals, consumers of agricultural products, especially in Europe and the Americas are advocating for chemical-free food products for guaranteed health and long lives. Organic agriculture is thus of late gaining much popularity. It is threatening however that, agrochemicals such as Atrazine, Aldrin, DDT, Paraquat, Alachlor, among others that have been banned for decades in the European Union (EU) and United States of America (USA) are still used extensively in many developing countries (Machipisa, 1996; International Union of Pure and Applied Chemistry (IUPAC), 2008) by local farmers to control pests and diseases of field crops and food products. Local farmers also have little or no knowledge on how, what, when and how often to apply agrochemicals on their crops; the consequence of which is the destruction of entire crop fields, polluting water bodies and putting human health andthe environment at risk (Ntow, 2008).

Incidentally, many farmers who use these agrochemicals do not know much about the dangers associated with them and hence end up tasting to determine their potency while also failing to protect themselves during their application. Though some stored farm produce are treated with few agrochemicals, most of the chemicals are frequently applied on field crops. As a result of continuous application and misuse of agrochemicals, the fertility status of farm lands is getting worse year after year; many insects and their predators are destroyed, and others have evolved resistant strains (Tanzubil, 1997). It is also worth noting that, despite the incessant use of agrochemical products by farmers, 20-40% of potential food production is still lost every year to pests and diseases (Obeng-Ofori, 1998). Therefore, an adequate reliable food supply cannot be guaranteed with the use of agrochemical products alone.

Many farmers in Nigeria and in many other developing countries rely heavily on agrochemicals in their quest to produce food crops and vegetables. However, the concern of this study is whether the farmers have adequate knowledge of the beneficial and harmful effects associated with the use of such chemicals, in a manner that will ensure that they pay utmost attention to the recommended practices.

In a market and farm survey by Laary (2012), various kinds of agrochemical products including herbicides, insecticides, fungicides, fumigants, fertilizers and plant growth regulators or hormones were found with agrochemical dealers. He reported that some of the agrochemicals found with market dealers had their labels scrapped off; others were expired and/or banned, whilst others were transferred into different containers. Those that had their labels scraped off or transferred into different containers were difficult to identify. He further reported thatfarmers were rarely given advice or instructions by the dealers on how to handle and use the agrochemicals when buying them because, most of the market dealers know little, or nothing about the agrochemical products they sell to farmers. The situation was further compounded by the fact that most farmers who buy these agrochemicals know virtually nothing on the possible dangers associated with their use. Hence, farmers' knowledge about recommended agrochemical practices can be best described as grossly inadequate. Therefore, apart from the possibility of using an expired product, most of them may not formulate the agrochemicals well before applying them and may therefore not achieve the desired results from their application.

The aim of farmers for applying agrochemicals on their crops is either to enhance growth or control pests and diseases that threaten the survival and yield potential of their crops (Hill and Waller, 1982). Various pests and disease symptoms were mentioned by the farmers and identified with them on their crops (Laary, 2012). This implies some level of knowledge about pest and disease symptoms since farmers were able to identify the various pests and diseases which they believe constitute economic loss to them.

Some of the chemical products used by the farmers have residues which can be retained on crops and vegetables for extended periods (Kleter *et al*., 2008). Research also has it that, there is gradual cumulative evidence of increasing human vulnerability to agrochemicals and chemically applied food products (Ntow, 2008; Amoah *et al*., 2005; Smith *et al*., 1999). The findings of Laary (2012) revealed that some farmers have reasons necessitating numerous chemical applications while majority of them do not know why they keep applying agrochemicals. To them, treating the crop continuously with agrochemicals is a common practice to maximize yield and attract good market prices; because both leaves and fruits will be free of insect and disease infestation and will be more appealing and attractive to the consumer.

Ajayi and Akinnifesi (2005) reported that farmers understand labels that advise users to protect themselves. These were labels which advised users to protect their eyes, put on boots, hand gloves or to protect their nose and mouth. This indicated that farmers were well aware of the possible health effects of pesticides on humans. However, some farmers bought pesticides without labels as reported by Amera and Abate (2008).

According to the study by Ajayi and Akinnifesi (2005), farmers themselves or someone they know in their village have suffered from pesticide-related health symptoms at one time or the other in the past. As a result, it was easier for farmers to easily understand why they should protect themselves. Observations made during spraying operations as one of the methods employed in the study revealed that farmers made efforts to protect their mouth and nose with clothes and other cotton fabric materials that they improvised on their own. However, the materials used were not always effective as they sometimes absorbed pesticide solution during spraying (Ajayi and Akinnifesi (2005).

More than half of the farmers understood very well the labels that warn users of the potential health danger linked to pesticides and, the labels that advised users to take a bath with water after spraying. The safety label that was most misinterpreted and misunderstood by majority of farmers, according to Ajayi and Akinnifesi (2005), was (1) that which warned users to keep pesticides securely out of reach of children; (2) the one with precaution of wearing breathing apparatus; and (3) the one with the safety precaution that pesticides are harmful to fish and flowing rivers. Only few farmers correctly understood safety labels that warned users on the potential negative effects of pesticides on animals and the environment. Some farmers thought that the label on the potential effects of pesticides on rivers and fishes meant that they "should not go fishing after completing a pesticide field operation".

In terms of training, only few farmers had attended at least one formal agricultural training session on pesticides and spraying operations (Ajayi and Akinnifesi (2005). They found further that most farmers stored pesticides within their homes and rooms, and most of the farmers did not have special location for storage of chemicals. Due to lack of knowledge about the quantity needed; farmers may acquire the would-be quantity of pesticides needed for a given agricultural season, and keep the consignments in their homes from where they take small quantities needed during each spraying operation. The recommended period of storage might lasts for months but farmers may continue to store for more than a year in cases where the pesticides acquired were not completely used during the season. Also, due to difference in prices, farmers may procure cheaper formulated brands which could be more toxic.

Ajayi and Akinnifesi (2005) also found cases of misuse of pesticides through diversion of pesticides registered for a particular crop to other crops or non-crop purposes e.g. for treating vegetable gardens, treatment of wounds, removal of ticks on cattle and domestic animals and the control of ants. Most cases of pesticide misuse occurred during the ‘off’ season by using insecticides that remained after pesticide spraying activities for the agricultural year ended.

Pesticide applicators recognized the consequences of spraying against the wind or when the speed of wind is high. They took precautionary measures to observe the direction of the wind before they begin spraying, using improvised methods such as ‘plant leaves method’, “*flag/cloth*” method, “*Machine vapour*” method, “*Tobacco*” method, and ‘dust’ method. However, farmers rarely put on any form of protective clothing. In most cases, they made attempts to protect themselves against pesticide exposure, using improvised materials, such as face caps or local hats and a piece of cloth or handkerchief tied around the mouth and nose. The effectiveness of the different materials is, no doubt, questionable. The protective clothing consisted mainly of cotton materials which may absorb pesticide solution during spraying. On few occasions, farmers wore boots and hand gloves. This may not be unconnected with the associated high cost of the apparels. Although farmers interpreted safety labels reasonably correctly, their pesticide handling and field spraying practices did not sufficiently demonstrate this level of knowledge (Ajayi and Akinnifesi, 2005).

Despite appreciable farmer awareness of the toxicity of pesticides, irregular hygienic practices and rare use of protective clothing result in greater levels of exposure for equivalent pesticide use in developing countries compared to developed countries (Cole *et al.,* 1998). A study in Ecuador found that although more than 70% of the farmers interviewed agreed that pesticides cause serious human health problems and also 81% of them read pesticide warning labels correctly, yet the farm workers used little or no protection against exposure during spraying operations, apart from rubber boots (Crissman *et al.,* 1994). A study in northern Greece (Damalas *et al.,* 2006) showed that almost all farmers were aware that pesticides can potentially impact negatively on users, but about half of farmers interviewed did not use any special protective equipment when spraying pesticides. Similar results have also been reported among pesticide applicators in India (Mancini *et al.,* 2005).

2.3.1Post-spraying and pesticide disposal practices

After spraying of chemicals, applicators should wash their sprayers in flowing streams and rivers close to their field and normally took a bath. Whenever they suspected cases of serious exposure to pesticides, they applied home grown remedies such as drinking lemon juice, drinking fresh milk or massaging the body with shea-butter oil. They believed that these items would nullify negative health effects of pesticides. Farmers disposed off empty pesticide containers in various ways. Most of the farmers leave the containers in the field after use. Such disposal method may pose some risks to nearby streams, animal food and children health. In some cases, pesticide containers are re-used by the household or by other persons. Some containers ended up being used by humans in one way or the other.However, the findings of Ajayi and Akinnifesi (2005) represented an improvement (in terms of posing a health hazard) over the widespread re-cycling of pesticide containers that was reported in previous studies that were carried out in the same area (Richardi, 1992).

Generally, farmers have varying level of knowledge on the harmful effects of pesticide to human health, animal health, wild life, as well as water bodies (Amera, and Abate, 2008).Zyoud *et al.* (2010) found a significant positive correlation between the knowledge and safety procedure scores. Unsafe behaviors were identified as the storage of pesticide products at home, the preparation of pesticides in the kitchen, inadequate disposal of empty pesticide containers, eating and drinking during pesticide application, and using inadequate protective clothing. The most frequent self-reported toxicity symptoms associated with pesticide use were skin rashes, headache, excessive sweating, and diarrhea. There was a strong significant negative correlation between self-reported toxicity symptoms and scores for protective measures.

IsinandYildirim (2007) have reported that although, farmers in Turkey read the recommendations and instructions on pesticides’ labels, less than 60% of them exactly followed the directions. Ntow*et al.* (2006) tested the perceptions of farmers about chemicals' potential for harm among vegetable farmers in Ghana. They found that various inappropriate practices in the handling and use of pesticides caused possible poisoning symptoms among those farmers who generally did not wear protective clothing.

2.3.2 Farmers' knowledge and awareness of pesticides

This sub-chapter discusses (1) the Knowledge of farm workers regarding name, health effects, biological and natural controls, route of pesticide entry into body, and fate of pesticide residue, (2) the knowledge of toxicity symptoms among farm workers and (3) the farm workers' use of protective measures and their knowledge about those measures.

2.3.2.1 *Knowledge of farm workers regarding name, health effects, biological and natural controls, route of pesticide entry into body, and fate of pesticide residue*

Knowledge of farm workers in the Gaza Strip about the effects of pesticides on human health was relatively accurate, a finding inconsistent with a study from the Netherlands (Ohayo-Mitoko *et al.*, 2000). They reported that knowledge of the names of pesticides used was also relatively accurate, whereas knowledge concerning biological and natural control was low. This situation might necessitate the launch of educational extension programmes on pesticide alternatives among farm workers in the study area.

The level of knowledge could put farm workers at risk when contact is made with pesticide residues on plants, in soil, and in dust particles after spraying. Yassin *et al*. (2002) found a moderate to low awareness among farm workers towards the fate of pesticide residues in soil, in air, on plants, and in groundwater. They also found that a high proportion of farm workers were more aware of inhalational and dermal absorption of pesticides than other routes of exposure agreeing with other studies which have found that most occupational exposure to pesticides occur from skin absorption and through inhalation (Smit*et al.,* 2003,and Kamel *et al.*, 2005).

2.3.2.2 *Knowledge of toxicity symptoms among farm workers*

There are toxicity symptoms associated with the use of agrochemicals, the knowledge of which could guide against poor handling by farmers. Yassin *et al.* (2002) found that most farm workers had knowledge of a burning sensation in the eyes/face, watering of eyes, old/breathlessness/chest pain, itching/skin irritation, headache, and dizziness. Also, several cases of poisoning and death associated with pesticide use (within three years) were recalled. However, loss of libido and forgetfulness were least known. Such knowledge suggests that farm workers experienced these symptoms in situ. Most of these symptoms are considered to be common manifestations of acetylcholinesterase inhibition (WHO, 2004).

2.3.2.3 *Farm workers' use of protective measures and their knowledge about those measures*

The use of protective measures could contribute to decreasing the health effects of pesticides. Also, this would lead, as expected, to a decrease in poisoning prevalence parallel to the reduction in exposure. Farmers and farm workers should have good knowledge about protective gear. Farm workers with good pesticide knowledge are expected to be more inclined to use pesticides according to the recommended guidelines for protective measures.

According to Yasin *et al*. (2002) and Salameh *et al.* (2004), farm workers had information that gloves, goggles, hats, boots, masks, overalls can protect skin of the hands, eyes, head, feet, mouth/nose and whole body respectively from the adverse health effects of pesticides. Unexpectedly, they found the use of protective measures to be poor as no one took precautions unless they knew about the measures. The poor use of protective measures found in their studies is inconsistent with the study from Sri Lanka and the USA (Wilson and Tisdell, 2001, and Koh and Jeyaratman (1996). The reason for not using protective gear, among farm workers who knew the benefit of the gear, could be attributed to carelessness, discomfort, cost, or unavailability of protective devices. Why knowledge and awareness do not necessarily translate into action remained a big question to be answered. However, this is not within the scope of this study.

Experiences on the field have shown that farmers mix two or more pesticides as well as use more than the recommended concentrations of pesticides. This practice could put the farm workers at risk, due to the synergistic or potentiating effect of chemicals. Yasin *et al.* (2002) confirms this experience. Yet, other farmers use less than the recommended concentration of pesticides which could lead to pesticide failure.

The practice of preparing and storing pesticides at home might expose children and adults to hazardous risks. In the same vein, disposal of empty containers in local waste containers or by washing and reusing the container at home could expose the public to hazardous risks. Such practices were considered to be one of the main problems associated with pesticide use in developing countries (Wessling *et al.*, 1997). In addition, burning empty pesticide containers in open fires or burying empty containers are usually recommended by distributors and suppliers as a method of management and disposal of empty pesticide containers, but they are potentially hazardous to human health and the environment. Safe burning procedures require a good understanding of pesticide chemistry, while safe burial requires adequate knowledge of local hydrology as well as of the environmental behavior of pesticides. Many users do not have such knowledge or cannot apply it properly to their particular circumstances. In the local areas, most of the time, empty pesticide containers are highly valued and used or exchanged as storage containers for other materials such as fuel, other chemicals, and sometimes even drinks or food. Such practices are dangerous and can be prevented; for example, by puncturing any empty pesticide containers that cannot be returned to the supplier, in accordance with WHO recommendations (WHO, 1991).

Researchers have concluded that farm workers in developing countries will continue to use pesticides in increasing quantities because of the lack of alternatives to pesticides, ignorance of the sustainability of pesticide use, and the weak enforcement of regulations and laws on pesticide use (Wasseling *et al.,* 1997, Wilson and Tisdell, 2001). Workers' knowledge of hazards, which must be correct, is important for the prevention of acute and chronic poisoning: erroneous beliefs can seriously impair workers' capacity to protect themselves against the risks of pesticides (Koh and Jeyaratnam, 1996). Zyoud *et al.* (2010) found that the common symptoms among the farm workers were skin rash, headache, excessive sweating, and diarrhea. Most of the reported symptoms of pesticide use are considered to be common manifestations of acetylcholinesterase-inhibiting insecticides (Ohayo-Mitoko *et al.*, 2000; Smit *et al.,* 2003; Kamel *et al.,* 2005).

2.3.2.4 ***Practices towards pesticides***

Empirical studies on pesticide spraying practices and the effects of pesticides on farmers' health in developing countries have been documented in Africa (Mekonnen and Agonafir, 2002;Ngowi *et al.,* 2007; Ajayi and Waibel, 2003; Drafor, 2003; Maumbe and Swinton, 2003; Ngowi and Partanen, 2002; Rother, 2000, 2008).Understanding of the health hazards of relevant pesticides, use protective equipment properly, practice personal hygiene measures, becoming familiar with and adopt proper work practices, recognizing early symptoms of overexposure to pesticides, and obtaining first aid at the earliest time possible, are very crucial in the practices towards pesticides. The WHO has recommended the use of pesticides only by trained people (WHO, 1991). For most pesticides, using protective measures results in a decrease of exposure to pesticides. Similar reductions are seen for farm workers using gloves compared to those not using gloves (Woodruff *et al*., 1994). The use of protective measures could contribute to decreasing the health effects of pesticides. Also, this would lead, as expected, to a decrease in poisoning prevalence parallel to the reduction in exposure. Among Chinese farm workers, a safety educational program decreased the prevalence of pesticide poisoning from 1.05% to 0.25% (Chen, 1998).

Knowing the types/names of the pesticides frequently used could also be an indication of good practices towards pesticides. In the Gaza strip, a study revealed that farmers and farm workers know the names of the pesticides used (Zyoud *et al.,* 2010). They found that the most common insecticides were organophosphates, carbamates, pyrethroids, and organochlorines. Other types of agricultural pesticides used included fungicides and fumigants.

Re-entering the sprayed field should normaly be after 12 hours after applying pesticides. Also, keeping first aid equipment, and participation in seminars, training, and other activities related to the hazards of pesticides and their effects on human health, are very important in the practices towards agrochemicals to ensure adequate safety measure.

Organisations like Environmental Protection Agency, Research Institutes, NAFDAC, Ministry of Agriculture, ADPs, chemical distributors/agencies are in position to conduct seminars and training for farmers on regular basis. This study intends to find out the actual situation in Nigeria.

This study will not differentiate between the seriousness of the intoxications experienced within certain periods or with certain types of pesticides as this is beyond the scope of the study. The possible symptoms experienced by the farmers might, in some of the cases, have been due to causes other than pesticide exposure. Also, this study will not assess treatment for these normally less serious intoxications with symptoms lasting for hours to days.

2.4 Factors Influencing Farmers' Adoption ofRAPs

The decision to adopt recommended practices in the use of agrochemicals will be influenced by several factors which would be useful to policy-making. Namwata*et al.*(2010) reported that increased household income, sex, marital status, increased farming experience, access to credit and extension services were positively and significantly associated with overall adoption of improved agricultural technologies among farmers in Tanzania. The decision to adopt organic farming is influenced more by environmental and ideological reasons than economic ones (Theocharopoulos *et al.*, 2012).

However, the adoption of agrochemicals is positively associated with: being literate, older than 40 years of age, having higher income from sales, living in villages distant to

Accra (capital of Ghana), having access to hi-tech machinery, being migrant, and being linked to extension services and financial institutions. Contrary to expectation, a farmer's sex and association with farmer-based organizations (FBO) and non-governmental organizations (NGO) did not make a difference (Egyir *et al.*, 2011). The results of a logit regression analysis to determine factors influencing adoption of organic farming (OF) in Bangladesh showed that perceptions of OF, household access to extension services, number of family labourers and household income were significantly associated with decisions to adopt OF (Sarker *et al.,* 2010).

Access to credit and extension advisory services, high level of education as well as membership of agricultural associations were the determinants of improved agricultural technology adoption in Mozambique (Uaiene *et al.*, 2009).In a study to identify factors that may explain differences in adoption between poor (small) and larger farmers, Robert (1999) found that education, farm size, and frequency of contacts with extension staff were statistically significant (at alpha=10%) for poor farmers, but not for richer farmers. High income was the major factor influencing farmers to adopt soil conserving measures. The predicted probability of pesticide use was however, very low for both groups of farmers.

Zhou *et al.* (2010) found many subjective factors to have great significance in determining famers' decisions on the intensity of fertilizer use. Such subjective factors are irrigation, gains in crop yield and higher earning goals. But, farm size, manure application, soil fertility and the distance to fertilizer markets did not affect farmers' decision. The decision to overuse fertilizer was a function of low education.Results revealed that crop farmers' education level, family size, farming experience, availability of market, and frequency of contacting extension officers significantly influenced the adoption of sunflower farming innovations. However, sex, age and marital status of respondents did not significantly influence the adoption of the innovations.

Farmers' training and knowledge help in proper use of pesticides (Mariyono and Bhattarai, 2010). The study also found that increased price has positive impact on the level of pesticides used by an average chili farmer. Likewise, relative impact of education, farming experience, and area cultivated has moderate impact on level of pesticides use. As a farmer becomes more experienced in chili cultivation, or more educated, the farmer is expected to reduce the level of pesticide use. Area of improved cowpea cultivated, yield, market price of seed, use of pesticides and threshing quality were found to influence farmers' decision to transfer improved cowpea variety (Kormawa*et al.*, 2001).Also, age, sex, household size, farm size, perceived price of fertilizer, value of farm output, extension agent visit, number of goats and sheep owned by farmers, and decision to own poultry by farmers as well as the distance to fertilizer selling point are significant factors affecting fertilizer use intensity among arable crop farmers in Abak agricultural zone in Akwa Ibom State.

Sex, age, farm income, marital status and years of farming experience have positive influence on the adoption of agrochemicals in a study carried out in Kwali area of Abuja, Nigeria. Similarly, result of the probit model analysis on adoption of IPM in Delta State revealed that marital status, household size, involvement of every household member were the significant demographic factors influencing the use of the innovation.

2.5 Consequences of Non-adoption of RAPs

2.5.1 Risks to human health

A particular pesticide will have an adverse impact on human health when the degree of exposure exceeds the levels considered to be safe. There can be direct exposure to pesticides (by the industrial workers who produce pesticides and the operators – in particular farmers – who use them). There can also be indirect exposure (by consumers, residents and bystanders) in particular while or after pesticides are used in agriculture, landscaping, and on sports grounds, and for public building maintenance, road and railway side weed control, lawn care, and other activities.

According to a survey carried out by the European Federation of Agricultural Workers' Unions (EAF), the most common adverse effects of pesticides on workers and operators include acute headaches, vomiting, stomach-aches, and diarrhoea. They occur through exposure during the application, preparation or mixing of pesticides, and the handling of containers. Low but constant exposure levels may lead to long-term and chronic health impairment (e.g. cancer, birth defects, reproductive problems, sensitisation). More often than not, people do not realise the connection between exposure to pesticides and the disease. This is because there are no obvious symptoms of poisoning immediately following exposure. Residents and bystanders can be indirectly exposed to pesticides as a result of spray drift. So can consumers, through residual amounts in agricultural products or water. The consequences can be worse for highly vulnerable population groups, such as children (who are particularly sensitive to suspected 'cocktail effects'), the elderly, or other particular risk groups (immunologically compromised people, the chronically sick, etc.), and of course workers (because they may suffer intensive exposure). Exposure to pesticides exceeding safe levels is generally due to a lack of knowledge and awareness of the risks which the use of pesticides entails and of how to reduce them.According to Dugje *et al.*(2008), many farmers and extension agents lack the technical skills for proper and effective use of pesticides. This has had many unfortunate consequences, including human and livestock exposure to pesticide poisoning, crop injuries, soil degradation, and environmental pollution. Many accidents, and even deaths, have occurred due to improper use of pesticides.

2.5.2 Risks to the environment

Through misuse of pesticides, including overuse, chemical substances may end up contaminating water, air and soil, with adverse effects on plants and wildlife, and a loss of biodiversity in general (although the latter is also influenced by a number of other factors). In particular, plant protection products released into the environment in an uncontrolled way by spray drift, leaching or run-off may pollute soil, surface water and ground water (Konradsen*et al.*, 2003). Environmental contamination can also occur during and after application, when cleaning equipment, or through the uncontrolled illegal disposal of pesticides or of their containers (point sources).

According to the European water suppliers' organization (Butterfield*et al.*, 2000), pesticide contamination of raw water is very severe in lowland rivers. Indeed, a high proportion of contamination exceeds the 0.1 μg/l threshold value, in which case the water must be treated to remove the pesticides in excess before it can be distributed as drinking water. The potential contamination of surface water and ground water requires constant monitoring and high scrutiny in the regulatory process, because contamination and remediation take place over a long period of time.Indiscriminate use of pesticides could cause ecological imbalances that could exacerbate, rather than alleviate, a pest problem. This background underscores the need for effective and broad-based policy on the safe use of agrochemicals.

All pesticides need to be evaluated and authorised before they can be placed on the market. The *Common Agricultural Policy* (CAP) (in Europe) was in place since the mid-1980s, with reforms in 1992. This policy has had an enormous impact on agricultural production methods. A study carried out in 1998 suggested that 20% of changes in the use of plant protection products may be attributed to the effects of the CAP. This percentage may be higher in sectors which rely heavily on pesticides and large CAP payments, such as cotton or tobacco (Oppenheimer and Donnelly, 1998).

There are different types of policies in place that significantly affect pesticide usage in the major crops. Such, according to Agne *et al.* (1995) may include pricing, trade and input, regulation, and research, education and extension policies. There is a need for assessing the possibility of modifying or even eliminating the policies that distort pesticide pricing and utilization to levels that are substantially different from the socially optimal levels.

Policies banning the use of some hazardous pesticides had been enacted by the Fertilizer and Pesticide Authority (FPA) of the Philippines in the early 1980s. In 1989, the Ramos administration began developing the pesticide policy package (PPP), which was implemented between 1992 and 1996. The PPP was a multi-pronged approach to the safe and effective use of pesticides that directly targeted:

- The use of highly toxic insecticides in rice growing

- Regulatory policies and implementing guidelines on the importation, formulation, distribution, sale, and use of pesticides
- The illegal smuggling of pesticides
- Regulation on the labeling and advertising of pesticides
- Hazard awareness, through an agro-medical training program
- Improved product stewardship, undertaken jointly by the pesticide industry and the government.

In spite of the upsurge in the use of pesticides in Nigerian agriculture, there has been little or no awareness among the users on the hazard to the environment. Information on their use, distribution and environmental impacts is scanty in Nigeria. Until the recent publication of the "Guidelines and Standards for Environmental Pollution Control in Nigeria" (1991) by the Federal Environmental Protection Agency (FEPA), there had been no government regulation or control of the use of pesticides and other toxic chemicals in the country.

2.6Farmers' Constraints to Adoption of RAPs

Pingali and Gerpacio (1997) noted that a large proportion of the pesticides exported to the developing countries consists of products that are no longer used in the developed countries on experimental and health grounds. Weir and Shapiro (1981), for instance, pointed out that at least 25% of US pesticide exports are products that are banned, heavily restricted, or have never been registered for use in the United States. Warburton, Palis, and Pingali (1997) also reported that the vast majority of insecticides used in developing Asian countries were classified as highly hazardous category I and II chemicals by the World Health Organization and that many of them have been banned for agricultural use in most developed countries. These insecticides include the organochlorine, endosulfan; organophosphates, such as methyl parathion, monocrotophos, and chlorpyrifos; carbamates, such as BPMC, carbaryl, and carbofuran; and pyrethroids such as cypermethrin and deltamethrin. However, these chemicals continue to be widely used in tropical Asia, either because of ignorance or substantially lower costs compared to safer alternatives.

In Nigeria, the high incidence of pesticide failure due to adulteration and poor handling of pesticides with attendant decrease in crop yield has been the bane of crop farming throughout the country (National Agricultural Extension and Research Liaison Services [NAERLS] and National Programme on Agriculture and Food Security[NPAFS], 2011). Farmers are faced with many constraints in using agrochemicals. According to FAO (1998);Asogwa and Dango (2009); and Issa*et al.* (2011) such constraints bother on personal, technical and institutional problems.

The use of pesticides for effective pests control has generated a lot of concerns relating to public health and environmental pollution (Asogwa and Dongo, 2009). It has been estimated that about 125,000 - 130,000 metric tons of pesticides are applied every year in Nigeria. There have been reports of high incidence of mismanagement of equipment by cocoa farmers such as incorrect handling, leaving formulated pesticides in the sprayer overnight etc. The farmers also occasionally damage nozzles by enlarging the hole to increase the discharge rate. The lack of maintenance of pesticide application equipment is as a result of lack of spare parts (due to unavailability and unaffordability) and specialized mechanics to repair and maintain the equipment. Most farmers are not literate, hence they indulge in serious malpractices in pesticide application such as; wrong use of nozzles, mixing together of different classes of pesticides, unable to distinguish one pest from the other, use of wrong formulations and doses, wrong timing of application and lack of knowledge on the time needed for degradation of pesticides (Asogwa, 2006, 2008).

A major constraint to good pest management in Nigeria is that of inconsistent pesticide availability (FAO, 1998). Due to limited infrastructure and inefficient supply chain, pesticides are not present when needed, thus defeating one of its most significant advantages, that of rapid effectiveness during sudden pest population increases. There are also serious cases of fake, adulterated and banned pesticides still being sold in the local markets (Victor, 2008; Auwal-Ahmad and Awoyale, 2008). Asogwa and Dango (2009), in a study on problems associated with pesticide usage and application in Nigerian cocoa production, found that majority of the Nigerian cocoa farmers still make use of substandard and inappropriate spraying pumps such as the ‘Lancet’. However, even in cases where they use recommended pumps, little attention was paid to the use of appropriate (cone/fan) jets and extension lances. Most of the trees are not covered adequately by the pesticides, the target pests are missed or partially attacked, resulting in the gradual emergence of resistant biotypes and/or strains (Idowu, 1989).

Lack of safety precautions causes contaminations and poisoning in the field. Unfortunately, investments in protective clothing, masks or gloves only pay back in terms of health and well-being, not in financial terms. Most farmers are ignorant of the hazardous effects of pesticides and are very unlikely to buy protective clothing, especially in cases where they are scarce. In Nigeria generally, farmers do not wear any protective materials at all, no matter what pesticide is being applied (Meijden, 1998). Other precautionary measures are scarcely observed by these farmers as they are found eating, smoking or drinking in-between spraying activities. The left over pesticides and empty containers are not properly disposed as the containers are sometimes washed and used for domestic purposes.

Sprayer calibration is usually proposed and taught in research and training institutions, but is hardly ever done in practice, which usually results in the use of wrong dosage of pesticides. Calibration of sprayers is very essential even when they are in perfect working conditions. The spraying of maize farms with overdose of pesticides will result in farmers incurring huge financial losses due to wastage and phytotoxicity, which will decrease the yield. However, the major risk of overdose or underdose is the increased likelihood for the pests to develop resistance against pesticides, which can have devastating large-scale effects on crop production (Meijden, 1998).

There is evidence of poor pesticide education and misuse in Nigeria, for instance a situation where over dosage for the purpose of effecting rapid kill of crop pests is common among government trained, or agency trained and assisted small-scale farmers (Ivbijaro, 1998). It has also been noticed that these farmers sometimes use these pesticides for purposes other than that for which they are manufactured. Some stunning revelations of pesticide misuse have been reported by some scientists (Ivbijaro, 1977; Youdeowei, 1989; Ivbijaro, 1990, 1998) as follows: (i) Lindane formerly used for the control of cocoa mirids is poured into rivers, lakes and streams to kill fish, which is then sold for human consumption. (ii) Spraying Gamalin 20 on drying cocoa beans to prevent moulds and maggot development. (iii) Careless disposal of expired pesticides and use of pesticide containers for domestic purposes.

In Nigeria, the pesticide regulatory role of the government is generally not carried out satisfactorily. The effective control of pesticides in the West-African sub-region generally remains poor and seriously hampered by several factors including lack of proper legislative authority; shortage of personnel in pesticide regulatory procedures, lack of infrastructure, transportation, equipment and materials, very low budgetary allocation of operating funds, lack of formulation control and pesticide residue analysis facilities and capabilities (Youdeowei, 1989).

2.7Agricultural Modernization and the Demand for Agrochemicals

In the developing world, agricultural modernization, which is meant to include agricultural intensification and increased market orientation, has spurred rapid growth in the demand for agrochemicals. The Green Revolution in cereal crop production, especially in Asia during the late 1960s and the 1970s, led to an upward shift in the demand for modern agricultural inputs, including pesticides (Edache, 1998). Although demand for pesticides as a whole grew very quickly, an examination of the trends for the chemical subgroups (insecticides, herbicides, and fungicides) indicates that there was substantial variation by country or region and by crop. Pingali (1997) have provided a stylized representation of the factors leading to regional differences in pesticide use, which is summarized here.

Agricultural intensification — the movement from an extensive to an intensive production system, or from a subsistence production system to a commercial one — has been extensively documented to have promoted increased use of agrochemicals. Increasing land scarcity and increasing market orientation have differential effects on the demand for chemicals. Consider first a sparsely populated subsistence society with limited access to markets. Agriculture in such societies is characterized by extensive land use and an almost complete reliance on non-traded inputs, such as farmyard manure. Pest pressure is low in such systems and is kept that way through a variety of management practices such as crop rotations and the use of traditional cultivars with known resistance to chronic pest problems.

Increasing land scarcity caused by population growth in subsistence societies leads to agricultural intensification — that is, increased intensity of land use (Boserup, 1965; Pingali and Binswanger, 1987). Where the opportunity costs of family labor are low, food production continues to rely predominantly on nontraded inputs. Pest pressure increases with intensification as pests are carried over both spatially and temporally. Although increased weed pressure is handled by family labor, increased insect pressure is no longer amenable to traditional management practices, and small amounts of insecticides begin to be used for cereal crops, even in subsistence societies. Low to moderate amounts of fungicides also tend to be used on such crops as cotton, tobacco, and horticultural products, especially fruits and vegetables.

The contrasting scenario is one of a sparsely populated area that has excellent access to markets. In this case, agricultural intensification will be high because of high land values, but unlike the subsistence case, the opportunity cost of labor will also be high: hence the high levels of traded input use. Even though increasing insect pressure can be controlled through appropriate crop rotations and seasonal fallows, the dominant constraint is weeds, and high levels of herbicide use are the norm in such societies. High use of fungicides can also be observed for horticultural crops, especially fruits and vegetables. Where market access and land scarcity are both high, high opportunity costs of land and labor result in agricultural intensification with a high use of traded inputs. The demand for all chemicals is high in such societies.

It is also recognized that pesticide use was further aggravated by modern cereal crop production systems. Intensive monoculture systems using high yielding varieties of cereal crops resulted in an environment conducive to pest buildup and infestation, and the consequent use of pesticides disrupted the natural pest-predator balance. The risk of insect and disease-related losses increased because early modern varieties were often highly susceptible to local pests and because crop heterogeneity was lost. Regular prophylactic pesticide application promoted by extension services and supported by government subsidies became a standard part of the early Green Revolution package.

CHAPTER THREE

THEORETICAL FRAMEWORK

3.1 Introduction

A research is normally hinged on relevant theories and a conceptual framework in order to give it a solid foundation and focus of analysis. With this background, the theoretical/intellectual foundations of this study are the expectancy theory, theory of adoption behavior, and health belief model.

3.2 Expectancy Theory

The expectancy theory, especially as explained by Ejiogu (1992), regards man as a rational being who chooses at any given point in time from a set of alternative plans of behavior the one he expects will maximize the attractiveness of the sum of outcomes that would result. The theory is an attempt to explain an individual's perception of the relationships between behavior and its antecedents or consequences.Ejiogu (1992) pointed out that "perception" (the process by which individuals attach meaning to their experiences) is the keyword in any discussion on expectancy theory. That is because although there, indeed, maybe a perfect contingency relationship between performance and desired consequences, unless the person perceives this relationship, it will not positively influence the person's motivation to act (adopt a particular recommended practice such as usage of agrochemical) in a way. Two types of expectancies have been formulated by Ejiogu (1992):

i. Expectancy I: Effort-Performance expectancy. This refers to a person's perception of a chance that a given level of effort will bring about a better result (e.g. crop yield resulting from the use of agrochemicals).

ii. Expectancy II: Performance-Consequence expectancy. This refers to a person's perception of the probability that a certain level of job performance (adoption of recommended agrochemical practices) will lead to certain consequence (e.g. eradication of pests and diseases).

Lawler (1973) later summarized the main issues of expectancy theory thus:

"The strength of a tendency to act in a certain way depends on the strength of an expectancy that the act will be followed by a given consequence (or outcome/result) and on the value of attractiveness of that consequence (or outcome) to the actor".

3.2.1 Basic assumptions of the expectancy theory

Cameron (1973) itemized four basic assumptions on which the theory rests thus:

(a) that people do have preferences among the various outcomes that they see as possible;

(b) that people have expectancies about the likelihood that an action or effort on their part will lead to the behavior or performance that they intend it to;

(c) that people have expectancies about the likelihood that certain outcomes will follow their behavior, and

(d) that people do not behave at random.

Importantly, the expectancy theory aims at explaining what determines the behavior that the person adopts in order to achieve some outcomes sought by individuals.A crucial question which the expectancy theory is designed to answer therefore, concerns the factors which influence the choice of a particular line of action by a person. Ryan and Smith (1962) thought that 'an individual will not undertake an activity unless he sees at least some chance of arriving at the goal'. His perceived ability is, therefore, an important determiner of his choice.

Concisely, the proposition of the expectancy theory is that people, whether in work organizations or in ordinary life situations, will tend to do a thing the more they think that such performance will lead to results which they want. It however, admits the possibility of individuals having varying goals or need, and of perceiving different connections between their actions and achievements of these goals.

3.3 Theory of Adoption Behavior

There is an extensive body of literature on the economic theory of technology adoption. Adoption theories in extension became necessary because economic models only focus on interest and profit maximization. Also, economic models fail to conceptualize the social dimensions of knowledge, information, communication and rationality (Leeuwis, 2003). Furthermore, economic models have limited ability to explain decision and to capture complexity of farmers' attitudes and behavior. Hence, adoption theories try to fill these gaps.

The understanding of the driving forces of adoption is important for the appreciation of recommended agrochemical practices because the effectiveness of the recommendations will depend on where, when and how they are used (Stoneman and David, 1986). For many years, there were separate adoption theories in education, sociology, anthropology, medicine, extension and rural sociology. Much of it was based on “contagion” theory, which associated the probability of adoption with the proximity of a prior adopter. Griliches (1957), in his path-breaking work on hybrid corn, showed that profitability was the largest determinant of adoption. Rogers (1983) agreed that the attributes of the technology were important, but that profitability was only one component. He stated that the “five attributes of innovations are (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability” (Rogers, 1983). Profitability in its narrowest sense is only a factor within the first category. However, the other categories can all represent ‘costs’ to a potential adopter because they encompass new information and adjustments that must be made.

The adoption of technology for natural resource management and conservation, such as soil conservation, integrated pest management, soil nutrient testing, and irrigation management, are considered apart from the use of conventional inputs such as agricultural fertilizers and chemicals. While decisions on the amount of conventional inputs to apply are made on a seasonal or annual basis, the adoption of new technology represents a significant shift in a farmer’s production strategy. The decision to adopt new technology is analogous to an investment decision. The decision may involve substantial initial fixed costs, while the benefits accrue over time. The initial costs may include the purchase of new equipment and of learning the best techniques for managing the technology on the farm. A producer may perceive the nonmonetary costs of change to be very high and this may shapen the way he adopts the technology.

An individual's assessment of the new technology is subjective and may change over time as the individual learns more about the technology from neighbors who have already adopted it, the extension service, the media or any other source. When a technology first becomes available, uncertainty about its performance under local conditions is often high. Significant adaptation of the technology may be necessary before it performs well in the local production environment. Over time, as some farmers in an area adopt and gain experience with the new technology, the uncertainty and cost of adoption fall. Some farmers may fail to adopt the technology altogether if they determine that it simply does not perform well under their resource conditions, or if the size or type of their farm operation is not suited to the technology in question (Griliches, 1957).

A new technology or innovation will change the marginal rate of substitution between inputs in a production process. Some changes may be perceived as large by a potential adopter. Early studies of adoption were based on the assumption that people were resistant to change and that resistance had to be overcome (Nowak, 1992). There is a distinct difference, however, between a farmer who is unable to adopt versus one who is unwilling to adopt. Nowak (1992) summarized these two types of barriers to adoption:

(a) Inability to adopt:(1) Information lacking or scarce; (2) Costs of obtaining information too high; (3) Complexity of the system too great; (4) Too expensive; (5) Labor requirements excessive; (6) Planning horizon too short (benefits too far in the future); (7) Limited availability and accessibility of supporting resources; (8) Inadequate managerial skill; and (9) Little or no control over the adoption decision.

(b) Unwillingness to adopt:(1) Information conflicts or inconsistency; (2) Poor applicability and relevance of information; (3) Conflicts between current production goals and the new technology; (4) Ignorance on the part of the farmer or promoter of the technology; (5) Inappropriate for the physical setting; (6) Increased risk of negative outcomes; and (7) Belief in traditional practices.

Many of the distinctions made between inability and unwillingness to adopt are however based on relative judgments (i.e., too high, too short, inadequate) and would be difficult to test empirically. Another way to differentiate non-adopters is to characterize them as (1) those for whom adoption would not be more profitable than continuing with current practices, and (2) those for whom adoption would be more profitable but who choose not to switch technologies due to other barriers. Policies designed to encourage adoption would need to be targeted differently for these two groups. Many of the conservation or chemical-reducing technologies included in the Area Studies analysis can be classed as 'preventive innovations' in that they facilitate the adopter's avoiding some unwanted future event such as groundwater contamination or loss of productive soils. As Rogers (1983) points out, preventive innovations have a low rate of adoption because it is hard to demonstrate the advantages of adoption since those benefits occur only at some future, unknown time. Pample and van Es (1977) distinguished between practices designed to protect natural resources and those designed primarily to increase farm profits. They conclude that the 'means and goals of the two types of practices appear sufficiently different to possibly result in different adoption behaviors.'

The current economic theory of adoption is based on the assumption that the potential adopter makes a choice based on the maximization of expected utility subject to prices, policies, personal characteristics, and natural resource assets. A discrete choice of technology is made that leads to a level of input use and profit gained.If the benefits associated with the use of a conservation technology accrue primarily beyond the farm, producers would not be expected to include those benefits in their decision to adopt the technology. Many of the recommended practices are designed to reduce off-site environmental impacts rather than to increase on-site productivity. The total benefits of switching to these technologies may outweigh the costs by a large margin, but if those gains are not realized by the farmer who bears the costs, the voluntary adoption of preferred technologies may not occur.

Since neither farms nor farmers are identical, there will be differences in whether a particular technology is adopted and when. Farmers will differ in their ability to understand and adapt to innovative methods, and in the quality of the land they control. The farmer is aware of these factors and uses that knowledge to assess the expected gain of adoption. The distribution of the underlying heterogeneous factors will determine the pattern of practice adoption. When one of the heterogeneous factors is associated with natural resource characteristics, the adoption pattern can be defined spatially.

The effectiveness of policies designed to improve crop production through promoting the use of agrochemicals and management strategies will depend on an understanding of how farmers choose their production practices as well as the understanding of the recommended practices. The theory of behavior modification (Albrecht *et al.*, 1989) is more relevant to drive home the conceptual framework of this study. Albrecht *et al.* (1989) postulated that change in behavior is a result of the interaction between driving forces and inhibiting forces. This can be mathematically expressed as:CB = DF – IFWhere:

CB = Change in Behavior;

DF = Driving Forces; and

IF = Inhibiting Forces.

Inhibiting forces are those forces/factors negatively influencing behavioural change e.g. limited liquidity for buying herbicide, lack of spraying equipment, limited knowledge etc while driving forces are factors conducive to positive target (adoption) e.g. training, extension visit, input availability, provision of subsidies etc. Moreover, the theory sees behavior (adoption) as resulting from the psychological field of inhibiting and driving forces. Hence, these forces are present in a state of equilibrium or dis-equilibrium with varying degree of tension between them. Once such forces are identified in the farmers' decision making process, the chances of diffusion can be estimated and consequences for promotion programs can be concluded (Kriesemer and Grötz 2008).

3.3.1 Relevance of adoption behaviour theory to this study

The importance of this theory is that it recognizes the barriers of different dimensions (social, economic, policy, technological, institutional, cultural, and personal) to adoption of innovation by farmers. It also considers the element of time in the position of equilibrium or dis-equilibrium achieved while the inhibiting and driving forces interact. However, the theory failed to recognize that the interaction amongst the three phases of interaction (i.

disturbance of the former equilibrium, ii. Shift to new equilibrium and iii. Stabilization of modified behavior) will not necessarily remain stable especially depending on the technology and the environment in question. Also, the theory assumes that driving forces will always be greater than the inhibiting forces thus assuming a perfect society where all things are functioning normally.

Importantly, the theory provided a basis for testing if the variables in this study are relevant in the transfer and adoption of recommended agrochemical practices by farmers in the study area.

3.4 Health Belief Model

The Health Belief Model (HBM) was first developed in the 1950s by social psychologists Godfrey Hochbaum, Irwin Rosenstock, and Stephen Kegels working in the U.S. Public Health Services. The model was developed in response to the failure of a free tuberculosis (TB) health screening program. It was developed to explain why so few people were participating in programs to prevent and detect the disease. The HBM is a conceptual framework used to understand health behaviors and the possible reasons for non-compliance with recommended health actions (Becker and Rosenstock, 1984). HBM is a good model for addressing problem behaviors that evoke health concerns (Croyle, 2005). The model was first presented with only four key concepts: Perceived Susceptibility, Perceived Severity, Perceived Benefits, and Perceived Barriers. The concept of Cues for Action was added later to "stimulate behavior." Finally, in 1988, the concept of Self-Efficacy was added to address the challenges of habitual unhealthy behaviors such as smoking and overeating.

The HBM can provide guidelines for programme development allowing partners to understand and address reasons for non-compliance with recommended health actions. Such reasons include perceived barrier of recommended health actions, perceived benefits of recommended health actions, perceived susceptibility of the disease, and perceived severity of the disease. In addition, there are modifying factors (also referred to as cues for action) that can affect behavior compliance. Modifying factors will include media, extension agency and/or professionals, personal relationships, incentives (such as regular training), and self-efficacy of the recommended health action.

The health belief model proposes that a person's health-related behavior depends on the person's perception of four critical areas: (i) the severity of a potential illness, (ii) the person's susceptibility to that illness, (iii) the benefits of taking a preventive action, and (iv) the barriers to taking that action. The model postulates that health-seeking behaviour is influenced by a person's perception of a threat posed by a health problem and the value associated with actions aimed at reducing the threat.HBM addresses the relationship between a person's beliefs and behaviors. It provides a way to understanding and predicting how clients will behave in relation to their health and how they will comply with health care therapies.

Farmers use pesticides to protect their crops from pests which in-turn helps them to maximize agricultural output on limited acres of land. However, the extensive use of such pesticide results in substantial health and environmental threats. According to WHO (1990), pesticide's use causes 3.5 to 5 million acute poisonings a year. Rough estimates show 20,000 workers dying from exposure every year and most of them from developing countries.

Available literature shows that the health and environmental hazards of pesticide use occur due to lack of information, awareness and knowledge which are chief contributing factors of extensive overuse or misuse of hazardous pesticides and dangerous practices (Forget, 1991). Research has also shown that the health and environmental hazards of pesticides can be avoided by awareness, education and changing farmers' attitude and behavior regarding pesticide use (Dasgupta and Meisner, 2005). Therefore, the first step in developing pesticide's health and environmental hazard reduction policy is to set up the extent of the problem by investigating farmers' attitudes and behaviors regarding pesticide use (Koh and Jeyaratnam, 1996; Dasgupta and Meisner, 2005; Dasgupta *et al.*, 2005). Such information is critical to identifing the prospects and constraints to the adoption of alternative crop protection policy (Ajayi, 2000).

According to the classical microeconomic consumer theory, individuals make choices following their preferences. However, the classical microeconomic models of consumer behavior are poor in explaining and predicting consumer behavior and do not focus on the processes of individual's reasoning behind choices. An obvious shortcoming of the microeconomic models is that they do not consider psychological, sociological, and other (non-economic) factors that guide consumer behavior (Huang, 1993).

Theories of cognitive psychology show that at personal level people develop risk understandings through two interacting systems: a cognitive analytic system and an intuitive experiential system. Experiential information is more meaningful to change behavior than abstract information (Severtson, 2006). According to Leventhal *et al.* (1983), experiences drive most of the risk perceptions and outcomes. One of the factors that affect whether or not farmers adopt environmentally sound behavior of pesticide use is, ‘whether or not they have experienced a personal health effect’ (Lichtenberg and Zimmerman, 1999). As health psychology literature says, most of our knowledge in our lives comes from actual personally relevant experiences rather than from intellectual exercises. Williamson (2003), in the context of farmer field schools says that it has been found that adults learn best from experience; firsthand knowledge is superior to information received from others. Communication researchers recommend applying behavioral theory to understand psychological processes that explain the relationship between experience and behavior (Severtson, 2006).The health belief model provides a framework for understanding the effect of experience on perception and outcomes. This study therefore combines an approach from social psychology with new classical theory to illustrate individual reasoning behind their decisions (Pouta, 2003).

The rapid increase in pesticide use has caused a huge cost in terms of human health and environment. Azeem *et al.* (2002) estimated that the environmental and social cost of pesticide use in nine major cotton growing districts in Punjab is 11,941 million Pak-rupees per year. While estimating the health and environmental cost; they reported that about 1.08 million persons were subjected to pesticide associated sickness, among those 24,000 persons were hospitalized because of serious illness and about 271 fatalities happened in these districts. In another study, Hassan (1994) reported that 22 out of 25 blood samples of farmers were found contaminated with pesticide residues in Multan division. In addition to health effects, many studies (e.g. Iqbal *et al.*, 1997; Hasnain, 1999; Azeem *et al.*, 2002) have noted that indiscriminate use of pesticide has resulted in development of resistance in pests against the pesticide which ultimately leads to increase in their population. Due to extensive use of pesticide, the flora and fauna have been destroyed causing imbalance in agro-ecosystem and biodiversity (Iqbal *et al.*, 1997). Studies have also noted that in cotton growing areas of the country, the population of natural enemy pests has declined substantially (Hasnain, 1999).

There are several limitations of the HBM which limit its utility in public health. The limitations of the model include the following:

- It does not account for a person's attitudes, beliefs, or other individual determinants that dictate a person's acceptance of a health behavior.
- It does not take into account behaviors that are performed for non-health related reasons such as social acceptability.
- It does not account for environmental or economic factors that may prohibit or promote the recommended action.
- It assumes that everyone has access to equal amounts of information on the illness or disease.
- It assumes that cues to action are widely prevalent in encouraging people to act and that "health" actions are the main goal in the decision-making process.

The Health Belief Model is a simultaneous process used to encourage healthy behavior among individuals who put themselves at risk of developing negative health outcomes. A person must evaluate their perceptions of susceptibility and severity of developing a disease. Then it is necessary to feel threatened by these perceptions. Lastly, the benefits to change must be weighed against the barriers to change behavior in order to determine that taking action will be worthwhile.

3.4.1 Relevance of Health Belief Theory to this study

Despite the limitations of this theory, the HBM provides guidelines for researchers to understand the reasons for non-compliance with recommended health actions inherent in the recommended agrochemical practices. Also, the health belief model helps to link farmers' pesticide-associated adverse health problems and risk perceptions to environmentally sound behavior of pesticide use.

3.5The Conceptual Model

With the above theoretical backgrounds in mind, a model for assessing the adoption of recommended agrochemical practices was developed using crop farmers in Nigeria as a focal point as shown in Figure 3.1.The model explained the factors influencing the level of adoption of recommended agrochemical practices by the cropfarmers in Nigeria. It has three major components.

The first component consists of the independent variables; that is, the socio-economic characteristics of the farmers, the technological attributes, and the institutional factorswhich are posited to affect the rate of adoption of RAPs.The second part consists of the dependent variables which are the recommended agrochemical practices.The third component comprises the consequences resulting from adoption of the RAPs. The desire is that, when recommendedagrochemical practices are properly adopted; safety will increase while incidence of agrochemical misuse/failure, and environmental hazards, will reduce. Thus, leading to change in yield, output, income and standard of living.

The various components of the model as shown in Figure 3.1 are related to one another and the directions of their relationship are shown by the arrows. The concomitant effect of all the independent variables enumerated above is therefore, a determinant of the outcome (increased yield and output, enhanced income, and improved living standard) ofadoption of RAPs incrop production which may be high, moderate or low.

The solid lines between the independent variables and the dependent variable indicate the concern of this study which is to determine the extent to which the independent variables (X) can predict/influence the dependent variable (Y). The dotted line between the dependent variable and the outcome indicates that this study did not measure the outcomes resulting from the interaction between the independent and dependent variables. The unidirectionality of both the solid and dotted lines clearly indicates the direction of relationship to be measured in this study.

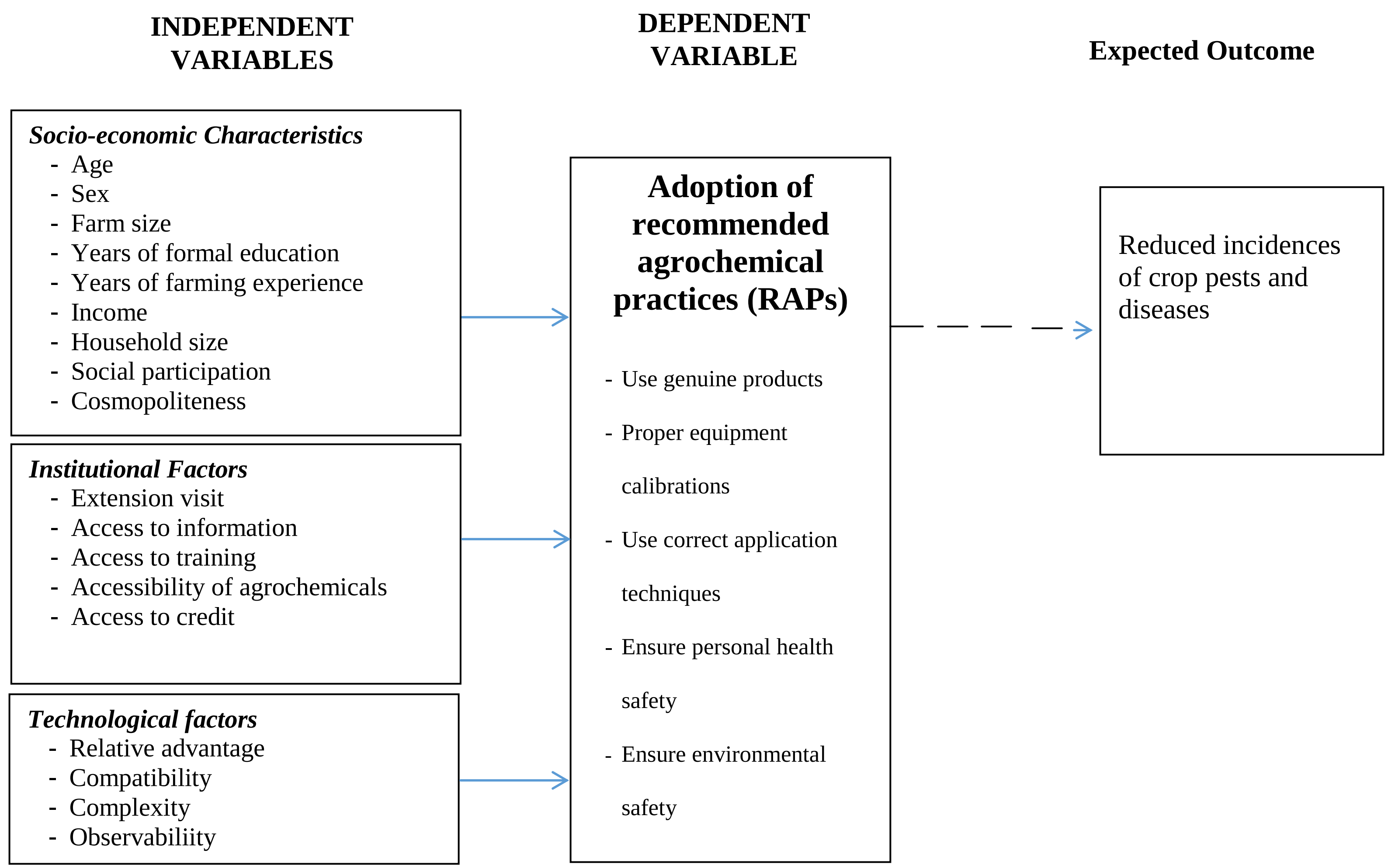

Figure 3.1: A model of factors influencing adoption of Recommended Agrochemical Practices among crop farmers and the expectedoutcome of adoption

CHAPTER FOUR

METHODOLOGY

4.1 The Study Area

Kaduna and Ondo States from Northern and Southern Nigeria, respectively were selected for this study. Both States have the highest record of use of agrochemicals in the different agro-ecology (NAERLS and NPAFS, 2011). Kaduna State lies between longitude 06′00 and 09′10′East of the Greenwich Meridian between and latitudes $09^0$00 and $11^0$30 North of the Equator. Occupying an area of approximately 48,473.2 square kilometers (FOS, 2006), Kaduna State shares common borders with Kano and Katsina States to the north; Bauchi and Plateau States to the north-east; the Federal Capital Territory and Nasarawa State to the south; and Niger and Zamfara States to the south-west. Apart from six major ethnic groups found in the State, there are over twenty other ethnic minority groups, each with its language and arts or religion different from the other. Agriculture accounts for an estimated 56 percent of Kaduna's GDP and employs approximately 4 million people.

Kaduna State (created in 27^{th} May, 1967) has 23 Local Government Areas and its population was put at 6, 066, 526 people (National population Commission [NPC], 2006) and had a projected population of 8, 007, 814 people in 2016 using an annual growth rate of 3.2%. The vegetation in the state is divided into northern guinea savannah in the northern part of state and southern guinea savannah in the southern part of the State. The State experiences both wet and dry seasons with the wet season commencing in the month of April in the southern part of the state and between May and June in the northern part of the state. Rainfall is heaviest in the southern part of the state and decreases northwards with mean annual rainfall varying between 942mm and 1000mm. the rainfall lasts from May to

October. The dry season sets in immediately after the rainy season and is characterized by the harmattan period with a temperature ranging from 18^0C to 26^0C and the hot period with a temperature that ranges from 32^0C to 39^0C.

The climate of the State favours the production of crops such as rice, maize, beans, sorghum, millet, cotton, yam, carrot, sugarcane, tomatoes, pepper, onions, garden egg-plant, lettuce, amaranthus and tobacco. Livestock reared in the State include sheep, goats, cattle, poultry and pigs.

Ondo State was created on 3 February 1976 from the former Western State. It originally included what is now Ekiti State, which was created in 1996. Akure is the State capital. OndoState lies between latitudes 5°45' and 7°52'N and longitudes 4°20' and 6° 05'E. Its land area is about 15,500 square kilometres. Ondo State is bounded to the east by Edo and Delta states, to the west by Ogun and Osun States, to thenorth by Ekiti and Kogi States and to the south by the Bight of Benin and the Atlantic Ocean. The State has 18 Local Government Areas and its population was put at 3, 460, 877 people (NPC, 2006) and had a projected population of 4, 568, 357 people in 2016 using an annual growth rate of 3.2%. The State is dominated by the Yoruba people who speak various dialects of the Yoruba language such as the Akoko, Akure, Apoi, Idanre, Ikale, Ilaje, Ondo and the Owo and a minority speaking the Ijaw Language. The people are mostly subsistence farmers, fishermen and traders. The people are lovers of arts, music and literature. In Nigeria, Ondo State tops the list in cocoa production (Moore 1980; Ogunlade and Aikpokpodion, 2010) which involves heavy use of fungicides for the control of fungal diseases.A wide range of fungicidesare available in the State (Olabode*et al.*, 2011).

The two States have markedly different agroecological conditions. This difference couldmake crop protection practices (as well as the type of agrochemicals used) to vary substantially in the two States. However, both States are noted for heavy use of agrochemicals. Most Nigerian rural residents are engaged in smallholder semi-subsistence agriculture (Ajibolade, 2005). Traditionally, Nigerian farmers have been relying heavily on pesticides for the control of various weeds, insect pests and diseases, leading to the high importation of these products and their prices have become so high that it is becoming impossible for local farmers to afford (Schwab *et al.*, 1995). The two (2) States that comprised the study area are depicted in Figure 4.1.

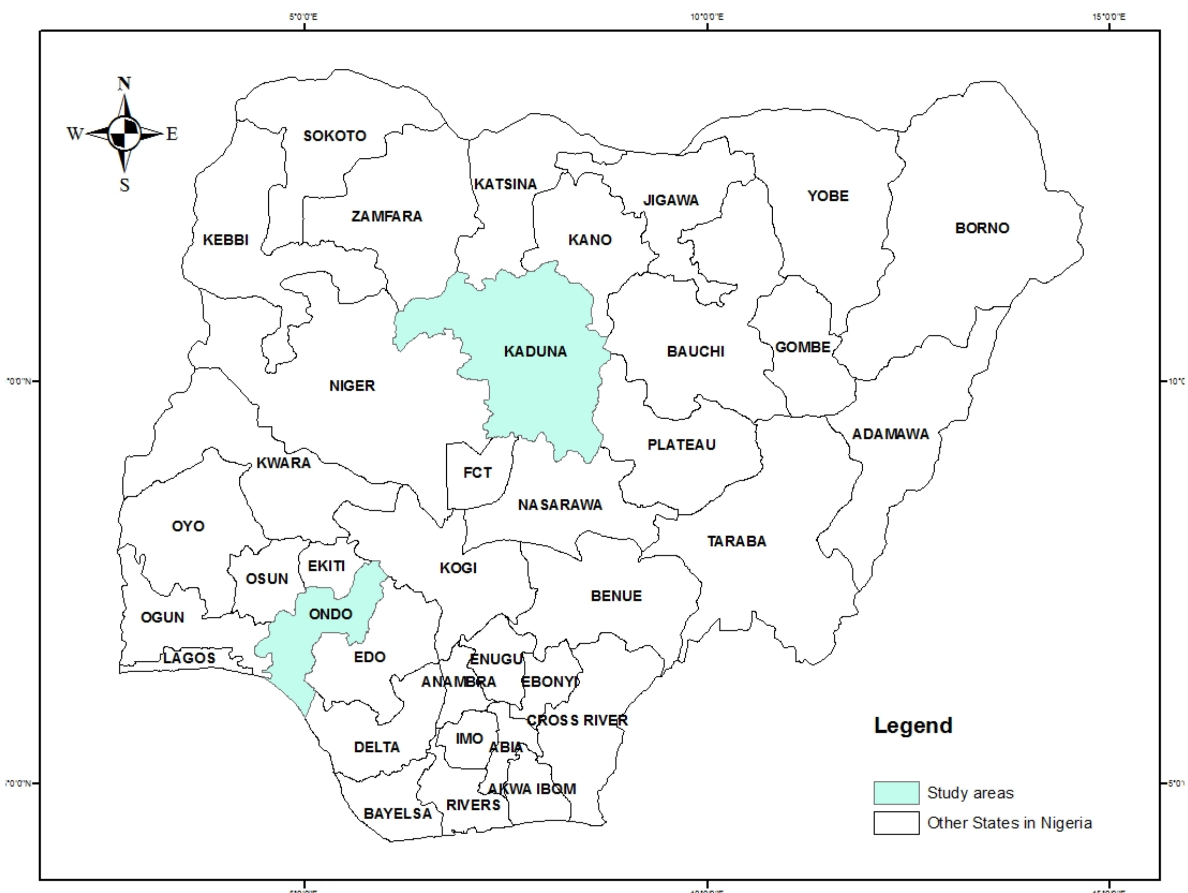

Figure 4.1: Map of Nigeria showing the study States

Statistics on agrochemicals procured by the two States and distributed to farmers for use between 2008 and 2014 indicated that an estimated 143,330 liters were used in Kaduna State while 308,053 liters were used in Ondo State. Agrochemical supplying companies operating in Ondo State include Saro Agro Science, FITSCO Nigeria Limited, INSIS Nigeria Limited, while Dizengof African Agro, Jubaili, and Saro were the major sources of agrochemical in Kaduna State.

Since 2008 to date, the pests and diseases of major crops in Kaduna State include rice blast, mango mealybug, brown leaf spot of citrus, maize borer, sorghum stem borer, cassava leaf blight, cocoyam leafblight, maize striga, rice blast, cowpea anthrachnose, cowpea aphids, and cowpea pod borer.Conversely, pests and diseases of major crops in Ondo State include aphids, birds, beetle, cotton stainer, grasscutter, stemborer, streak, leaf curl, and downy mildew.

Tables 4.1 presents the estimated land area cultivated to major cereals and tubers in Kaduna and Ondo States while the estimated crop production is presented in Table 4.2. An estimated 5,622,000 metric tonnes of maize was produced between 2007 and 2014 in Kaduna State while 3,286,000 metric tonnes was produced in Ondo State. For cassava (between 2007 and 2014), a total of 11,244,000 metric tonnes was produced in Kaduna State. In Ondo State, theproduction estimate for cassava was 18,894,000 metric tonnes.

Table 4.1: Land area cultivated of major cereals and tubers in Kaduna and Ondo States ('000 Ha)

Crops	**Years**																**Total**	
	2007		**2008**		**2009**		**2010**		**2011**		**2012**		**2013**		**2014**			
	K	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**
Sorghum	330.55	-	333.86	-	273.36	-	288.28	-	270.65	-	289.72	-	481.6	-	489.6	-	2,165.79	-
Maize	440.35	155.43	453.12	165.53	460.49	182.08	460.00	1037.10	379.26	238.80	398.80	238.80	686.6	556.8	729.7	586.8	3,732.62	2,248.53
Rice	132.86	22.40	134.19	29.22	143.52	36.90	149.75	363.40	170.59	51.05	171.98	52.85	294.9	148.9	329.4	159.0	1,075.73	612.35
Cassava	187.88	107.73	159.70	115.27	192.47	119.69	195.87	120.10	168.17	125.36	106.46	126.7	1725.7	2991.5	1725.7	2991.6	1,297.88	844.74
Cocoyam	3.32	23.34	3.35	25.67	-	36.69	3.98	34.55	2.80	41.34	2.98	41.82	24.4	297.5	24.8	297.5	19.7	246.45
Yam	180.01	128.01	180.10	140.81	97.10	130.63	95.35	131.02	258.91	133.22	258.70	133.96	1797.5	1227.1	1897.8	1327.3	1,138.79	942.19

Source: NAERLS Agricultural Performance Survey of Wet Season in Nigeria 2007 – 2014.

K = Kaduna, O = Ondo

Table 4.2: Production estimates of major cereals and tubers in Kaduna and Ondo States (‘000MT)

Crops	**Years**																**Total**	
	2007		**2008**		**2009**		**2010**		**2011**		**2012**		**2013**		**2014**			
	K	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**
Sorghum	472.27	-	424.27	-	441.87	-	-	-	484.31	-	-	-	487.4	-	398.7	-	2,310.12	0
Maize	966.29	295.91	1014.61	316.62	1027.79	373.58	190.08	524.41	770.68	553.09	792.61	556.22	860.6	666.8	413.9	102.1	6,036.56	3,388.7
Rice	356.63	41.67	350.10	53.58	364.17	55.29	30.26	60.74	360.67	106.06	361.06	107.68	342.2	159.3	185.2	59.6	2,165.09	584.3
Cassava	1863.3	2360.9	1583.8	2526.3	1907.6	2413.8	1951.2	2678.2	1725.6	2908.3	1725.6	2908.6	487.4	3098.6	197.4	189.2	11,441.9	19,084.0
Cocoyam	36.7	190.5	38.6	209.5	-	269.4	31.0	291.6	24.3	296.8	23.9	297.3	25.8	297.5	8.8	35.8	180.4	1852.6
Yam	1980.06	2000.7	1980.1	2000.9	999.6	2194.6	981.0	2253.8	723.3	2289.3	723.3	2289.3	1843.3	2389.3	281.0	154.2	9,230.7	1,5417.8

Source: NAERLS Agricultural Performance Survey of Wet Season in Nigeria 2007 – 2014.

K = Kaduna, O = Ondo

4.2 Sampling Procedure and Sample Size

This study focused on crop farmers who had been using agrochemicals for at least five years in Kaduna and Ondo States of Nigeria. The selections were based on high volume of crop production and prominent use of agrochemicals as reported by NAERLS and NPAFS (2011). A multi-stage sampling technique was employed in selecting the farmers(who were adopters of agrochemicals). Stages one and two involved purposive selection of two ADP Zones per State; and 2 Blocks per Zone, respectively. The purposive selection was based on the intensity of agrochemical use based on the record of the ADPs. The third stage involved purposive selection of two villages per Block. Lastly, the fourth stage involved using the list of farmers obtained from the reconnaissance survey (conducted between 2nd and 9th September, 2013) to randomly select 15% of the farmers from each of the eight villages (Table 4.3).In all, a total of 135 and 125 crop farmers were selectedfrom Kaduna and Ondo State, respectively aggregating to a total of 260 crop farmers. :

Table 4.3: Proportionate sample distribution of crop farmers

Study States	**Purposively Selected ADP agricultural Zones**	**Purposively Selected Blocks**	**Purposively selected villages**	**№ of crop farmers who have adopted the use of agrochemicals**	
				Actual	**Randomly Selected Farmers (15%)**
Kaduna	Birnin-Gwari	Kuyello	Tabanni	213	32
		Birnin-Gwari	Kakangi	227	34
	Maigana	Giwa	Kaya	241	36
		Kudan	Kauran-Wali	220	33
Ondo	Owo	Ikare	Ise	207	31
		Owo	Owo	220	33
	Ondo	Ondo West	Idanre	214	32
		Ile-Oluji	Farm Settlement	193	29
Total	**4**	**8**	**8**	**1732**	**260**

Source: Reconnaissance survey, 2013

4.3 Method of Data Collection

Primary data for this study were collected with the use of a structured interview schedulethat was administered on the farmers. Personal observation was also used. Secondary sources such as reports of ADPs, published materials like textbooks, journals, bulletins and extension guides as well as reports from relevant institutions among others were utilized mainly for the literature content. Internet materials were also used.The interview schedule was pretested for content validation. Farmers were visited to conduct on-the-spot interview. The data collection exercise was conducted between 26th August and 29th September, 2014. Trained enumerators were used for the data collection. All survey locations were geo-referenced by using the global positioning system (GPS). It was envisaged that farmers would have difficulties in pronouncing the names of agrochemicals they used. The reasons for this thought were (1) poor literacy level of farmers and the expected poor recalling-ability of farmers, (2) names of most agrochemicals are technical, and (3) the need to avoid using trade names of agrochemicals for ethical reason. Hence, a catalogue of agrochemical containers was prepared for ease of identification by the respondents. This enabled the farmers to identify the specific agrochemicalsthey had used.

For the questionnaire pretest, twenty-five crop farmers (who were not included among the respondents that were finally used for the study) were selected from both States through random sampling technique and were asked the questions contained in the research instrument to determine the degree to which the questions contained therein would be clearly understood when finally used for actual data collection. The pretest was carried out between 4th and 11th June, 2014. Validity test of the research instrument is necessary to ascertain if the research instrument could measure what it was designed to measure. Use of judges was employed to validate the instrument. Experts in Agricultural Extension and Rural Sociology and senior lecturers in the Department of Agricultural Economics and Rural Sociology, and NAERLS, Ahmadu Bello University, Zaria were also given the research instrument for their scrutiny and comments.

The use of judges was important in validating particularly the hypothetical situations that were created to measure the perceptions of farmers in the study to ensure that they could actually measure what the researcher intended them to measure. Based on the comments of the judges and experts, the research instrumentwas modified before being used for the data collection.

The instrument was also tested to determine its reliability before final use. A test-retest method was used to determine the reliability of the instrument. The formula used for the reliability test used was Cronbach's alpha quoted by Wells and Wollack (2003):

$$\hat{\alpha} = \left(\frac{k}{k-1}\right)\left[1 - \frac{\sum_{i=1}^{k} P_i(1-P_i)}{\hat{\delta}^2{}_X}\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:

K = Number of items tested i.e. total number of questions in the research instrument

P = Number of questions to which answers were correctly provided i.e. proportion of questions that were difficult to answer to number of questions asked

$\hat{\delta}^2$ = Sample variance for total score

$\hat{\alpha}$= Reliability coefficient

A correlation coefficient of 0.76 was obtained and considered assatisfactory enough to conclude that the instrument was reliable.

To confirm the responses of farmers especially with regards to provision of training as wellas types of agrochemicals used, a questionnaire was administered on agricultural input supply agencies and major private dealers in both States. A separate questionnaire was administered to Agricultural Desk Officers in major radio stations in the two States to obtain information about airing of agricultural programmes specifically on the use of agrochemicals.

4.4 Analytical Techniques

The choice of a particular statistical technique is often largely influenced by the type of data involved. This study, however, consists of data that were nominal, ordinal and interval in nature. Hence, a variety of relevant statistical tools (descriptive and inferential) were employed in data analysis at different stages.

Descriptive tools: In describing the data, both measures of central tendency (location) and variability (dispersion) were involved. Central tendency is the measure of average of a distribution. Mean and median were used. These were used to achieve objectives i, ii, iii,iv and vi. This is because the nature of the data made them more amenable to this method. Data generated were analysedusing IBM Statistical Package for Social Science – version 20 (SPSS, 2010).

Inferential tools:Multiple regression analysis was used to determine the relationship between dependent and independent variables and make inferences.

Z-test analysis: This was used to compare adopters and non-adopters of RAPs between the two study locations.

Z-statistics is expressed as:

$$\mathbf{Z} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\delta^2{}_1}{n_1} + \frac{\delta^2{}_2}{n_2}}} \text{...(2)}$$

where,

$\bar{x}_1$= Adopters of RAPs

$\bar{x}_2$ = Non-adopters of RAPs

$\frac{\delta^2{}_1}{n_1}$ = Variance for adopters of RAPs

$\frac{\delta^2{}_1}{n_1}$ = Variance for non-adopters of RAPs

$\delta =$ Variance

Multiple Regression Analysis: This is the measurement used when "a given dependent variable is affected simultaneously by several independent variables. Regression analysis shows the quality or magnitude of the change in the dependent variable, brought about by all the independent variables put together (Ogunfiditimi, 1986).

Multiple regression techniquewas used to estimate the relationship between farmers' socio-economic characteristics,technological, and institutional variables and level of adoption of RAPs to achieve objective v.

Multiple regressions was determined by using:

$Y = a_0 + b_1x_1 + b_2x_2 + b_3x_3 \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots b_{18}x_{18} + e$..............(3)

Where:

Y= Level of adoption (Total number of RAPs adopted)

X_1= Age (years)

X_2 = Sex(male or female)

X_3 = Farm Size (hectares)

X_4 = Years of formal education (years)

X_5 = Years of farming experience (number of years in farming)

X_6 = Income (Naira per anum)

X_7 = Household size (number)

X_8 = Social participation (number of association participated in andmembership status)

X_9 = Cosmopoliteness (Number of times travelled out of village for agricultural purpose)

X_{10} = Extension contact(Number of extension visits enjoyed per year as well as number of times a farmer heard the use of agrochemicals on radio)

X_{11}= Access to information (Number of sources accessible to crop farmers)

X_{12} = Access to training (number of trainings attended in the last 5 years)

X_{13}=Sources of agrochemicals (number of sources available to crop farmers)

X_{14}= Access to credit (amount in Naira)

X_{15} = Relative advantage (Perception measured by weighted mean)

X_{16} = Compatibility (Perception measured by weighted mean)

X_{17} = Complexity (Perception measured by weighted mean)

X_{18}= Observability(Perception measured by weighted mean)

a = Constant term

e = Error terms

4.5 Operationalization and Measurement of Variables

There were three categories of variables that were measured namely: Dependent variable, Independent variables and Outcome variables

4.5.1 Dependent variable

Level of adoption of recommended agrochemical practices (Y)

Adoption is the decision of farmers to make full use (application) of specific recommended practices of agrochemicals on continuous basis (for at least 5 years) as the best course of action available. Recommended practices describe the efficient and effective use of a specific agrochemical in a worthwhile manner as suggested by relevant authority (producer or regulatory agent).A list of twenty-five recommended practices on the usage of agrochemicals in crop production was drawn thus:

i. Purchasing from reputable source

ii. Avoid using expired/banned chemicals

iii. Using the appropriate agrochemicals

iv. Checking that seals and original labels have not been broken

v. Avoid buying chemical too early in the growing season

vi. Proper calibration of sprayer

vii. Using the right dosage

viii. Regular repair and maintenance of spraying equipment

ix. Using the right equipment

x. Following labeling instructions

xi. Avoid spraying against wind direction

xii. Wearing protective clothing

xiii. Keep herbicides separate from other types of pesticides

xiv. Observation of the waiting period

xv. Avoid entering sprayed farm until 12 hours after spraying

xvi. Avoid indiscriminate mixing herbicides with fungicides

xvii. Check stored pesticides regularly for sign of damage or leakages

xviii. Applying the agrochemical at the right time

xix. Never store pesticides in living rooms, kitchen, animal house or toilets

xx. Avoid leaving pesticides in equipment overnight

xxi. Avoid eating, drinking or smoking during spraying

xxii. Proper handling and storage of agrochemicals

xxiii. Proper disposal of empty containers

xxiv. Avoid using chemicals for different purpose e.g. treating of wound

xxv. Keep pesticides away from source of drinking water, wells and streams

Responses were rated on a 3-point Likert'stype scale thus: very often (3), seldom (2), and never (1) for each RAP. The responses were counted with respect to the weights. The score for each variable was multiplied by the corresponding weight to obtain a weighted score. Further, the weighted scores were summed to obtain a weighted sum. The weighted sum was further divided by the number of respondents to obtain a weighted mean for each variable. Finally, the weighted means were sorted in descending order against the decision rule. The mid-point values of the scale were summed up and further divided by 3 to obtain a mean of 2. Any variable with weighted mean value equal to or above the cut-offf mean of 2 was considered to have "high" adoption, while any variable with weighted mean of less than 2 was considered to have "low" adoption. These weighted means were used to determine the relationship between the dependent variable (level of adoption of RAPs), and the independent variables. The weighted score was used as the dependent variable in the regression.

4.5.2 Independent variables

The socio-economic characteristics; technological attributes; and institutional factors considered were:

i. Age (X_1): Age is the actual number of years an individual has spent on earth from birth to the study period. This was measured in completed years as at the time of interview for this study. It is assumed that older people will adopt RAPs more than the younger ones. Crop farmers were required to give their age in years. Responses were classed with an interval of 10.

ii.Sex(X_2): Sex refers to whether a crop farmer is male or female. This variable was measured by assigning 1 and 2 to males and females respectively. It is assumed that the sex composition of the family will determine adoption of RAPs since human mentality with respect to health and safety in the use of agrochemical is sex-based.

iii.Farm size (X_3): Farm size refers to the total size of land cultivated by the farmer. Crop farmerswere required to indicate the total land area (Ha) owned (cropped or not) in the previous year. Responses were classified thus: <2, 2 – 5, and >5.

iv.Years of formal education(X_4): This is the number of years a crop farmer has spent in formal schooling. This study assumed that the higher the number of years of education of farmers; the more their likelihood of understanding and adopting the recommended agrochemical practices. Crop farmerswere required to indicate the number of years of formal education. Responses were classified thus: 0, 1 – 6, 7 – 12, and above 12.

v.Years of farming experience (X_5): Experience in farming refers to the number of years that a farmer has been engaged in farming activities. Farming experience of a farmer affects his/her skills, managerial know-how and decision making. It also influences farmers' understanding of the use of agrochemicals. Crop farmerswere asked to specify the number of years they have been involved in crop farming. It is assumed that farmers' years of experience will positively influence the adoption of recommended agrochemical practices. Responses were classified into <25, 25 – 40, and above 40.

vi.Income (X_6): The availability of farm earnings to finance the purchase of inputs such as agrochemical is essential. Positive relationship was expected between farm income and adoption of RAPs. Crop farmerswere asked to state their income from the different crops they produced. Responses were grouped with an interval of ₦100,000.

vii.Household size (X_7): The size of a household was expected to have a significant effect on the resources available to the farmer in terms of labour and funds. Crop farmers were required to indicate the size of their households. This variable were measured by adding the number of wives, children, relatives/dependants that were actually living with the respondent or dependent on him for feeding, housing and clothing at the time of the survey. Responses were grouped with an interval of 5.

viii. Social participation (X_8): Daane and Mangbo (1991) asserted that group participation is a framework by which farmers defend and negotiate their interests. Membership of associations is expected to assist farmers to get easy access to credit and other production inputs. It can also enhance access to technological information (Ogunsumi, 2007, Tiamiyu *et al.*, 2009). Membership in farmers' association was however found to be a non-significant factor in adoption of many practices (Mugisa-Mutetikka, 2000). Crop farmers were asked to indicate whether they are members, committee members or officials of associations such as religious societies, cooperative societies, social clubs etc. Ordinary membership was scored 1 point, committee membership was scored 2 and being an official was scored 3 points.

ix. Cosmopoliteness (X_9): Cosmopoliteness is a character for delineating ones exposure towards the environment and to sources of information. It can be through training, exposure visit, etc. For this, a farmer can better know about his surroundings in case of agriculture as well as livelihood. Cosmopoliteness is the degree of orientation of the respondents towards outside social systems to which he or she does not belongs. It was measured by frequencies of visits to outside his or her area of residence for agricultural purpose only. Cosmopoliteness, as an independent variable, is expected to have positive relationship with the adoption of innovations (Rogers and Shoemaker, 1971). It provides more chance of exposure to external information and environment.

x. Extension visit (X_{10}): It is the primaryduty of the front-line staff of the extension system to enlighten the farmers on safety precautions as well as general knowledge on pesticide application. In Nigeria, these roles are limited by high extension agent:farmer ratio, poor staffing and mobility. Extensionists also generally lack support, are poorly trained in pesticide management, lack motivation, and there are hardly any follow-up (Meijden, 1998). Extension contact is very important determinant of technology adoption because, any newly developed technology is introduced to farmers through the activities of extension agents. A farmer whose contact with extension agents is very high is expected to be more familiar and more knowledgeable about the use of agricultural innovations. This variable is therefore expected to be positively related to technology adoption. Crop farmers were asked to indicate the frequency of contacts with extension agents, as well as the number of times respondents have listened to programmes on use of agrochemical on radio in the last one year. Responses were grouped thus: 0, 1– 8 times, 9 – 16 times, and >16 times.

xi. Access to information (X_{11}): This refers to access to various sources through which crop farmers first heard about each of the 25 RAPs. The score for this variable was the number of sources through which crop farmer claimed to have heard about the RAPs. The assumption here was that the more the farmers have access to information about RAPs; the more the farmersare likely to adopt RAPs.Bonabana (2002) also found farmers' access to information from researchers and training in pest control activities as influencing factor on adoption. According to Baral *et al.* (2006), neighbors and relatives were valuable sources of information, but extension agents and radio broadcasts were not. This situation is identical to what is happening in Bangladesh (Rashid *et al.*, 2003) and in other States of India (Alam *et al.*, 2006). Thirteen sources of information were drawn. Crop farmers were asked to state the extent of usefulness of each source of information which was rated thus: 3 (very useful), 2 (useful), and 1 (not useful). Weighted scores were obtained for each of the sources of information.

xii. Access to training (X_{12}): Crop farmerswere asked if they have been exposed to any formal/intensive training on the use of agrochemicals. A 'yes' or 'no' response was recorded. Farmers who gave a 'yes' response were further requested to indicate when, where and who organised such training. Because the training is expected to be practical, crop farmerswere also requested to indicate how the training was conducted. Furthermore, crop farmerswere asked to indicate their level of satisfaction with the efficacy of the training. 'Are you satisfied with the quality of training received' was the question asked here. A 'yes' or 'no' response was recorded. However, farmers with a 'no' response were further asked to state the reasons for the non-satisfaction. Nominal value was assigned to the following reasons/problems: 1=Too theoretical, 2=poor timing, 3=lack details, 4=Too high transportation cost, 5=Too far away, 6=inappropriate venue, 7=poor publicity, 8=poor trainers, 9=too crowded, and 10=Others.

xiii. Efficacyand accessibility of agrochemicals (X_{13}): Nominal values were assigned to different sources of agrochemicals/spraying equipment thus: 1= Agroservice center 2=Input dealer 3=Salesmen 4=Research Institute 5=Open market 6=Others.Also, crop farmerswere asked to assess the efficacy of agrochemicals/spraying equipment. Scores of 1 to 3were assigned to 'High efficacy, Fairefficacy, and Poor efficacy'' respectively. Lastly, perception of accesibility (which is the degree to which agrochemicals are readiliy available and affordable with minimum effort and price) was rated thus 1= Highly accessible, 2=Accessible, 3=Poorly Accessible and 4=Not Accessible.

xiv. Access to agricultural finance (X_{14}): This was measured by sources as well amount of credit received form six different sources drawn for this study. They include personal savings, financial institutions, NGO, input traders, relative/friends, and farmers' groups. Crop farmers were asked to state the extent of usefulness of each source of credit which was rated thus: 3 (very useful), 2 (useful), and 1 (not useful). Weighted scores were obtained for each of the sources of credit. For the amount of credit received, responses were grouped with an interval of ₦100,000.

Technological Attributes of RAPs as Perceived by Crop Farmers

Farmers' perceptionwas measured through their feelings towards some declarative statements about recommended practices followingJibowo and Francis (1989). Based on the researcher's observation of farmers' practices, literature reviewed and consultation with extension administrators and field workers, twenty-two declarative statements consisting of both positive and negative items were drawn to test this construct of interest. They were structured in a three-point Likert's type scale of Agreed (A); Undecided (U); and Disagreed (D) and scored 3, 2, and 1 respectively. The statements gave respondents the opportunity to say at which level they were or were not convinced that the recommended practices were relevant. Positive statement were scored 3, 2, 1 for A, U, and D respectively; while negative statements were scored 1, 2, and 3 for A, U, and D respectively. The statements were further classified into relative advantage, compatibility, complexity, and observability. Total scoreswere computed for each of the respondents as the addition of the scores for all the statements in each class.This procedure applied to relative advantage, compatibility, complexity and observability rates. Furthermore, weighted means were computed to arrive at a decision thus: weighted mean scoresequal to and >2 indicate high perception while weighted mean score below 2 point indicate low perception.

Structural equation model was used to estimate the latent contribution of individual characteristics for each sub-variable (relative advantage, observability, complexity, and compatibility) thus:

$y_i = \beta_{12}\gamma_2 = \varphi_{11}\omega_1 + \epsilon_1$

$$\beta_{21}\gamma_1 + \gamma_2 = \varphi_{22}\omega_2 + \varphi_{23}\omega_3 + \epsilon_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where:

$\varphi(\mathrm{j} = \omega = 1,2,3,..\mathrm{n}) = \text{latent variables}$

$x_{ij = observed\ variables\ i \ldots j}$

β, γ, ω = unknown parameters for the variables to be determined

xv. Relative advantage(X_{15}): This refers to the degree to which the RAPs are perceived as superior to the crop farmers' usual practice.

xvi. Compatibility (X_{16}): This is the degree to which the RAPs are peceived as consistent with the needs, values, norms, beliefs and past experiences of the crop farmers.

xvii. Complexity(X_{17}): This is the degree to which the RAPs are peceived to be relatively difficult to uderstand and use by the crop farmers.

xviii. Observability(X_{18}): This is the degree to which the result of adopting RAPs are peceived by the crop farmers to be visible and could be discussed with other farmers.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Socio-economic, Technological and Institutional Variables

Table 5.1 summarizes the socio-economic characteristicsof the crop farmers as well as the institutional variables.

5.1.1 Socio-economic characteristics of crop farmers

5.1.1.1 Age of crop farmers:

The mean age of the crop farmers in Kaduna State was 44.3 while that of Ondo State was 51.4 years. This implies that majority of the farmers were still in their active years, thus vibrant in carrying out farm work. This means that the farmers were comparatively younger and within the age defined by the FAO (1987) as economically productive and this should have a positive influence on the farmers' probability of adopting RAPs. Similar findings were reported by Agwu and Chukwu (2006) that only 19% of rice farmers in Aninri local government area of Enugu State, Nigeria were above 50 years old. This is an advantage for adoption and spreading of recommended agrochemical practices. The trend of age range in Kaduna and Ondo States is similar as most crop farmerswere within the age range of 41 and 50.

5.1.1.2 Crop farmers' sex

Majority (93%) of the crop farmers were male. Male domination in farming has been reported by several authors (Lami and Abraham, 2013; Enete and Amusa, 2010; Keraita, 2002; Obosu-Mensah, 1999). Only 3.7% were female in Kaduna State compared to Ondo State with 11.2%. This indicates that more women were engaged in farming in Ondo State than in Kaduna State. This finding negates the claim by Boserup (1970, 1979) that African agricultural system is female dominated. The Islamic culture which predominates in the Kaduna State setting of the study area could have accounted for the wide difference. The culture of Islam practiced in Kaduna State restricts unguarded mixture of men with the female folks.

5.1.1.3 Farm size of crop farmers

The result in Table 5.1 revealed that the average farm size cultivated by crop farmers was 3.01 and 4.08 ha in Kaduna and Ondo State respectively. This shows that farming in the study area is still dominated by small-holder farmers and production is done on highly fragmented lands. Similar result was found by Awotide *et al.* (2010).Land is the most important factor in agriculture; without adequate land for food production, this may lead to hunger, malnutrition, poverty and death. Inadequate farm land can limit the production capacity of agricultural produce.

Table 5.1: Distribution of crop farmersaccording to socio-economic characteristics, and institutional factors

Variables	Minimum		Maximum		Mean		SD		SE	
	Kaduna	Ondo	Kaduna	Ondo	Kaduna	Ondo	Kaduna	Ondo	Kaduna	Ondo
Age	24	20	63	82	44	51	9.777	12.439	0.546	0.669
Farm size	1	1	15	17	3.01	4.08	2.827	2.892	0.025	0.032
Farming experience	5	5	45	60	24	25	9.890	12.467	0.490	0.584
Level of education	0	0	16	18	11	13	3.690	5.171	0.228	0.352
Household size	1	1	32	22	10	7	6.854	3.247	0.417	0.321
Membership of associations	0	0	5	4	2	2	1.15	1.12	0.069	0.058
Level of income	50,000	95,000	1,500,000	2,000,000	432,320	752, 463	238,722.00	275,900	15,783	17,446
Cosmopoliteness	1	1	36	26	15	11	9.183	6.854	0.835	0.748
Extension visits	1	0	20	26	9	12	6.165	8.740	0.531	0.782
Access to Information	1	1	5	7	3	3	1.42	1.57	0.076	0.092
Access to Formal Trainings	1	1	2	2	1	1	0.427	0.488	0.037	0.044
Amount of credit	0	0	500,000	2,600,000	42,148.15	111,608.850	93,348.85	283,997.64	8,034.19	25,401.52

5.1.1.4Crop farmers' years of farming experience

Results shown in Table 5.1also revealed that the mean years of farming experience of the farmers was about 25 years in both States. This means that farmers had relatively many years of farming experience. This is an advantage for adoption of RAPs since farmers were likely to understand the rudiments involved in agrochemical application techniques. Ani (1998) and Iheanacho (2000) also indicated that farming experience to a large extent affects farmers' managerial know-how and decision making. Besides, it influences the farmers' understanding of climatic and weather conditions as well as socio-economic policies and factors affecting farming.

5.1.1.5 Crop farmers' level of education

The mean years of formal education were 11.5 for Kaduna State and 13.39 years for Ondo State. This indicates that the enterprise had a good proportion of literate people (Table 5.1). This means that a good number of the farmers were literate, especially at primary (30.8%) and secondary (41.2%) levels and this could have enhanced the transfer of recommended agrochemical practices. Rapidly increasing unemployment in industries, ministries and government parastatals has caused many school leavers to opt for agriculture and other menial jobs to sustain life. The literacy level of these farmers is capable of promoting the adoption of recommended agrochemical practices. Moreso, an educated farmer understands an innovation that may appear complex compared to an illiterate farmer (Cary and Barr, 1992).Literate farmers tend to read, participate in relevant fora, listen to and find out more for themselves. Comparatively, farmers in Ondo State seem to be more educated (M=13.39) than those in Kaduna State (M=11.5).

5.1.1.6 Household size of crop farmers

The mean household size of the crop farmers was 8 in Kaduna State while that of Ondo State was 6. This indicates that households were larger in Kaduna State wheremost (46.5%) of the crop farmers had household size of between 6 and 10 persons. The relatively high household size could be an indication of the desire for manpower benefits. This implication was buttressed by the fact that 60% of the crop farmers exclusively use family labour for their farm operations.

5.1.1.7 Crop farmers' membership and participation inassociations

From the results, membership of associations had a mean of 1.47 (for Kaduna) and 1.51 (for Ondo State). This indicates that most of the crop farmers belonged to one association or the other. Further analysis revealed that majority (70.3%) of the crop farmers belonged to an average of 3 social organizations indicating high social participation. Such social organizations may provide a forum for exchange of ideas about new farm practices (Onu 1995, and 2005). However, farmers in the study area were communalistic and traditionally would like to belong to many social groups as that is indicative of social status.

Most (above 80%) of the farmers belonged to more than one association. Investigation on crop farmers' participation in different association gave an insight into their involvement in the different associations. Majority (78.7%) of crop farmers who indicated membership of associations were members of cooperative societies. Majority of them also played the role of holding one office or the other. The involvement of the crop farmers in all the categories of organizations investigated in this study shows a form of social participation. In Kaduna

State, majority (57.7%) of the crop farmers were ordinary members in religious associations while most (47.3%) of the crop farmers were members of cooperative societies.

5.1.1.8 Crop farmers' level of income

Most (46.5%) of the crop farmersobtained between ₦101, 000 and ₦200,000 as farm income annually. The income derived from the farming indicates the level of profit obtained by the farmers. The expectation was that farmers would have as much capital to plough back into the production process in order to increase profit. Wealthier farmers are more likely to be able to afford and apply expensive inputs aimed at increasing productivity; hence income is expected to influence the adoption of RAPs positively.The mean farm income of crop farmers in Ondo State was ₦157,000 and that of Kaduna State was ₦125,000 indicating that farming business is relatively more profitable in Ondo State.This result could be due to the types of crops (cash crops) grown in Ondo State.

5.1.1.9 *Crop farmers' cosmopoliteness*

It can be seen from Table 5.1 that 65.5% of the crop farmers visited other wards in the LGA. Also, 61.1% of them had visited other States in the country for agricultural purpose. The main purpose of visiting the nearby town as expressed by them was to purchase farm inputs and sell farm produce. Some of them were visiting the nearby town to visit friends and relatives, to get banking services, for medical treatment and for entertainment purposes. However, 21.9% of the crop farmers had not visited other places for agricultural purpose. Majority (92.8%) of the farmers in Kaduna State visited other places for agricultural purposes compared to farmers in Ondo State. This could be due to the high concentration of agricultural institutions such as National Agricultural Extension and Research Liaison Services, National Animal Production Research Institute, Institute for Agricultural Research etc within Kaduna State.

5.1.2 Crop farmers' perception of technological attributes of RAPs

Result in Table 5.2 indicates that the crop farmers' perception of the compatibility of the recommended practices was low (WM=1.53 and 1.66 for Kaduna State and Ondo State, respectively). Crop farmers expressed the difficulty in wearing the spraying apparels which they regarded as uncomfortable. Probably for same reason, their perception of the complexity of the recommended practices was very high (WM=2.84 and 2.82) despite the very high (WM=2.81 and 2.88) perception of the relative advantage of the practices in Kaduna and Ondo State, respectively. This means that farmers believed that RAPs have a lot of advantage but yet they are complex to practice.This result is consistent with the assertion of Murray and Taylor (2001) that the personal protective equipment (PPE) is neither effective nor appropriate in the developing world due to high cost and because it is completely unrealistic for hot tropical climates.Generally, the crop farmers' perception of the qualities (technological attributes) of the recommended practices was high (WM=2.44 and 2.47 in Kaduna and Ondo State, respectively).

Table 5.2: Distribution of crop farmers bytheir perception of technological attributes of RAPs

Technological Attributes	Agreed		Uudecided		Disagreed		Weighted Sum		Weighted Mean		
	K	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**K**	**O**	**Both**
Relative advantage	115	112	15	11	5	2	380	360	2.81**	2.88**	2.84**
Observability	86	80	37	29	12	16	344	314	2.56**	2.51**	2.54**
Compatibility	30	37	11	9	95	79	207	208	1.53*	1.66*	1.59*
Complexity	113	103	22	22	0	0	383	353	2.84**	2.82**	2.83**
Overall perception									2.44**	2.47**	2.45**

K=Kaduna, O=Ondo
**High perception, *Low perception

5.1.3 Institutional factors

5.1.3.1 Crop farmers' sources of information

Table 5.3 shows the sources of agrochemical information for the crop farmers. While the Agricultural Development Programmes (ADPs) were the most useful in informing farmers about recommended agrochemical practices in Ondo State (98.4%); other farmers were indicated as the most useful source of information for farmers in Kaduna State (94.8%). This implies that sources of information to farmers with respect to agrochemical recommended practices are highly informal in Kaduna State. This could be due to inefficiencies in the public extension. The ranking shows that least information on recommended agrochemical practices come to farmers in Kaduna and Ondo States through the Environmental Protection Agency (EPA) (12.6% and 15.2%) respectively. Nonetheless, farmers frequently suggest that other farmers were an important source of information about farming. According to Baral*et al.* (2006) neighbors and relatives were valuable sources of information in India, but extension agents and radio broadcasts were not. This situation is identical to what is happening in neighboring Bangladesh (Rashid *et al.*, 2003) and in other States of India (Alam*et al.*, 2006) where informal sources were more useful as source of information about farming. The dwindling number of extension personnel could have been the reason.

Table 5.3: Distribution of crop farmersbased on sources of information on RAPs*

Sources	**Usefulness**		**Rank**	
	Kaduna	**Ondo**	**Kaduna**	**Ondo**
ADPs	119 (81.1)	123 (98.4)	3	1
Research institutes	111 (82.2)	108 (86.4)	5	4
Input dealers	112 (82.9)	118 (94.4)	4	3
Other farmers	128 (94.8)	120 (96)	1	2
Village head	94 (69.6)	94 (75.2)	7	8
Cooperatives	97 (71.8)	77 (61.6)	6	9
Radio	127 (94.1)	106 (84.8)	2	5
Television	58 (42.9)	99 (79.2)	10	6
Newspapers	63 (47.6)	61 (48.8)	9	11
Internet	43 (31.9)	62 (49.6)	11	10
Agricultural show	90 (66.7)	98 (78.4)	8	7
NAFDAC	40 (29.6)	44 (35.2)	12	12
EPA	17 (12.6)	19 (15.2)	13	13

*Multiple responses

Figures in parentheses are percentages

5.1.3.2 Extension visit to crop farmers

More than 50% of the crop farmersin Kaduna State were not visited in the last one year while majority (66.6%) of the crop farmers in Ondo State were visited 1 – 8 times in a year by extension agents (Table 5.4). This may be due to the fact that the extension agent:farmer ratio in Ondo State (1:1,480) is less than what was obtained in Kaduna State (1:4,826. Farmers in Ondo State seem to enjoy more extension visit (M=6) compared to farmers in Kaduna State (M=4). However, this result negates the report of NAERLS and Federal Department of Agricultural Extension [FDAE] (2014) which revealed that extension visit to farmers increased by 18% from 2013 to 2014 in Kaduna State where the EA:Farmer ratio was 1:3704. It must be noted that Kaduna State operated with just 26% of the required village extension agents (VEAs) workforce in 2013 and 2014 by having only 161 VEAs out of the required 606 VEAs. In Ondo State, the number of VEAs has also declined by about 10% between 2013and 2014. That farmers in Ondo State enjoy more extension visit compared to their Kaduna State counterparts negates *apriori* expectation due to the fact that there are more agricultural research institutions in Kaduna State compared to Ondo (Idachaba, 1980).

Table 5.4: Distribution of crop farmers according to number of extension visits

Number of extension visits per year	Kaduna (n=135)	Ondo (n=125)	Both (n=260)	Mean		
				Kaduna	Ondo	Both
0	68 (50.3)	12 (9.6)	80 (30.7)	4	6	5
1 – 8	49 (36.3)	83 (66.6)	132 (50.7)			
9 – 16	18 (13.3)	27 (21.6)	45 (17.3)			
Above 16	0	3 (2.4)	3 (1.2)			

Extension contact with farmers enhances acquisition of new knowledge, skill and practices on improved technology by the farmers as well as their innovativeness (Dey, 2001; Tanko and Olowogbaji 2009) which is expected to translate into increased adoption of RAPs. Contacts with extension agents afford the farmers the opportunity of sharing ideas and information on modern farm production practices by interacting with other farmers. This suggests that the extension services are not adequate in the survey area given the recommended extension agent to farmer ratio. Importantly, inadequate funding and staffing, inadequate staff training and poor mobility were the major problems of ADPs across the country (NAERLS and FDAE, 2014).

5.1.3.3 Radio programmes heard on the use of agrochemicals, and the number of times

A large majority (81.2%) of the crop farmers had not heard any programme on the use of agrochemicals on radio in both States (Table 5.5). This fact was corroborated by the findings from radio stations where all the radio stations interviewed confirmed that they had not aired any programme specifically on the use of agrochemicals in the last three years. The most that had happened was the mention of agrochemicals to be used while discussing the cultural practices in relation to the production of the particular crops being discussed.

Table 5.5: Distribution of crop farmers by radio programmes heard on the use of agrochemical, and the number of times

Variables	**Kaduna (n=135)**	**Ondo (n=125)**	**Both (n=260)**
Whether crop farmers had listened to programmes on the use of agrochemical on radio (n=260)			
Have listened to	26 (19.3)	23 (8.4)	49 (18.8)
Have not listened to	109 (80.7)	102 (81.6)	211 (81.2)
Number of times respondents heard programme on use of agrochemical on radio	(n=26)	(n=23)	(n=49)
1 – 3	21 (80.7)	20 (86.9)	41 (83.7)
1 – 6	5 (19.2)	3 (13.0)	8 (16.3)

5.1.3.4 Agrochemical-related training received by crop farmersand number of times trained

5.1.3.4.1 Agrochemical-related training received by crop farmers

Majority of the crop farmers (77% and 61.6% in Kaduna and Ondo State, respectively) had not received any training on the use of agrochemicalsin the last three years (Table 5.6). Training is an added input which enhances good performance and adoption (Meenambigai and Seetharaman, 2003). This result agrees with the findings of Meijden (1998) that farmers were not exposed to training on the use of agrochemicals. NAERLS and FDAE (2014) reported that extension visit to farmers increased by 18% between 2013 and 2014 in Kaduna State where the number of forthnightly trainings (FNTs) conducted declined by 8% within the same period. The increased visit might not have being training on RAPs.

Training makes a trainee more knowledgeable and efficient. It is important to build the capacity of the farmer more profoundly. When a farmer attends more training organized by extension agencies or any other relevant institutions, he/she will be more acquainted with the activities of the institutions as well as gather more knowledge regarding new agricultural practices with skill. So, training is the means through which farmers can be equipped with the latest knowledge regarding agrochemical practices.

5.1.3.4.2Number of times crop farmers were trained in the last 5 years:

Majority (53.2, and 52.9%) of those crop farmers who received training on agrochemicals were trained just one time on application techniques and safety precautions respectively. In a study carried out in Ethiopia; Amera and Abate (2008) found that only 12.1% and 12.5% of crop farmers received training on health and safety, and application techniques respectively while only 7.1% of them received training on IPM.Generally, most of the trainings were organized by the NGOs as indicated by majority (54.4%) (Table 5.6). Dugje *et al.* (2008) found that many pesticide users lack awareness and technical training.

Table 5.6: Distribution of crop farmers by number of times trained, and the organizers* (n=79)

Variable	**Type of Training**					
	Application techniques		**Health and safety**		**I P M**	
	Kaduna (n=31)	**Ondo (n=48)**	**Kaduna (n=21)**	**Ondo (n=47)**	**Kaduna (n=13)**	**Ondo (n=40)**
Number of times trained						
0	181 (69.6)					
1 – 2	30 (96.8)	42 (87.5)	20 (95.2)	35 (74.5)	12 (92.3)	37 (92.5)
3 – 4	1 (3.2)	6 (12.5)	1 (4.8)	12 (25.5)	1 (7.7)	3 (7.5)
Organizers* (n=79)						
ADP	12 (38.7)	30 (62.5)	4 (12.9)	11 (22.9)	8 (25.8)	7 (14.6)
Input trader/dealer	6 (19.3)	15 (31.3)	5 (16.1)	12 (25)	2 (6.5)	4 (8.3)
Research Institutes	0	0	3 (9.7)	1 (2.1)	0	0
NGO	23 (74.2)	20 (41.7)	18 (58.1)	15 (31.3)	14 (45.2)	10 (20.8)
LGA	0	0	10 (32.3)	8 (16.7)	10 (32.3)	8 (16.7)
Producer/distributor	1 (3.2)	3 (6.3)	0	0	0	0
Cooperative	0	2 (4.2)	0	1 (2.1)	0	1 (2.5)
Ministry of Agriculture	0	0	0	0	0	0
International Agencies	0	0	0	0	0	0

*Multiple responses indicated, Figures in parentheses are percentages

5.1.3.4.3 Farmers'perception of accessibility, timeliness and quality of training: Despite the fact that the number of crop farmers who received training was low, result in Table 5.7 indicates that in Ondo State, majority (66.7%) of the farmers perceived trainings on application techniques as accessible. Also, majority (97.8%) perceived trainings on safety precautions as timely. In the same vein, majority (85%) perceived trainings on IPM as highly qualitative.However, most (40.4%) of farmers who received training on safety precautions perceived the trainings as poorly accessible. Trainingshould not only be accessible to farmers but should also be timely and of good quality in order to efficiently enhance farmers' knowledge and skills especially in the use of agrochemicals.

Table 5.7: Distribution of crop farmers by perception of accessibility, timeliness and quality of training* (n=79)

Variable	Type of training					
	Application techniques		Health and safety		IPM	
	Kaduna (n=31)	Ondo (n=48)	Kaduna (n=21)	Ondo (n=47)	Kaduna (n=13)	Ondo (n=40)
Accessibility of training						
Highly accessible	4 (12.9)	6 (12.5)	5 (23.8)	10 (21.3)	4 (30.8)	8 (20.0)
Accessible	17 (54.8)	32 (66.7)	7 (33.3)	15 (31.9)	2 (15.4)	15 (37.5)
Poorly accessible	10 (32.3)	10 (20.8)	9 (42.9)	22 (46.8)	7 (53.8)	17 (42.5)
Timeliness of training						
Timely	27 (87.1)	45 (93.6)	19 (90.5)	46 (97.8)	12 (92.3)	38 (95.0)
Not timely	4 (12.9)	3 (6.3)	2 (9.5)	1 (2.1)	1 (7.7)	2 (5.0)
Quality of training						
High quality	20 (64.5)	45 (93.6)	13 (61.9)	37 (78.7)	10 (76.9)	34 (85.0)
Average quality	10 (32.3)	1 (2.1)	8 (38.1)	10 (21.3)	3 (23.1)	6 (15.0)
Low quality	1 (3.2)	2 (4.2)	0	0	0	0

*Multiple responses indicated
Figures in parentheses are percentages

5.1.3.5 Sources of agriculturalavailable tocrop farmers

5.1.3.5.1Major sources of financeavailable tocrop farmers:

Personal savings was the most major source of agricultural financeavailable to majority of the crop farmers recording a weighted mean of 2.87 and 2.76 in Kaduna and Ondo, respectively (Table 5.8). This result clearly depicts that farmers heavily rely on informal (non-conventional) sources to fund for their farming activities. This may be due to dysfunctionality of formal credit institutions or the stringent conditions attached to loan procurement. Such conditions include high interest rate, low moratorium, and high collateral.

Table 5.8: Distribution of crop farmers according to major sources of finance*

Sources of Finance	Weighted Scores						Weighted Sum		Weighted Mean		Rank	
	Very Useful		Useful		Not Useful							
	K	O	K	O	K	O	K	O	K	O	K	O
Financial institutions	3	0	36	14	116	118	155	132	1.15*	1.06*	7	7
NGOs	57	21	66	34	83	101	206	156	1.30*	1.25*	5	5
Input traders	30	27	32	28	109	102	171	157	1.27*	1.26*	6	4
Government institution	30	21	46	22	102	107	178	150	1.32*	1.20*	4	6
Relatives/friends	57	117	36	12	98	80	191	209	1.42*	1.67**	2	2
Farmers' groups	60	72	8	60	111	71	179	203	1.33*	1.62**	3	3
Personal savings	357	315	30	20	1	10	388	345	2.87***	2.76***	1	1
Weighted Mean Average									3.11	2.98		

***Very Useful, **Useful, *Not Useful
K=Kaduna, O=Ondo
*Multiple responses indicated

5.1.3.5.2 Amount of credit received by crop farmers:Result in Table 5.9 revealed that majority (78.5%) of the crop farmers got a credit equal to or less than ₦100,000. Credit use is expected to assist farmers purchase necessary inputs for crop production. However, many sources of credit nowadays, give the farmer more chances of securing improved inputs rather than cash. The mean amount of credit received by crop farmersin the last one year was ₦65,842 and ₦79,773 in Kaduna and Ondo State, respectively.Rahman (2008) similarly found that most farmers received little or no credit to operate their farms.

Table 5.9: Distribution of crop farmers based on amount of credit received in one year (Mean=₦79,773)

Amount of Credit Received (₦)	Kaduna (n=135)	Ondo (n=125)	Both (n=260)	Mean	
				Kaduna	**Ondo**
≤ 100,000	126 (93.3)	78 (62.4)	204 (78.5)	65,842	79,773
101,000 – 200,000	7 95.2)	21 (16.8)	28 (10.8)		
210,000 – 300,000	2 (1.9)	9 (7.2)	11 (4.2)		
301,000 – 400,000	1 (0.7)	8 (6.4)	9 (3.5)		
401,000 – 500,000	0	5 (4.0)	5 (1.9)		
>500,000	0	4 (3.2)	4 (1.5)		

Figures in parentheses are percentages

5.2 Crop Farmers' Perception of Efficacy and Accessibility of Agrochemicals

Table 5.10 presents the result of crop farmers' sources, efficacy, and accessibility of agrochemicals. Majority (52.6% and 50.4%) of the crop farmers in Ondo and Kaduna State,respectively patronized the input traders. Analysis showed that 34.6%, and 32.3% bought pesticides from agro-service centers and open market respectively. Only 5.0% bought pesticides from licensed vendors and the others bought from vendors they knew but werenot sure about the license. This result confirms the findings of Mokwunye *et al*. (2012)that the source of pesticides used by the farmers includes agrochemicals retailers, traders, and Agricultural Development Programmes (ADPs).

With respect to distance to source of agrochemical, though majority (50.4%) of the crop farmers travelled less than 20 Kilometers to purchase agrochemicals, 49.6% of them travelled over 20 kilometers to buy agrochemicals. There is no doubt that farmers located far away from reputable sources might find it easier to patronize sources (pesticide sellers) who are not reputable. The negative consequence of this is that the farmers might have been exposed to fake, adulterated and obsolete pesticides with further resultant effects of agrochemical failure. Closeness to reputable sources of agrochemicals would enhance the adoption of recommended practices relating to the use of genuine products as declared by Amsalu and De Graaff (2006).

Furthermore, most (51.2%) of the crop farmers perceived the efficacy of agrochemicals to be just average. In fact, 11.5% perceived the efficacy to be poor. Two reasons can be adduced for this finding. The first one is that farmers might have used fake or adulterated chemicals in the past. The other reason might be that such farmers might have misused the chemical due to lack of training. Above all, many (43.8%) of the crop farmers declared their dissatisfaction with the efficacy of agrochemicals. This finding corroborates that of NAERLS and NPAFS (2013) who lamented the prevalence of fake and adulterated pesticides in the Nigerian market.

Oncrop farmers' perception of accessibility of agrochemicals; many (42.3%) of the farmers perceived the accessibility of agrochemical as poor or not accessible. Majority (57.7%) of the crop farmers who perceived agrochemicals as accessible or highly accessible might have been those who are closer to the urban areas where agrochemicals are easily found. The truth, however, is that farmers who need agrochemicals abound more in the rural areas. This underscores the need for agrochemical sales to be visible in the rural areas.

Table 5.10: Distribution of crop farmersbased on sources, perception of efficacy, and accessibility of agrochemicals

Variable	Kaduna (n=135)	Ondo (n=125)	Both (n=260)
Source of agrochemicals*			
Agro-service center	38 (28.1)	52 (41.6)	90 (34.6)
Input traders	71 (52.6)	63 (50.4)	134 (51.5)
Research Institute	2 (1.5)	2 (1.6)	4 (1.5)
Open market	45 (33.3)	39 (31.2)	84 (32.3)
Licensed vendor	5 (3.7)	8 (6.4)	13 (5.0)
Distance to source (Km)			
< 20	70 (51.9)	61 (48.8)	131 (50.4)
21 – 40	30 (22.2)	23 (18.4)	53 (20.4)
41 – 60	10 (7.4)	7 (5.6)	17 (6.5)
61 – 80	7 (5.2)	14 (11.2)	21 (8.1)
81 – 100	14 (10.4)	12 (9.6)	26 (10.0)
Above 100	4 (2.9)	8 (6.4)	12 (4.6)
Perception of efficacy of agrochemical			
High	53 (39.3)	44 (35.2)	97 (37.3)
Fair	64 (47.4)	69 (55.2)	133 (51.2)
Poor	18 (13.3)	12 (9.6)	30 (11.5)
Perception of accessibility of agrochemical			
Highly accessible	4 (2.9)	15 (12.0)	19 (7.3)
Accessible	70 (51.8)	61 (51.2)	131 (50.3)
Poorly accessible	54 (40.0)	41 (32.8)	95 (36.5)
Not accessible	7 (5.2)	8 (6.4)	15 (5.8)
Perception of timeliness of supply			
Timely	92 (68.1)	87 (69.6)	179 (68.8)
Not timely	43 (31.8)	38 (30.4)	81 (31.2)

*Multiple responses indicated

Figures in parentheses are percentages

5.2.1 Types of agrochemicals used by crop farmers

Pesticides commonly used by crop farmers are presented in Table 5.11. Glyphosate, paraquat, and atrazine was found as commonly used herbicides by majority (88.8%, 73.5%, and 65% respectively) of the crop farmers. For insecticides, chlopyrifos and cypermethrin were the most used as indicated by majority (60.8%, and 56.2%, respectively). Metalaxyl-M was the most widely used fungicide as indicated by 61.1% of the crop farmers. The high consumption of fungicide in Ondo State could not be unconnected with the prevalence of fungal attack on cocoa, the production of which the State is noted for. More so, Ondo State is more humid than Kaduna State and high humidity favours disease development. Different pesticides are used for different products (crops) depending on the problem and situation. Different companies produce pesticides that contain the same active ingredient, which are sold under several trade names. The active ingredient (abbreviated as a.i.) is the compound that is used to control the harmful organism. Its ability to kill, harm or deter a certain pest or disease has been proven and its use for this purpose is authorized through a registration process. Pesticides used in Nigeria include certain chemicals that for environmental reasons, have been partially or completely banned in developed countries, but for which effective cheap substitutes have yet to be evolved. Such chemicals continue to find their way into Nigeria for pest control (Akinyosoye, 2005).

Table 5.11: Types of agrochemicals used by crop farmers*

Pesticide Group	Types of agrochemicals used	Kaduna (n=135)	Ondo (n=125)	Both (n=260)
Herbicides	Glyphosate	119 (88.1)	112 (89.6)	231 (88.8)
	Paraquat	96 (71.1)	95 (76.0)	191 (73.5)
	Atrazine	88 (65.2)	81 (64.8)	169 (65.0)
	Atrazine + Metolachlor	69 (51.1)	63 (50.4)	132 (50.8)
	Butachlor	47 (34.8)	42 (33.6)	89 (34.2)
	2-4-D	15 (11.1)	17 (13.6)	32 (12.3)
Insecticides	Chlorpyrifos	77 (57.0)	81 (64.8)	158 (60.8)
	Cypermethrin	77 (57.0)	69 (55.2)	146 (56.2)
	Carbufuran	33 (24.4)	28 (22.4)	61 (23.5)
	Dichlorvos	74 (54.8)	65 (52.0)	139 (53.5)
	Cypermethrin+Dimethoate	23 (17.0)	11 (8.8)	34 (13.1)
	Imidachloprid	13 (9.6)	10 (8.0)	23 (8.8)
	Aluminium phosphide	9 (6.7)	12 (9.6)	21 (8.1)
	Lambda-cyhalothrin+Dimethoate	8 (5.9)	7 (5.6)	15 (5.8)
	Dimethoate	40 (29.6)	20 (16.0)	6 (2.3)
Fungicides	Metalaxyl-M	37 (27.4)	102 (81.6)	159 (61.1)
	Carbendazim	28 (20.7)	91 (72.8)	129 (49.6)
	Copper hydroxide	19 (14.1)	105 (84.0)	124 (47.7)
	Mancozeb	19 (14.1)	54 (43.2)	75 (28.8)
	Copper hydroxide + Metalaxyl-M	9 (6.7)	64 (51.2)	73 (28.1)
	Mancozeb + carbendazim	7 (5.2)	31 (24.8)	38 (14.6)

*Multiple responses indicated
Figures in parenthesis are percentages

5.2.2 Years of use of agrochemicals by crop farmers

The number of years that farmers had been using agrochemicals was high in both States (Table 5.12). Agrochemicals have been used for 15 years and above by crop farmers in Ondo (40%) and Kaduna (33.3%) States. The general indication is that individuals with more experience in using agrochemicals would likely adopt RAPs. Tekwa *et al.* (2010) found that farmers in Adamawa State had 16 – 20 years of experience in herbicide use.

Table 5.12: Distribution of crop farmers by years of agrochemical use (n=260)

Years of use of agrochemicals	Kaduna	Ondo	Mean Kaduna	Mean Ondo
5 – 14	90 (66.7)	75 (60.0)	13.1	13.55
15 – 24	28 (20.7)	37 (29.6)		
25 – 34	13 (9.6)	9 (7.2)		
35 and Above	4 (2.9)	4 (3.2)		

5.2.3Changes in the quantity of pesticides used in the last 5 years and how pesticides were stored by crop farmers

The amount of pesticides usedby the farmers in the last 5 years had increased as indicated by 69.6% of the crop farmers whereas 20.4% indicated that the amount of pesticide used decreased (Table 5.13). Increased use of agrochemicals was more in Kaduna State (compared to Ondo State) as indicated by 88.1% of the crop farmers. The possible reason could be that over 54% of the farmers in Kaduna State perceived agrochemicals as accessible (Table 5.10). This implies that pesticide use by farmers in Nigeria is on the increase. NAERLS and FDAE (2014) and Keri (2009) confirmed this findings too. Amera and Abate (2008) found similar result in an assessment of pesticide use by farmers in Ethiopia.Hence, the need for farmers to adopt RAPs is dire. Majority (75%) store their pesticides in a separate place specified for pesticide storage. However, 25% of them store their pesticides in undesignated places in the house such as living room, kitchen, and toilet. The practice of preparing and storing of pesticide at home might expose children and adults to hazardous risks.

Table 5.13: Changes in the quantity of yearly pesticides used and how pesticides were stored by crop farmers in the last 5 years

Variable	Kaduna (n=135)	Ondo (n=125)	Both (n=260)
Direction of change in the quantity of pesticide use			
Increased	119 (88.1)	62 (49.6)	181 (69.6)
Decreased	6 (4.4)	47 (37.6)	53 (20.4)
Same	4 (2.9)	12 (8.9)	16 (6.2)
Don't know	6 (4.4)	4 (3.2)	10 (3.8)
Storage places			
Separate store	85 (62.9)	110 (88)	195 (75.0)
Living room	40 (29.6)	6 (4.8)	46 (17.7)
Kitchen	10 (7.4)	2 (1.6)	12 (4.6)
Toilet	0	6 (4.8)	6 (2.3)
Anywhere	0	1 (0.8)	1 (0.4)

Figures in parenthesis are percentages

5.2.3.1 Reasons for changes in the quantity of pesticides used by crop farmers

Result presented in Table 5.14 shows the reasons for the changes in the amount of pesticides used by crop farmers. For those who indicated that the amount of pesticides used increased; many (42.2%) indicated prevalence of pests and diseases as the reason. This corroborates the findings of NAERLS and FDAE (2014) that increased pressure of pests and diseases of crops occurred during the 2014 season. Stoll (2000) asserted that there have been cases of pests becoming tolerant or resistant to pesticides, resulting in the use of double and triple application rates.

Many (33.7%) of those who indicated decrease in the quantity of pesticide used did so because of high cost of pesticides. Similar result was found by NAERLS and FDAE (2014). Also, non-expansion in farm size was indicated by majority (75%) as the reason for using the same quantity of pesticide. Few (5.9% and 1.6% for Kaduna and Ondo State, respectively) of the crop farmers did not know whether or not there were changes in the quantities of pesticides they appliedon their farms over the years. This could be due to lack of good record keeping.

Table 5.14: Reasons for the changes in pesticide used by crop farmers

Reasons	Kaduna	Ondo	Both
Reasons for increased quantity	**(n=91**	**(n=90**	**(n=181)**
Prevalence of pests and diseases	41 (45.1)	38 (42.2)	79 (42.2)
Increase in farm size	30 (32.9)	29 (32.2)	59 (32.6)
Chemical less effective	13 (14.3)	9 (10.0)	22 (11.8)
High cost of labour	5 (5.5)	10 (11.1)	15 (8.0)
Ageing of plantation	0	3 (3.3)	3 (1.7)
Subsidized price	2 (2.2)	1 (1.1)	3 (1.6)
Reasons for decreased quantity	**(n=26)**	**(n=27)**	**(n=53)**
High cost	11 (42.3)	9 (33.3)	20 (37.7)
Use of IPM	6 (23.1)	11 (40.7)	17 (32.1)
Reduced incidence of pests and diseases	6 (23.1)	5 (18.5)	11 (20.8)
Effectiveness of chemical	3 (11.5)	2 (7.4)	5 (9.4)
Reasons for same quantity	**(n=10)**	**(n=6)**	**(n=16)**
No expansion of farm	8 (80.0)	4	12 (75.0)
Proper usage	2 (20.0)	2	4 (25.0)

Figures in parenthesis are percentages

5.2.3.2 Time of acquisition of agrochemicals by crop farmers

Majority (52.8%) of the crop farmers in Ondo preferred to buy agrochemicals when the need arose, while farmers in Kaduna State (50.1%) preferred to buy at the beginning of the cropping season (Table 5.15).

Table 5.15: Distribution of crop farmers based on the time of the year when agrochemicals were acquired

Time of the year when crop farmers acquired agrochemicals	Kaduna(n =135)	Ondo (n=125)	Both (n=260)
Beginning of the cropping season	73 (50.1)	34 (27.2)	107 (41.2)
End of cropping season	0 (0)	16 (12.8)	16 (6.2)
When the need arises	58 (42.9)	66 (52.8)	124 (47.7)
When it is available for sale	4 (2.9)	9 (7.2)	13 (5.0)

Figures in parenthesis are percentages

5.2.4 Possession and use of spraying equipment

Generally, most of the crop farmers did not possess most of the spraying equipment in both Kaduna and Ondo States. Majority (94.4%, and 58.5%) of the crop farmers in Ondo and Kaduna State,respectively possessedonly sprayers (Table 5.16).

The issue of wearing prescribed attire when spraying is a vital precaution against hazard during farm operation. Result in Table 5.17 indicates that crop farmers in both Kaduna and Ondo States did not use spraying apparels during spraying. This implies that crop farmers were exposed to the risks of agrochemicals. Lack of safety precautions causes contamination and poisoning in the field. Unfortunately, investments in protective clothing, masks or gloves by farmers only pay back in terms of health and well-being, not in financial terms.

Most farmers are ignorant of the hazardous effects of pesticides and are very unlikely to buy protective clothing, especially in cases where they are scarce. The finding of this study is consistent with the assertion of Meijden (1998) that in Nigeria generally, farmers do not wear any protective materials at all, no matter what pesticide is being applied. Other precautionary measures are scarcely observed by these farmers as they are found eating, smoking or drinking in-between spraying activities. This finding indicates that farmers take their health for granted when using agrochemicals on their farms.

For most pesticides, using protective measures results in a decrease of exposure to pesticides. Similar reductions are seen for farm workers using gloves compared to those not using gloves (Woodruff *et al.,* 1994). Murray (2002) reported that there exists risk when agrochemicals are used without protective clothing and hence the risk of contamination.

Table 5.16: Distribution of crop farmers based on possession of spraying equipment

Items	Possession			Non-possession		
	Kaduna (n=135)	Ondo (n=125)	Both (n=260)	Kaduna (n=135)	Ondo (n=125)	Both (n=260)
Sprayer	79 (58.5)	118 (94.4)	197 (75.8)	56 (41.5)	7 (5.6)	63 (24.2)
Overall	27 (20)	60 (48)	87 (33.5)	108 (80)	65 (52)	173 (66.5)
Goggles	3 (2.2)	26 (20.8)	29 (11.2)	132 (97.8)	99 (79.2)	231 (88.8)
Boot	69 (51.1)	89 (71.2)	158 (60.8)	66 (48.9)	36 (28.8)	102 (39.2)
Gloves	21 (15.6)	61 (48.8)	82 (31,5)	114 (84.4)	64 (51.2)	178 (68.5)
Respirator	2 (1.5)	15 (12)	17 (6.5)	133 (98.5)	110 (88)	243 (93.5)
Mask	2 (1.5)	36 (28.8)	38 (14.6)	133 (98.5)	89 (71.2)	222 (85.4)
Hat	25 (18.5)	54 (43.2)	79 (30.4)	110 (81.5)	71 56.8)	181 (69.6)

Figures in parenthesis are percentages

Table 5.17: Frequency of crop farmers' use of spraying apparels

Items	Often		Occasionally		Never		Weighted sum		Weighted mean	
	Kaduna (n=135)	Ondo (n=125)	Kaduna (n=135)	Ondo (n=125)	Kaduna (n=135)	Ondo (n=125)	Kaduna	Ondo	Kaduna	Ondo
Overall	28 (20.7)	15 (12)	17 (13.6)	44 (35.2)	90 (66.6)	66 (52.8)	208	199	1.54*	1.59*
Goggles	0	9 (7.2)	3 (2.2)	17 (13.6)	132 (97.7)	99 (79.2)	138	160	1.02*	1.28*
Boot	9 (6.7)	49 (39.2)	23(17.0)	13 (9.6)	103 (76.3)	63 (50.4)	176	236	1.30*	1.88*
Gloves	8 (5.9)	16 (12.8)	32 (23.7)	27 (20)	95 (70.3)	82 (65.6)	183	184	1.35*	1.47*
Respirator	0	2 (1.6)	2 (1.5)	4 (3.2)	133 (98.5)	119 (95.2)	137	131	1.01*	1.05*
Mask	0	2 (1.6)	2 (1.5)	12 (9.6)	133 (98.5)	111 (88.8)	137	141	1.01*	1.13*
Hat	3 (2.2)	8 (6.4)	20 14.8)	8 (6.4)	112 (82.9)	109 (87.2)	161	149	1.19*	1.19*
Weighted mean average									1.20*	1.37*

Figures in parenthesis are percentages,
*Not Used

5.2.5 Other methods of pest and disease control used by crop farmers

While land preparation was the most frequently used method of pest and disease control in Kaduna State as indicated by 72.6% of the crop farmers; regular weeding was indicated by majority (74.4%) of crop farmers in Ondo State (Figure 5.1). Use of local plant extracts was not reported by farmers in both Kaduna and Ondo States. This negates the findings of Roy *et al.* (2005) that the use of such plant extracts to control pests is not a new innovation, as it has been widely used by small-scale subsistence farmers. Scientists are now experimenting and working to prevent or reduce pest infestation using indigenous plant materials (Roy *et al*., 2005).

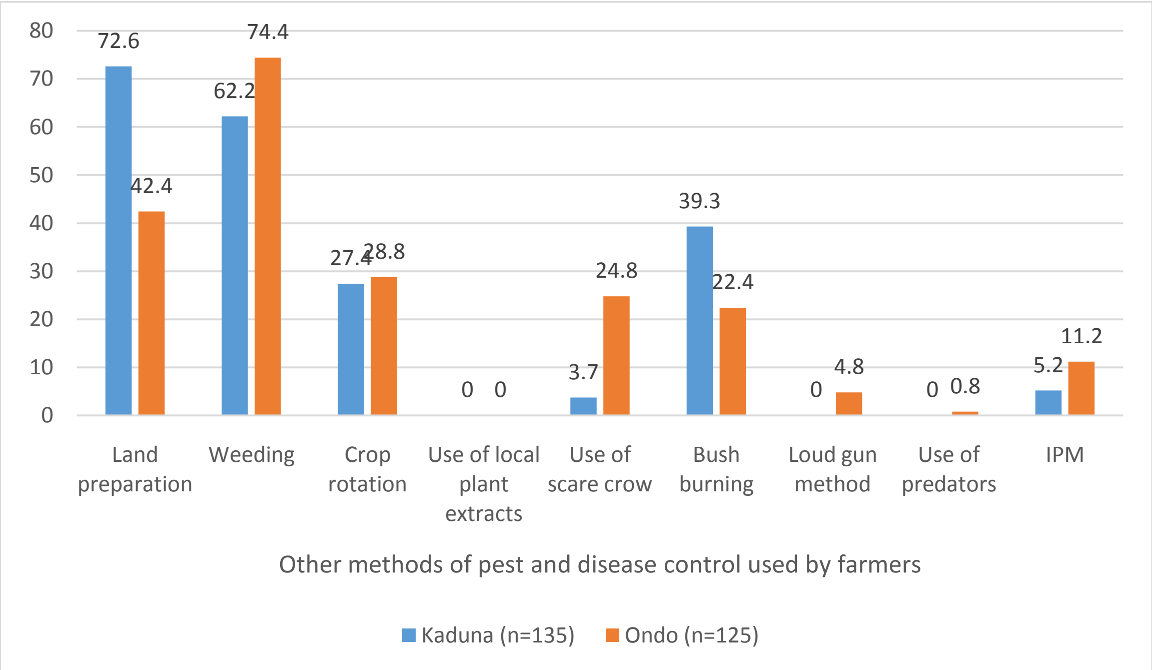

Figure 5.1: Distribution of crop farmers based on other methods used for pest and disease control*

*Multiple responses indicated

5.2.6Methods of disposal of empty containersby crop farmers

Methods of disposing empty containers of agrochemicals used by the farmers are presented in Figure 5.2. While some (35.6%) farmers in Kaduna State washed and used the empty pesticides containers for domestic purposes, most (41.6%) farmers in Ondo State buried the containers.

This finding partly corroborates that of Dugje *et al.* (2008) that the left over pesticides and empty containers are not properly disposed as the containers are sometimes washed and used for domestic purposes or thrown anywhere. Disposal of empty containers in local waste containers or by washing and reusing the containers at home could expose the public to hazardous risks. Such practices were considered to be one of the main problems associated with pesticide use in developing countries (Wesseling *et al.*, 1997; Dugje *et al.*, 2008). WHO recommended puncturing any empty pesticide containers that cannot be returned to the supplier as a way of preventing the practice of reusing empty pesticide containers (WHO, 1991).

Empty pesticide containers should be safely disposed off immediately in a way that will not cause hazard to man, animals, and valuable plants. Empty paper containers should also not be left lying about as they may be blown away and end up in the wrong location. Empty paper packages and cartons are also supposed to be burnt and ashes buried unless there is an instruction not to do so on the package. Dugje *et al.* (2008) however, declared that pesticides containers should not be burnt except in incinerators designed for this purpose. Fumes from burning pesticides could be poisonous, if inhaled. Punch holes in pesticide containers, flatten them and then bury them deep in the ground in locations where the possibility of contaminating a water supply is minimal. Glass containers should be broken and then buried.

There is evidence of poor pesticide education and misuse in Nigeria, for instance a situation where over dosage for the purpose of effecting rapid kill of crop pests is common among government trained, or agency trained and assisted small-scale farmers (Ivbijaro, 1998). It has also been noticed that these farmers sometimes use these pesticides for purposes other than that for which they are manufactured. Some stunning revelations of pesticide misuse have been reported by some scientists (Ivbijaro, 1977; Youdeowei, 1989; Ivbijaro, 1990, 1998; Dugje *et al.*, 2008) as follows:i) Lindane formerly used for the control of cocoa mirids is poured into rivers, lakes and streams to kill fish, which is then sold for human consumption.ii) Spraying Gamalin 20 on drying cocoa beans to prevent moulds and maggot development.iii) Careless disposal of expired pesticides and use of pesticide containers for domestic purposes.iv) Spraying pesticide using leaves deepen in open buckets.

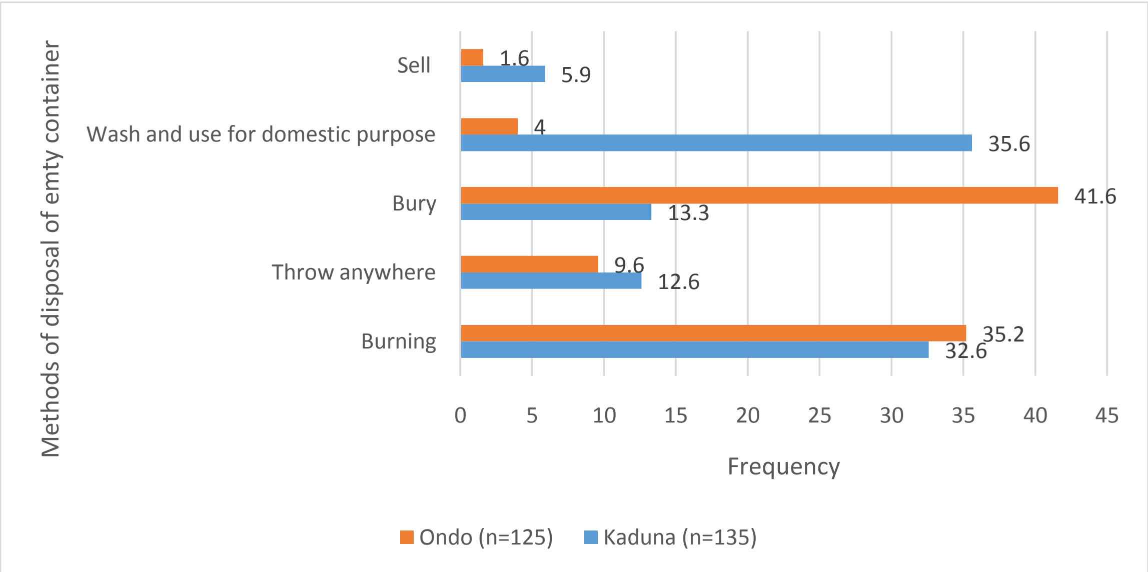

Figure 5.2: Distribution of crop farmers according to methods of disposal of empty containers

5.3 Farmers'Level of Knowledge of Recommended Agrochemical Practices

Result in Table 5.18 indicates that most farmers in Kaduna and Ondo States had good knowledge and understanding of the recommended agrochemical practices (M=2.12 and 2.16, respectively). Farmers' level of knowledge of RAPs was found to be generally higher in Ondo State compared to Kaduna State. The reason for this could be due to the fact that the number of farmers trained on RAPs in Ondo State was higher as reported in Table 5.6. More so, the ADP was ranked as the most useful source of information available to farmers in Ondo State thus, makig this finding not surprising.

Generally, purchasing pesticide from reputable source (M=2.37) and checking if seals and original label have not been broken (M=2.66) recorded the highest weighted mean in Kaduna and Ondo State, respectively. Furthermore, proper calibration of sprayer recorded the lowest weighted mean of 1.48 and 1.49 in Kaduna State and Ondo State, respectively. This implies that crop farmers in both States did not know how to calibrate sprayers for spraying of pesticides.

Knowledge had been identified as an important variable in the adoption decision of a farmer. This is because a farmer cannot adopt if he/she did not know the recommended practices. The high level of knowledge of RAPs found in this study was similar to the findings of Ohayo-Mitoko *et al.,* 2000; Yassin *et al*., 2002 and Salameh *et al*., 2004 in Kenya, Israel, and Lebanon, respectively.

Table 5.18: Level of crop farmers' knowledge of RAPs

Variables	Level of Knowledge									
	FullKnowledge		Partial Knowledge		No Knowledge		Weighted Sum		Weighted Mean	
	K	O	K	O	K	O	K	O	K	O
Genuine Product									**2.25****	**2.44****
Purchasing from reputable source	222	225	74	60	24	20	320	305	2.37	2.44
Avoid using expired/banned chemicals	180	207	90	70	30	21	300	298	2.22	2.38
Using the appropriate agrochemicals	156	180	94	86	36	22	286	288	2.12	2.30
Checking that seals and original labels have not been broken	189	255	10 4	76	20	2	313	333	2.32	2.66
Avoid buying chemical too early in the growing season	177	189	90	108	31	7	298	304	2.21	2.43
Equipment Calibration									**1.98****	**2.15****
Proper calibration of sprayer	48	36	66	74	86	76	200	186	1.48	1.49
Using the right dosage	129	159	98	112	43	16	270	287	2.00	2.29
Regular repair and maintenance of spraying equipment	216	207	66	62	30	15	312	284	2.31	2.27
Using the right equipment	186	213	80	102	22	3	288	318	2.13	2.54
Application Techniques									**2.26****	**2.49****
Following labeling instructions	201	225	74	90	31	5	306	320	2.27	2.56
Avoid spraying against wind direction	186	198	92	88	27	15	305	301	2.26	2.41
Health and Safety									**1.89****	**2.32****
Wearing protective clothing	204	249	80	82	27	1	311	332	2.30	2.66
Keep herbicides separate from other types of pesticides	63	114	11 0	126	59	24	232	264	1.72	2.11
Observation of the waiting period	159	177	92	102	36	15	287	294	2.13	2.35
Avoid entering sprayed farm until 12 hours after spraying	93	114	82	94	63	40	238	248	1.76	1.98
Avoid mixing herbicide with fungicide	204	213	78	92	28	8	310	313	2.29	2.50
Check stored pesticides regularly for sign of damage or leakages	150	144	90	92	40	31	280	267	2.07	2.14
Applying the agrochemical at the right time	177	189	96	106	28	9	301	304	2.23	2.43
Never store pesticides in living rooms, kitchen, animal house or toilets	147	162	82	90	45	26	274	278	2.03	2.22
Avoid leaving pesticides in equipment overnight	168	210	78	84	40	13	286	307	2.12	2.46
Avoid eating, drinking and smoking during spraying	189	195	78	88	33	16	300	299	2.22	2.39
Environmental Safety									**2.09****	**2.35****
Proper handling and storage of agrochemical	156	171	78	86	44	25	278	282	2.06	2.26
Proper disposal of empty container	117	162	68	78	62	32	247	272	1.83	2.18
Avoid using chemical for different purpose e.g. treating animal wound	177	219	74	82	39	11	290	312	2.15	2.49
Keep pesticides away from source of drinking water, wells, & streams	219	219	68	72	28	16	315	307	2.33	2.46
Weighted Mean Average									**2.12****	**2.16****

5.4 Farmers' Level of Adoption of Recommended Agrochemical Practices (RAPs)

The distribution of farmers based on level of adoption of RAPs is shown in Table 5.19. All the recommended practices were yet to gain grounds as they generally recorded poor adoption. Many farmers were aware of the recommended practices but were unwilling to adopt them. For proper understanding, recommended practices were categorized into five (5). These are application techniques, health and safety, environmental safety, genuine products, and equipment calibration. An overall adoption mean of 1.43 and 1.66 was generally obtained in Kaduna and Ondo State, respectively for the whole RAPs examined.

Items measured under equipment calibration recorded the lowest level of adoption in both State. This is in line with the result presented in Table 5.19 where equipment calibration recorded the lowest weighted mean in terms of farmers' level of knowledge. This could be a result of the high technicalities involved in equipment calibration. Improper calibration could result in high or low dosage thereby resulting in undesired result i.e. leading to either poisoning or agrochemical failure, respectively. Some farmers still mix herbicide in open buckets and apply the chemicals using leaves. Irregular repair and maintenance of equipment recorded a weighted mean of 1.30 and 1.55 in Kaduna and Ondo State, respectively implying that farmers did not have good maintenance culture for their pesticide spraying equipment. Sprayer calibration is usually proposed and taught in research and training institutions, but it is hardly ever done in practice, which usually results in the use of wrong dosage of pesticides. Calibration of sprayers is very essential even when they are in perfect working conditions.

Table 5.19: Level of crop farmers' adoption of Recommended Agrochemical Practices

Variables	Level of Adoption									
	Very Often		Seldom		Never		Weighted Sum		Weighted Mean	
	Kaduna	Ondo	Kaduna	Ondo	Kaduna	Ondo	Kaduna	Ondo	Kaduna	Ondo
Genuine Product									**1.57***	**1.71***
Purchasing from reputable source	63	60	42	50	93	80	198	190	1.47	1.52
Avoid using expired/banned chemicals	57	63	40	62	96	73	193	198	1.43	1.58
Using the appropriate agrochemicals	21	27	146	152	55	40	222	219	1.64	1.75
Checking that seals and original labels have not been broken	78	90	68	76	75	57	221	223	1.64	1.78
Avoid buying chemical too early in the growing season	99	111	78	82	63	47	240	240	1.78	1.92
Equipment Calibration									**1.26***	**1.42***
Proper calibration of sprayer	12	27	38	50	112	86	162	163	1.20	1.30
Using the right dosage	33	62	22	28	113	85	168	175	1.24	1.40
Regular repair and maintenance of spraying equipment	30	60	42	43	104	78	176	181	1.30	1.45
Using the right equipment	33	75	38	50	105	70	176	195	1.30	1.56
Application Techniques									**1.69***	**1.92***
Following labeling instructions	24	39	30	50	112	87	166	176	1.23	1.41
Avoid spraying against wind direction	183	195	68	94	40	13	291	302	2.16	2.42
Health and Safety									**1.31***	**1.49***
Wearing protective clothing	9	21	14	22	125	107	148	150	1.09	1.20
Keep herbicides separate from other types of pesticides	9	24	14	24	125	105	148	153	1.09	1.22
Observation of the waiting period	12	24	22	38	120	98	154	160	1.14	1.28
Avoid entering sprayed farm until 12 hours after spraying	12	27	20	38	122	97	154	162	1.14	1.29
Avoid mixing herbicide with fungicide	15	27	22	48	119	92	156	167	1.16	1.34
Check stored pesticides regularly for sign of damage or leakages	33	51	42	58	103	79	178	188	1.32	1.50
Applying the agrochemical at the right time	30	51	52	72	99	72	181	195	1.34	1.56
Never store pesticides in living rooms, kitchen, animal house or toilets	45	66	50	60	95	73	190	199	1.41	1.59
Avoid leaving pesticides in equipment overnight	33	69	56	70	96	67	185	206	1.37	1.65
Avoid eating, drinking and smoking during spraying	147	159	90	110	41	17	278	286	2.06	2.29
Environmental Safety									**1.35***	**1.68***
Proper handling and storage of agrochemical	24	36	40	54	107	86	171	176	1.27	1.41
Proper disposal of empty container	33	60	26	80	111	65	170	205	1.26	1.64
Avoid using chemical for different purpose e.g. treating animal wound	51	90	30	76	103	57	184	223	1.36	1.78
Keep pesticides away from source of drinking water, wells, & streams	54	111	62	70	86	53	202	234	1.49	1.87
Weighted Mean Average									**1.43***	**1.66***

*Low adoption

The spraying of crop with overdose of pesticides would result in farmers incurring huge financial losses due to wastage and phytotoxicity, which would decrease crop yields.

However, Meijden (1998) asserted that the major risk of overdose or under-dose is the increased likelihood for the pests to develop resistance against pesticides, which can have devastating large-scale effects on crop production.

Health and safety measures in the use of agrochemicals were mainly not adopted by the crop farmers despite their level of knowledge. Non-wearing of protective clothings, non-observance of waiting period, entering sprayed farm less than 12 hours after spraying, and mixing herbicides with fungicides were common practices among farmers. It is well recognized that if a pesticide is applied too close to harvesting date, toxic substances are probably retained in consumer food. Ekanayaka and Wijeratne (2004) reported that farmers in Sri Lanka did not adhere to the pre-harvest interval (PHI) (waiting period). Farmers harvested their crops just 4–7 days after pesticide application instead of the recommended 14 days after using Bencarb. Two families lost key members when they slept in the same room where cowpea treated with fumigants was stored, due to inhalation of toxic gases. Three contract sprayers lost their lives when they sprayed insecticides to control cowpea insect pests without wearing suitable protective clothing (Dugje *et al.,* 2008). Farmers often find that protective clothing is uncomfortable to wear and choose not to use it, which adds unnecessary risk.

Studies have shown negative attitudes towards special protective clothing (Rucker *et al.* (1998) Gomes *et al.* (1999), and Mekonnen and Agonafir (2002). In the study by DeJonge *et al.* (1983), farm workers felt positive towards a traditional work shirt-and-jeans-type outfit. As an alternative to standard, often uncomfortable personal protective devices, the use of traditional work clothing fabrics with selected chemical finishing has been suggested (Csiszar, 1998).

In the same vein, environmental safety measures were poorly adopted by the crop farmers. Proper handling and storage of pesticides as well as proper disposal of empty containers recorded the lowest weighted mean of 1.33 and 1.48 respectively.Generally, items categorized under ‘genuine products’ also recorded low adoption. This indicates that the farmers used inappropriate chemicals, used banned/expired chemicals; and still purchased chemicals from non-reputable sources.

Youdeowei (1989) noted that the pesticide regulatory role of the Nigerian government is generally not carried out satisfactorily. The effective control of pesticides in the West-African sub-region remains poor and seriously hampered by several factors including lack of proper legislative authority; shortage of personnel in pesticide regulatory procedures, lack of infrastructure, transportation, equipment and materials.It must be noted that only two items were fairly adopted by the crop farmers i.e. avoid spraying against the wind (2.28), and avoid eating/drinking/smoking during spraying (2.17). This could be due to the fact that non-compliance with both practices usually has instant and direct consequences on human health.

Similar to the findings of Raksanam *et al.* (2012), Isin and Yildirim (2007) have reported that although, farmers (in Turkey) read the recommendations and instructions on pesticides’ labels, less than 60% of them exactly followed the directions. Some of them prefer to use unsuitable pesticides in order to ensure the yield and quality of fruits. Several factors such as nonchalant attitude, might account for this apparent reckless attitude regarding self-protection by the farmers.

Ntow *et al.* (2006) tested the perceptions of farmers about chemicals' potential for causing harm among vegetable farmers in Ghana. They found that various inappropriate practices in the handling and use of pesticides caused possible poisoning symptoms among farmers who generally did not wear protective clothing.

5.5 Farmers' Knowledge of the Consequences of Non-Adoption of Recommended Agrochemical Practices (RAPs)

5.5.1 Sources of knowledge of risks and hazards of pesticide

All (100%) the crop farmers had knowledge (full or partial) of the risks and hazards associated with pesticides usage. Only 20% of the crop farmers however, indicated input traders as source of knowledge on these issues (Table 5.20). This result could be because the major aim of the input trader is to make profit and maytherefore, not emphasize the risks and hazards of pesticides.

Table 5.20: Farmers' sources of awareness of risks and hazards of pesticides

Sources	**Kaduna (n=135)**	**Ondo (n=125)**	**Both (n=260)**
Agricultural officer	72 (53.3)	93 (74.4)	165 (63.5)
Health officer	1 (0.7)	3 (2.4)	4 (1.5)
Input trader	34 (25.2)	18 (14.4)	52 (20.0)
Personal experience	28 (20.7)	11 (8.8)	39 (15.0)

Figures in parenthesis are percentages

5.5.2 Farmers' Knowledge of pesticide-related discomfort/illness

Crop farmers had knowledge of the various pesticide-related discomforts/illnesses. Majority (64% and 51.8%) knew that skin and eye irritation respectively, were consequences of non-adoption of RAPs (Table 5.21). Bull (1982) reported regular and widespread incidence of poisoning and misuse of pesticides. Improper handling of pesticides could cause various discomforts. Zyoud *et al.* (2010) found that the common symptoms exhibited after pesticide application among the farm workers were skin rash, headache, excessive sweating, and diarrhea. Ntow (2008) found that the most frequently reported possible pesticide poisoning symptoms were body weakness and headache/dizziness.

A study by Udoh (2009) on pesticide use in Akwa-Ibom State, Nigeria found unsafe practices of storage and application of pesticides among farmers. He asserted that more than 600,000 farming households in the State might have been exposed to various problems due to poor handling and use of pesticides.

The findings of this study could be due to the poor maintenance of spraying equipment especially with the use of highly toxic pesticides. Many of the Class I (highly or extremely toxic) pesticides are still being used in developing countries (Friedrich, 1996). A major cause of poisoning when using knapsack or trombone sprayer is the spilling of pesticides over the back of the operator because of a faulty locking cap of the container. Cracks and leaks in containers and in over-aged rubber hoses, and not renewing or loosing washers caused leakages that often poison the user, wastes pesticides, causes environmental pollution and may become phytotoxic where pesticides fall on crops at high doses (Meijden, 1998).

Table 5.21: Distribution of crop farmersbased onknowledge of pesticide-related discomfort/illness*

Types of Discomfort/Illness	**Kaduna (n=74)**	**Ondo (n=65)**	**Both (n=260)**
Skin irritation	51 (68.9)	48 (73.8)	89 (64.0)
Eye irritation	42 (56.8)	30 (46.2)	72 (51.8)
Head/body ache	25 (33.8)	18 (27.7)	43 (30.9)
Nausea (stomach upset)	23 (31.1)	17 (26.2)	40 (28.7)
Vomiting	9 (12.2)	5 (7.7)	14 (10.1)
Cramps (muscle pain)	9 (12.2)	4 (6.2)	13 (9.4)
Fatigue/weakness	7 (9.5)	3 (4.6)	10 (7.2)
Excessive sweating	2 (2.7)	2 (3.1)	4 (2.9)

*Multiple responses indicated
Figure in parenthesis are percentages

5.5.3 Environmental hazards recorded by crop farmers

Burning of crop was indicated by majority (76.5% and 56.7%) of the crop farmers in Kaduna and Ondo State, respectively, as environmental hazards of pesticides (Table 5.22). Dugje *et al.* (2008) reported that whole fields of crops had been lost in many cases because the application of herbicides had been carried out wrongly.Pesticide use on cocoa farms has over the years become more specific and less toxic but environmental pollution still exists. However, since practically no data exist on this issue in Nigeria, the extent of the pollution of the agrarian communities can only be guessed.

Table 5.22: Distribution of crop farmers based on record of environmental hazards of pesticides

Environmental hazards	Kaduna (n=115)	Ondo (n=104)	Both (n=219)
Burning of crops	88 (76.5)	59 (56.7)	133 (60.7)
Contamination of food	23 (20.0)	19 (18.3)	25 (11.4)
Death of livestock/fish	18 (15.7)	14 (13.5)	28 (12.9)
Contamination of water	19 (16.5)	26 (25.0)	33 (15.1)

Figures in parentheses are percentages

Presently, there is neither any detailed research on environmental impact of pesticides in Nigeria nor any monitoring process in place. The only form of regulation involves the registration of brands of agro-chemicals by the National Agency for Food and Drug Administration and Control (NAFDAC) and screening and recommendation of pesticide formulations and spraying equipment by various research institutes with mandates for different crops. The procedures are to ensure that substandard products are not marketed in Nigeria and to confirm the efficacy of formulations offered for crop pest control.

5.6 Factors Influencing Adoption of RAPs by Crop Farmers: Hypotheses Testing

The 5th objective of this study was to determine the factors influencing adoption of RAPs. Results of multiple regression analysis of factors influencing adoption of RAPs are presented in Tables 5.23; 5.24 and 5.25.

5.6.1 Socio-economic characteristics influencing adoption of RAPs: Hypothesis one

The adjusted R^2 was 0.63, and 0.67 for Kaduna and Ondo State, respectively. This implies that 63% of the variations in the adoption of RAPs in Kaduna State was contributed by the independent variables specified in the model, while 67% of the variations in the adoption of RAPs in Ondo was contributed by the independent variables. This shows that the variables fit the model. Some variables were found to significantly influence adoption of RAPs ($P<0.01$, $P<0.05$, and $P<0.10$) in both States (Table 5.23). It was hypothesized that there is no significant relationship between farmers' socio-economic characteristicsand adoption level of RAPs.In Kaduna State, level of education (0.058, $P<0.05$), farming experience (0.017, $P<0.05$), social participaption (0.806, $P<0.10$) and cosmopoliteness (0.057, $P<0.10$) were found to significantly influence adoption of RAPs. For Ondo State, the variables were level of education (0.015, $P<0.01$), farming experience (0.032, $P<0.05$), social participation (0.300, $P<0.01$), and cosmopoliteness (0.004, $P<0.05$). These variables were strong determinants of adoption of RAPs among crop farmers. Therefore, contrary to the stated null hypothesis; farmers' socio-economic characteristics significantly influenced adoption of RAPs. Hence, the null hypothesis was rejected.

Table 5.23: Socio-economic characteristics influencing adoption of Recommended Agrochemical Practices (RAPs) in Kaduna and Ondo States

Variables	Kaduna State Coef.	Kaduna State Std. Err	Kaduna State Z	Ondo State Coef.	Ondo State Std. Err	Ondo State Z
Age	0.0002	0.002	0.13	0.0002	0.002	0.12
Gender	-0.005	0.079	0.07	-0.005	0.078	0.06
Farm size	0.006	0.007	-0.89	0.006	0.007	-0.87
Education	0.058	0.004	5.84***	0.065	0.004	4.17***
Farming exp.	0.017	0.008	2.15**	0.032	0.015	2.12**
Income	0.102	0.912	0.58	0.110	0.994	0.65
Household size	-0.011	0.003	-3.87	-0.009	0.002	-3.21***
Social participation	0.806	0.477	1.69*	0.300	0.500	4.55***
Cosmopoliteness	0.060	0.026	2.32**	0.004	0.002	2.14**
R^2	0.630			0.690		
Adjusted R^2	0.613			0.674		
***P<0.01						
**P<0.05						
*P<0.1						

A strongly positive and significant relationship was found between crop farmers' educational level and adoption of RAPs (0.058, P<0.01) and (0.015, P<0.01) for Kaduna and Ondo State, respectively. This implies that a unit increase in the educational level of the farmer will bring about 5% and 6% increase in adoption of RAPs in Kaduna and Ondo State, respectively. In other words, farmers with higher education were better adopters, a result consistent with the findings of Yasin *et al.* (2003). The probability of adoption given literacy is 58% and 65% in Kaduna State and Ondo States, respectively, making this factor the greatest driver of RAPs' adoption by crop farmers. Education creates a favourable mental attitude for the acceptance of new practices. Education affords a person the ability to read and understand sophisticated information that may be contained in a pesticide's package thereby increasing adoption. Farmers' exposure to education also increases their ability to obtain, process and utilize information relevant to the adoption of IPM technologies (Bonabana-Wabbi, 2002).

Cosmopoliteness was also found to have positive and significant relationship with adoption of RAPs in Kaduna (0.060, P<0.05) and Ondo State (0.004, P<0.05). This means that farmers who were more cosmopolite adopted RAPs more than the less cosmopolite ones. Okuthe, Kioli, and Abuom (2013) found a significant relationship between cosmopoliteness and adoption of integrated natural resource management (INRM)technologies. However, Munikrishnappa *et al*. (2002) from an analysis in Mysore district, observed that cosmopoliteness had a significant association with the knowledge level of small-scale sericulturists but were hampering the adoption of improved practices among small-scale farmers.

A positive and significant relationship was similarly found between years of farming experience and adoption of RAPs in Kaduna State (0.017, P<0.05) and Ondo State (0.032, P<0.05). The number of years that farmers had been using agrochemicals was high; recording a mean of 24.7 (Table 5.1). The general indication is that individuals with more experience in using agrochemicals, would likely adopt RAPs perhaps reflecting their experience. Ani (1998) and Iheanacho (2000) also indicated that farming experience of farmers, to a large extent, affects their managerial know-how and decision making. Namwata*et al.*(2010) reported that increased farming experience was positively and significantly associated with overall adoption of improved agricultural technologies among farmers in Tanzania. However, on the contrary, Adesope *et al*. (2012) found an inverse relationship between adoption of organic farming and farming experience which means that those with less farming experience have higher adoption level.

Experience of the farmer is likely to have a range of influence on adoption. Experience will improve farmers' skill at production. A more experienced farmer may have a lower level of uncertainty about the innovation's performance. Farmers with higher experience appear to have often full information and better knowledge and are able to evaluate the advantage of the technology considered. Therefore, it was hypothesized that farming experience has a positive influence on adoption of INRM technologies (Okuthe *et al.*, 2013; Bello *et al.*, 2010).

The relationship between adoption of RAPs and household size was weak and negative in Kaduna (-0.011) and Ondo State (0.002), which indicates that size of holding did not affect the adoption of RAPs in the study area. This implies an inverse relationship among Kaduna farmers, a finding consistence with Yasin *et al.* (2003). The result implies that the larger the household size; the less the likelihood of adoption of RAPs. It is logical that larger households means more economic pressure on households which can make adoption of some RAPs very difficult. Tokula *et al.*(2009) however, found household size to positively influence the adoption of improved cassava production technologies in Kogi State, Nigeria.

Farmers' sex had a negative but statistically insignificant coefficient in the model for both Kaduna State (-0.005) and Ondo State (-0.005). It is important to discuss the implications of this result. Contrary to previous studies suggesting gendered patterns in adoption due to women's limited access to resources including land and credit (Adesina *et al.*,2000; Tonye, 1997) the results suggest no significance difference between male and female farmers in both State. However, this result is similar to that of Doss and Morris (2001) who observed that the adoption of maize varieties and fertilizer is not associated with the sex of maize farmers in Ghana. This may be due to increased efforts by government policy as well as development agents in widening opportunities for hitherto vulnerable groups especially women. Indeed at 11% significant level, there is a

6 percent probability that women farmers would adopt agrochemicals rather than men (Egyir, 2008).

Age, farm size, and income had nosignificant relationship with adoption level in both Kaduna State (0.002, 0.006, and 0.102, respectively) and Ondo State (0.002, 0.006, and 0.110, respectively). These results negate the findings of Onyebinama (2000) that personal characteristics, especially age and income influence adoption level. Similarly, Munikrishnappa *et al*. (2002) found age and area under mulberry significantly influenced the adoption level of improved sericultural practices. Contrary to this, Bonabana-Wabbi, (2002) reported that farmers' age had negative and strong correlation with pesticide usage. Tijani and Nurudeen (2012) also found same. Bonabana-Wabbi (2002) found that farm size is negatively correlated with the adoption of chemicals by plantain farmers in Ghana.

Social participation had significant relationship with adoption of RAPs in both Kaduna (0.806, $P<0.10$) and Ondo (0.500, $P<0.01$) States. Iwueke (1987) also found out that social participation was one of the variables that was positively related to the farmers' decision to adopt new practices and that the adoption of small-scale farmers could not be predicted on the basis of family size and farming experience but by peer-group's decisions.

5.6.2 Institutional factors influencing adoption of RAPs: Hypothesis two

It was also hypothesized that there was no significant relationship between institutional variables and adoption of RAPs. In Kaduna State, access to training (0.103, $P<0.01$) and accessibility of agrochemicals (0.113, $P<0.10$) were found to significantly influence adoption of RAPs (Table 5.24). Similarly, in Ondo State, the variables were access to training (0.113, P<0.05) and accessibility of agrochemicals (0.022, P<0.05) (Table 5.26). These variables were strong determinants of adoption of RAPs among crop farmers. Therefore, contrary to the stated null hypothesis; institutional variables significantly influenced adoption of RAPs. Hence, the null hypothesis was rejected.

The adjusted R^2 was 0.58, and 0.59 for Kaduna and Ondo State, respectively. This implies that 58% of the variation in the adoption of RAPs in Kaduna State was contributed by the independent variables specified in the model, while 59% of the variations in the adoption of RAPs in Ondo was contributed by the independent variables.

Training received was also found to significantly influence adoption of RAPs in both Kaduna State (0.103, P<0.01) and Ondo State (0.113, P<0.05). This result was expected because a well-trained farmer would likely understand the rudiments of using agrochemicals as well as the recommended practices. The probability of adoption of RAPs given adequate and regular formal training was 70 and 81 percent (in Kaduna and Ondo States, respectively), making this factor one of the greatest driver of RAPs' adoption. This result implies that a unit increase in the number of training on agrochemical usage offered to farmers will bring about 70 percent and 81 percent increase in adoption of RAPs in Kaduna State and Ondo State, respectively.

Table 5.24: Institutional factors influencing adoption of Recommended Agrochemical Practices (RAPs) in Kaduna and Ondo States

	Kaduna State			**Ondo State**		
Variables	**Coef.**	**Std. Err**	**Z**	**Coef.**	**Std. Err**	**Z**
Extension visit	0.001	0.002	0.77	0.002	0.003	0.83
Access to infos	0.001	0.002	0.75	0.002	0.003	0.75
Training agro.	0.703	0.035	2.98***	0.813	0.053	2.14**
Acess to agro.	0.113	0.058	1.94*	0.022	0.009	2.44**
Credit received	0.583	0.296	0.36	0.655	0.391	0.48
R^2	0.547			0.563		
Adjusted R^2	0.579			0.591		
***P<0.01						
**P<0.05						
*P<0.1						

Farmers' training and knowledge help in proper use of pesticides (Mariyono and Bhattarai, 2010). It is important to know that this study assessed the formal training received by farmers (outside the routine extension visit). The findings of this study are consistent with that of Abdulai and Binder (2006); and Moser and Barrett (2003) who found a positive and statistically significant relationship between adoption and access to formal training. This finding of this study suggests that providing regular formal trainingis important in any efforts aimed at encouraging adoption of RAPs in the study area.

Another explanation for this result is that farmers who had access to training also had opportunity to spraying equipment, and such farmers try to be a good example to others. The effect of farmer linkages with formal training suggests that linkages between farmers and holders of agrochemical practices (including knowledge, techniques and the agrochemicals) are important.

Extension visit was found to be positive but not significantly related with adoption of RAPs in both Kaduna (0.439) and Ondo State (0.512). This may be counter-intuitive. This is because extension contact with farmers enhances acquisition of new knowledge, skill and practices on improved technology by the farmers as well as their innovativeness (Dey *et al*., 2000; Tanko and Olowogbaji 2009) which is expected to translate into increased technology adoption and increased outputs. Contacts with extension agents afford the farmers the opportunity of sharing ideas and information on recommended practices through interaction with other farmers.

The finding of this study is consistent with earlier results by Enwerem and Ohajianya (2012) who found a positive but non-significant relationship between technology adoption and extension contact. This suggests that the extension services are not adequate in the survey area given the recommended extension agent to farmer ratio. More so, farmers were visited only 4 and 6 times in the previous year in Kaduna State and Ondo State, respectively (Table 5.4). Furthermore, Meijden (1998) noted that extensionists are generally trained more on which pesticides should be used for which pest rather than on the equipment and application techniques. He added that, for the fact that extension workers are not always available (may be due to high extension agent: farm family ratio) for advice, the farmers rely on pesticide vendors and product labels for information on how to apply the pesticides and the safety precautions. The major producers and distributors of pesticides in Nigeria have in most cases not taken responsibility to provide training for their retailers to enable them assist the end users with precautionary measures (Asogwa and Dongo, 2009). Namwata*et al.*(2010) however, reported that increased extension contact was positively and significantly associated with overall adoption of improved agricultural technologies among farmers in Tanzania.

Meanwhile, apart from cases of non-visitation by extension agents to farmers, there also exist cases of extension visitation without effective delivery. This might be due to low competency on the part of the extension agent, or due to inadequate teaching aids, among other possible reasons. Adedoyin (1996) and Issa (2006) advocated that extension agents' visits must be essentially pursoseful (for efficient delivery) in order to be effective.

5.6.3 Technological attributes influencing adoption of RAPs: Hypothesis three

Some technological attributes were found to significantly influence adoption of RAPs ($P<0.01$, $P<0.05$, and $P<0.10$) in both States (Table 5.25). It was hypothesized that there was no significant relationship between technological attributes of RAPs and adoption level of the RAPs. In Kaduna State, observability (0.081, $P<0.1$), complexity (-0.042, $P<0.05$), and compatibility (0.060, $P<0.05$) were found to significantly influence adoption of RAPs (Table 5.25). For Ondo State, the variables were observability (0.092, $P<0.01$), complexity (-0.043, $P<0.05$), and compatibility (0.004, $P<0.05$). These variables were strong determinants of adoption of RAPs among crop farmers. Therefore, contrary to the stated null hypothesis; technological attributes significantly influenced adoption of RAPs. Hence, the null hypothesis was rejected.

The adjusted R^2 was 0.55, and 0.58 for Kaduna and Ondo State, respectively. This implies that 55% of the variations in the adoption of RAPs in Kaduna State was contributed by the independent variables specified in the model, while 58% of the variations in the adoption of RAPs in Ondo was contributed by the independent variables.

Table 5.25: Technological attributes influencing adoption of Recommended Agrochemical Practices (RAPs) in Kaduna and Ondo States

	Kaduna State			**Ondo State**		
Variables	**Coef.**	**Std. Err**	**Z**	**Coef.**	**Std. Err**	**Z**
Relative advantage	0.002	0.005	-0.45	0.003	0.005	-0.53
Observability	0.081	0.013	6.08***	0.092	0.027	6.22***
Complexity	-0.021	0.009	-2.29**	-0.043	0.020	-2.15**
Compatibility	0.005	0.002	2.21**	0.004	0.002	2.37**
R^2	0.521			0.537		
Adjusted R^2	0.547			0.582		
***P<0.01						
**P<0.05						

A significant but negative relationship was found between farmers' perception of the degree of complexity of RAPs and its adoption. A coefficient of -0.021, P<0.05 was obtained for Kaduna State while -0.043, P<0.05 was obtained for Ondo State. This implies that the higher the complexity of RAPs; the less farmers adopt RAPs. Hence, a unit increase in the degree of complexity of RAPs will bring about 21% decrease in adoption. This result complied with the *apriori* expectation since complexity of a technology connotes negativity. The Z values of -2.29 and -2.21 obtained (for Kaduna State and Ondo State, respectively) indicate that the estimate was reliable at 5% level of significance. The result of this analysis is consistent with the farmers' perception of complexity of RAPs which was found to be very high in both States (Table 5.2). This finding suggests that efforts by research and extension geared towards reducing the degree of complexity of RAPs will enhance their adoption by farmers.

Compatibility was found to positively and significantly influenced the adoption of RAPs in Kaduna State (0.005, $P<0.05$), and Ondo State (0.004, $P<0.05$). This implies that the more the RAPs are consistent with the expectations and socio-cultural circumstances of the farmers, the higher the adoption level. This result was expected more so that the farmers' perception of compatibility of RAPs was low (Table 5.2). To this extent, this finding further suggests that if research efforts are tamed towards enhancing the compatibility of RAPs (for example, developing appropriate personal protection equipment in a manner that is realistic to hot tropical climates); adoption will be increased.

5.7 Outcome of Adoption of RAPs

According to the model of this study, the expected outcomes of adoption of RAPs were change in yield, output, income and standard of living. Hence, further analysis was carried out to ascertain the differences in yield, output and income of farmers between the two study States. The result presented was obtained by using Z-test.

5.7.1 Difference in yield resulting from adoption of RAPs in Kaduna and Ondo States

The difference in yieldbetween farmers in Kaduna and Ondo States was tested. Result in Table 5.26 indicates a Z-value of -7.074 and a mean difference of -0.141. Using the two-sided test Z-test, the Z-calculated (-7.054) was greater than the critical value of 1.96, in absolute value. This means that there is significant difference in crop yield between the two States. This result could be attributed to the wide variation in the types of crops grown in the two States.

Table 5.26: Z-test for difference in yield in Kaduna and Ondo States

States	N	Mean	Mean Difference	Std Deviation	Z-Cal	Sig (2-tailed) (Z-tab)
Kaduna	135	0.422	-0.141	0.181	-7.074	.000*
Ondo	125	0.563		0.135		

*P<0.01

5.7.2 Difference in output resulting from adoption of RAPs in Kaduna and Ondo States

The difference in outputbetween farmers in Kaduna and Ondo States was also tested". Result in Table 5.27 indicates a Z-value of -7.083 and a mean difference of -0.161. Using the two-sided test Z-test, the Z-calculated (-7.083) was greater than the critical value of 1.96, in absolute value. This means that there is significant difference in output between the two States. This result could be justified by the fact that the average farm size cultivated by crop farmers was 3.01 and 4.08 ha in Kaduna and Ondo States, respectively as revealed in Table 5.1.

Table 5.27: Z-test for difference in output in Kaduna and Ondo States

States	N	Mean	Mean Difference	Std Deviation	Z-Cal	Sig (2-tailed) (Z-tab)
Kaduna	135	0.432	-0.161	0.193	-7.083	.001*
Ondo	125	0.583		0.157		

*P<0.01

5.7.3 Difference in income resulting from adoption of RAPs in Kaduna and OndoStates

The difference in income between farmers in Kaduna and Ondo States was tested. Result in Table 5.28 indicates a Z-value of -4.054 and a mean difference of -0.0557. Using the two-sided test, the Z-calculated (-4.054) in absolute value was greater than the critical value of 1.96. This means that there is significant difference in farmers' income between the two States. In Table 5.1, the mean farm income of crop farmers in Ondo State was ₦157,000,while that of Kaduna State was ₦125,000.

Table 5.28: Z-test for difference in income in Kaduna and Ondo States

States	**N**	**Mean**	**Mean Difference**	**Std Deviation**	**Z-Cal**	**Sig (2-tailed)**
Kaduna	135	0.403	-0.056	0.125	-4.054	0.010*
Ondo	125	0.459		0.093		

*P<0.01

5.8 Constraints to Adoption of Recommended Agrochemical Practices (RAPs) by Crop Farmers

High cost of agrochemicals (Mean=3.02), unavailability of pesticides (Mean=2.75) and inadequate technical know-how (Mean=2.71) were the most serious constraints to adoption as indicated by crop farmers in Ondo State while adulteration (Mean=2.75), expired/banned chemical (Mean=2.73), and high cost of agrochemical (Mean=2.69) were rated highest by crop farmers in Kaduna State (Table 5.29). An important limitation of adopting agrochemical practices was the costs of purchasing the chemicals. This finding corroborate that of Phillip *et al.* (2009) who noted that small-scale farmers rarely apply insecticides at recommended levels due to high on-farm costs of agrochemicals.It was expected that farmers with higher farm incomes had a higher probability of adopting chemicals. This result is consistent with previous studies (Abdulai and Binder, 2006; Moser and Barret, 2003) which suggest that gross income from sale of produce is the major source of funds for most producers; hence the larger it is; the more likely farmers can re-invest part in innovations.

Also, Victor (2008) asserted that a major constraint to good pest management in cocoa agro-ecologies of Nigeria is that of inconsistent pesticide availability. Due to limited infrastructure and inefficient supply chains, pesticides are not present when needed, thus defeating one of their most significant advantages, that of rapid effectiveness during sudden pest population increases. There are also serious cases of fake, adulterated and banned pesticides still been sold in the local markets (Victor, 2008; Auwal-Ahmad and Awoyale, 2008). In the same vein, Keri (2009) noted that majority of Nigerian cocoa farmers still make use of substandard and inappropriate spraying pumps such as the ‘Lancet’, thereby justifying the findings of this study that spraying equipment was inadequate.As at August 2008, Nigeria had registered a total number of 354 pesticides (Keri, 2009).

Furthermore, high incidence of adulteration of farm inputs - fertilizer, pesticides, livestock feeds/drugs has been reported as a major problem confronting the agricultural sector (Akinyosoye, 2005; NAERLS, 2009 - 2014). Incessant misuse and adulteration were the major reasons for failure of agrochemical. There is complete absence of quality control of agro-inputs. The existence of enabling regulatory laws is doubtful while the enforcement is absent. This is justified by the existence of fake, banned or adulterated agrochemicals in the Nigerian market. Stakeholders within the supply-demand chain possess little to no training in the use of agrochemicals. Transportation, handling and storage of agrochemicals are such that are open to the discretion of who is concerned.

Table 5.29: Distribution of crop farmers based on constraints to adoption of RAPs

Constraints to adoption of RAPs	Frequency			
	Kaduna (n=135)	Ondo (n=125)	Both (n=260)	Rank
Adulteration of chemicals	133 (98.5)	112 (89.6)	245 (94.2)	1st
High cost of agrochemicals	118 (87.4)	124 (99.2)	242 (93.1)	2nd
Inadequate technical knowhow	129 (95.6)	108 (86.4)	237 (91.2)	3rd
Unavailability of agrochemicals	116 (85.9)	117 (93.6)	233 (89.6)	4th
Problem of expired/banned chemicals	108 (80.0)	122 (97.6)	230 (88.5)	5th
High rate of equipmentbreakdown	103 (76.3)	109 (87.2)	212 (81.5)	6th
Too long waiting period	98 (72.6)	103 (82.4)	201 (77.3)	7th
Uncomfortability of using protective wears	95 (70.4)	105 (84.0)	200 (76.9)	8th
High cost of spraying equipment	94 (69.6)	100 (80.0)	194 (74.6)	9th
Far distance to market	89 (65.9)	92 (73.6)	181 (69.6)	10th
Inadequate specialists for equipment repairs &maintenance	76 (56.3)	97 (77.6)	173 (66.5)	11th
Unavailability of protective clothing	66 (48.9)	91 (72.8)	157 (60.4)	12th
Inadequate equipment	71 (55.6)	83 (66.4)	154 (59.2)	13th
Unclear user manual	68 (50.4)	72 (57.6)	140 (53.8)	14th

Figures in parentheses are percentages

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

This study analysed the adoption of recommended agrochemical practices among crop farmers in Kaduna and Ondo States of Nigeria. The specific objectives were to: describe the socio-economic characteristics of the crop farmers; describe the efficacy and accessibility of the agrochemicals; determinefarmers'level ofknowledgeand adoption of RAPs; and determine the factors influencing adoption of recommended agrochemical practices; analysefarmers'knowledge of the consequences of non-adoption of RAPs on human, and environmentalsafety; and identifycrop farmers' constraints to adoption of RAPs. A total of 260 crop farmers who had sustained the use of agrochemicals for at least five years were selected for the study by using a multi-stage sampling technique. Primary data were collected by using a structured, pretested interview schedule.Descriptive statistics (means and percentages) and inferential statistics (Multiple regression and t-test) were used for data analysis. Result obtained shows that the efficacy of the agrochemicals was perceived by the crop farmers to be fair in both Kaduna State (47.4%) and Ondo State (55.2%), while most (51.8% in Kaduna and 51.2% in Ondo) agreed that agrochemicals were accessible. Also, the results obtained revealed that crop farmers had high level of knowledge (weighted mean average = 2.22) of RAPs but the level of adoption was low (1.49). In both Kaduna and Ondo States, adoption of RAPs was positive and significantly influenced by farmers' characteristics of being experienced in the use of agrochemicals, literate, cosmopolite, the training exposed to, and the degree of compatibility of RAPs. Also, adoption of RAPs was negativebut significantly influenced by the degree of complexity (-0.021, $P<0.05$ for Kaduna and -0.043, $P<0.05$ for Ondo) of RAPs. There were no exclusions to adopt RAPs adoptionbased on age, farm size, sex, household size, income, extension contact, and credit received. However, the level of adoption of RAPs was found to be generally low (1.43 and 1.66 in Kaduna State and Ondo State, respectively). There weresignificant differences in the yield, output and income between farmers in the two States resulting from adoption of RAPs. All (100%) the farmers had knowledge of the risk and hazards of agrochemicals, while majority (84.2%) had knowledge of the environmental harzards of agrochemicals. Adulteration of agrochemicals (94.2%), high cost of agrochemicals (93.1%) and inadequate technical know-how (91.2%) were the most serious constraints to adoption of RAPs by crop farmers in the study area.

6.2 Conclusion

This study concludes that farmers' adoption of RAPs was low despite the high level of knowledge. This implies that there were other important factors hindering their adoption. It further concludes that farmers lack the adequate skill to effectively adopt RAPs. Also, farmers exhibited nonchalant attitude on the health implications of non-adoption of RAPs.Furthermore, agrochemicals were accessible but the efficacy was just fair. Education, farming experience, and exposure to training, are important in the adoption of RAPs by farmers. Non-adoption of RAPs had negative consequences on human, and environmental safety. Furthermore, farmers were knowledgeable of the consequences of non-adoption of RAPs but this has not motivated them to holistically adopt RAPs on health and safe use of chemicals. Also, extension did not impart any training on recommended practices for farmers. Adulteration of agrochemicals; high cost of agrochemicals; and inadequate technical know-how were the most serious constraints to adoption of RAPs in Kaduna and Ondo States.

6.3 Recommendations

Based on the findings of this study, the following recommendations were made in order to improve the adoption of RAPs by farmers in Nigeria:

i. Adulteration, high costs, and inadequate technical know-how were the most prominent constraints to adoption of RAPs as identified by farmers. In order to prevent adulteration, fake and banned agrochemicals, regulatory policies should be revisited and adequately enforced. The problem of high cost is associated with the fact that agrochemicals were not produced in the country. Government should device a policy and special financial incentives geared towards boosting local production of agrochemicals. Establishment of more Agro-input centers in remote villages would reduce the problem of adulteration. Also, agro-input agencies should use mobile agro-sales especially during on-season.

ii. Exposure to formal training in the use of agrochemical was found to be significant and directly associated with adoption of RAPs. To this end, stakeholders (public extension services, EPA, NAFDAC, input dealers, FBOs and NGOs) should collaborate to support and facilitate provision of proper and regular training of farmers on RAPs. The regular training of farmers should practically emphasize application techniques, as well as personal health and safety measures. Such training should take full advantage of farmers-based organizations. This is justified by the fact that majority of the crop farmers studied belonged to one association or the other. More so, majority of the few farmers who received training on the use of agrochemicals were trained by NGOs or private organizations. It is therefore, logical for government to reform existing extension service of the ADPs such that it would have the capacity to train farmers on the techniques of agrochemicals application. This can be achieved through collaboration with private organizations.

iii. The low adoption of RAPs despite adequate knowledge by farmers suggests a case of nonchalant attitude regarding the health, safety and environmental hazards of pesticides. Therefore, all forms of communication through the print and electronic media could be put to advantageous use by extension agencies in appealing to farmers to change their attitude in favour of the adoption of RAPs.This underscores the need for educational intervention efforts to stress the health impacts and environmental issues on pesticide use in Nigeria. Greater enforcement of regulations regarding field and housing sanitation are needed as well as to enhance the level of substantive dialogue with government policy makers.

iv. Farmers' perception of compatibility of RAPs was found to be positive and significantly influenced by adoption of RAPs. Hence, research institutes should focus on how the local environment (physical and non-physical) of the rural farmers can be exploited in the re-designing of existing agrochemical practices. For example, more comfortable clothing for spraying agrochemicals should be improvised.

v. The increased adoption of agrochemicals by farmers suggests that the issue of safe handling need priority attention and the functions of all stakeholders in agrochemical would need further re-orientation. Thus, there is a need to reorganize the market from both the demand and supply sides to enable proper use of agrochemicals without compromising standards and environmental consequences on human and animal lives.

6.4 Contributions to Existing Knowledge

This study has provided a baseline data for understanding how recommended agrochemical practices (RAPs) are being adopted by farmers;provided empirical facts on the handling and use of agrochemicals in two different agroecological zones of Nigeria; exposed the consequences of non-adoption of RAPs;andgenerated considerable data which can serve as basis for understanding the adoption of RAPs in Nigeria.These data can be used in re-formulating policies to address issues surrounding the use of agrochemicals (like adulteration, misuse and mishandling).

Specifically, this study established that:

i. socio-economic factors such as education, farming experience, household size and social participation collectively contributed 61% and 67% of the total variation in the adoption of recommended agrochemical practices (RAPs) in Kaduna and Ondo State, respectively.

ii. institutional factors such as training on agrochemical usage influenced 59% of the respondents to adopt RAPs in Kaduna and Ondo States.

iii. 64% of the respondents from the pooled States perceived that skin and eye irritation was a major consequence of non-adoption of RAPs.

iv. 77% and 57% of the respondents in Kaduna and Ondo State, respectively attested that burning of crops was a major environmental hazard of pesticide usage.

v. 88% of the respondents attested that glyphosate was effective in control of weedswhile 61% of the respondents attested that chloropyrifos and metalaxyl-M were effective insecticide and funficide used in crop production.

vi. the most serious constraints to adoption of RAPs were adulteration of pesticides (94.2%), high cost of agrochemicals (93.1%), and inadequate technical know-how (91.2%).

6.5 Suggestions for Further Research

The importance of following recommended practices in the use of agrochemicals cannot be over-emphasized. The safety of humans and that of the environment seriously depends on it. Adoption of RAPs results in efficient use of agrochemicals by farmers without which no any appreciable measure of success in crop production can be guaranteed. This study has been an attempt to assess the extent to which RAPs had been adopted by farmers. But, based on the experiences gathered in this study, there are other related areas which could be examined in future. These are as follows:

i. Replication of this study (especially the socio-economic, institutional, and technological variables that influenced crop farmers' adoption of RAPs) in other States and agro-ecological zones of Nigeria.

ii. Replication of the perception of quality and accessibility of agrochemicals among non-crop farmers in Nigeria.

iii. Census of agrochemical-related poisoning and illness among farmers should be carried out.

iv. Assessment of the extent of enforcement of agrochemical regulatory policies in Nigeria.

REFERENCES

Abdulai, A.C, and Binder, C. (2006). Slash and burn cultivation practice and agricultural input demand and output supply. *Journal of Environment and Development Economics*, 11(2): 201-220.

Abdullahi, A. (2012). Comparative economic analysis of rice production by adopters and non-adopters of improved varieties among farmers in Paikoro Local Government Area of Niger State.*Nigerian Journal of Basic and Applied Science*, June, 20(2): 146-151.

Abdullahi, S. U. (2008). The Vice Chancellor's opening remarks delivered at the National Workshop on pesticide usage, handling and safety procedures held at NAERLS conference hall, Ahmadu Bello University, Zaria on 18th November.

Adedoyin, S. F. (1996). Extensionvisits and technology delivery. Paper presented at the 1996 pre-season training of field staff of Lagos State Agricultural Development Authorityheld at CAPL Training School, Ikeja between 3rd and 11th March.

Adesina, A.A., Mbila, C., Nkamleu,G.B. and Endamana, D. (2000).Analysis of the determinants of adoption of alley farming by farmers in the forest zone of Southwest Cameroon.*Agriculture, Ecosystems & Environment*, 80: 255-265.

Adesope, O. M., Matthews-Njoku, E.C., Oguzor, N.S. and Ugwuja, V.C. (2012). Effect of socio-economic characteristics of farmers on their adoption of organic farming practices, Crop Production Technologies, In Peeyush Sharma (Ed.), *InTech*, pp 211 – 220. Available at: http://www.intechopen.com/books/crop-production-technologies/effect.Assessed 26/11/2012.

Agne, S., Fleischer, G., Jungbluth, F. and Waibel, H. (1995). Guidelines for pesticide policy studies: A framework for analyzing economic and political factors of pesticide use in developing countries. *A Publication of the Pesticide Policy Project Hannover*, January, Publication Series No.1.Pp 33.

Agwu, A. E., Chukwu, P. C. (2006). Intra-household roles and constraints in rice cropping systems in Aninri local Government Area of Enugu State, *Nigeria International Journal of Agricultural and Rural Development*, 7:1-9.

Ahmad, I. (1992). A study into the adoption of plant protection measures by the citrus fruit growers of Toba Tek Singh District. *Report*.Department of Agriculture Extension, University of Agriculture, Faisalabad.

Aigner, D. J., Hsiao, C., Kapteyn, A. and Wansbeek, T. (1984) Latent variable models ineconometrics, In Z. Griliches and M.D. Intriligaror (Eds)*Handbook of Econometrics*, Vohlme II, Elsevier Science Publishers. Pp 1323 – 1386. Aigner *et al.* (1984)

Ajayi, O. C. and Akinnifesi, F. K. (2005).Farmers' understanding of pesticide safety labels and field spraying practices: a case study of cotton farmers in northern Côte d'Ivoire. *Scientific Research and Essay*,2(6): 204-210, June. http://www.academicjournals.org/SRE.Assessed 20/11/2012.

Ajayi, O. O. (2000). Pesticide use practices, productivity and farmers' health: The case of cotton-rice systems in Côte d'Ivoire, West Africa, (*Pesticide Policy Project Publication Series Special Issue* No. 3, November.

Ajayi, O.C. and Waibel, H. (2003). Economic cost of occupational human health of pesticides among agricultural households in West Africa. In: Wollny C, Deininger, A; Bhandari, N; Maass, B; Manig, W; Muuss, U; Brodbeck, F, Howe I (eds) *Technological and Institutional Inno- vations for Sustainable Rural Development*, Book of Abstracts, Klartext publishers, Goettingen, Germany. ISBN: 3-9808714-3-6.

Ajibolade, E.O. (2005). Effects of land acquisition for large scale farming on the productivity of small-scale farming in Okitipupa LGA, Ondo State.*Unpublished MSc Thesis,* Department of Agricultural Economics and Extension, Federal University of Technology, Akure.

Akinyosoye, V. O. (2005). *Government and agriculture in Nigeria: Analysis of policies, programmes and administration.* Macmillan Nigeria Publishers Limited, Lagos. Pp598.

Akunyili, D., Ivbijaro, M.F.A. (2006). Pesticide regulations and their implementation in Nigeria. In; Ivbijaro, M.F.A.; F. Akintola and R.U. Okechukwu (eds). *Sustainable Environmental Management in Nigeria.*Mattivi Production Ibadan. pp. 187-210.

Alam, S.N., Hossain, M. I., Rouf, F.M.A., Jhala, R.C., Patel, M.G., Rath, L.K., Sengupta, A., Baral, K., Shylesha, A. N., Satpathy, S., Shivalingaswamy, T.M., Cork, A. and Talekar, N.S. (2006). Implementation and promotion of IPM strategy for eggplant fruit and shoot borer in South Asia. *Technical Bulletin* 36.AVRDC – The World Vegetable Center, Shanhua, Taiwan.74 pp.

Albrecht, H., Bergamann, H., Diederich, G., Grober, E., Hoffmann, V. Keller, P. Payr, G., and Sulzer, R. (1989).*Rural Development Series: Agricultural Extension,* Vol. 1: Basic Concepts and Methods.Eschorn, Germany: GTZ Gmbtt.

Amera, T. and Abate, A. (2008). An assessment of the pesticide use, practice and hazards in the Ethiopian Rift Valley.*Africa Stockpiles Programme,* Annex *6.*Pp 61.

Amoah, P., Drechsel, P., Abaidoo, R. C. and Ntow, W. J. (2005).Pesticides and pathogens contaminations of vegetables in Ghana's urban markets.*Archives of Environmental Contamination and Toxicology.* 50(1):1-6.

Amsalu, A., and J. De Graaff (2006).Determinants of Adoption and Continued use of Stone Terraces for Soil and Water Cconservation in an Ethiopian Highland Watershed.*Journal of Ecological Economics,* 61(2-3): 294-30.

Ani, A.O., (1998). Assessment of farmers' extension education needs in Yobe State, Nigeria. *Nigerian Journal of Agricultural Education,* 1: 152-158.

Anyadiegwa, A. (2007).Baseline study towards non-toxic environment in Africa country report NIGERIA 19 September 2007

Arokoyo, T. (1998). Agricultural technology development and dissemination: A case study of the Ghana and Nigeria experiences. The Netherlands Technical Centre for Agricultural and Rural Cooperation. (A C P–E U) Wageringen.

Asogwa, E. U. (2006). Preview of rational pesticide use protocols. Extracts from round table discussions at the NCDC-sponsored farmers field school master trainers and supervisors training workshop. CRIN Ibadan, June 5 – 16, 2006. 12pp.

……... (2008). Crop protection practices for cashew and cocoa production in Nigeria. Paper presented at the National Training Workshop for Farmers Development Union (FADU) Officials on Cocoa and Cashew Production in Nigeria. Ibadan, May 8-9, 2008. 43 slides.

Asogwa, E.U. and Dango, L.N. (2009). Problems associated with pesticide usage and application in Nigerian cocoa production: A review.*African Journal of Agricultural Research* Vol. 4 (8), pp. 675-683, August.Retrieved from http://www.academicjournals.org/AJAR Assessed: 13/04/2012.

Atu, U.G. (1990). Pesticide usage by Imo State farmers in 1983 and 1988.*Nigeria Journal of Plant Protection*, 13: 66-71.

Auwal-Ahmad, G., Awoyale, F. (2008). NAFDAC warns against use of banned chemicals in food storage. *The Guardian*, Wed. May 14, 2008. pp. 3

Awotide, B.A., Awoyemi, T.T. and Ojehomon, E.T. (2010).Farm-level constraints and adoption of improved rice varieties in Nigeria.*Learning Publics Journal of Agriculture and Environmental Studies* Vol 1 (2): 12 – 29.

Azeem, M., Iqbal, M., Ahmad, I., Soomro, M. H. (2002). Economic evaluation of pesticide use externalities in the cotton zones of Punjab, Pakistan, *The Pakistan development review* 41:4 part 2 pp.683-698.

Baral, K., Roy, B.C., Rahim, K.M.B., Chatterjee, H., Mondal, P., Mondal, D., Ghosh, D. and Talekar, N.S. (2006). Socio-economic parameters of pesticide use and assessment of impact of an IPM strategy for the control of eggplant fruit and shoot borer in West Bengal, India. *Technical Bulletin* No. 37.AVRDC – The World Vegetable Center, Shanhua, Taiwan.36 pp.

Becker, M. H. and Rosenstock, I. M. (1984).Compliance with medical advice. In Steptoe, A. and Mathews, A. (eds) *Health care and human behavior*. London: Academic Press. Pp 135 – 152.

Bello, M., Ibrahim, H.I., Salau, E.S., Kaura, A.G. and Age, A.I. (2010).Factors influencing the adoption of agro-chemical technology by small-scale farmers in Kwali Area Council of Abuja FCT, Nigeria.*Journal of Environmental Issues and Agriculture in Developing Countries*,2(1), April.Pp 176- 190.

Bonabana-Wabbi, J. (2002). Assessing factors affecting adoption of agricultural technologies: The case of Integrated Pest Management (IPM) in Kumi District, Eastern Uganda.*MSc (Agricultural and Applied Economics) Thesis* submitted to the faculty of the Virginia Polytechnic Institute and State University. 146 pp.

Boserup, E. (1970). *Woman's role in economic development*, New York, NY:St Martins Press.

Boserup, E. (1979). The position of women in economic production and in households with special reference to Africa, In Preveolu, G. and Swart, S. S. (eds) *The household women and agricultural development.* Pp 243 – 259.

Bull, D. A. (1982). *Growing problems: Pesticides and the third World poor*. OXFAM, Oxford.

Butterfield, D., Isaac, J., Kubursi, A. and Spencer, S. (2000). Impacts of water and export market restrictions on Palestinian agriculture. Toronto: McMaster University and Econometric Research Limited,*Applied Research Institute of Jerusalem (ARIJ)*. http://www.socserv.mcmaster.ca/kubursi/ebooks/water.htm. Assessed: 13/05/2014.

Cameron, S. (1973). *Job satisfaction, the concept and its measurement,* London: Work Research Unit, Dept of Employment. P7.

Cary, J. and Barr N. (1992). The semantics of forest cover: How green was Australia? In: Lawewnc G. Vanclay, Furze B (Eds). *Agriculture, environment and society,* Macmillan, Melbourne.

Cole, D.C., Fernando, C. and Ninfa, L. (1998).Conceptual and methodological aspects of investigating the health impacts of agricultural pesticide use in developing countries. In: Crissman, C.C, Antle, J.M and Capablo, S.M. (eds) *Economic, Environmental, and Health Trade-offs in agriculture: Pesticides and Sustainability of Andean Potato Production,* Kluwer Academic Publishers, Dordrecht, Boston and London.

Crissman, C.C., Cole, D.C. and Carpio, F. (1994).Pesticide Use and Farm Worker Health in Ecuadorian Potato Production.*American Journal of Agricultural Economics.* 76: 593-597.

CropLife International (2006).*Annual Report* 2005/2006, Brussels.

……...(2010). *Facts and Figures* – The Status of Global Agriculture, Brussels.

Croyle, R. T. (2005). Theory at a Glance: Application to health promotion and health behavior (Second Edition). U.S. Department of Health and Human Services, National Institutes of Health. Available at www.thecommunityguide.org.Assessed 12/09/2014.

Csiszar, E., Borsa, J., Racz, I., Obendorf, K. (1998). Reduction in human exposure to pesticide using traditional works clothing fabrics with chemical finishing: carboxymethylation and starch. *Arch Environ Contam Toxicol*; 35: 129–134.

Daane, J.R. and Mongbo, R.L. (1991).Peasant influence on development project in Benin.*Geneva Afrque*, 29: 50-75.

Damalas, C.A., Georgiou, E.B. and Theodorou, M.G. (2006). Pesticide use and safety practices among Greek tobacco farmers: A survey. *International Journal of Environmental Health Research*. 16(5): 339 – 348.

Dasgupta, S., and Meisner, C. (2005). Health effects and pesticide perception as determinants of pesticide use: Evidence from Bangladesh, *World Bank Policy Research Working Paper* 3776, November.

Dasgupta, S., Meisner, C., Wheeler, D., Thi, Lam N., Xuyen, K. (2005).Pesticide poisoning of farm workers: implications of blood test results from Vietnam", *World Bank Policy Research Working Paper* 3624.

DeJonge, J.O., Vredevoogd, J. and Henry, M.S. (1983).Attitudes, practices, and preferences of pesticide users toward protective apparel.*Clothing Textiles Research Journal,* 1983–1984; 2:9.

Dey, M. M, Paragnas, G. B and Regaspi, P. B (2000).Technical Efficiency of Tilapia growth out of pornd operation in the Phillippines.Aquaculture, economics and management. 4 (2): 33-46.

Doss, C.R. and Morris, M.L, (2001). How does gender affect the adoption of agricultural Innovations? The Case of Improved Maize Technology in Ghana.*Journal of Agricultural Economics*, 25: 27–39.

Drafor, I. (2003). Pesticide use and consumer and worker safety: experiences from Kenya and Ghana, Paper presented at the *25th Triennial Conference of the International Association of Agricultural Economists (IAAE)*, 16-22 August, Durban, South Africa.

Dugje, I.Y., Ekeleme, F., Kamara, A.Y., Omoigui, L.O., Tegbaru, A., Teli, I.A. and Onyibe, J.E. (2008). Guide to safe and effective use of pesticides for crop production in Borno State, Nigeria. 23 pp.

Ecobichon, D. J. (2001).Pesticide Use in Developing Countries, *Toxicology*. 160, 27–33

Edache, O. A. (1998). Pesticide usage in crop production. Paper presented at the *National Programme on Agrochemical Technology*. University of Agriculture, Markudi, July 26-29, 1998. 16pp.

Edeoghon, C.O. (2008). Awareness and use of sustainable agricultural practices by arable crop farmers in Ikpoba Local government Area of Edo State.*Journal of sustainable Development in Agricultural and Environment:* 3(2): 55-63.

Egyir, I. S. (2008).Assessing the factors of adoption of agro-chemicals by plantain farmers in Ghana using the ASTI analytical framework.Pp 30.

Egyir, I. S., Owusu-Benoah, E., Anno-Nyako, F.O. and Banful, B. (2011). Assessing the factors of adoption of agrochemicals by plantain farmers in Ghana, *Journal of Enterprising Communities:* People and Places in the Global Economy, Vol. 5 Iss: 1, pp.83 – 97.

Ejiogu, A. M. (1992). *Theories of job satisfaction and job performance.*Third Edition, JOJA Press Ltd. Lagos. Pp 35 – 40.

Ekanayaka, H.K.J. and Wijeratne, M. (2004).Adoption of preharvest interval in rice production in Sri Lanka.*IIRR* 29.1, June. Pp 81 – 82.

Enete, A. A. and Amusa, T. A. (2010).Determinants of women's contribution to farming decisions in cocoa based agroforestry households of Ekiti State, Nigeria.*Field Actions Science Reports* Vol. 4, pp 1 – 6.

Enwerem, V.A.1 and Ohajianya, D.O. (2013). Farm Size and Technical Efficiency of Rice Farmers in Imo State, Nigeria. *Greener Journal of Agricultural Sciences*,3(2),February, pp. 128-136.

Eurostat Statistical Books (2007).The use of plant protection products in the European Union – Data 1992 – 2003, Luxembourg.

Federal Office of Statistics (2006).*Annual Abstract of Statistics.*Federal Office of Statistics,Abuja.

Food and Agricultural Organization (1997).Statistics on pesticide use.Internet copy. Statistical Analysis Services ESSA. Statistics Division. Rome, Italy: FAO

Food and Agricultural Organization (1998).Pesticide application techniques in West-Africa.Pp 13.

Food and Agricultural Organization (2004).The state of food insecurity in the World 2004.Economic and Social Department, Food and Agriculture Organization of the United Nations, Rome.

Food and Agricultural Organization / World Health Organization (2001).*Amount of poor-quality pesticides sold in developing countries alarmingly high. Press Release, 1st February, 2001*. Rome.

Forget, G. (1991). Pesticide and the third world, *Journal of Toxicology and Environmental Health*, Vol.32, Pg. 11-13

Friedrich, T. (1996).Agricultural pesticide application. FAO Agricultural Engineering Branch AGSE, FAO Rome.

Gomes, J., Lloyd, O.L., Revitt, D. M. (1999).The influence of personal protection, environment hygiene and exposure to pesticides on the health of immigrant farm workers in a desert country.*Int Arch Occup Environ Health;* 72: 40–45.

Griliches, Z. (1957). Hybrid Corn: An exploration in the economics of technological change, *Econometrica*, 24, pp. 501-522.

Hassan, I.J. (1994). The cure that kills", Herald (a monthly English magazine: September issue), Karachi.

Hill, D.S. and Waller, J.M. (1982).*Pests and Diseases of Tropical Crops.Vol. 1.Principles and Methods ofControl.*Longman. London. Pp 175.

Huang, C. L. (1993). Simultaneous-Equation Model for estimating consumer risk perceptions, attitudes and willingness-to-pay for residue-free produce, *Journal of Consumer Affairs*, Vol. 27.

Idachaba, F. S. (1980) Agricultural research policy in Nigeria.*Research Report 17.*International Food Policy Research Institute.August.Pp73.

Idowu, O.L. (1989). Control of economic insect pests of cacao. In: *Progress in Tree Crop Research.* 2nd Ed.CRIN, Ibadan, Nigeria. pp. 89-102.

Idowu, O.L. (1996). Safe use of Agro-chemicals. A lecture delivered at *National Agricultural Land Development Authority pre-season training for resource persons.*NAERLS South-West zone, Moor plantation, Ibadan Nigeria. July 23-26.

Iheanacho, A.C., (2000). Economics of Millet production under different cropping systems in Borno State of Nigeria.*Unpublished Ph.D. Thesis*, University of Maiduguri, Nigeria.

Integrated Regional Information Network (IRIN) (2008.) Nigeria – Toxic grain threatens food security, www.irinnews.org/printreport.aspx?reportid=78242, March. Accessed on 17 January 2013.

International Labour Organization and Food and Agriculture Organization (2012). Food, agriculture and decent work: Safety and health. Available at: wwwfao-ilo.org/more/fao-ilo-safety/en/ Assessed 24th March, 2015.

International Union of Pure and Applied Chemistry (2008).Global availability of information on agrochemicals.*12th IUPAC International Congress on Pesticides Chemistry,* 15th July. http://agrochemicals.iupac.org/. Assessed 15/08/2010.

Iqbal, Z., Zia, K. & Ahmad, A. (1997). Pesticide abuse in Pakistan and associated human health and environmental risks, *Pakistan Journal of Agriculture science*, 34(1-4): 23-29.

Isin, S., and Yildirim, I. (2007). Fruit-growers' perceptions on the harmful effects of pesticides and their reflection practices: The case of Kemalpasa, Turkey. *Crop Protection*, 26, 917-922.

Issa, F. O. (2006). On-Farm Adaptive Research and Small Plot Adoption Technique as strategies for agricultural technology delivery in Lagos State.*Proceedings of 11th Annual Conference of Agricultural Extension Society of Nigeria.*Held at University of Agriculture, Abeokuta from 3rd to 6th April.Pp 249 – 256.

Issa, F.O., Ilu, I.Y. and Akolade, G.O. (2011). Effect of extension training on adoption of improved agricultural technologies by crop farmers in Lagos State, Nigeria.*Nigerian Journal of Farm Management*, 12(1): 62 – 67.

Ivbijaro, M.F.A. (1977). Gamma – BHC residues in kolanuts, Cola nitida and control of kola nut weevil, Balanogastris kolae (Desbr). *Indian Journal of Experimental Biology*, 15 (12): 1236-1238

Ivbijaro, M.F.A. (1990). Natural pesticides: Role and production potential in Nigeria. *National workshop on the pesticide Industry in Nigeria*, University of Ibadan. Sept. 24 – 27, 1990. 24pp.

Ivbijaro, M.F.A. (1998). National Programme on agrochemical technology.*A keynote address presented at the Centre for Agricultural Technology*, University of Agriculture, Makurdi, July, 26-29. 10pp.

Iwueke, C.C., (1987). Farmer related factors influencing the Adoption of Agricultural Innovations in Imo State. *Unpublished Ph. D Thesis*, Dept. of Agricultural Extension UNN, Nigeria.

Jibowo, A.A. and Francis, T.M. (1989). Factors associated with adoption of fertilizer application in Vegona LGA of Rivers State, Nigeria. *Ife Journal of Agriculture*, Vol. II, (1&2).Pp 94 – 103.

Kamel, F., Engel, L.S., Gladen, B.C., Hoppin, J.A., Alavanja, M.C., and Sandler, D.P. (2005). Neurologic symptoms in licensed private pesticide applicators in the agricultural health study. *Environmental Health Perspect;* 113(7):877–882. doi: 10.1289/ehp.7645.

Keraita, B. (2002). Wastewater use in urban and periurban vegetable farming in Kumasi, Ghana.*Unpublished MSc. Thesis.* Wageningen University, The Netherlands.

Keri, H. J. (2009). Nigeria's status on pesticide registration and maximum residue levels. The workshop on pesticide Maximum Residue Levels (MRLs) held in Alexandria, Egypt. 30th March to 2nd April.

Kishi, M. (2005). The health impacts of pesticides: What do we know? The Pesticide Detox (J. Pretty), London.

Kishi, M., Hirschon, N., Djajadisastra, M., Satterlee, L.N., Strowman, S. and Dilts R (1995). Relationship of pesticide spraying to signs and symptoms in Indonesian farmers.*Scandinavian Journal of Work and Environmental Health* 21(2): 124–133.

Kleter, G. A., Harris, C., Stephenson, G. & Unsworth, J. (2008).Comparison of Herbicide Regimes and the Associated Potential Environmental Effects of Glyphosate-resistant Crops Versus What They Replace in Europe.*Journal of Pest Management Science.* 64(4): 479-488.

Koh, D. and Jeyaratnam, J. (1996).Pesticides hazards in developing countries.*Science of the Total Environment*; 188(1):S78–S85. doi: 10.1016/0048-9697(96)05279-5. Assessed 06/04/2012.

Konradsen, F., Hoek, W., Cole, D.C., Hutchinson, G., Daisley, H. and Singh, S. (2003). Reducing acute poisoning in developing countries—options for restricting the availability of pesticides. *Toxicology*; 192(2–3):249–261.

Kormawa, P., Awoyemi, T.T. and Akingbile, A. (2001) Farm Management in the Provision of Extension Services in Nigeria: An assessment and a strategy for improvement; Report submitted to the FAO, UN.

Kriesemer, S. K.; Grötz, A. (2008).The Adoption and Diffusion of Small-Scale Pond-Aquaculture in Africa with special Reference to Malawi.

Kughur, P. G. (2012). The effects of herbicides on crop production and environment in Makurdi Local Government Area of Benue State, Nigeria.*Journal of Sustainable Development in Africa,* 14(4): 23-29.

Laary, J.K. (2012). Dry-season farming and agrochemical misuse in upper east region of Ghana: Implication and way forward. *Journal of Agricultural, Food and Environmental Sciences,*Volume 5, Issue 1, 10 pp.

Lami, A. N, Abraham, E. A. (2013). Perception of agrochemical use and organic farming in Makurdi, Benue State.*International Journal of Environmental Protection*, 3(8): 48-52.

Lawler, E. E. (1973). *Motivation in work organization.* Brooks Cole Publishing Company, California. P 45.

Leeuwis, C. (2003). *Communication for rural innovation: rethinking agricultural extension.*3rd Edition.Blackwell Publication.

Leventhal, H., Safer, M., Panagis, F. D. (1983). The impact of communications on the self-regulation of health beliefs, decisions, and behavior, *Health Education Quarterly*, 10(1), 3–29.

Lichtenberg, E. and Zimmerman, R. (1999). Adverse health experiences, environmental attitudes, and pesticide usage behavior of farm operators, *Risk Analysis*, Vol. 19, No. 2

Lomborg, B. (2001). *The Skeptical Environmentalist*. Cambridge University Press; Reprint edition August 28, ISBN: 0521010683

Machipisa, L. (1996). Banned pesticides heavily used in the third World countries. *Albion monitor,* November 23. http://www.monitor.net/monitor.

Mancini, F., van Bruggen, A.H.C., Jiggins, J.L.S., Ambatipudi, A.C., Murphy, H. (2005). Acute pesticide poisoning among female and male cotton growers in India.*International Journal of Occup. Environ. Health*, (11): 221–232.

Mariyono, J. and Bhattarai, M. (2010).Factors determinant of pesticides use in chili pepper farming in Central Java, Indonesia,*Manuscript submitted to Agricultural System Journal.* 44 pp.

Maumbe, B.M., Swinton, S.M. (2003). Hidden health costs of pesticide use in Zimbabwe's smallholder cotton growers. *Social Science.Med.* 57: 1559– 1571.

Meenambigai, J. and Seetharaman, R.N. (2003). Training needs of extension personnel in communication and Transfer of technology. *Agricultural Research and Extension Network Newsletter* No 48; pp 19

Meijden, G. V. (1998). Pesticide application techniques in West Africa.A study by the Agricultural Engineering Branch of FAO through the FAO Regional Office for Africa. 17pp.

Mekonnen, Y. and Agonafir, T. (2002).Pesticide sprayers' knowledge, attitude and practice of pesticide use on agricultural farms of Ethiopia.*Occup. Med.,* 52(6): 311–315.

Miller, G. T. (2002). *Living in the environment*.12th Edition.Praeger Publishers, London. 285p.

Mokwunye, I.U., Babalola, F.D., Ndagi, I., Idrisu, M., Mokwunye, F.C., and Asogwa, E.U. (2012). Farmers' compliance with the use of approved cocoa pesticides in cocoa producing States of Nigeria. *Journal of Agriculture and Social Research (JASR)*, 12(2): Pp 44 – 60.

Moore, N. (1980). History of agricultural chemicals.Publication No 215 of Department of Corp Science, North Carolina State University.

Moser, C.M., and Barrett, C. B. (2003). The disappointing adoption dynamics of a yield-increasing, low external-input technology: The Case of SRI in Madagascar. *Journal of Agricultural Systems*, 76(3): 1085-1100.

Mugisa-Mutetikka, M., Opio, A.F., Ugen, M.A., Tukamuhabwa, P., Kayiwa, B.S. Niringiye, C.and Kikoba, E. (2000).Logistic Regression Analysis of Adoption of New Bean Varieties in Uganda.*Unpublished*.

Munikrishnappa, H. M., Jagadisha, K. and Srinivasa, G.(2002).Association of socio-economic characters with knowledge and adoption of improved sericultural practices by sericulturists in Mysore district.*Indian Journal of Sericulture,* 41(1):89-91.

Murray, S. (2002). Supporting Environmental Education in Namibia (SEEN).Published material on environmental education in Namibia, NIED/Okahangja. 26pp.

Murray, D. L. and Taylor, P. L. (2001). Beyond safe use: Challenging the international pesticide industry's hazard reduction strategy. *International Institute for Environmental and Development.*Gatekeeper Series no. 103.Pp 20.

Namwata, B.M.L., Lwelamira, J. and Mzirai, O.B. (2010). Adoption of improved agricultural technologies for Irish potatoes (*Solanumtuberosum*) among farmers in Mbeya Rural district, Tanzania: A case of Ilungu ward. *Journal of Animal & Plant Sciences*, 8(1): 927- 935.

National Agricultural Extension and Research Liaison Services and Federal Department of Agricultural Extension (2014). Agricultural performance survey of 2014 wet season in Nigeria, *Executive summary*. October.Pp 23.

National Agricultural Extension and Research Liaison Services and National Programme on Agriculture and Food Security (2011).*National report of Agricultural performance survey of 2010 wet season in Nigeria.*December.175 pp.

National Agricultural Extension and Research Liaison Services (Several Editions) *Communique of the annual National Agricultural Extension Review and Planning meeting* held between 1st and 5th December 2014, 3rd and 5th December 2013, 19th and 23rd November, 2012.

National Population Commission (2006).Census Report of Nigeria.*Population and Development Review*,33(1) (Mar., 2007), pp. 206-210 Published by: Population Council Article Stable URL: http://www.jstor.org/stable/25434601 Assessed 7th May 2013.

Ngowi, A.V.F. and Partanen, T. (2002). Treatment of pesticide poisoning: a problem for health care workers in Tanzania. *AfricanNewsletter of Occup. Health and Safety* (12): 71.

National Bureau of Statistics (2005) The Nigerian statistical fact sheets on Economic and Social Development, FOS, Nigeria.

Ngowi, A.V.F., Mbise, T.J., Millinga, L., Ijani, A.S.M., London, L. and Ajayi, O.C. (2007). Smallholder vegetable farmers in Northern Tanzania: Pesticides use practices, perceptions, cost and health effects. *Crop Protection* DOI: 10.1016/j.cropro.

Nigerian Institute of Social and Economic Research (NISER) (1999). A Characterization of industrial demand for major agricultural commodities in Nigeria, Ajakaiye D.O. and Akande S.O. (eds) *Nigerian Institute of Social and Economic Research*, Ibadan, Nigeria.

Nowak, P. (1992). Why farmers adopt production technology. *Journal of Soil and Water Conservation* 47, 14-16.

Ntow, W. J. (2008). Organochlorine pesticides in water, sediments, crops and human fluids in a farming community in Ghana.*Journal of Archives of Environmental Contamination and Toxicology*.40(4): 557-563.

Ntow, W.J., Gijzen, H.J., Kelderman, P. and Drechsel, P. (2006).Farmers' perceptions and pesticide use practices in vegetable production in Ghana. *Pest Management Science*, 62:356-365.

Nyatuame, M. and Ampiaw, F. (2015). Assessment of farmers' awareness on the safety and health implications on the use of agrochemicals: A case of Afife rice farm in Ghana. *Asian Journal of Agricultural Extension, Economics and Sociology,* 7(3): 1 – 9.

Obeng-Ofori, D. (1998). Post-Harvest Science.Crop Science Department.University of Ghana, Legon, October.71 Pp.

Obeta, M.E. and Nwagbo, E.C. (1999).The adoption of agricultural innovations in Nigeria.A case study of an improved IITA technology package in Anambra State. In:Olukosi, J.O, Ogungbile, A.O. and Kulu, B.A. (eds) *Appropriate Agricultural Technologies for Resource Poor Farmers.*

Obosu-Mensah, K. (1999). *Food production in urban areas.A case study of urban agriculture in Accra, Ghana.*Ashgate Publishing Limited, Gower House, Croft Road Aldershot, Hampshire GU11 3HR, England.

Ogunfiditimi, T. O. (1986).*Community survey methods statistical techniques and computer analysis,* Marygrant (Educational) Publishers, Ibadan, Nigeria.Pp 43.

Ogunlade, M. L. and Aikpokpodion, P.O. (2010).Physico-chemical properties of selected cocoa soils in three cocoa growingecological Zones of Nigeria.*Proceedings of 44th Annual Conference of Agricultural Society of Nigeria* 15-47pp.

Ogunsumi, L. O. (2007). Socio-economic conditions of peasant farmers: The case of agricultural technologies' sustainability in Southwest Nigeria. *World Journal of Agricultural Sciences* 3 (5): 678-684.

Ohayo-Mitoko, G.J.A., Kromhout, H., Simwa, J.M., Boleij, J.S.M., and Heederik, D. (2000).Self-reported symptoms and inhibition of acetylcholinesterase activity among Kenyan agricultural workers.*Occup. Environ. Med*. 57:195-200. doi:10.1136/oem.57.3.195. Assessed 19/10/2009.

Okuthe, I.K., Kioli, F. and Abuom, P. (2013).Socio cultural determinants of the adoption of integrated natural resource management technologies by small scale farmers in Ndhiwa Division, *Kenya Current Research Journal of Social Sciences*. 5(6): 203-218.

Olabode, O.S., Adesina, G.O. and Olapeju, T.R. (2011).Survey of agricultural chemicals available to farmers in South Western Nigeria.*International Journal of Agricultural Economics and Rural Development,* 4 (1):12 – 18.

Onu, D.O. (1995). Factors associated with small scale farmer's adoption of improved soil conservation technologies under intensified agriculture in Imo State, Nigeria. *Unpublished Ph.D Theses* of the University of Nigeria, Nsukka, Nigeria.

Onu, D.O. (2005). Analysis of factors influencing farmers' adoption of alley farming technology under intensified agriculture in Imo State, Nigeria, using a Qualitative choice model: *Agro Forestry Systems International;* 29 (4): 76-187.

Onyebinama, U.A.U. (2000). Technology adoption and food security: The role of the Nigeria agricultural insurance scheme. *Agro- Science;* 1:1 -4.

Oppenheimer, W. and Donnelly, H. (1998). Possibilities for future EU environmental policy on plant protection products, *Synthesis report of six sub-reports in PES-A/phase 2*.

Organic Consumer Association (OCA), (2008) 30 Agrochemical Products Banned in Nigeria after Deaths, Finland 11.

Pample, F., Jr., and van Es, J. C. (1977). Environmental quality and issues of adoption research, *Rural Sociology*, 42(1):57-71.

Pan African Regulation (2000).Pan Africa regulation of dangerous pesticides in Ghana.*Pan African Monitoring and Briefing Series* No. 5, Dakar, Senegal, 16Pp.

Pesticide Action Network (2010).Communities in Peril – Global report on health impacts of pesticide use in agriculture, Manila.

Phillip, D., Nkonya, E., Pender, J. and Oni, O. A. (2009). Constraints to increasing agricultural productivity in Nigeria: A review. *Nigeria Safety Support Program (NSSP).* Background Paper No, NSSP 006 September, 72pp.

Pingali, P.L., and Gerpacio, R. V. (1997). Towards reduced pesticide use for cereal crops in Asia. CIMMYT Economics Working Paper 97-04. Mexico, D.F.: CIMMYT.

Pouta, E. (2003). Attitude-behavior framework in contingent valuation of forest conservation, *Academic Dissertation,* Faculty of Agriculture and Forestry of the University of Helsinki.

Rahman, S.A. (2008). Women's involvement in agriculture in Northern and Southern Kaduna State, Nigeria.*Journal of Gender Studies*, 17(1):17-26.

Raksanam, B., Taneepanichskul, S., Siriwong, W. and Robson, M. G. (2012). Factors associated with pesticide risk behaviors among rice farmers in rural community, Thailand. *Journal of Environment and Earth Science*, 2(2): 32 – 39.

Rashid, M. (1980). Some personal and socio-economic factors associated with the adoption of recommended agricultural practices in Rural Egypt, *World Agric. Economics and Rural Sociology Abst.*, 19(12), 800.

Rashid, M.A., Alam, S. N., Rouf, F.M.A. and Talekar, N.S. (2003).Socio-economic parameters of eggplant protection in Jessore District of Bangladesh.*Technical Bulletin 29.*AVRDC – The World Vegetable Center, Shanhua, Taiwan.37 pp.

Richardi, T. (1992). Project utilisation efficace et sûre des pesticides en Côte d'Ivoire: Enquête préliminaire, D 441 CIRAD/PRIFAS Montpellier, Paris.

Rogers, E. M.(1983). *Diffusion of innovations.* 3rd ed. Free Press, New York.

Rogers, E. M. and Shoemaker, F. F. (1971).*Communication of innovations: A cross-cultural approach.* 2nd ed. Free Press, New York.

Rother, A. (2008). South African farm workers' interpretation of risk assessment data expressed as pictograms on pesticide labels, *Environmental Research* .108, 419-427.

Rother, H.A. (2000). Influence of pesticide risk perception on the health of rural South African women and children. *African Newsletter* 2: 42-46.

Roy, B., Amin, R., Uddin, M. N., Islam, A.T.M.S., Islam, M.J., and Halder, B.C. (2005). Leaf extracts of shiyalmutra (Blumea lacera Dc.) as botanical pesticides against lesser grain borer and rice weevil. *Journal of Biological Sciences.* 5(2): 201-204.

Rucker, M., Branson, D., Nelson, C., Olson, W., Slocum, A., and Stone J. (1998). Farm families' attitude and practices regarding pesticide application and protective clothing: a five-state comparison:Launderee data. *Clothing Textiles Research Journal;* 6: 37.

Ryan, T. A. and Smith, P. C. (1962).*Principles of Industrial Psychology*, New York.The Ronald Press Company. Pp 387 – 388.

Salameh, P.R., Baldi, I., Brochard, P., and Abi Saleh, B. (2004). Pesticides in Lebanon: A knowledge, attitude, and practice study. *EnvironmentalResearch.;*94(1):1–6. doi: 10.1016/S0013-9351(03)00092-6. Assessed: 20/09/2014.

Sarker, M. A., Itohara, Y. and Hoque, M. (2010).Determinants of adoption decisions: The case of organic farming (OF) in Bangladesh. *Extension Farming Systems Journal*, 5(2) http://www.csu.edu.au/faculty/science/saws/afbmnetwork/efsjournal/index.htm

Schwab, A.I., Jager, I., Stoll, G., Gorgen, R., Prexterschwab, S., and Attenburger, R. (1995). Pesticide in tropical agriculture: hazards and alternatives. *PAN ACTA Tropical Agroecology*.No. 131.

Secretariat of the Rotterdam Convention (2010).Pilot study on agricultural pesticide poisoning in Burkina Faso – Final Report.

Severtson, D. J., Baumann, L., Brown, R. L. (2006). Applying a health behavior theory to explore the influence of information and experience on arsenic risk representations, policy beliefs, and protective behavior, *Risk Analysis,*26(2).

Shaib, B., Aliyu, .A. and Bakashi, J.S. (eds) (1997). *Nigeria National Agricultural Research Strategy Plan 1996 – 2010.* Department of Agricultural Sciences.Federal Ministry of Agriculture and natural Resources Abuja, Nigeria. Intec Printers Limited.

Smit, L.A., van-Wendel-de-Joode, B.N., Heederik, D, Peiris-John, R.J., and Hoek, W. (2003). Neurological symptoms among Sri Lankan farmers occupationally exposed to acetylcholinesterase-inhibiting insecticides. *American Journal of Ind Med.*; 44(3):254–264. doi: 10.1002/ajim.10271. Assessed 13/04/2014.

Smith, K. R., Corvalan, C.F. & Kiellstrom, T. (1999). How much global ill health is attributed to environmental factors? *Journal of Epidemiology*, 10(5): 573-84.

Stoll, G. (2000). Natural Crop protection in the tropics: Letting information come to life. 2nd enlarged edition. Margraf Verlag, Weikersheim. 376pp.

Stoneman, P. L., and Paul A. D.(1986). Adoption subsidies vs. information provision as instruments of technology policy, *The Economic Journal*, 96: 142-150.

Swanson, B. E. (1997). Strengthening research-extension-farmer linkages. In B.E. Swanson, R.P. Bentz and A.J. Sofranko., (eds) *Improving agricultural extension: A reference manual.*Rome, Food and Agriculture Organization of the United Nations.

Tanko, L and Olowogbaji, J.A. (2009).Technical efficiency and the determinants in yam production in Bosso area, Niger State, Nigeria.*Food production in a developing economy*, 1: 296-303.

Tanzubil, P. B. (1997). None-pesticidal approaches to managing insect pests of sorghum in Ghana. In: *Proceedings of the Third National Workshop on Improving Farming Systems in the Interior Savanna of Ghana.* Nyankpala, Tamale, Ghana. April, 1993. Pp 227-236.

Tekwa, I. J., Ambali, O. Y. and Gabdo, B. H. (2010). Economic analysis of farm hazards associated with the use of agrochemicals on agricultural farms. *Australian Journal of Agricultural Engineering* 1(1):7 – 13.

Theocharopoulos, A., Melfou, K. and Papanagiotou, E. (2012). Analysis of decision making process for the adoption of sustainable farming systems: The case of peach farmers in Greece. *American-Eurasian Journal of Sustainable Agriculture*, 6(1): 24-32.

Tiamiyu, S.A., Akintola, J.O.and Rahji, M.A.Y. (2009). Technology adoption and productivity difference among growers of New Rice for Africa in Savanna Zone of Nigeria.*TROPICULTURA*, 27(4), 193-197.

Tijani, A. and Nurudeen, S. (2012). Assessment of farm level pesticide use among maizefarmers in Oyo State, Nigeria.*Food Science and Quality Management*,Vol 3, 8 pp.www.iiste.orgAssessed 24/11/2012.

Tokula, M. H., Ekwe, K. C. and Ikeorgu, J. C. (2009).Adoption of yam minisett technology among farmers in North Central Nigeria.*Journal of Agriculture and Social Research* 9(1): 29-34.

Uaiene, R.N., Arndt, C. and Masters, W.A. (2009).Determinants of agricultural technology adoption in Mozambique.*Discussion papers* No. 67E. January National Directorate of Studies and Policy Analysis, Ministry of Planning and Development Republic of Mozambique 31 pp.

Udoh, A. J. (2009). Nigerian farm household hazards.http://www.pan-uk.org/pestnews/Issue/pn40/pn40p8.htm Assessed 26th March, 2015.

United Nations Environment Programme (UNEP) (2004). Childhood Pesticide Poisoning, Châtelaine

Vaagt, G. (2005). International Conventions - Implications to pesticides management, *Regional Workshop on the International Code of Conduct*, Presentation, www.fao.org/docrep/008/af340e/af340e05.htm. Accessed: 19/04/2012.

Victor, S. (2008). Food poisoning: NAFDAC bans 30 agrochemical products. *The Punch* Wed. May 14, P10.

Wells, C. S. and Wollack, J. A. (2003). An instructor's guide to understanding test reliability. *Testing and Evaluation Services*, University of Wisconsin, WI53706.Pp 7.Retrieved 7th March 2015 from: http://www.wiscinfo.doit.wisc.edu/exams/Reliability.pdf

Wesseling, C., McConnell, R., Partanen, T. and Hogstedt, C. (1997). Agricultural pesticide use in developing countries: Health effects and research needs. *International Journal of Health Services*; 27: 273–308.

Williamson, S. (2003). Economic costs of pesticide reliance, PAN UK, IPM features, pesticide news, 61.

Wilson, C. and Tisdell, C. (2001). Why farmers continue to use pesticides despite environmental, health sustainability costs? *Ecol Econ.*; 39(3):449–462. doi: 10.1016/S0921-8009(01)00238-5. Assessed: 15/06/2012.

Woodruff, T.J., Kyle, A.D., Bois, F.Y. (1994).Evaluating health risks from occupational exposure to pesticides and the regulatory response.*Environmental Health Perspective*; 102(12):1088–1096. doi: 10.2307/3431997. Assessed: 15/06/2012.

World Health Organization (1990).Public health impact of pesticide used in agriculture, World Health Organization, New York, USA.

World Health Organization (1991).Safe use of pesticides.Fourteenth report of the WHO expert committee on vector biology and control.*World Health Organ Tech Rep Ser*.; 813:1–27.

World Health Organization (2002). Health situation and trends assessment: Health situation in the South-East Asia Region 1998-2000, WHO Regional Office for Southeast Asia, New Delhi.

World Health Organization (2004).Recommended classification of pesticides by hazard and guidelines to classification. Geneva, Switzerland.

World Health Organization (2008).Public Health and Environment and Quantifying Environmental Health Impact. (www.Who.int/topical environmentalhealth/en/.Retrieved 7th August 2013.

World Health Organization (2009). The WHO Recommended Classification of Pesticides by Hazards, Geneva.

Yasin, G., Aslam, M., Parvez, I. and Naz, S. (2003).Socio-economic correlates of pesticide usage: The case of citrus farmers. *Journal of Research (Science)*, Bahauddin Zakariya University, Multan, Pakistan, 14(1), June, pp. 43-48.

Yassin, M.M., Abu Mourad, T.A. and Safi, J.M. (2002). Knowledge, attitude, practice, and toxicity symptoms associated with pesticide use among farm workers in the Gaza Strip. *Occup Environ Med*, 59:387-393.

Youdeowei, A. (1989).Provisional report on pesticide management in Anglophone West Africa.Prepared for FAO Rome.

Zyoud, S.H., Sawalha, A.F., Sweileh, W.M., Suleiman, R.A., Al-Khalil, I., Al-Jabi, S.W. and Bsharat, N.M. (2010).Knowledge and practices of pesticide use among farm workers in the West Bank, Palestine: safety implications. Pp 15.

Appendix:

Interview Schedule for Farmers

ANALYSIS OF ADOPTION OF RECOMMENDED AGROCHEMICAL PRACTICES AMONG CROP FARMERS IN KADUNA AND ONDO STATES OF NIGERIA

ID №: ....

Interview schedule for farmers

Background Information

Name of interviewer:……………………………………......Phone:...............................
Date.................. Time interview started:…………State:………..…Zone:…..……......
LGA................ Block:………....... Cell:…………… Name of village:……….....……..…
Respondent's phone number:……………..…......…… GPS Reading:…..…..…..………
Respondent's name (Optional): ....

Good day sir/ma,

We are researchers from the Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria. We are interested in talking to you about your farming practices specifically concerning your use of agrochemicals for crop protection. The aim is to assess how recommended agrochemical practices have been adopted. Hence, you have been selected because you use agrochemicals for protecting your crops. We shall be very grateful if you can give us part of your valuable time. Please feel free and answer the questions accurately and honestly. The result generated will be used purely for academic research purpose and your responses will be treated with utmost confidentiality.

Thank you.

Socio-economic Characteristics, technological attributes, and Institutional variables:

a. Socio-economic characteristics

1. Occupation:
   a. What is your major occupation? ....……
   b. List 3 minor occupations you engaged in. (List them in descending order of importance). i. .... ii. .... iii. ....
2. Age of farmer: ....years
3. What is the average size of your farm?: ....ha.
4. Years of farming experience: ....years
5. Sex: Male ( ) Female ( )
6. Years of formal Education: ....years
7. Size of Household: Total ....

.

Age	Number	
	Male	**Female**
0 – 15		
16 – 60		
>60		

8. Type of labour used for applying agrochemical: i. Self only ( ) ii. Hired only ( ) iii. Family only ( ) iv. Self & Family ( ) v. Self & Hired ( ) vi. Family & Hired ( ) vii. Self + Family + Hired ( )

9. a. Do you belong to an association? Yes ( ) No ( )
   b. Organizational participation: Please indicate your level of participation in each.

S/N	Organization	Level of Participation		
		Ordinary member (1)	**Committee member (2)**	**Office holder (3)**
1	Cooperative society			
2	Religious group			
3	Community-based group e.g. village council			
4	Social club			
5	Others (specify)			

10. Output (from last harvest) of 3 major crops grown (in descending order of importance):

Crop	Size of land cultivated (ha)	Total Output (kg or bag)	Quantity Consumed (kg or bag)	Quantity given out as gift (kg or bag)	Quantity sold (kg or bag)	Price/unit (₦)

11. Cosmopoliteness:
   a. Have you ever visited other places (for agricultural purpose only) in the last one year? Yes… No…
   b. How many times have you traveled in the last one year?

S/N	Places Visited	Frequency (in the last 1 year)		
		1 – 3	**4 – 6**	**Above 6**
1	Other farms in the community			
2	Other villages in the Ward			
3	Other Wards in the LGA			
4	Other LGAs in the State			
5	Other States in the country			
6	Other countries in the World			

b.Technological attributes

Perception of relevancy (relative advantage, compatibility, complexity, and observability) of recommended practices:

12. What is your perception of relevancy of the recommended practices to your farming situation? Pls tick appropriately

Quality of Recommended Practices	**Perception of relevancy**				
	Strongly Agreed	**Agreed**	**Undecided**	**Disagreed**	**Strongly Disagreed**
i. Recommended practices ensures safety (RA)					
ii. Recommended practices is cost effective (RA)					
iii. Recommended practices safes energy (RA)					
iv. Recommended practices safes time (RA)					
v. Recommended practices ensures environmental safety (RA)					
vi. Recommended practices ensures higher yield (O)					
vii. Recommended practices ensures effective pest and disease control (O)					
viii. Recommended practices is suitable for small-scale farmers (C)					
ix. Protective clothing is comfortable to wear (C)					
x. Recommended practices comes in simple language on labels (Cx)					
xi. Application techniques are very easy (Cx)					

c. Institutional factors

13. Extension visit: How many times have you been visited by extension agents in the last 1 year? ....times.
14. Use of radio:
    a. Do you have a radio in good working condition in your home? Yes ( ) No ( )
    b. If 'No', do you have a place you can listen to one? Yes ( ) No ( )
    c. Have you heard the use of agrochemicals on the radio in the last 1 year? Yes ( ) No( )
    d. If 'yes' what station was the programme aired? Pls specify ....
    e. How many times did you hear such programme in the last one year? ....times.

15. Access to Training:
    a. Have you been trained on the use of agrochemicals before? Yes… No…
    b. Report the formal/intensive training on the use of agrochemical and the quality of such training

S/	Type of training	Number of times	When last	Where (Venue	Sponsor/ Organizer[1]	Perception of accessibility 1=Highly	Perception on timeliness	Perception on quality 1=High	Are you satisfied with the quality of training	If 'no' why not?2 Give at

N		trained	(years)	)		accessible ( ) 2=Accessible 3=Poor accessibility 4=Not accessible	of training 1=Timely ( ) 2=Untimely ( )	quality ( ) 2=Average quality ( ) 3=Poor quality ( )	received? Yes/No	least 3 reasons		
										1	2	3
1	Application techniques											
2	Health and safety											
3	IPM											

[1]**Sponsor/organizer:** 1= ADP 2=Input trader/dealer 3=Research Institute 4=NGO 5=LGA 6=Producer/distributor7=Cooperative8=NAFDAC9=Ministry ofAgric 10=Environmental protection agency 11=International agency 12=Other (specify)….

[2]**Why not satisfy needs:** 1=Too theoretical 2=Poor timing 3=Lack details 4=Too high transportation cost 5=Training venue too far 6=Inappropriate venue 7=Poor publicity 8=Poor trainers 9=Too crowded 10=Others (specify)…

16. Do you think you need regular training on how to handle and use agrochemicals? Yes… No…
17. Source of credit/capital for your farm: Rate the following sources

Sources	**Rating**		
	Very major (2)	**Major (1)**	**Not major (0)**
i. Financial institutions			
ii. NGO			
iii. Input traders			
iv. Government institution			
v. Relatives/friends			
vi. Farmers' groups			
vii. Personal savings			
viii. Others (specify) …..			

18. What is the total amount of credit received in the last 1 year? ₦.....................................

Level of knowledge and adoption of recommended agrochemical practices:

19. Please rate the usefulness of the following sources of information to your use of recommended agrochemical practices.

S/N	**Source**	**Rating**		
		Very useful (2)	**Useful (1)**	**Not useful (0)**

1	Extension agents			
2	Research institutes			
3	Salesmen/Company			
4	Other farmers			
5	Village head			
6	Cooperative			
7	Radio			
8	Television			
9	Newspaper			
10	Internet			
11	Agricultural show			
12	NAFDAC			
13	EPA			
14	Others (specify)…………			

20. Rate your level of knowledge and adoption of the following practices: (Circle the appropriate one)

S/N	**Recommended Practices**	**VARIABLES**					
		LEVEL OF KNOWLEDGE			**LEVEL OF ADOPTION**		
		Full Knowledge	**Partial Knowledge**	**No Knowledge**	**Very Often**	**Seldom**	**Never**
1	Using the right agrochemicals GP						
2	Avoid using expired/banned chemicals GP						
3	Purchasing from reputable source GP						
4	Avoid buying chemical too early in the growing season to avoid long storage GP						
5	Checking that seals and original labels have not been broken GP						

6	Using the right dosage EC						
7	Using the right equipment EC						
8	Proper calibration of sprayer EC						
9	Regular repair and maintenance of spraying equipment EC						
10	Following labeling instructions AT						
11	Avoid spraying against wind direction AT						
12	Avoid mixing herbicide with fungicide HS						
13	Applying the agrochemical at the right time HS						
14	Observation of the waiting period HS						
15	Wearing protective clothing HS						
16	Avoid leaving pesticides in equipment overnight HS						
17	Avoid eating, drinking and smoking during spraying HS						
18	Avoid entering sprayed farm until 24 hours after spraying HS						
19	Never store pesticides in living rooms, kitchen, animal house or toilets HS						
20	Keep herbicides separate from other types of pesticides HS						
21	Check any pesticides you are storing regularly for sign of damage or leakages HS						
22	Proper disposal of empty container ES						
23	Proper handling and storage of agrochemical ES						
24	Keep pesticides away from source of drinking water, wells, and streams ES						
25	Avoid using chemical for different purpose e.g. treating animal wound ES						

21. Which of the following factors motivate you to adopt the recommended practices:

Motivating Factors	**Rating**
i. Personal health care	

Rating scale

Very often 4

ii. Care about others			Often	3
iii. Care about the environment			Seldom	2
iv. Care about livestock/aquaculture			Occasionally	1
v. Need to avoid wastage			Never	0
vi. Need to avoid pesticide failure				
vii. Increased Output				
viii. Others (specify).................				

Constraints to adoption of recommended agrochemical practices:

22. To what extent has the following constrained your adoption of the recommended practices?

S/N	Constraints to adoption of RAPs	Rating		
1	High cost of agrochemicals			
2	Adulteration of chemicals			
3	Unclear user manual		Very often	4
4	Too long waiting period		Often	3
5	Inadequate equipment		Seldom	2
6	Inadequate technical knowhow		Occasionally	1
7	Unavailability of protective clothing		Never	0
8	High cost of spraying equipment & clothing			
9	Far distance to market			
10	Problem of agrochemical failure			
11	Problem of expired/banned chemicals			
12	Irreputable sources			
13	Unavailability of agrochemicals			
14	Toxicity (poisonous nature of chemicals)			
15	Spare parts not available/affordable			

16	Inadequate of specialists for repairs & maintenance of equipment	
17	High breakdown rate / short lifespan of equipment	
18	Resistance of pests	
19	Uncomfortability of using protective wears	

Source, efficacy and accessibility of agrochemicals:

23. Report the sources, efficacy and accessibility of agrochemicals

S/N	Name of Agrochemical	Major source[1]	Distance to source (Km)	Perception of accessibility: 1=Highly accessible ( ) 2=Accessible ( ) 3=Poorly accessible ( ) 4=Not accessible ( )	Perception on timeliness of availability: 1=Timely ( ) 2=Untimely ( )	Perception of the efficacy: 1=High efficacy ( ) 2=Fair efficacy( ) 3=Poor efficacy( )	Are you satisfied? Yes/No	If 'no', why not?[2] Give at least 3 reasons		
								1	2	3
1										
2										
3										

[1]**Source:** 1= Agroservice center 2=Input trader 3=Salesmen 4=Research Institute 5=Open market 6=Licenced vendor 7=Other (specify)….

[2]**Why not satisfy needs:** 1=Too expensive 2=Not available on time 3=Quantity sold not enough 4=High transportation cost 5=Too far away 6=Poor road or lack of transportation vehicle 7= Ineffectiveness 8=Other (specify…

Adoption pattern of RAPs

24. Length (years) of use: How long have you been using agrochemicals in your farm? ......years
25. a. Does the quantity of pesticide used on your farm increase or decrease in the last 5 years?

    i. Increased ( ) ii. Decreased ( ) iii. Same( ) iv. Dont know ( )

    b. What is the reason for the answer in 'a' above?

    ....
26. Type of agrochemicals used in the last three season (on the field and store):
    Name the various types and specify the crops each agrochemical is used for as well as the frequency of use of each agrochemical. (Refer to the catalogue of agrochemical containers provided)

S/N	Agrochemical	Crop for which it is used	Frequency of use				
			Very often(4)	Often (3)	Occasionally(2)	Seldom(1)	Never (0)

1	Herbicide: i. ii.						
2	Fungicide: i. ii.						
3	Insecticide: i. ii.						
4	Rodenticides: i. ii.						
5	Others i. ii.						

27. Decision to use agrochemical: who initiates your use of agrochemicals?
    i. Own decision ( ) iii. Advice from vendor ( ) v.Others (specify) …..
    ii. Advice from extension officer( ) iv. Advice from neighbor/friends( )
28. Does the use of agrochemical solve your intended crop production problem? a.Yes( ) b.No ( ) c.Dont know ( )
29. Does the use of agrochemical increase your output? a. Yes ( ) b. No ( ) c. Don't know ( )
30. Does the use of agrochemical reduce your cost of production? a. Yes ( ) b. No ( ) c. Don't know ( )
31. What time of year do you usually acquire chemicals for use in your farm?
    i. Beginning of the cropping season( ) iii.When the need arises ( ) v. Others (specify) …..
    ii. Ending of cropping season ( ) iv.When it is available for sale(
32. Who sprays/applies agrochemicals for your farm?
    i. Self only ( ) iii. Family only ( ) v. Self &Hired( ) vii. Self + Family + Hired( )
    ii. Hired only( ) iv.Self & Family () vi. Family & Hired ( ) viii. Service provider ( )
33. Possession of spraying equipment: Which of the following do you own personally? (Tick as applicable)
    i. Sprayer ( ) iv. Boot ( ) vii. Mask ( )
    ii. Overall( ) v.Glove () viii. Hat ( )
    iii. Goggles ( ) vi. Respirator ( ) ix. Others (specify) ...
34. How often do you (or your farm worker) use protective wears while spraying:

S/N	**Protective wears**	**Frequency of use**				
		Very often (4)	**Often (3)**	**Occasionally (2)**	**Seldom (1)**	**Never (0)**
1	Boot	4	3	2	1	0
2	Gloves	4	3	2	1	0
3	Mask	4	3	2	1	0

4	Hat	4	3	2	1	0
5	Goggles	4	3	2	1	0
6	Overall	4	3	2	1	0
7	Respirator	4	3	2	1	0

35. Maintenance of spraying equipment:
    a. How frequent do you maintain your spraying equipment?
       i. Monthly ( ) ii. seasonally ( ) iii. when necessary ( )
    b. Who usually helps you to maintain your spraying equipment? (specify the most major)
       i. Self( ) iii. Family member( ) v. Sales agent( ) vii. Input dealer ( )
       ii. Extension agent( ) iv.Fellow farmer () vi. Accredited mechanics( ) viii. Others (specify)........
36. What other methods do you use for pest and disease control on your farm? (Specify the most important 3)
    i. Land preparation ( ) iv. Use of local plant extracts ( ) vii. loud gun method ( )
    ii. Weeding ( ) v. Use of scare crow() viii. Use of predators ( )
    iii. Crop rotation ( ) vi. Bush burning ( ) ix. IPM ( )
    x. Others (specify).................
37. How do you dispose the used empty agrochemical container? (Specify the most major)
    i. Burn them ( ) iii. Burry them in soil ( ) v. Sell them ( )
    ii. Throw them anywhere ( ) iv. Wash & use in domestic activities() vi. Others (specify).......
38. Where do you store your agrochemicals?
    i. In the kitchen ( ) iii. In the room ( ) v. Anywhere in the house ( )
    ii. In the toilet ( ) iv. In a separate store () vi. Others (specify).......
39. a. Do you store left-over chemicals? Yes ( ) No ( )
    b. Number of day you usually store your left-over chemical: ....days
    c. Reason for having left-over: i. Weather interruption ( ) ii. Equipment breakdown ( ) iii. Emmergencies ( ) iv. Completed the required work ( ) v. Others (specify)........
40. Do you usually read the guides on pesticide containers? Yes ( ) No ( )
41. a. Have you ever bought chemical pesticides without instructions manual? Yes ( ) No ( )
    b. If Yes, please specify from whom/where) ....
42. Have you ever used chemicals with instructions written in a language you don't understand? Yes ( ) No ( )
43. Do you understand the instructions for use? Yes ( ) No ( ) Sometimes ( )

Knowledge of the Consequences of non-adoption of RAPs

44. a. Are you aware of the risks and hazards of pesticides? Yes ( ) No ( )
    b. If yes, what is the major source?
       i. Agric officer ( ) iii. Health officer ( ) v. NAFDAC officer( )
       ii. FEPA/SEPA officer( ) iv. Personal experience vi. Input trader ( )
       vii. Others (Specify)……..
45. Pesticide knowledge and perception: The use of pesticide is:
    i. Always good ( ) iii. Always harmful( ) v. Dont know ( )
    ii. Sometimes good ( ) iv. Sometimes harmful ( )
46. What is the damage? It is toxic to:
    i. human health ( ) iii. wildlife ( ) v. all the above( )
    ii. animal health ( ) iv. water bodies ( ) vi. Dont know ( )
47. a.Have you had any incident of pecticide poisoning in the family during the last 1 year: Yes ( ) No ( )
    b. If Yes, what is the effect? i. Poisoned and recovered ( ) ii. Longtime injuries/Illnes ( ) Death ( )

48. a. Have you ever felt any discomfort/illness after agrochemical application? Yes ( ) No ( )

b. If 'Yes'; what is/are your feelings?

Note: Let respondent give an answer and then mark down against alternative answers: do not prompt with possibilities.

i. Nausea(stomach upset)( )	v.Skin irritation( )	ix. Excessive sweating ( )
ii. Vomiting ( )	vi. Eye irritation( )	x. Tremors (Nervous problem) ( )
iii. Head/bodyache ( )	vii. Fatigue/weakness( )	xi. Others (specify).......
iv. Cramps (muscle pains) ( )	viii. Impaired vision ( )	

49. a. Do you report such agrochemical incidence that occur? Yes ( ) No ( )

b. If 'Yes' in "a" above; to whom/where do you report such incidence?

i. Agric officer ( ) iii. Health office ( ) v. NAFDAC office( )

ii. FEPA/SEPA ( ) iv. Input dealer/fellow ( ) vi. Others (specify).................

50. What environmental hazards have you encountered as a result of using agrochemicals?

i. Burning of crops ( ) iii. Death of livestock/fish ( ) v. Contamination of water ( )

ii. Contamination of food( ) iv. Death of fellow farmer() vi. None ( ) vii. Others (specify)

51. a. Have you ever recorded agrochemical failure? Yes ( ) No ( )

b. Frequency of agrochemical failure:

S/N	Agrochemical	Frequency of failure		
		Very frequent (3)	Frequent (2)	Less frequent (1)
1	Herbicide: i. ii.			
2	Fungicide: i. ii.			
3	Insecticide: i. ii.			
4	Rodenticides: i. ii.			
5	Others:			

52. What (in your own opinion) is/are the ways by which the adoption of RAPs can be encouraged among farmers?

Please list them:

....

……………………………………………………………………………………..

The End

Thank you very much for your cooperation

Interviewer's comment: ....

Time Interview ended: ………………………

Appendix 2: Questionnaire for Input Agencies and Agrochemical Dealers

ANALYSIS OF ADOPTION OF RECOMMENDED AGROCHEMICAL PRACTICES AMONG CROP FARMERS IN KADUNA AND ONDO STATES OF NIGERIA

Questionnaire for State Input Agency and Private Dealers

Background Information
Name of Agency:…………………………………....................................Date..........................
State:………..…...................Zone:…..……...............LGA.....................................Block:………….
…........ Name of village:……......………………………
Respondent's phone number:……………..….... Respondent's name (Optional): ....

Good day sir/ma,
I am a researcher from the Department of Agricultural Economics and Rural Sociology,Ahmadu Bello University, Zaria. I am interested in information about your activities specifically concerning your sales of agrochemicals for crop protection. The aim is to assess how recommended agrochemical practices have been adopted by farmers. As a major stakeholder in input distribution; I shall be very grateful if you can give me part of your valuable time. Please feel free and answer the questions accurately and honestly. The result generated will be used purely for academic research purpose and your responses will be treated with utmost confidentiality.

Thank you.

1. Type of agrochemicals sold in the last three season (for use on the field and store): Name 5 major types in each category, specify the crops each agrochemical is used for and estimate the quantity sold last season

Agrochemicals	Crop for which it is used	Quantity sold	Nature of herbicide Contact OR systemic
Herbicide: i. ii. iii. iv. v.			
Fungicide: i. ii. iii. iv. v.			
Insecticide: i. ii. iii. iv. v.			

Rodenticides: i. ii. iii. iv. v.			
Others i. ii. iii.			

2. a. Does the amount of pesticide soldincrease or decrease in the last 5 years?
   i. Increased ( ) ii. Decreased ( ) iii. Same( ) iv. Dont know ( )
   b. What do you think is/are the reason for the answer in 'a' above?
   ....
3. Do you think the use of agrochemical solve farmers' crop production problem?
   a. Yes ( ) b. No ( ) c. Dont know ( )
4. What time of year do you think farmers acquire chemicals for use on their farms?
   i. Beginning of the cropping season( ) iii.When the need arises ( ) v.Others (specify) …..
   ii. Ending of cropping season ( ) iv.When it is available for sale( )
5. Which of the following is stocked by your agency? (Tick as applicable)
   i. Sprayer ( ) iv. Boot ( ) vii. Mask ( )
   ii. Overall( ) v.Glove () viii. Hat ( )
   iii. Goggles ( ) vi. Respirator ( ) ix. Others (specify) ...
6. How often do farmers buy the following protective wears?

S/N	Protective wears	Frequency of buy		
		Very often	Often	Never
1	Boot	2	1	0
2	Gloves	2	1	0
3	Mask	2	1	0
4	Hat	2	1	0
5	Goggles	2	1	0
6	Overall	2	1	0
7	Respirator	2	1	0

7. Maintenance of spraying equipment:
   a. Does your agency maintain spraying equipment?
   i. Monthly ( ) ii. seasonally ( ) iii. when necessary ( )
8. How do you think farmers dispose the used empty agrochemical container?

i. Burn them ( ) iii. Burry them in soil ( ) v. Sell them ( )
ii. Throw them anywhere () iv. Wash & use in domestic activities() vi. Others (specify).......

9. Where do you think the farmers store agrochemicals?
   i. In the kitchen ( ) iii. In the room ( ) v. Anywhere in the house ( )
   ii. In the toilet ( ) iv. In a separate store () vi. Others (specify).......
10. a. Do you think farmers store left-over chemicals? Yes ( ) No ( ) Dont know ( )
    b. What is the maximum number of daysthat is appropriate to store left-over chemical: ....days
11. Do you think farmers usually read the guides on pesticide containers? Yes ( ) No ( )
12. Have you ever sold chemical without instructions manual? Yes ( ) No ( )
13. Have you ever sold chemicals with instructions written in a language farmers don't understand? Yes ( ) No ( )
14. a. Do you think farmers are aware of the risks and hazards of pesticides? Yes ( ) No ( )
    b. If yes, what is the source of their awareness?
    i. Agric officer ( ) iii. Health officer ( ) v. NAFDAC officer( )
    ii. FEPA/SEPA officer( ) iv. Input agency vi. Others (specify)................
15. a.Have you heard any incident of pesticide poisoning in the State during the last 1 year: Yes ( ) No ( )
    b. If Yes, what is the effect? i. Poisoned and recovered ( ) ii. Longtime injuries/Illness ( ) Death ( )
16. a. Do you have report of any discomfort/illness after agrochemical application by farmer? Yes ( ) No ( )
    b. If 'Yes'; what is/are the reported illness?
    i. Nausea(stomach upset)( ) v.Skin irritation ( ) ix. Excessive sweating ( )
    ii. Vomiting ( ) vi. Eye irritation( ) x. Tremors (Nervous problem) ( )
    iii. Head/bodyache ( ) vii. Fatigue/weakness ( ) xi. Others (specify).......
    iv. Cramps (muscle pains) ( ) viii. Impaired vision ()
17. Where do you think such agrochemical incidence that occur was reported?
    i. Agric officer ( ) iii. Health office ( ) v. NAFDAC office( )
    ii. FEPA/SEPA ( ) iv. Input supplier vi. Others (specify)................
18. What environmental hazards have been reported to you as a result of using agrochemicals?
    i. Burning of crops ( ) iii. Death of livestock/fish ( ) v. Contamination of water ( )
    ii. Contamination of food( ) iv. Death of fellow farmer() vi. None ( ) vii. Others(specify)
19. a. Do you think farmers have ever recorded agrochemical failure? Yes ( ) No ( )
    c. If "yes", what is the frequency of such agrochemical failure:

S/N	**Agrochemical**	**Frequency of failure**		
		Very frequent (3)	**Frequent (2)**	**Less frequent (1)**
1	Herbicide: i. ii.			
2	Fungicide: i. ii.			
3	Insecticide: i. ii.			

4	Rodenticides: i. ii.			
5	Others:			

20. Training:
    a. Have you trained farmers on the use of agrochemicals before? Yes (   )No (   )
    b. Report the formal/intensive training on the use of agrochemical and the quality of such training

S/N	Type of training	№ of times trained	№ of farmers trained	When last(years)	Where (Venue)	Perception of accessibility 1=Highly accessible ( ) 2=Accessible 3=Poor accessibility 4=Not accessible	Perception on timeliness of training 1=Timely ( ) 2=Untimely ( )	Perception on quality 1=High quality ( ) 2=Average quality ( ) 3=Poor quality ( )	Do you think farmers are satisfied with the quality of training received? Yes/No	If 'no' why not?[1] Give at least 3 reasons		
										1	2	3
1	Application techniques											
2	Health and safety											
3	Integrated Pest Mgt											

[1]**Why not satisfy needs:** 1=Too theoretical 2=Poor timing 3=Lack details 4=Too high transportation cost 5=Training venue too far 6=Inappropriate venue 7=Poor publicity 8=Poor trainers 9=Too crowded 10=Others (specify)…

21. Do you think farmers need regular training on how to handle and use agrochemicals? Yes… No…

Level of knowledge/awareness and adoption of recommended agrochemical practices:

22. Rate the perceived level of awareness and adoption of the following practices by farmers: (Circle the appropriate one)

S/N	**Recommended Practices**	**VARIABLES**					
		LEVEL OF KNOWLEDGE			**LEVEL OF ADOPTION**		
		Full	**Partial**	**No**	**Very Often**	**Seldom**	**Never**
1	Using the right agrochemicals	0	1	2	2	1	0
2	Avoid mixing herbicide with fungicide	0	1	2	2	1	0
3	Using the right dosage	0	1	2	2	1	0
4	Following labeling instructions	0	1	2	2	1	0
5	Applying the agrochemical at the right time	0	1	2	2	1	0
6	Observation of the waiting period	0	1	2	2	1	0

7	Using the right equipment	0	1	2	2	1	0
8	Proper calibration of sprayer	0	1	2	2	1	0
9	Wearing protective clothing	0	1	2	2	1	0
10	Avoid spraying against wind direction	0	1	2	2	1	0
11	Regular repair and maintenance of spraying equipment	0	1	2	2	1	0
12	Proper disposal of empty container	0	1	2	2	1	0
13	Proper handling and storage of agrochemical	0	1	2	2	1	0
14	Avoid leaving pesticides in equipment overnight	0	1	2	2	1	0
15	Avoid eating, drinking and smoking during spraying	0	1	2	2	1	0
16	Avoid expired chemicals	0	1	2	2	1	0
17	Avoid using banned chemicals	0	1	2	2	1	0
18	Purchasing from reputable source	0	1	2	2	1	0
19	Avoid entering sprayed farm 24 hours after spraying	0	1	2	2	1	0
20	Never store pesticides in living rooms, kitchen, animal house or toilets.	0	1	2	2	1	0
21	Avoid buying chemical too early in the growing season to avoid long storage	0	1	2	2	1	0
22	Checking that seals and original labels have not been broken	0	1	2	2	1	0
23	Keep herbicides separate from other types of pesticides	0	1	2	2	1	0
24	Check any pesticides you are storing regularly for sign of damage or leakages.	0	1	2	2	1	0
25	Keep pesticides away from source of drinking water, wells, and streams	0	1	2	2	1	0
26	Avoid using chemical for different purpose e.g. treating animal wound	0	1	2	2	1	0

Constraints to adoption of recommended agrochemical practices:

23. To what extent do you think the following has constrained farmers' adoption of the recommended practices?

S/N	**Constraints to adoption of RAPs**	**Rating**
1	High cost of agrochemicals	

2	Adulteration of chemicals	
3	Unclear user manual	
4	Too long waiting period	
5	Inadequate equipment	
6	Inadequate technical knowhow	
7	Unavailability of protective clothing	
8	High cost of spraying equipment& clothing	
9	Far distance to market	
10	Problem of agrochemical failure	
11	Problem of expired/banned chemicals	
12	Irreputable sources	
13	Unavailability of agrochemicals	
14	Toxicity (poisonous nature of chemicals)	
15	Spare parts not available/affordable	
16	Inadequate of specialists for repairs and maintenance of equipment	
17	High breakdown rate / short lifespan of equipment	
18	Resistance of pests	
19	Uncomfortability of using protective wears	
20	Poor attitude of farmers	

Very often	3
Often	2
Occasionally	1
Never	0

Source, efficacy and accessibility of agrochemicals:

24. Report the sources, efficacy and accessibility of agrochemicals

S/N	Name of Agrochemical	Major source	Perception of accessibility: 1=Highly accessible ( ) 2=Accessible ( ) 3=Poorly accessible( ) 4=Not accessible ( )	Perception on timeliness of availability: 1=Timely ( ) 2=Untimely ( )	Perception of theefficacy: 1=High ( ) 2=Fair( ) 3=Poor ( )	Do you think farmers are satisfied? Yes/No	If 'no', why not?[2] Give at least 3 reasons		
							1	2	3
1									
2									
3									

[2]**Why not satisfy needs:** 1=Too expensive 2=Not available on time 3=Quantity sold not enough 4=High transportation cost 5=Too far away 6=Poor road or lack of transportation vehicle 7= Ineffectiveness 8=Other (specify…

Perception of relevancy (relative advantage, compatibility, complexity, and observability) of recommended practices

25. What is your perception of relevancy of the recommended practices to farmers' situation? Pls tick appropriately

Quality of Recommended Practices	**Perception of relevancy**				
	Strongly Agreed (5)	**Agreed (4)**	**Undecided (3)**	**Disagreed (2)**	**Strongly Disagreed (1)**
i. Recommended practices ensures safety	5	4	3	2	1
ii. Recommended practices ensures higher yield	5	4	3	2	1
iii. Recommended practices is cost effective	5	4	3	2	1
iv. Recommended practices is suitable for small-scale farmers	5	4	3	2	1
v. Recommended practices is efficient	5	4	3	2	1
vi. Other farmers follow Recommended practices	5	4	3	2	1
vii. Recommended practices ensures effective pest and disease control	5	4	3	2	1
ix. Recommended practices safes energy	5	4	3	2	1
x. Recommended practices safes time	5	4	3	2	1
xi. Recommended practices comes in simple language on labels	5	4	3	2	1
xii. Protective clothing is comfortable to wear	5	4	3	2	1

26. Airing of programme on the use of agrochemical
    a. Have you heard any agricultural programme specifically on the use of agrochemicals on the radio?Yes (   ) No (   )
    b. If 'yes' what station was the programme aired? Pls specify ....
    c. How many times did you hear such programme? ....times.
27. What are the measures put in place by your agency to promote the adoption of recommended agrochemical practices?
    i. ....
    ii. ....
    iii. ....
28. What (in your own opinion) is/are the ways by which the adoption of Recommended Agrochemical Practices can be encouraged among farmers?

Please list them: ....
………………………………………………………….............................

29. Do you have constraint of fund to purchase agrochemicals to time? Yes ( ) No ( )

The End

Thank you very much for your cooperation

Interviewer’s comment: ....

Time Interview ended: ………………………

Appendix 3: Questionnaire for Radio Stations

ASSESSMENT OF ADOPTION OF RECOMMENDED AGROCHEMICAL PRACTICES AMONG CROP FARMERS IN KADUNA AND ONDO STATES OF NIGERIA

Questionnaire for Media Houses

Background Information
Name of Media House:…………………………………..... Date...................
State:……….........................Zone:…..……...............................LGA...................................
Respondent's phone number:……………..…....… Respondent's name (Optional): ....

Good day sir/ma,
I am a researcher from the Department of Agricultural Economics and Rural Sociology,Ahmadu Bello University, Zaria. I am interested in information about your activities specifically concerning the use of agrochemicals for crop protection by farmers. The aim is to assess how recommended agrochemical practices have been adopted. I shall be very grateful if you can give me part of your valuable time. Please feel free and answer the questions accurately and honestly. The result generated will be used purely for academic research purpose and your responses will be treated with utmost confidentiality.

Thank you.

1. a. Have you aired/published any agricultural programme specifically on the use of agrochemicals? Yes ( ) No ( )
   b. If 'yes' when was such programme aired/published last?
   Pls specify the date and the title of the programme...
   a. How many times did you air/publish such programme within the last two years? ....times.
2. Training:
   a. Have you trained on the use of agrochemicals before? Yes… No…
   b. Report the formal/intensive training on the use of agrochemical and the quality of such training

Type of training	Number of times such training was staged	How long ago	Where (Venue of such training)	Perception of accessibility 1=Highly accessible ( ) 2=Accessible 3=Poor accessibility 4=Not accessible	Perception on timeliness of training 1=Timely ( ) 2=Untimely ( )	Perception on quality 1=High quality ( ) 2=Average quality ( ) 3=Poor quality ( )	Are you satisfied with the quality of training received? Yes/No	If 'no' why not?[1] Give at least 3 reasons		
								1	2	3
Application techniques										
Health and safety										

Integrated Pest Mgt										

[1]**Why not satisfy needs:** 1=Too theoretical 2=Poor timing 3=Lack details 4=Too high transportation cost 5=Training venue too far 6=Inappropriate venue 7=Poor publicity 8=Poor trainers 9=Too crowded 10=Others (specify)…

3. If "no" in 2a (above); do you think you need regular training on how to handle and use agrochemicals? Yes… No…

Level of awareness and adoption of recommended practices

4. Rate the perceived level of knowledgeand adoption of the following practices by farmers:

(Circle the appropriate one)

S/N	Recommended Practices	VARIABLES					
		LEVEL OF KNOWLEDGE			LEVEL OF ADOPTION		
		Full	Partial	No	Very Often	Seldom	Never
1	Using the right agrochemicals	0	1	2	2	1	0
2	Avoid mixing herbicide with fungicide	0	1	2	2	1	0
3	Using the right dosage	0	1	2	2	1	0
4	Following labeling instructions	0	1	2	2	1	0
5	Applying the agrochemical at the right time	0	1	2	2	1	0
6	Observation of the waiting period	0	1	2	2	1	0
7	Using the right equipment	0	1	2	2	1	0
8	Proper calibration of sprayer	0	1	2	2	1	0
9	Wearing protective clothing	0	1	2	2	1	0
10	Avoid spraying against wind direction	0	1	2	2	1	0
11	Regular repair and maintenance of spraying equipment	0	1	2	2	1	0
12	Proper disposal of empty container	0	1	2	2	1	0
13	Proper handling and storage of agrochemical	0	1	2	2	1	0
14	Avoid leaving pesticides in equipment overnight	0	1	2	2	1	0
15	Avoid eating, drinking and smoking during spraying	0	1	2	2	1	0
16	Avoid expired chemicals	0	1	2	2	1	0
17	Avoid using banned chemicals	0	1	2	2	1	0
18	Purchasing from reputable source	0	1	2	2	1	0
19	Avoid entering sprayed farm 24 hours after spraying	0	1	2	2	1	0
20	Never store pesticides in living rooms, kitchen, animal house or toilets.	0	1	2	2	1	0

21	Avoid buying chemical too early in the growing season to avoid long storage	0	1	2	2	1	0
22	Checking that seals and original labels have not been broken	0	1	2	2	1	0
23	Keep herbicides separate from other types of pesticides	0	1	2	2	1	0
24	Check any pesticides you are storing regularly for sign of damage or leakages.	0	1	2	2	1	0
25	Keep pesticides away from source of drinking water, wells, and streams	0	1	2	2	1	0
26	Avoid using chemical for different purpose e.g. treating animal wound	0	1	2	2	1	0

5. What is your perception of relevancy of the recommended practices to farming situation? Pls tick appropriately

Quality of Recommended Practices	**Perception of relevancy**				
	Strongly Agreed (5)	**Agreed (4)**	**Undecided (3)**	**Disagreed (2)**	**Strongly Disagreed (1)**
i. Recommended practices ensures safety	5	4	3	2	1
ii. Recommended practices ensures higher yield	5	4	3	2	1
iii. Recommended practices is cost effective	5	4	3	2	1
iv. Recommended practices is suitable for small-scale farmers	5	4	3	2	1
v Recommended practices is efficient	5	4	3	2	1
vi Other farmers follow Recommended practices	5	4	3	2	1
vii. Recommended practices ensures effective pest and disease control	5	4	3	2	1
ix. Recommended practices safes energy	5	4	3	2	1
x. Recommended practices safes time	5	4	3	2	1
xi. Recommended practices comes in simple language on labels	5	4	3	2	1
xii. Protective clothing is comfortable to wear	5	4	3	2	1

Constraints to adoption of recommended agrochemical practices:

6. To what extent do you think the following has constrained farmers' adoption of the recommended practices?

S/N	Constraints to adoption of RAPs	Rating
1	High cost of agrochemicals	
2	Adulteration of chemicals	
3	Unclear user manual	
4	Too long waiting period	
5	Inadequate equipment	
6	Inadequate technical knowhow	
7	Unavailability of protective clothing	
8	High cost of spraying equipment& clothing	
9	Far distance to market	
10	Problem of agrochemical failure	
11	Problem of expired/banned chemicals	
12	Irreputable sources	
13	Unavailability of agrochemicals	
14	Toxicity (poisonous nature of chemicals)	
15	Spare parts not available/affordable	
16	Inadequate of specialists for repairs and maintenance of equipment	
17	High breakdown rate / short lifespan of equipment	
18	Resistance of pests	
19	Uncomfortability of using protective wears	

Very often	3
Often	2
Occasionally	1
Never	0

Source, efficacy and accessibility of agrochemicals:

7. What do you think is the major source of agrochemicals purchased by farmers?
   i. Agroservice center ( )ii.Input trader ( ) iii.Salesmen ( ) iv. Research Institute ( )
   v. Open market ( ) vi. Licensed vendor ( )vii.Other (specify)…........
8. What is your perception of the efficacy of agrochemical purchased by farmers?
   i. High ( ) ii.Fair ( )iii.Poor
9. What is your perception of the accessibility of agrochemical?
   i. Highly accessible ( ) ii.Accessible ( ) iii.Poorly accessible ( ) iv. Not accessible ( )
10. What is your perception of the timeliness of the availability of the agrochemicals?i. Timely ( ) ii. Untimely ( )
11. a.Do you think farmers are satisfied with the source, efficacy and accessibility of the agrochemicals? Yes ( ) No ( )
    b.If "no"; what do you think are the reasons for their non-satisfaction? Tick the most important 3.

i. Too expensive( ) ii. Not available on time( ) iii. Quantity sold not enough( )
iv. High transportation cost ( ) v. Too far away ( ) vi. Poor road or lack of transportation vehicle ( ) vii.Ineffectiveness ( ) viii. Other (specify…................

12. a. Do you think the amount of pesticide used by farmers have increase or decrease in the last 5 years?
    i. Increased ( ) ii. Decreased ( ) iii. Same( ) iv. Dont know ( )
    b. What do you think is/are the reason for the answer in 'a' above?
    ....
13. Does the use of agrochemical solve farmers' crop production problem? a.Yes( ) b.No ( ) c.Dont know ( )
14. Does the use of agrochemical increase farmers'output? a. Yes ( ) b. No ( ) c. Don't know ( )
15. Does the use of agrochemical reduce farmers' cost of production? a. Yes ( ) b. No ( ) c. Don't know ( )
16. What time of year do you advice farmers to acquire chemicals for use in their farm?
    i. Beginning of the cropping season( ) iii.When the need arises ( ) v.Others (specify) …..
    ii. Ending of cropping season ( ) iv.When it is available for sale( )
17. How often do you think farmers (or farm worker) use protective wears while spraying:

S/N	**Protective wears**	**Frequency of use**			
		Very often (3)	**Often (2)**	**Occasionally (1)**	**Never (0)**
1	Boot	3	2	1	0
2	Gloves	3	2	1	0
3	Mask	3	2	1	0
4	Hat	3	2	1	0
5	Goggles	3	2	1	0
6	Overall	3	2	1	0
7	Respirator	3	2	1	0

18. What other methods do you think farmers use for pest and disease control on your farm? (Tick the most important 3)
    i. Land preparation ( )
    ii. Weeding ( )
    iii. Crop rotation ( )
    iv. Use of local plant extracts ( )
    v. Use of scare crow()
    vi. Bush burning ( )
    vii. loud gun method ( )
    viii. Use of predators ( )
    ix. IPM ( )
    x. Others (specify).................
19. How do you think farmers dispose the used empty agrochemical container?
    i. Burn them ( )
    ii. Throw them anywhere ( )
    iii. Burry them in soil ( )
    iv. Wash & use in domestic activities()
    v. Sell them ( )
    vi. Others (specify).......
20. Do you think farmers understand the instructions for use of pesticides? Yes ( ) No ( ) Sometimes ( )

21. a. Do you think farmers are aware of the risks and hazards of pesticides? Yes ( ) No ( )
    b. If yes, what is the major source of their awareness?
        i. Agric officer ( )   iii. Health officer ( )   v. NAFDAC officer( )
        ii. FEPA/SEPA officer( )   iv. Others (specify).................
22. a.Do you have report of any incident of pesticide poisoning in the last 1 year: Yes ( ) No ( )
    b. If Yes, what is the effect? i. Poisoned and recovered ( ) ii. Longtime injuries/Illnes ( ) Death ( )
23. a. Have you ever heard of any discomfort/illness after pesticide application by farmers? Yes ( )No( )
    b. If 'Yes'; what is/are theillness?

i. Nausea(stomach upset)( )	v.Skin irritation ( )	ix. Excessive sweating ( )
ii. Vomiting ( )	vi. Eye irritation( )	x. Tremors (Nervous problem) (
iii. Head/bodyache ( )	vii. Fatigue/weakness ( )	xi. Others (specify).......
iv. Cramps (muscle pains) ( )	viii. Impaired vision ()	

24. Do you think farmers report such agrochemical incidence that occur? Yes ( ) No ( )
    If 'Yes'; to whom/where do they report such incidence?
        i. Agric officer ( )   iii. Health office ( )   v. NAFDAC office( )
        ii. FEPA/SEPA ( )   iv. Others (specify).................
25. What environmental hazards do you think farmers encountered as a result of using agrochemicals?
        i. Burning of crops ( )   iii. Death of livestock/fish ( )   v. Contamination of water ( )
        ii. Contamination of food( )   iv. Death of fellow farmer()   vi. None ( ) vii. Others(specify)
26. a. Have you ever heard reported cases of agrochemical failure? Yes ( ) No ( )
    d. Pls mention the name of the agrochemical: ....
27. What (in your own opinion) is/are the ways by which the adoption of Recommended Agrochemical Practices can be encouraged among farmers?
    Please list them:
    ....
    ………………………………………………………………………………...

    General Comment:
    ....
    ....

The End

Thank you very much for your cooperation