UNIVERSITY OF CAPE COAST

PESTICIDE MANAGEMENT AND EXTENSION INFORMATION SUPPORT FOR SMALL- SCALE FARMERS IN THE GA EAST AND GA WEST DISTRICTS OF THE GREATER ACCRA REGION OF GHANA

MARY OPOKU-ASIAMA

2008

UNIVERSITY OF CAPE COAST

PESTICIDE MANAGEMENT AND EXTENSION INFORMATION SUPPORT FOR SMALL-SCALE FARMERS IN THE GA EAST AND GA WEST DISTRICTS OF THE GREATER ACCRA REGION OF GHANA

BY

MARY OPOKU-ASIAMA

THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION, SCHOOL OF AGRICULTURE, UNIVERSITY OF CAPE COAST, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE IN AGRICULTURAL EXTENSION

MAY, 2008

CANDIDATE'S DECLARATION

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

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

Name:……………………………………………………………………...

SUPERVISORS' DECLARATION

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature………….......................... Date………………

Name: ……………………………………………………………………......

Co-Supervisor's Signature: …………………………….. Date………………

Name: …………………………………………………………………….......

ABSTRACT

The study which was carried out in the Ga East and Ga West districts of the Greater Accra Region of Ghana, examined the competencies of small-scale farmers in the sound management of pesticides.

A descriptive correlational survey was used to determine the small-scale farmers' perceived awareness levels of alternative pest control methods, perceived environmental, health and safety awareness levels and perceived usefulness of major sources of pesticide management information available to them. The study also determined the relationship between the perceived competencies of farmers in the sound management of pesticides and key selected independent variables of the study. The predictor(s) of the competencies of small-scale farmers in the sound management of pesticides were also determined.

The results of the study showed that, the mean perceived environmental, health and safety awareness level of effects of pesticide use in agriculture (Mean = 2.75; SD = 0.99) mean perceived overall awareness level of alternative pest control methods (Mean = 2.55; SD = 0.97) of small-scale farmers were moderate. They perceived AEAs as being a very effective source of pesticide management information (PMI) while, their perceived awareness level of environmental, health and safety effects of pesticides was the overall best predictor, and accounted for 59.3% of the variance in their perceived competence in the sound management of pesticides.

It is recommended that, there should be intensive training of small-scale farmers in best practices for the proper management of pesticides in agriculture.

ACKNOWLEDGEMENTS

I wish to thank Prof. J.A. Kwarteng, my principal supervisor who from the onset said I was capable of doing this work. His continuous encouragement to literally increase the “fire” kept my head above deep waters. I am equally indebted to Dr Paul-Mathias Braun, who has done a yeoman’s job, co-supervising this thesis.

Behind the scene, Dr. Ismail Yahaya, Dr Ernest Okorley, and Mr Nathan Adu Gyimah have been of immerse help. All the lecturers of School of Agriculture, especially those of the Department of Agricultural Economics and Extension are appreciated for their constructive criticisms, encouragement and moral support.

The input of Ministry of Food and Agriculture staff and small-scale farmers in the Dangbe West, Ga East and Ga West districts of the Greater Accra Region is duly acknowledged. Dr. K. A. Amezah, Messrs Peter Osei-Asibey, Theophilus Osei-Wusu, Prince, Awudu and all the staff of the Directorate of Agricultural Extension Services of the Ministry are duly appreciated for their support in this venture.

My colleagues at the Department of Agricultural Economics and Extension, Messrs Martin Bosompem, Serlorm Akaba and Samuel Ndzebah are appreciated for their support. Martin’s input and tolerance cannot be overemphasized.

I am sincerely grateful to Dr. Francis Ofori, Mr. A. A. Adjekum, Dr. J. A. Sackey, Mrs Baaba Sakyi, Miss Emelia Annang and Mr. Pius Dzinyela for their

motivation, advice, encouragement, financial and material support contributed greatly to this achievement.

Finally, I acknowledge with thanks and appreciation, the support of my immediate and distant families for their contributions in making this work a success.

DEDICATION

This work is dedicated to my children; Eileen, Marijke and Grace Opoku-Asiama.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

AEA	Agricultural Extension Agent
AESA	Agro-ecological Systems Analysis.
ANADER	Agence Nationale d'Appui au Developpement Rural (National Agency for Support of rural Rural Development)
CBOs	Community Based Organisations
CIDT	Compagne Ivorienne pour le Developpement des Textiles et Fibres (Ivorian company for textiles and fiber products development)
COCOBOD	Ghana Cocoa Board
CSIR	Council for Scientific and Industrial Research
DAES	Directorate of Agricultural Extension Services
EPA	Environmental Protection Agency
EurepGAPs	Good Agricultural Practices in the field and pack houses as required by European markets.
FAO	Food and Agricultural Organisation of the United Nations
FBOs	Farmer Based Organisations
IPM	Integrated Pest Management
MAG	Ministerio de Agricultura y Ganaderria (Ministry of Agriculture and Livestock)
MoFA	Ministry of Food and Agriculture
MRLs	Maximum Residue Levels
NARP	National Agricultural Research Project

NGO	Non-governmental Organization
Pc	Pesticides
PM	Pesticide Management
PMI	Pesticide Management Information
PPRS	Plant Protection and Regulatory Services
PPRSD	Plant Protection and Regulatory Services Directorate
RELC	Research-Extension-Linkage Committee
SMP	Sound Management of Pesticides
SPSS	Statistical Products for Services Solutions
WHO	World Health Organisation of the United Nations

CHAPTER ONE

INTRODUCTION

Background to the study

Globally, about 2.5 million tonnes of pesticides are applied annually to control pest organisms. Most of this application is targeted on agricultural crops (Pidwirny, 2002). About 80 percent of farmers in the Ga East and Ga West districts use pesticides on their farms. According to Williamson (2003), pesticides are considered an essential aspect of making a significant contribution to increasing agricultural production in Africa. However, the dangers posed by their misuse can override the benefits derived from them if the necessary precautions are not taken.

The use of pesticides in Ghana dates back to 1957, when Gammalin 20 was first used on cocoa capsids (Al-Hassan and Jatoe, 2005). Today, pesticide use has become an integral part of agricultural production, especially in the area of vegetables (Okorley and Kwarteng, 2002). However, recent reports indicate a high incidence of misuse of pesticides which has resulted in adverse effects on the environment, the applicators of these pesticides and the consumers of the produce. Other reports indicate inappropriate handling of pesticides and the dangers this poses to human health (Davis, 1997; Critchley, 1996).

For the farmer however, the profitability from intensification depends on the cost of pesticide used compared to the expected loss in yield or crop quality that would have occurred without pesticide use. On the other hand, pesticide use involves external costs that reduce the gains achieved by improved agricultural production. These costs include the adverse effects of pesticides in the form of contamination of food and water sources, development of resistance to pesticides by pests, loss of biodiversity as a result of damage to non-target organisms and, above all, the effects on human health and related costs of treatment in cases of pesticide poisoning. But external costs could be minimized if crop protection in general would be based on information that would lead to a balanced use of both chemical and non-chemical methods plus the general application of sound practices in application.

Crop protection policies play a very essential role within the context of efforts to increase agricultural production. In Ghana, several government institutions are currently involved in policy formulation, pesticide management (PM) control and management of pesticides. It is estimated that, about 100 out of the estimated total of 250 large scale pesticide dealers in pesticides, are registered with Environmental Protection Agency (EPA) (Gerken et al., 2001). This list includes all importers and wholesalers as well as some of the retailers.

The stakeholders in pesticide management, namely, the farmer-agricultural extension agent (AEA) - and the pesticide- dealer (F-A-D) chain play a very important role in the sound management of pesticides. The competencies of these stakeholders have been questioned in recent times following reported cases of poisoning from pesticide contaminated vegetables and the introduction of fake pesticides onto the pesticide market. The role of adequate and relevant information on pesticides and their proper management cannot be over emphasized. Finally, in considering the sound management of pesticides (SMP) by farmers, it is also important to assess their awareness of alternative means of pest control. This brings to the fore the issue of integrated pest management (IPM), which is the use of cultural and biological systems, so that the application of 'hard' chemical pesticides is regulated and means of control is specifically targeted. The study proposes to assess the competency levels of small-scale farmers in the Ga East and West districts in the sound management of pesticides (SMP), determine the information gaps and recommend extension information support systems that would help bridge their need gaps.

Statement of the problem

In view of threats posed to agricultural production, especially in the area of crop pests and diseases, the use of pesticides such as weedicides, insecticides and fungicides has become an integral part of Ghanaian agriculture. As a result of the advantages these chemicals offer, farmers seem to continue to intensify their use so long as they perceive pesticides as a means of increasing production. It is now a common and strong belief among vegetable growers in some parts of the country that it is impossible to produce vegetables on commercial basis without the use of pesticides (Okorley and Kwarteng, 2002). Small-scale farmers in the Ga East and West districts are no exception. For the larger society however, pesticide use involves external costs that reduce the gains made by improved agricultural production (Gerken et al., 2001). According to the authors, these external costs include the cost of treatment in cases of pesticide poisoning, contamination of food and water, development of resistance to pesticides and a loss of biodiversity not to talk of the cost of fatal deaths.

In an effort to intensify agriculture in order to increase production as a step towards economic growth, it is expected that the use of pesticides will also be intensified on a national basis. The use of pesticides by small-scale farmers has been made easier by their availability in local agro-chemical shops. A survey of pesticide use by urban vegetable growers in the Central Region of Ghana shows that there is a wide range of pesticides on the market, including restricted ones and those brought from unauthorized sources (Okorley and Kwarteng, 2002). The use of pesticides, though a means of increasing agricultural production and making available to the consumer a more attractive produce, has given rise to national concerns as a result of indications of the apparent incompetencies of stakeholders in pesticide use and recent reports of harmful pesticides found in vegetables. Apart from direct contamination, the method of pesticide application also has an effect on the fate of the pesticide (Mabbett, 2004a).

Lack of adequate information on SMP for farmers, pesticide dealers and agricultural extension agents could be a major contributing factor to the apparent misuse and abuse of pesticides in Ghanaian agriculture, thus resulting in a myriad of problems in the environment and to humans. Okorley et al. (2005) have reported from their study on extension training needs in pesticide use by urban vegetables growers in the Central Region of Ghana that, pesticide sellers in the region do not have adequate training to understand the special nature of their work and the requirements that go with it. They also reported that vegetable farmers, pesticide sellers and Agricultural Extension Agents in the region need information and training in the use and handling of pesticide. In the Daily Graphic issue of Friday, July 23, 2004, it was reported that, " The Food and Drugs Board has warned residents of Tarkwa and its environs against the consumption of vegetables from the area since they have been proven to contain harmful pesticides" (Boadu-Ayeboafoh, 2004). Similar reports have appeared on the national front over the decades and point to the dangers posed to humans by such mismanagement of pesticides. Farmers in the Ga East and Ga West districts are also known to use empty pesticide containers to hold water and salt while others taste pesticide solutions to test their potency. From the foregoing, it appears, there are serious problems with pesticide management in Ghana and more specifically in the Ga East and Ga West districts. There is, therefore, a need to ascertain the knowledge and competency level of the small-scale farmers in the Ga East and Ga West districts who contribute to the production of a large proportion of Ghana's food, in the sound management of pesticides.

Objectives of the study

The overall objective of the study is to examine pesticide management and extension information support for pesticide management by small-scale farmers in the Ga East and Ga West districts of the Greater Accra Region of Ghana.

The specific objectives of the study are to:

1. Describe the demographic and occupational related characteristics of small-scale farmers

2. Describe pesticides available to farmers in the districts in terms of:

- Sources of pesticides
- Types of pesticides
- Accessibility to pesticides
- Cost of pesticides
- Purposes for which pesticides are used

3. Describe pesticide management practices by farmers

4. Describe the current sources of pesticide management information available to farmers.

5. Examine the environmental, safety and health awareness levels of farmers in terms of:

- Environmental hazards from pesticide use
- Pesticide residues in agricultural products
- Effects of pesticides on public health
- Effects of pesticides on game and wild life.
- Effects of pesticides on livestock, bees and other pollinating insects e.g. butterflies and ants.
- Effects of pesticides on natural enemies of pests
- Effects of pesticides on development of pest resistance
- Effects of pesticides on resurgence of pests
- Waiting periods after chemical application before harvesting
- Adverse effects of pesticides on non-target organism

6. Examine the perceived awareness levels of farmers in alternative methods of pest control in terms of:-

- Biological methods
- Physical methods
- Cultural methods
- Indigenous methods
- Integrated Pest Management
- Biopesticides
- Sanitary measures

7. Describe the perceived competencies of farmers in the sound management of pesticides in terms of:-

- Identification of pests and diseases
- Identification of beneficial insects/ arthropods
- Determination of possible pest damage
- Identification of pesticides
- Classification of pesticides
- Pesticide selection
- Dosage determination
- Calibration of spraying machines
- Reading of pesticide labels
- Understanding pesticide labels
- Understanding pictograms on pesticide labels
- Proper handling of pesticides
- Use of protective clothing
- Precautions when spraying

- Maintenance of personal hygiene
- Maintenance of spraying machines
- Storage of pesticides
- Disposal of pesticide containers
- First Aid in pesticide poisoning
- Alternative pest control methods
- Decision on when to use pesticides
- Food safety issues e.g. EurepGAPs, MRLs.

8. Determine the relationship between the perceived competencies of farmers in the sound management of pesticides and:

- Farmers' perceived environmental, safety and health awareness levels.
- Farmers' perceived awareness levels of alternative pest control methods
- Farmers' perceived effectiveness of pesticide management information (PMI) available to them.
- How often farmers examined equipment and protective clothing when handling pesticides.
- Selected demographic characteristics (age, educational level and farming experience).

9. Determine the best predictor(s) of the competencies of farmers in the sound management of pesticides.

Research questions

The research questions for the study are as follows:

1. What are the demographic and occupational characteristics of farmers in the study areas?
2. What are the types and sources of pesticides used in the study area and how readily available are they to the small-scale farmers the Ga East and Ga West districts?
3. What are the current sources of pesticide management information (PMI) and their perceived effectiveness in the dissemination of information on pesticide use to small-scale farmers?
4. What are the demographic and occupational characteristics of farmers in the study areas?
5. What are the perceived environmental, safety and health awareness levels of farmers in pesticide management in agriculture?
6. What are the awareness levels of farmers in alternative methods of pest control?
7. What are the perceived competencies of small-scale farmers in the sound management of pesticides?
8. Is there a relationship between the competencies of farmers in the sound management of pesticides and:
   - their perceived environmental, health and safety awareness levels.
   - their perceived effectiveness (usefulness) of extension information support available to them?
   - their perceived awareness level in alternative pest control methods?

- and selected socio-demographic characteristics of farmers?

9. What are the best predictors of the perceived competence level of farmers in the sound management of pesticides?

Conceptual framework

The conceptual framework for this study identifies the major factors in pesticide management as price, institutional and information factors, with information playing a key role. The framework links the sound management of pesticides to relevant and adequate information flow among Researchers, Plant Protection and Regulatory Services (PPRS) and Agricultural Extension Directorates of the Ministry of Food and Agriculture, Projects/NGOs, Pesticide companies, Agricultural Extension Agents (AEAs), Pesticide dealers and farmers.

The theory guiding the framework is that, small-scale farmers lack the information required for competency levels that ensure the sound management of pesticides. According to Kujeke (1999: 100) in Zimbabwe, "lack of information, uncertainty, and perceived risk have been shown to inhibit decision–making at farm level. Jungbluth (2000) in Thailand also stated that, pesticide use supporting factors identified can be categorized as price, institutional and information factors. Information provided by extension workers, pesticide retailers and chemical industries etc. is one of the institutional and macroeconomic factors which influence pesticide use (Agne, 2000). The framework for the study envisages that, the availability and suitability of unbiased information can only be sustained through regular feedback from AEAs, pesticide dealers, farmers and pesticide applicators who are the end - users of the information from research and pesticide manufacturers. Williamson (2003) in a study on pesticide use in Africa has recommended the encouragement of exchange of information between farmers in an effort to promote integrated pest management.

In order to facilitate the SMP, research information on pesticide management must be packaged in a suitable manner by Plant Protection and Regulatory Services Directorates (PPRSD), Projects and Pesticide companies for the benefit of AEAs, pesticide dealers and farmers. It is conceptualized that, efficiency in good quality pesticide management information flow will translate into developing the competencies of farmers in the sound management of pesticides. Although farmers may then resort to overdependence on pesticides, environmental and food safety will be assured. There will also be a reduction in pesticide poisoning cases when farmers develop a higher competency in the sound management of pesticides.

The philosophy of the study is that, as the major producers of food for both local consumption and export for Ghana, the competence level of small-scale farmers in the sound management of pesticides is important in ensuring the safety of the environment, consumers of their produce while ensuring their own safety.

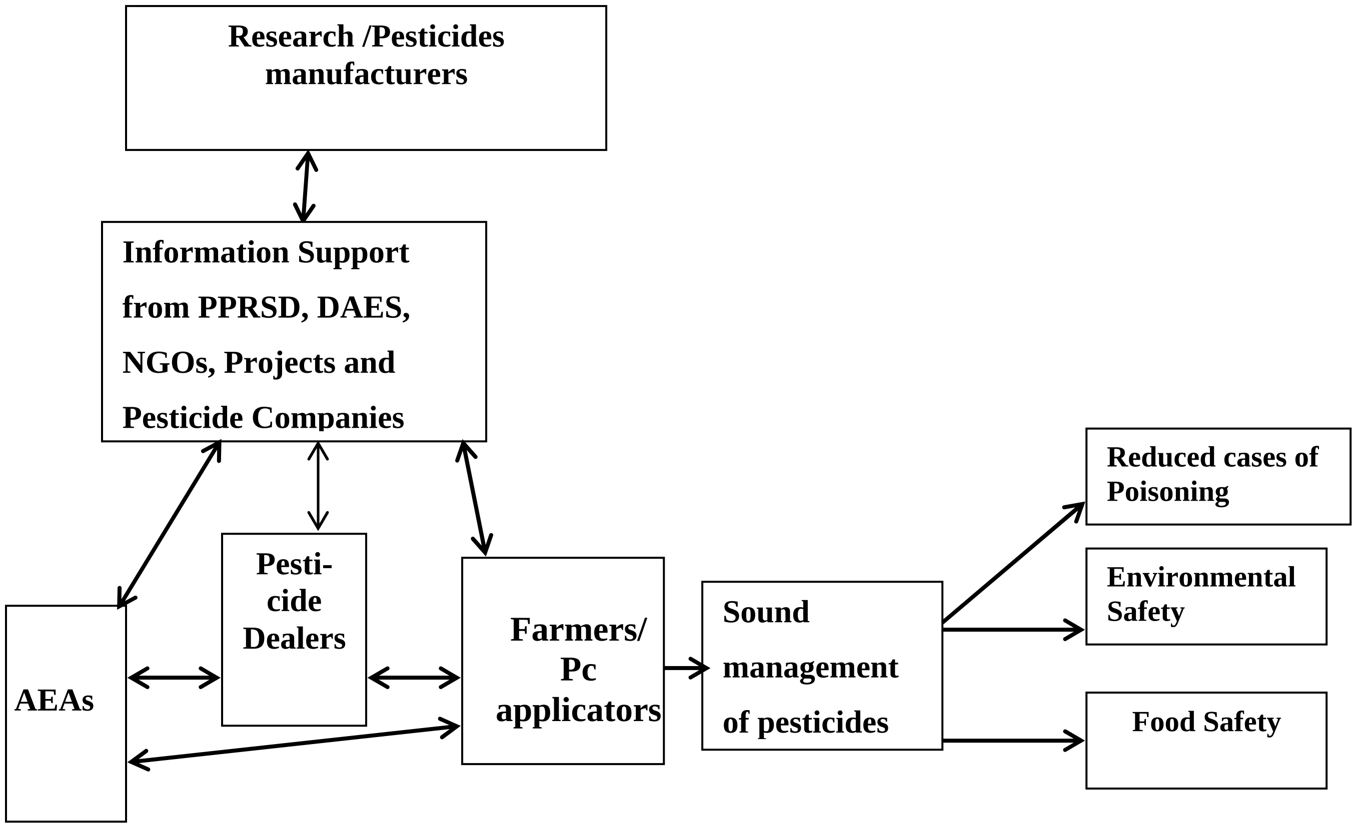


Figure 1: Conceptual framework for effective information support system for sound management of pesticides
Source: Authors' construct (2006)

Research variables

1) The Dependent Variable

- Competence in the sound management of pesticides (SMP).

2) The Independent Variables:

i. Demographic characteristics:

- Sex of respondents
- Age and level of education
- Occupation
- Years of farming

ii. Occupational characteristics:

- Farming practices
- Crops cultivated
- Availability of pesticides to small-scale farmers

iv. Extension information support for pesticide management:

- Sources of pesticide management information (PMI) available to small-scale farmers.
- Perceived effectiveness of sources of pesticide management information
- Number of pesticide management training courses attended by farmers.

v. Perceived environmental, health and safety awareness levels of farmers.

vi. Farmers' perceived awareness level of alternative pest control methods.

Hypotheses of the study

1. H_o. There is no relationship between the perceived levels of competencies of small-scale farmers in the sound management of pesticides (SMP) and small-scale farmers' perceived awareness level of environmental, health and safety implications of pesticide use in the study area.

   H_1. There is a relationship between the perceived levels of competencies of small scale farmers in the sound management of pesticides and small-scale farmers' perceived awareness level of environmental, health and safety implications of pesticide use in the study area.

2. H_o. There is no relationship between the competency levels of small-scale farmers in the sound management of pesticides and small scale farmers' perceived level of awareness of alternative pest control methods in the study area.

   H_1. There is a relationship between the competency levels of small-scale farmers in the sound management of pesticides and farmers' perceived level of awareness of alternative pest control methods in the study area.

3. H_o. There is no relationship between the competency levels of small-scale farmers in the sound management of pesticides and the perceived effectiveness of sources of pesticide management information available to small-scale farmers in the study area.

   H_1.There is a relationship between the competency levels of small-scale farmers in the sound management of pesticides and the perceived effectiveness of sources of pesticide use information available to small-scale farmers in the study area.

4. H_o. There is no relationship between the competency levels of small-scale farmers in the sound management of pesticides and their examination and use of spraying equipment and protective clothing in the study area.

H_1. There is a relationship between the competency levels of small-scale farmers in the sound management of pesticides and their examination and use of spraying equipment and protective clothing in the study area.

5. H_o. There is no relationship between the competency levels of small-scale farmers in the sound management of pesticides and the age of small-scale farmers in the study area.

H_1. There is a relationship between the competency levels of small-scale farmers in the sound management of pesticides and the age of small-scale farmers in the study area.

6. H_o. There is no relationship between the competency levels small-scale farmers in the sound management of pesticides and educational level of small-scale farmers in the study area.

H_1. There is a relationship between the competency level of small-scale farmers in the sound management of pesticides and educational level of farmers in the study area.

7. H_o. There is no relationship between the competency levels of small-scale farmers in the sound management of pesticides and years of farming experience of small-scale farmers in the study area.

H_1. There is a relationship between the competency levels of small-scale farmers in the sound management of pesticides and years of farming experience of small-scale farmers in the study area.

Justification of the study

The findings of the study would be important and beneficial to policy makers, extension practitioners, farmers, pesticide applicators, pesticide dealers, researchers, pesticide manufacturers and distributors.

Policy makers would be enlightened on the benefits and the accompanying external effects of pesticides, thus motivating them to develop an effective pesticide policy which ensures the provision of pesticide information centres. The study will also have information to guide them to set appropriate competency standards for pesticide dealers and applicators. In view of the health hazards facing pesticide applicators, policy makers could also consider a review of the prices of the equipment required for the sound management of pesticides, in order to make them more affordable to the small-scale farmer. Policy makers will also be more sensitive to food safety issues, and therefore facilitate processes that would protect consumers from unaccepted levels of pesticide residues in agricultural products by ensuring that maximum residue levels of pesticides are set for various crops and adhered to.

The results of the study will foster better collaboration among, manufacturers, researchers and extension service operators to ensure appropriate information support for small-scale farmers. Pesticide dealers would also be enlightened about their roles and responsibilities in the pesticide-use chain.

Small-scale farmers who have hitherto not been very keen on PMI will be encouraged by the findings of the study to seek adequate information on best practices in the management of pesticides. They would be sensitized about food safety issues and also be made to appreciate the role they play in the contamination of the environment.

The study will foster a better linkage among pesticide dealers, small- scale farmers and AEAs so that experiences and problems in pesticide management (PM) can be shared and same communicated effectively to research and pesticide manufacturers. This relationship will contribute to improve research for the benefit of all stakeholders in pesticide management. The results will also inform training methodology and evaluation to improve the competencies of small-scale farmers in the sound management of pesticides.

Limitations of the study

The study covered small-scale farmers in 6 out of the 8 zones in the two districts. Since the study measured the perceptions of respondents it is subject to certainty of response by the respondents. The listed farmers used for the study do not cover all small-scale farmers in the study area.

Delimitations of the study

The study was limited to small-scale farmers in the Ga East and Ga West districts, as a result of the limited time and resources available. Although pesticides are used by both crops and animal farmers, the study was limited to small-scale crop farmers.

Definition of terms

The following terms are defined within the context of the study to mean:-

Agricultural extension agents: All technical and professional agriculturists who are assigned to the district to facilitate the improvement in the livelihood of farmers through agricultural development.

Awareness: Having some knowledge about an issue

Competence: Having the ability to perform an activity with minimum supervision or "The ability to do a particular activity to prescribed standard"

Effectiveness: The effectiveness of the information source is in relation to the usefulness of the pesticide use message to the needs of the respondents.

Nontarget organism: An organism other than what a pesticide is originally meant to kill.

Perception: The process by which we receive information or stimuli from our environment and transform it into psychological awareness.

Pest: A living organism which has the ability to harm people or damage their property. In the context of is study, a pest is a living organism that has the ability to harm or destroy the crops of the farmer.

Pesticide: A substance or a mixture of substances that is used in the control of pests. Pesticides include all materials that are used to prevent, destroy, repel, attract or reduce the population of pest organisms.

Pesticide Company: Commercial enterprise, and organisations that imports, formulate, stock and sell pesticides.

Pesticide dealer: Private individuals who deal in stocking and selling of pesticides to farmers.

Sound management of pesticides: Handling and use of pesticides in a manner that is safe and efficient for all stakeholders and the environment in general.

Stakeholders: Stakeholders are people and groups who influence pesticide management and or are affected by the impact of pesticide management.

Study Area

The study was carried out in the Ga East and West districts (refer to figure 2) where most of the farming activities are performed by small-scale farmers, who cultivate local vegetables such as okro, tomatoes, garden eggs and pepper. They also grow exotic vegetable such as sweet pepper, cabbage, tinda and marrow. Other crops such as cowpea, pineapples, maize and cassava are also cultivated by these farmers. Cashew has been introduced in the past three years.

According to Ghana Statistical Services (2002), the 2000 National Population and Housing Census indicated that, the Ga East and Ga West districts had a total population of 550,000 people. About 70 percent of the population in the rural areas of the district depends on agriculture for their livelihood, while about 95 percent of the farmers are smallholders. The main crops grown in the district are pineapples, maize, cassava, papaya, cashew, okro, pepper, tomato, garden eggs, groundnuts, oil palm, mango, and cowpea.

The Ga East and Ga West districts have 8 zones, which are serviced by 52 field workers The field workers are supervised by 8 development officers, and 8 other officers who are in charge of special duties; fisheries, veterinary, crops and plant protection and regulatory services.

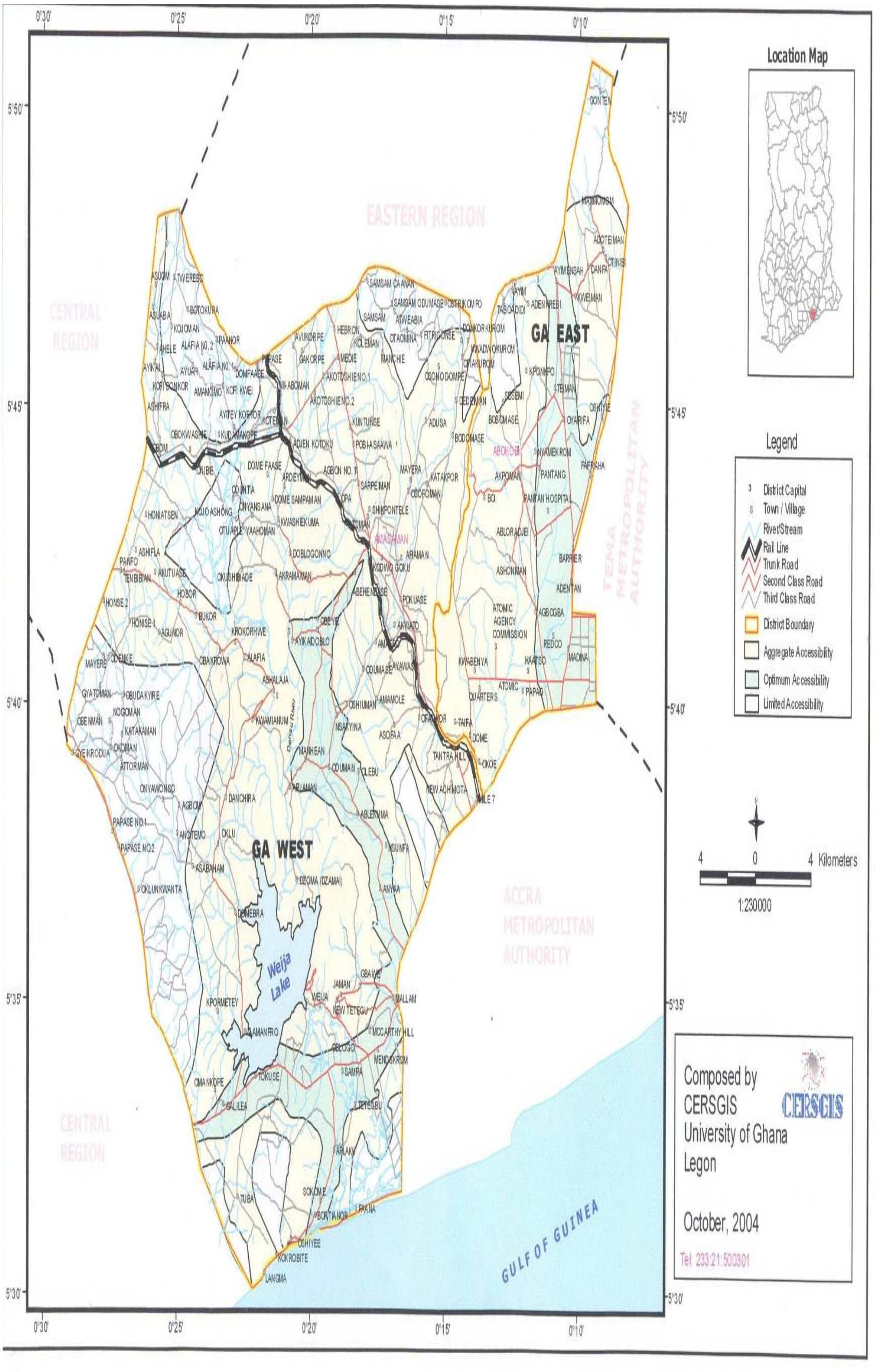


Figure 2: Map of the study area - Ga East and West Districts

CHAPTER TWO

LITERATURE REVIEW

General overview

The literature review tries to pull together existing theoretical and empirical studies that provide a background and necessary basis for the study. It attempts to review relevant studies done on various aspects of pesticide use, awareness levels of farmers, competencies of stakeholders in the sound management of pesticides (SMP) and the internal and external costs of pesticide management. The role and sources of pesticide management information (PMI) for stakeholders are also reviewed alongside the issues of adult learning and training of stakeholders in pesticide management (PM).

An overview of pesticide management in agriculture

Agriculture is the most important sector of the Ghanaian economy, with small-scale farmers who cultivate below 2.0 ha being major players. However, agriculture is seriously threatened by pests. In order to increase agricultural production on a sustainable basis, it is likely to be accompanied by an increased use of pesticides.

FAO (1986b) defines a pesticide as any substance or a mixture of substances intended for preventing, destroying or controlling any pest, unwanted species of plants or animal diseases, unwanted species of plants or animals causing harm during, or otherwise interfering with the production, processing , storage, transport or marketing of food, agricultural commodities, wood and wood products or feedstuffs, or which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies. According to WHO (1990), several insects and other arthropods, fungi, molluscs, and bacteria attack crops and result in quantitative and qualitative losses; the degree of damage, varying greatly in different climatic and agricultural regions.

During the last three decades, chemical control of pests has been introduced throughout the world. Pesticide use in Africa has increased dramatically in recent years, despite their escalating cost (Williamson, 2003). In an attempt to increase agricultural production, governments and development agencies have encouraged the use of pesticides, and farmers continue to increase their expenditure in terms of pesticide use. Williamson (2003), in her study concluded that farmers often use more pesticides than is cost effective, under pressure to compete with other producers, and Ghana is no exception. Although the contribution of pesticides to the success of agriculture cannot be over-emphasized, the expansion in use has raised queries about the competencies of stakeholders in the use of this important agricultural input, considering the adverse effects they could have on consumers, the applicators, non- target organisms, and the environment in general. If we are to derive the full benefits of pesticide use, there is a need to ensure that stakeholders in the management of pesticides are well informed.

Pesticide management and the environment

Up to 90 percent of the pesticides applied never reach the intended targets, as a result, other organisms in the same environment as the pest are accidentally affected adversely (Pidwirny, 2002). Although the yields obtained with the use of pesticides may generate more income, there may as well be serious environmental costs in the form of loss of soil quality, disappearance of essential or beneficial and pollinating insects, pest resistance, reduced biodiversity and an increased incidence of poisoning (Osorio and Travaglini, 1999). According to Osorio and Travaglini (1999), since the late 1960s, pesticides used to control pests in potato plantations in the Peruvian highlands have unsettled the balance of Andean ecosystems and given rise to numerous cases of poisoning among farmers.

Effects of pesticide management on non-target organisms

When pesticides are applied, usually, many non - target organisms are affected. These include other organisms which may be beneficial to the growth of many agricultural products (Pidwirny, 2002). The application of DDT in the 1950s and 1960s adversely affected several species of birds, including osprey, cormorant and brown pelican. Fish kills have also resulted from agricultural contaminations of waterways due to atmospheric fall out, drainage, run off and erosion (Pidwirny, 2002). According to Osorio and Travaglini (1999), pollution is caused by pesticides left on the ground, and these are spread by the wind to neighboring areas, contaminating water sources (ditches, rivers and ponds) causing health hazards and threatening wild animals, pets, pollinating insects and other essential wildlife. It is estimated that 20 percent of the honey bee colonies are eradicated by pesticide application worldwide (Pidwirny, 2002). In Thailand, Tayaputch and Mahittickurin (1980) reported the presence of pesticide residues in the stomach contents, livers and tissues of 90 species of birds in the agricultural control plain area. FAO (1990) reported that birds were common victims when isobenzan was used extensively against Diamond Back Moth in Malaysia between 1964 and 1966.

Effect of pesticides on non-target crops

Pidwirny (2002) has indicated that, some herbicides are misapplied which can cause injury to non-target plants resulting in phytotoxicity to plants that are not the target of the pesticides. Phytotoxicity may be caused by:-

1. drift of pesticides through the air
2. movement of the pesticides through the soil to sensitive plants present within the area of treatment
3. very high application rates and
4. accidental application.

Pesticide contamination of water resources

Pesticides can reach water resulting from direct treatment used to control pests, or indirectly (Pidwirny, 2002). It is estimated that 0.5 percent to 15 percent of a pesticide can be carried into an aquatic system due to run-off from agricultural lands. Waters are also contaminated through pesticide drift during application and atmospheric fall out on dust and rain. According to Pidwirny (2002), the victims of pesticides contamination of water systems are the organisms living in and using the water such as humans, domestic animals, fish, birds, plants and wildlife. Many modern pesticides are toxic to water-dwelling insects, planktons, crustaceans, and fish. Farmers in Chaglla, Peru, confirmed that 75 percent of the water sources and areas surrounding their farms were contaminated (Osorio and Travaglini, 1999).

Atmospheric contamination through pesticides management

Pidwirny (2002) has also indicated that pesticides may reach the atmosphere through spray drift during application, volatilization during application or from treatment surfaces, and escape from manufacturing or formulation plants. The author claims it has been demonstrated that pesticides are present in the atmosphere as either particulate matter or in the vapour phase. The inhalation of these pesticides can be toxic to many organisms.

Effect of pesticides on the soil

In a study to determine the effect of elemental sulphur as a fungicide for controlling powdery mildew (*Oidium anarcadii)* disease in cashew (*Anarcardium occidentale* L) upon soil fertility, Majule et al.(1997) reported that, annual sulphur dusting decreased the pH values to less than the critical 5.5 level in some areas. They also reported that at most sites, a decrease in pH was associated with the loss of major soil macronutrients from the top soil due to leaching.

Pesticide residues in food

The issue of pesticide use brings into focus the question of food safety. Kannan et al. (1992) reported significantly high levels of HCH, DDT, Aldrin and Dieldrin in foodstuffs collected from different regions in India. In Ghana, there is limited information on pesticide levels in foodstuff and there is no comprehensive information on the residue status of vegetables and other crops, nor is there any information on national tolerance limits (Biney, 2001). Studies on pesticide management and contamination at Akomadan, a major tomato growing area in the Ashanti Region of Ghana have revealed HCB concentrations which ranged from 0.07-0.30 ng/g in water bed segment and 0.16 – 3.13.ng/g in tomato fruits and leaves (Ntow, 2001). On the average however, the residue levels were below FAO/WHO Maximum Residue Levels (MRLs). Kumar (1986) has however indicated that, small concentrations of toxic residues may have substantial biological consequences. The most likely sources of residues may arise from over application of pesticides or the use of very high doses as a result of resistance build up and/or the use of restricted organochlorines, which are highly persistent (Biney, 2001).

Effect of pesticides on humans

Chemical pesticides are potentially harmful to every one and everything. The environmental effects of pesticides on wildlife, soil and water all strongly impact the quality of human life (Pidwirny, 2002). Over the last 50 years, many human illness and deaths have occurred as a result of pesticide contamination. WHO (1990) reported that about 1 million human pesticide poisoning and 20,000 deaths occur each year. These are mostly due to accidental exposure of farm workers and sprayers to pesticides. Accidental exposure may result from improper handling or the use of insufficient protective clothing when applying pesticides (Pidwirny, 2002).

All pesticides can be fatal if applied in large enough quantities even though the lethal dose (LD 50) may vary greatly. Organophosphate and carbamate compounds have been found to be the most harmful and acutely toxic to warm-blooded animals and humans. Small amounts of chlorinated hydrocarbons have been found to be present in the body of fat of humans. Long term effects of pesticide exposure can lead to cancer, mutations and congenital defects (Pidwirny, 2002). It is reported in the editorial of Pest Management in West Africa (2000) that the use of Endosulfan in cotton pest control resulted in the death of more that 35 people and poisoning of several others. Contact dermatitis resulting from long-term exposure to pesticide is reported among vegetable farmers (Biney, 2001). Low cost pesticides such as those made with organic phosphorus compounds are usually the most hazardous to farmers (Osorio & Travaglini, 1999).

Pest resistance to pesticides

Pests, especially insects, fungi, and even weeds can become resistant to indiscriminate and excessive use of pesticides. Resistance of pests is caused by frequent application of pesticides and farmers' pressurized into selecting pesticides with a specific effect (Osorio and Travaglini, 1999). According to the authors, about 150 species of phyto-pathogenic fungi have become resistant to various fungicides under field conditions. The resistance of *Phytophtora infestans* to metalaxil was reported in 1980 (Osorio and

Travaglini, 1999). In Ghana, carboxylase analysis of *Plutella xylostella* population collected around Accra indicated a probable incidence of insecticide resistance in the population (Kaiwa, 2000).

Pesticide management in Africa

Williamson (2005: 165) has indicated that, “pesticide use in Africa is the lowest of all the continents. Accounting for only 2 percent of world sales, and averaging in the 90s, 1.23 kg ha^{-1} compared with 7.17 kg in Latin America and 3.12 kg in Asia”. Williamson further indicates that, “this low use appears to suggest correspondingly low health and environmental hazards and indeed that African agriculture may need to increase its pesticide use”. Unfortunately, this assumption is wrong as African farmers tend to use many WHO Class Ia and Ib products and few users take precautionary measures to prevent harm (Gerken et al., 2001; Hanshi, 2001; Matthews et al. 2003).

Pesticide use in Ghana

Ghanaian farmers predominantly practice mixed cropping. Small-scale agriculture in Ghana is generally a combination of subsistence and semi-subsistence. It has been indicated by Gerken et al. (2001) that the most common agents for pest control in Ghanaian agriculture are chemical pesticides (Table 1). According to NARP (1993) and Dixon (1995) (Table 2), pesticides have assumed an increasingly significant role in the production of food crops such as cowpea, rice and vegetables with limited usage on maize, cassava. Williamson (2005:165) has also indicated that, “the largest requirements for pesticides are on cash crops, particularly, cotton, cocoa, oil palm, coffee and vegetables, most of which are grown by smallholders". As reported by Gerken et al. (2001), most small-scale farmers and to a lesser extent, medium-scale farmers do not know the brand names of the pesticide formulation they use, though they know the class or category. However, all large scale farmers knew the chemicals they applied.

Table 1: Use of chemical pesticides by farm Size (In percentages of farmers interviewed)

Use of Chemical pesticides	Farm size Small	Medium	Large
Yes	74.0	79.5	85.0
Not at all	25.9	20.5	15.0

Source: Gerken et al. (2001)

According to Gerken et al. (2001), the small-scale farmers applied a broader range of insecticides and more intensively compared to the medium- and the large-scale farmers. The authors reported that, "the situation was about the same with fungicides, though the level of intensity was lower. Large-scale farmers were the leading users of herbicides, especially, Roundup" Gerken et al. (2002: 100). According to Gerken et al. (2001), there was an extensive use of fungicides among the small- and medium- scale farmers

Table 2: Pesticide usage within the past 40 years (1951 – 1991) in Ghana

Pesticide group	1951– 1960	1961– 1970	1971– 1980	1981 – 1990	1991
Insecticides	100,000 litres	270,000 litres	500,000 litres	1,903,000 litres	241,600 litres
Herbicides	-	-	5720 litres	360,000 litres	115,000 litres
Fungicides	-	-	5,000kg	150,000kg	20,000kg
Others	-	-	1,000kg	10,000kg	260,000kg

- = No available data

Source: NARP 1993; Dixon (1995).

In the case of vegetables which were mainly grown by small- and medium-scale farmers, there was intensive application of insecticides. The authors also said the observation could be attributed to the small and large scale farmers not having a clear idea of which specific insecticide to use, and could have applied pesticides on a trial-and-error basis compared to the large-scale farmers who had more detailed knowledge of pests and the relevant pesticides. Contrary to expert opinion, the use of pesticide mixtures (Cocktails) seemed to be low compared to single formulations. Mixtures of two or more pesticide may be applied by only 22, 10 and 9 per cent of small, medium and large scale farmers respectively (Gerken et al., 2001). Small-scale farmers applied more mixtures than the other groups.

Childs (1999) in a bid to evaluate the potential of neem products in Ghana reported that, about 67 percent of farmers in her sample used chemical pesticides for crop protection. There was a significant difference in the extent to which pesticides were applied in the different agro-ecological zones. She found out that, on the average, farmers in the coastal savanna and the forest zones applied more pesticides than farmers in other areas did. The degree of urbanization also had an influence. In the urban areas, 94 percent of the farmers used pesticides while in the peri-urban and rural areas, 62 percent and 57 percent used pesticides respectively. Pesticides were mainly applied to vegetables like cabbage, tomato, eggplant, sweet pepper and okra as well as to legumes such as cowpea and soybeans. Other plant protection strategies like crop rotation, hand picking, biological control and use of traditional products were not widespread.

Decision making in pesticide application

Gerken et al. (2001) have indicated that farmers apply pesticides depending on either the intensity of the observed pest (i.e. curative), according to calendar spraying or as a result of expert advice. Ghanaian farmers claim they have limited information on pest levels and the nature of the damage they caused, yet only a few of them made the effort to contact experts before applying pesticides. Gerken et al. (2001), reported that 40.9, 52.9 and 6.2 percent of the small-scale farmers based their decision to spray on calendar spraying, curative spraying and on advice of experts respectively, while only 8.4 percent of all farmers based their decision to apply chemical pesticides on the advice of experts (Table 3).

“Farmers’ decision making on the type and amount of pesticide to use depends on several considerations, i.e. type of pest, expected crop loss, price ratio of input and output prices, risk attitude and availability of input resources” (Fleischer, 1999: 211). According to the Fleischer, “the decision making of the actual pesticide user, whether to apply pesticides or to use alternative protection methods is influenced also by some other reasons which are acting indirectly and are frequently hidden. Biases towards chemical solutions in institutional settings, such as the agricultural educational system, priorities in the research programs and organization of the extension service, have an important influence on the generation and the direction of technical progress and its implementation on the field level. With regard to human resources, the type and level of information on different crop protection strategies is decisive for the over- and misuse of pesticides as well as the under utilization of non – chemical alternatives”.

Table 3: Decision on application of pesticide by farm size

Farm size	Calendar spraying		Curative spraying		On advice of experts		Total	
	Case	%	Case	%	Case	%	case	%
Small	258	40.9	334	52.9	39	6.2	631	100.0
Medium	334	49.2	275	40.5	70	10.3	679	100.0
Large	110	51.9	83	39.2	19	9.0	212	100.0
All farmers	702	46.1	692	45.5	128	8.4	1522	100.0

Source: Gerken et al. (2001)

Table 4 presents some factors that cause excessive pesticide use.

Table 4: Factors causing excessive pesticide use

Category	Price factors	Non- price factors
Obvious	I 1. Government sells or gives pesticides.	III 1. Misguided use of governments' activities in reducing pesticide damage.
	2. Donors provide pesticides at low or no costs.	2.Governments incentive in pesticide research
	3. Government refunds pesticide company costs.	3.Inadequate government research in environmentally benign pest management
	4. Subsidized credit for pesticides	
	5.Preferential rates for tax and exchange rates	
Hidden	III. 1. Plant protection service outbreak budget.	IV 1.Lack of adequate procedures for: • pest definition • crop loss definition
	2. Pesticide production externalities.	2. Lack of information on Agro-ecological parameters

Table 4: Continued

Category	Price factors	Non- price factors
	3. Pesticide use externalities	3. Lack of transparency in regulatory decision making.
		4. Curricular of agricultural education and extension
		5. Dominance of pesticide industry in the market for crop protection information.

Source: Fleischer (1999)

Sources of pesticides for farmers

According to Ajayi (2000), in Cote d' Ivoire, although the government through its agency, Compagne Ivorienne pour le Developpement des Textiles et Fibres (CIDT) (Ivorian company for textiles and fibre products development) supplies the necessary quantities of pesticides to farmers to be used on specific crops, the reality is however different. "There are other sources and outlets of uses for these pesticides" Ajayi (2000: 76). The other sources of pesticides available to farmers include friends, market, and old stocks. The government agency however remains the most important source of pesticides to farm households, supplying 78 percent of all pesticides.

Gerken et al. (2001) have also indicated that, in Ghana the importation and distribution of pesticides has been dominated by the private sector. In their study they found that, "about 90 percent of all the respondents acquired their pesticides from private retailers although government institutions such as MOFA and COCOBOD continue to offer retail services" (Gerken et al. 2001:

103). Cooperative societies play a minor role in pesticide distribution while non-governmental organizations (NGOs) are involved only to a small extent. Table 5 presents the sources of pesticides available to farmers in the country.

Table 5: Sources of pesticides (In percentages of farmers interviewed, multiple answers)

Sources	Farm size		
	Small	Medium	Large
Private retailers	96.2	88.3	86.1
Co-operatives	1.3	1.0	2.8
From other farmers	7.7	8.7	0.0
Produce buying firms	1.3	6.8	2.8
Government institutions	23.1	3.3	30.6
NGOs	2.6	1.0	2.8
Others	1.3	1.9	0.0
Total	133.5	140.7	125.1

Source: Gerken et al. (2001)

The authors also reported that, in line with the frequent prophylactic strategies for plant protection, more than 55 percent of small- and medium-scale farmers acquired pesticides in advance compared to 40 percent of the large scale farmers, whiles 30 percent of all the farmers bought pesticides only after the appearance of pests.

According to Williamson (2005: 177) "unapproved and sometimes illicit supplies may also be obtained via unauthorised cross-border trade. In Ghana such trade is common from Cote d'Ivoire and Togo, as evidenced by the widespread sale of pesticides labeled in French, violating one of the key labeling requirements of the FAO Code of Conduct (FAO, 2002)". Cross-border trade is further encouraged by wide price and exchange rate differentials. The author indicated that, in 2001, some registered cotton insecticides used in northern Ghana cost ten times more than their counterpart in products in Côte d' Ivoire (Williamson, 2005).

In all four study areas, Ghana, Senegal, Benin and Ethiopia, Williamson (2005) found that, there has been a proliferation of informal pesticide trading following liberalization during the past decade. According to Williamson, "vegetable farmers in Senegal now purchase their pesticides from retail outlets of national distribution companies, small-scale informal traders operating in local shops, itinerant peddlers and open markets in large towns". A similar situation pertains in the Bia district of the Western Region of Ghana, as was asserted by an AEA. "Many of the pesticide dealers are not registered. They only come in on market days to sell and go away"

Small-scale informal traders, itinerant peddlers and open markets frequently repackage and re-label products, the content of which may have been diluted or mixed and they do not always correspond to labels. The author further emphasized that, "Farmers' lack of cash has encouraged the development of village-level trading of pineapple inputs in very small volumes in Benin, by the glassful or one eighth of a litre, compared with authorised outlets that mainly sell one or five litre containers". Williamson

(2005) reported that, pineapple farmers admitted to often using products without knowing their identity, name or characteristics. Farmers explained that, as agrochemical prices have increased, they look to obtain them via cheaper, informal sources. The advantage of the informal channel is that, it is quick, readily accessible and the cash outlay for small volumes is within their means.

Application of pesticides

According to Gerken et al. (2001), the use of specialized machinery - hand pumps, motorized sprayers and ultra low volume sprayers - in the application of pesticides is widespread among farmers of all categories. However, the authors have indicated that, only 13 percent of the small and 8 percent of the medium-scale farmers applied pesticides in the field by hand using brushes, brooms, cups, bottles etc. According to the authors, knapsack sprayers were the most widely used spraying machines, especially among the small scale farmers. Table 6 is a presentation of the various application methods for pesticides in the field.

Spraying machines are capital intensive items and this affects their distribution among small scale farmers who might not also have the technical know-how for their handling and maintenance. Okorley et al. (2005) in their study to assess the training needs of vegetables farmers in the central Region of Ghana reported that farmers in the study area had limited competence in the maintenance of spraying machines. Gerken et al. (2001: 104) also indicated that “the poor distribution of spraying machines among farmers meant making payment to hire the services of a sprayer or delay in acquisition of services. Manual application then becomes the last resort".

Table 6: Application methods of pesticides in the field (In percent of farmers interviewed)

Way of application	Farm size		
	Small	Medium	Large
By hand	13.5	7.6	0.0
Hand pump	65.6	59.5	57.5
Motorized sprayer	18.8	25.2	40.0
Ultra low volume sprayer	2.1	7.6	2.5
Total	100.0	99.9	100.0

Source: Gerken et al. (2001)

Persons applying pesticides in the field

Generally, farmers apply pesticides to crops and harvested produce themselves. Gerken et al. (2001) have also indicated that spouses, children, hired labourers, caretakers and extension agents also play a role in pesticide application. In the field survey, 91 percent of the small scale farmers applied the pesticides themselves whiles their children formed 5.1 percent of the labour for such services.

External effects of pesticide management

In Ghana, there is lack of adequate information on the extent of external effects of pesticides on the environment. According to investigations carried out for the National Profile to Assess Chemical Management in Ghana, the level of concern for water pollution and soil contamination is considered to be quite high (Osafo and Frempong, 1999). They reported that analysis of water and fish showed low levels of Lindane and no residues of Endosulfan in 1993. Similar analysis in 1995 revealed significant residue levels for both pesticides. Generally, they found that the residues of the pesticides found in fish were higher than those in water. However, the residues in fish were under the lethal dose at the time of the study.

Gerken et al. (2001) reports an instance of poisoning from pesticides when three (3) children died from possible overdose of carbamates in fruits in March 1999. Gerken et al. suspected that the farmer did not observe the necessary waiting period between the pesticide application and harvesting. They also indicated that health workers in the area of the accident were not trained to handle this kind of poisoning, and relevant antidotes were not available. Table 7 is a presentation of some fatal pesticide poisoning cases reported in Ghana (1986 - 1997).

Table 7: Some fatal pesticide poisoning cases reported in Ghana (1986 - 1997)

Year	Number of reported cases	Remarks
1986	4	All staff of Plant Protection and Regulatory Services Directorate.
1987	9	All volunteers, one died in Navrongo in the Upper East Region
1988	6	All farmers. One died in the Volta Region during control of army worms
1989	4	Staff of Plant Protection and Regulatory Services Directorate and some farmers were involved
1992	8	All farmers' children died after eating mango fruits contaminated with seed dressers
1996	5	All household died in Volta Region after eating okro sprayed with insecticide
2000	4	At Pwalugu in the Upper East Region, 2 farm hands died instantly after eating tomato fruits sprayed with organophosphate insecticide. Others were admitted at the Bolgatanga hospital

Source: Plant Protection and Regulatory Services Directorate (2007)

According Gerken et al. (2001), there is a general lack of countrywide statistics on the extent of poisoning of farmers through pesticide application. This situation, they say has resulted because:-

1. Farmers seek medical attention only in cases of serious health problems due to the cost involved,
2. most of the farmer6s are not aware of the specific symptoms of pesticide poisoning,
3. the system of health statistics does not clearly specify cases of poisoning and
4. in many cases of poisoning, or death, no further investigations are done due to lack of technical facilities for autopsies.

Clarke et al. (1997) have shown that there were direct linkages between knowledge and or the protective equipment of farmers on one hand and the extent of side effects on the other. They reported that most of the farmers were aware of pesticide-related symptoms and possible routes of absorption. There was also a general awareness of protective devises, but the transfer of knowledge into practice seemed to be weak. It was reported that most farmers stored their pesticides in their bedrooms or other rooms and the actual use of protective equipment was limited. Only 22 percent of them used boots while applying pesticides and this was the main protective measure. The common reason for non-utilization of protective equipment was unaffordable prices. The majority of the farmers had contact with and possible exposure to pesticides while storing, mixing, applying or working in recently sprayed fields.

Gerken et al. (2001) concluded from their study that many farmers have experienced side effects in the application of pesticides concerning health and phytotoxicity. Despite the awareness of possible dangers from pesticide application, farmers do not use appropriate protective gear, mainly due to financial restrictions and lack of awareness. Current education and training are inadequate to prevent side effects of pesticide use. The authors also indicated that, the lack of adequate management practices, first aid diagnosis and treatment can worsen the effects of pesticide poisoning.

Effects of pesticides on public health

Lack of awareness of many people of the effects of pesticides on human health has led to most people adopting a casual attitude to the use of protective clothing (Chivinge et al., 1999). According to Osoria and Travaglini (1999), farmers are not fully aware of the negative effects of pesticides and appear to have resigned themselves to believing that, it is the only alternative.

During his study, Ajayi (2000) found that there were some specific health symptoms that pesticide applicators did not suffer from before they started spraying, but which began only during a spraying operation or within 24 hours after the spraying operation ended. The aggregate health symptoms reported by pesticide applicators for the farming season are shown in Table 8.

Table 8: Pesticide related health symptoms

Type of Symptoms	% of occurrence
Headache	25
Rhume	18
Cough	17
Skin rash	13
Sneezing	11
Other Symptoms	16
Total	100

Source: Ajayi (2000)

The result of the study showed that in one out of five cases (20 percent) when insecticides were sprayed on cotton fields, pesticide applicators reported a health problem and also took special attention to seek treatment. This compares with the result of Kishi et al. (1995: 130) who reported that of all the respondents (pesticides applicators), only 24 percent took medication (Ajayi, 2000: 123). The Author reported that the symptoms that applicators reported are those they perceived to be severe cases. "The majority of pesticides sprayers that were monitored (80 percent) reported that there was nothing so special (*'rien a singuler'*) from pesticide spraying operation". According to Ajayi (2000: 123) "such pesticide applicators did not think that they encountered extra-ordinary health problems that are beyond normal level during the pesticides application".

Among all the pesticide-related health symptoms that pesticide applicators mentioned, only in 2 percent of the cases did the victims visit health centres for medical consultation or to seek formal medical assistance. For the remaining health symptom cases, the applicators bought drugs that were available in their vicinity and or they used home-grown healing methods (Ajayi 2000: 123). Also from a study in Indonesia, (Kishi et. al. 1995: 130) as cited by Ajayi (2000), it was reported that "less than 1 percent of the pesticides applicators went to a health centre with symptoms related to pesticide spraying". From these results it can be inferred that the official records of pesticides poisoning/health symptoms are most probably under–estimated given that only the health symptoms cases that are taken to formal health centers are documented. According to Ajayi (2000), the official documentation of actual pesticides poisoning cases appears to be very low in many countries. The results of the study show that households whose members engage in more "risky" pesticides spraying practices spend less on pesticides health symptoms. This result appears surprising because theoretically, one would expect that risky field practices would increase the risk of exposure to chemicals and also increase health costs. According to Ajayi (2000: 176), the results may signify an information gap among farm households; households who engage in practices that expose them to higher risks are most likely to be the same set of households who have a low level of information and low perception on pesticide-health symptoms linkages. Such households would include those who give low priority to health considerations because they want to minimize production costs (e.g. farmers who spray when the wind speed is high because they want to reduce the quantity of pesticides that they use). Despite the higher health risk that they face, applicators in such households are most likely to have a higher threshold (higher acceptance level) for health symptoms before they decide to take special care that involve direct expenditure of money. It is most likely that the same factors that make households to be less careful regarding field practices that expose them to health risks will also make them to pay less attention to health expenses that arise from such practices. Ajayi (2000: 149) concludes that although the awareness of farm households on health impact of pesticides use is low, his study established that "there are some human health problems associated with pesticides use".

According to Ajayi (2000: 149) "field practices of pesticide application are probably the closest indicators of farmers' level of knowledge on pesticide-health issues" In the author's opinion, the low level of awareness on pesticides and health cost among farmers in Côte d'Ivoire and the under-estimation of health costs in production decision most probably lead to sub-optimal decision-making by the households on the use of pesticides. Ajayi (2000) therefore emphasised that the household's level of awareness and knowledge are key issues that should be addressed by agricultural extension services in the study area to attain optimum pesticides use.

According to Gerken et al. (2001: 118-119), "The majority (58 percent of all the respondents.) of farmers interviewed knew of health problems associated with pesticides. The most serious problems farmers associated with pesticide use were general ill health, acute poisoning, and phytotoxicity in the treated crops". The authors indicated that, poisoning was a phenomenon more common among the illiterate farmers and that small and medium scale farmers generally experienced more problems with pesticides than large scale farmers. They reported that, the "farmers listed the following acute poisoning symptoms: headache, general weakness and dizziness, body pains, nausea and vomiting, stomach-ache and diarrhoea."

To analyse the possible side effects of pesticides use, on human health, Gerken et al. (2001: 116) suggest that "a distinction has to be made between the effects on the consumer of food products and the people who apply pesticides". According to the authors, "consumers can be affected through relatively low doses of pesticide residues in drinking water and in food products (long-term effects) or acutely through high doses caused by misuse, wrong application or overdose at the farm level". Osorio and Travaglini (1999: 59) have also reported that, "another indicator for establishing the social costs of the indiscriminate use of pesticides is the number of people poisoned each year in the countryside". According to the authors, the health sector does not pay enough attention to this problem, mainly because they are unaware of the danger and there is no policy of conducting epidemiological monitoring programs in farming areas.

Farmers' awareness of dangers in pesticide management

Often a farmer's lack of awareness is seen as one major reason for pesticide problems. Several studies about farmers' awareness conducted in Thailand in 1985 concluded that more than half of the farmers applied dosages higher than recommended on the label (Grandstaff, 1992). According to Chivinge et al. (1999) lack of awareness of the effects of pesticides on human health has led to most people adopting a casual attitude towards the use of protective clothing.

The level of awareness and knowledge of households are key issues in efforts of agricultural households to attain optimum pesticide use. These include the knowledge about health cost, the perception and the importance that households attach to pesticide related health issues (Ajayi, 2000). Clarke et al. (1997) also indicated that, there was a general awareness of protective devices, but the transfer of knowledge into practice seemed to be weak. Only 22 percent of them used boots while applying pesticides and this was the main protective measure. Similarly, Chivinge et al. (1999) reported that pesticide abuse which is rampant in Zimbabwe is partly due to ignorance and that, there is the need for more effort to make people aware of the dangers of pesticides by training the grassroot level.

Identification of pests

In Malawi, Chivinge et al. (1999) have indicated that, failure to identify pests has led to the wrong use of pesticides. In Cote d'Ivoire, however, Ajayi (2000: 88) has indicated that, "years of farming experience have helped most farmers to learn to identify the different species of insects in their fields. In more than 80 percent of the cases, farmers in his study area claimed they can distinguish between mites, leaf eating, piercing/ sucking and fruit boring insects. In most cases, the most important criteria that farmers use to identify harmful insects are colour, shape or the size of the insect in that order of importance". Other criteria include the odor of the insect, the behaviour of the insect (eating or rolling up of plant leaves). Hillock et al. (1999) also reported a high degree of awareness of pests and disease (described by their symptoms) by coffee farmers.

Storage of pesticides and disposal of empty containers

Storage of pesticides and disposal of empty containers have safety implications. In their study, Gerken et al. (2001) found that about 53 percent of the farmers stored their pesticides in the farm huts or in their houses. They however indicated that storing pesticides at home has safety implications especially for children. Clarke et al. (1997) also reported that most farmers stored their pesticides in their bedrooms or other rooms.

Gerken et al. (2001) found that about 20 percent of the farmers used empty pesticide containers for storing pesticides again or for other purposes such as storing fuel, water and seeds. They also sold or disposed of them in other ways without destroying them. Many deaths are caused by reuse of empty pesticide containers to store food and water.

Ajayi (2000) has indicated that, in the cotton growing region of Cote d'Ivoire, empty pesticide containers are disposed off in various ways. "In 13 percent of the cases, pesticide containers are reused by the household or by other persons (i.e. when sold). Households in the Long History region perform far better (containers are reused in only 5 percent of the cases) compared with their counterparts in the short history region where about one in every five empty container (16 percent) ends up being used by humans in one way or the other. Table 9 shows how empty pesticide containers are disposed off in the cotton growing region of Cote d'Ivoire. According to Ajayi (2000), the disposal methods do not yet conform strictly to recommendations, but there are indications of improvements compared to previous practices in the region.

Table 9: Methods of disposal of used pesticide containers

Disposal method	Long history region	Short history region
Left in the field	51	59
Thrown into the bush	32	14
Washed and used by farmer's household	2	11
Washed and then sold	3	5
Packed and then burnt	4	3
Buried in the soil	3	2
Others	5	6
Total	100	100

Source: Ajayi (2000)

Dosage determination

Several studies about farmers' awareness conducted in Thailand in 1985 concluded that more than half of the farmers applied dosages higher than that recommended on the label (Grandstaff, 1992). According to Ajayi (2000), studies in Cote d'Ivoire revealed that in almost all cases (more than 90 percent), when a herbicide is applied, the dosage is less than the recommended level. The author indicated that, when farmers spray herbicides in the northern cotton growing areas of Cote d'Ivoire they sometimes do not cover the whole field, some farmers spray the whole field only half of the time while in the remaining cases, they spray only portions of the field in order to reduce the quantity of the herbicide used. The main reason given for the decreasing trends in pesticide use are essentially economic factors. This could indicate that, farmers' reaction to pesticide policies is price elastic. Some of the farmers' pesticide practices on the field show that farmers' action may be due to the general pressure for economic considerations rather than making mistakes.

Use of protective clothing

Chivinge et al. (1999) have indicated that the majority of people applying, mixing , storing or dealing with pesticides in one way or the other do not wear appropriate protective clothing. Clarke et al. (1997) also observed that, there was a general awareness of protective devises, but the transfer of knowledge into practice seemed to be weak. Only 22 percent of them used boots while applying pesticides and this was the main protective measure. The common reason for non-utilization of protective equipment was unaffordable prices. The authors have shown that the majority of the farmers had contact with and possible exposure to pesticides while storing, mixing, applying or working in recently sprayed fields.

Alternatives to pesticides

Pesticides were considered to be an essential element of increasing food production in Africa however, experience has shown that they are causing more problems than they solve. According to Williamson (2002), alternative methods to pest control are needed if the damaging social and environmental impacts are to be reduced.

Ajayi (2000) has also pointed out that, the history of the free distribution of pesticides and the narrow base of crop protection makes it hard for farmers to know about other crop protection methods apart from pesticides. As a result, farmers take pesticides as a "reference point" against which they would evaluate alternative crop protection methods.

Table 10: Characteristics of alternative crop protection methods if farmers would adopt them

Performance with respect to pesticides	No. of farmers	%
Cheaper or same price	119	72
Effective on pests	91	55
Simple to handle	73	44
Assures same level or more yield	53	32
Easily available within reach	50	30
Less toxic to farm workers	45	27
Adopted by half or more fellow workers	41	25
Less toxic to the environment	7	4
Other diverse conditions	30	18

(n = 165) (multiple responses)

Source: Ajayi (2000)

According to the author, improving the awareness of farmers of other methods will be necessary for their adoption. The results of his study show that, farmers will most likely adopt alternative crop protection methods based on their perceived evaluation of the performance of alternative methods in comparison to pesticides. The criteria used by farmers are presented in Table 10.

The concerns that farmers have as regards the ‘high’ cost of pesticides and their perception on the declining effectiveness of pesticides suggest that farmers would be more receptive to alternative crop protection methods (Ajayi 2000). The technical feasibility of less chemical-dependent methods has been demonstrated in Cote d’Ivoire through threshold trials carried out by Angelini, Couilloud (1972), Danmotte (1974) and Angelini et al. (1980) as cited by(Ajayi 2000). Similar trials carried out in cotton fields by Ochou et al. (1997) and Ochou et al. (1998: 1) as cited by Ajayi (2000: 93) show that, with a reduced number of pesticide treatment, farmers obtain equal or higher yields than in fields where standard pesticide application practices were used.

According to Fleischer (1999: 211) “the decision making of the actual pesticide user, whether to apply pesticides or to use alternative protection methods is influenced by some other reasons which are acting indirectly and are frequently hidden. Biases towards chemical solutions in institutional settings, such as the agricultural educational system, priorities in the research programs and organization of the extension service, have an important influence on the generation and the direction of technical progress and its implementation on the field level. With regard to human resources, the type and level of information on different crop protection strategies is decisive for the over- and misuse of pesticides as well as the under utilization of non – chemical alternatives”.

Farmers' perception of cost of pesticides

Ajayi (2000: 92) has indicated that, "the concern that farmers currently have as regards the 'high' cost of pesticides, and their perception of the declining effectiveness of pesticides suggests that, farmers would be more receptive to alternative crop protection methods now (pesticides are no longer free) than they were in the past when insecticides were distributed free of charge".

Integrated pest management

There are many alternatives to pesticide use which are less damaging to the environment. According to Pidwirny (2002) integrated pest management (IPM) is an approach to crop protection which combines a number of techniques in an organized fashion in an attempt to suppress pest populations. The author reiterates that IPM is currently the most common alternative to the use of pesticides. Stakeholders in the development, transfer and use of IPM strategies include farmers, pesticide dealers, pesticide applicators, government services and research institutions (Gerken et al., 2001). The aim of IPM is to prevent economic loss resulting from pests as well as to avoid harm to people, non-target organisms and the environment.

Pidwirny (2002) emphasizes that, IPM is needed due to the over-reliance on pesticides which has developed since their rapid emergence which has led to contamination of the environment and the development of resistant species. Gerken et al. (2001) have also recommended that the adoption of an effective IPM programme and attitudinal change can be accelerated and consolidated by implementation of decisions of stakeholders on IPM strategies, promotion of exchange of information on farmer-to-farmer basis and monitoring of adoption rates and environmental, health and economic impacts. The experience gained in the IPM programmes promoted by public and private development projects have proved that it is possible to do without extremely toxic inputs when controlling plagues and disease in potatoes (Osorio and Travaglini, 1999).

Agne (2000) has indicated that, in Costa Rica, official recommendations on crop protection were chemical based for many years. In recent years however, the extension service has been looking for effective methods for farmer training in IPM. It has been difficult to convince Costa Rican farmers of the advantages of IPM mainly because:

- In many cases, the economic incentives for farmers to switch from purely chemical to integrated pest management methods are relatively small.
- Information about chemical use is available more easily, in any shop, at almost any time of the day whereas it may be more difficult to contact an extensionist for IPM directives.
- A change to IPM requires an investment in learning while simple methods of chemical treatment are readily available.
- Farmers prefer to rely on what they have done previously and what is still promoted by the chemical industry.

It has also been indicated by Kujeke (1999) that, little application of IPM strategies in most developing countries has been attributed to a variety of factors including a general lack of information and know-how of IPM practices within service institutions and at the user level.

Cultural farming practices and pest control

According to Ajayi (1999) some traditional agricultural practices that farmers employ in his traditional area incidentally reduce the build up of pest populations and infestation and therefore provide a crop protection function. Such farm practices include intercropping, shifting cultivation, crop rotation and the slash- and- burn system. Agne (2000) has also recorded that, in Costa Rica, a cultural strategy to delay the transmission of the Gemini leaf curl virus which is transmitted by the white fly (*Bemisia tabaci*) and causes major losses in tomato production to tomatoes, has been successfully tested.

Indigenous knowledge in crop protection

Investigations of previous methods of crop protection that early progenitors in the cotton growing area of Côte d'Ivoire have used in the past revealed that most of these methods were primarily directed against rodents and other forest animals that destroy crops. Traditional methods include soaking the bark of a local plant *Parkia biglobosa* in water for a few days and spraying the liquid solution on crops. The farmers believed that the bitter taste of these products make crops unattractive to ravaging animals.

Other methods are to fence the parcel of land against animals, to hunt animals or to set traps (Ajayi, 2000). Additionally, scarecrows are a common traditional means by which birds and rodents are controlled in fields. However, Ajayi (2000) indicates that virtually no mention is made of specific corresponding traditional methods to protect crops against insects which are the most important pests these days. Currently, indigenous methods of crop protection against insects and even rodents have been abandoned in favour of chemical pest control since the availability of free pesticides in the region. The author reports that it is in only a few cases that farmers continue to use some of these traditional methods, and that, the use of such methods was limited to root and tuber crops. Ajayi (2000) reasons that, the majority of present day farmers are not well acquainted with traditional methods because the elderly progenitors with the traditional knowledge are no longer alive. A similar reason has been given for the near extinction of traditional knowledge of pest control in other places such as Sri Lanka (Ulluwishewa, 1993) and Kenya (Conelly, 1987) as cited by Ajayi (2000).

It is also reported by Ajayi (2000) that, another reason for abandoning indigenous methods of crop protection was that, traditional methods are labour intensive especially given the increases in field sizes. This finding is in line with others found elsewhere in Africa. According to Atteh (1987), in Nigeria where pesticides are distributed free of charge or subsidized up to 67 percent, many traditional pest control practices by farmers have been displaced. Osorio and Travaglini (1999: 59) have also indicated that, "farmers who use pesticides have become dependent on the technologies derived from other cultures and have forgotten alternative technologies and alternative means of handling plagues".

Incidentally, a few Ghanaian farmers continue to control termites by truncating ant hills on the farm and putting salt in them (verbal discussions at regional planning session for Western Region on 24th May, 2007 at Sekondi, Ghana). On the other hand however, the sprinkling of wood ash on leafy vegetables to control lepidopterous larvae which was a well known traditional method of pest control is rather on the decline.

Table 11: Use of traditional products for crop protection according to farm size (In percentage of farmers interviewed). (Multiple responses)

Purpose	Farm size		
	Small	Medium	Large
For planting materials	8.2	11.8	2.8
In the field	17.8	9.8	0.0
For storage	5.5	8.8	13.9
Not at all	75.3	76.5	86.1
Total	106.8	106.9	102.8

Source: Gerken et al. (2001)

Gerken et al. (2001) have reported that, about one third of the non-users of chemical pesticides chose alternative pest control measures including neem extract. The authors cited the use of traditional products such as vegetable oils, wood ash, neem extracts and other mixtures as being well known to farmers especially for the control of storage pests in cereals. During their study, Gerken et al. (2001: 92) found that, between 14 percent and 25.5 percent of the farmers, depending on the size of their farms were found to use various traditional products for crop protection (Table 11). They also reported that small scale farmers used traditional products for field pests.

Perception

In an effort to study the perceived awareness and competencies of small scale farmers in pesticide management, it is appropriate to review what perception is all about. Varying definitions have been assigned to perception by different scholars. According to van den Ban and Hawkins (1996), perception is the process by which we receive information or stimuli from our environment and transform it into psychological awareness. A similar definition of perception has been given by Gamble and Gamble (2002) who said that, perception is the process of selecting, organising, and interpreting sensory data in a way that enables us to make sense of our world. From these definitions, perception may be understood as:

i. How we see and understand issues around us
ii. Our own judgement of a situation, an event or an issue
iii. One’s impression or opinion about an issue and
iv. The way we interpret what (things) we see

From the above, perception as a process, involves the use of the senses to interpret the ‘world’ or the environment. Gamble and Gamble (2002) have however pointed out that, perception involves more than the use of the senses alone. They epitomized perception as the “I” behind the senses, that is, what occurs in the real world may be very different from what is perceived to occur. This means that, the interpretations of events and issues may differ markedly from the actual events or issues among different people. This is because, people’s perceptions are influenced by a number of factors peculiar to the individual. The three most important factors that influence the perception of the individual are:

a. The culture of the individual
b. Past experiences of the individual and
c. Gender influences on the individual

Principles of perception

According Van den Ban and Hawkins (1996) perception is governed by general principles such as relativity, selectivity, organization, direction and cognitive style. Without taking actual measurements, we are able to judge that, one object is heavier, lighter or larger than another similar object. Hence, the authors assertion that our perceptions are relative rather than absolute. This principle of relativity must guide us when we design messages, since we must remember that, a person's perception of any part of the message will depend on the segment immediately preceding it. Perception of a message will also be influenced by its surrounding. In like manner, a farmer in his small village might have the erroneous self- perception that, he is the best of farmers until he moves out of his environment to see larger farms during a field trip or at a field day on a farm with more advanced facilities. Our perceptions do change with new encounters (Gyimah, 2003).

Our perceptions are also selective. At any moment in time, our senses are receiving floods of stimuli from the environment around us. Inspite of our capacity to process vast amount of information, our nervous system cannot make sense of all the stimuli available and therefore selects only a section of those stimuli. Hence an individual pays attention only to discussions that they find relevant to their need. According to Gamble and Gamble (2002), individuals select only those experiences that reaffirm existing attitudes, beliefs and values and tend to ignore or diminish the significance of those experiences that are inconsistent or in dissonance with their existing beliefs and values. The authors assert that, past experience and training do influence our selectivity of perception.

The organised nature of our perception has been alluded to by van den Ben and Hawkins (1996). They argue that, our perceptions are organised and that, we tend to structure our sensory experiences in a way which makes sense to us. This is why within a twinkle of an eye, we are able to sort our visual and aural stimuli into figures which stand out from a background. In order to attract attention, a designer may therefore incorporate a good ‘figure’ in a specific part of message. Perceptual organisation may also result in ‘closure’, a characteristic that allows the perceiver to complete or close a figure (Bosompem, 2006). This perceptual characteristic is what causes us to convert the booming, buzzing and confusion into some meaningful order. Learning therefore becomes difficult when a learner has to strain hard to make sense out of teaching instructions.

Our perceptions are also directed. We perceive what we are ‘set’ to perceive. Our mental set influences what we select and how we organize and interpret it. Set is an important perceptual concept that can be used by the communication designer to reduce the number of alternative interpretations, given to a stimulus. As indicated by Van den Ben and Hawkins (1996), perceptual set might also be a major deterrent when communicators want their audience to view or interpret a situation in a new way. According to Gamble and Gamble (2002), perceptual set is affected by age, motivation, past experiences and educational level. The authors however indicated that, age alone does not determine the part played by experience. They emphasized that even among people of the same age, past experiences differ and this may affect the way stimuli are perceived. The authors also indicated that, education, instead of becoming a facilitator or aid to communication, can become a barrier. In their opinion, since life experiences vary or differ for people, the perceptions of people differ with the same stimuli.

Our individual mental processes work in distinctively different ways depending on personality factors such as our tolerance for ambiguity, degree of open or close mindedness, and authoritarianism among others. Van den Ben and Hawkins (1996) alluded to this when they pointed out that, an individual's perception will differ markedly from another person's in the same situation because of different cognitive styles. There is therefore a need to design messages taking into account the cognitive styles of the audience but since it is not practicable to design different messages that take all the different combinations of cognitive styles into account for the same audience, it is recommended that, one adopts a strategy that will facilitate the presentation of the same idea in different ways which will appeal to many cognitive styles. This approach has been termed as message redundancy.

Perception of competence

According to Wiemann (1977), people will generally agree with one another on an overall evaluation of how competent or skilled another person is without necessarily agreeing on the component of or definition of just what competency is. There is also a problem of fitting what people perceive with what the other person is doing. For instance, Rubin (1985) among others have discovered that, people's perception of competency is often unrelated to the behaviour that they have observed. Finally, the nature of a person's perception can also be a problem. When you perceive other people as being competent communicators for instance, you perceive them more in terms of your own feelings, than according to what they are actually doing during the process of communication. We tend to perceive them more in the light of our own feelings.

It has however been agreed by Spitzberg and Gupach (1989) that, inspite of all these limitations, in our perception of competency, no discussion of competency can occur without mentioning three important components of competency. These are appropriateness, effectiveness and flexibility. In any appropriate interaction, no expected rules are broken. The behaviour simply ‘fits’ the context and yet he or she needs not to conform to be considered appropriate. Effectiveness is related to appropriateness in that, it is the accomplishment of a desired or preferred outcome. Spitzberg (1993) has indicated that, these outcomes need not be positive. Discussion of competency includes discussion of various degrees of effectiveness and appropriateness. It can therefore be said that, optimal competency occurs when it is both effective and appropriate. Flexibility or behavioural adaptability is recognized most often as a vital dimension of competency and hence is often used synonymously with competency (Spitzberg, 1993).

Competence of stakeholders in sound management of pesticides

The sound management of pesticides, to a large extent depends on the competencies of stakeholders in pesticide management. These include policy makers, pesticide manufacturers, AEAs, pesticide dealers, and farmers. According to the Joint Committee on Administrative Rules (1988), the Illinois Administrative Code 250 indicates that, the general competency standards required of stakeholders deal with the following:-

a) Label and Labeling comprehension:

b) Safety factors

c) Environment – The potential environmental consequences of the use and misuse of pesticides.

d) Pest factors

e) Pesticide factors

f) Application techniques factors

g) Laws and Regulation applicable to the state.

Small-scale farmers and pesticide applicators must be competent in the use and maintenance of pesticide application equipment. According to Chivinge et al. (1999) there are problems with pesticide application machinery which relate to calibration, worn out nozzles and inappropriate and faulty nozzles. The use of inappropriate spraying equipment has also led to excessive exposure to pesticides, especially to those applying the pesticides. The authors have also indicated that a majority of people applying, mixing, storing or dealing with pesticides in one way or the other do not wear appropriate protective clothing. They further reported that, there is failure to observe the safe period between time of spraying and harvesting especially in the case of leafy vegetables thus many people unknowingly eat vegetables bought from the market which contain pesticide residues. Chivinge et al. (1999) also indicated that pesticide abuse which is rampant in Zimbabwe is partly due to ignorance and that, there is the need for more effort to make people aware of the dangers of pesticides by training the grassroot level. It is also reported that in Zimbabwe, establishment of threshold levels before pesticide application is still a problem.

According to Kujeke (1999), the majority of pesticide applicators are unsophisticated commercial farm workers and smallholder farmers with limited knowledge of the technical, health, and safety issues related to pesticide use. The author asserts that, small-scale users of pesticides are unlikely to access more technical, health and safety information than that provided on the label. Kujeke (1999) points out that, field extension agents require a variety of pesticide use information to adequately address the needs of farmers. These include: -

- symptoms of pest attack,
- field diagnosis of the pests,
- life cycle of the pest,
- pest frequency,
- pesticide movements between countries and regions (negative effects of labels in foreign languages).
- survey methods,
- data collection and processing,
- sound pesticide management and
- pesticide application methods

Competencies in these areas go a long way to ensure the SM of pesticides. However, Kujeke (1999) asserts that, the information required is likely to be beyond the capabilities of typical field extension agents.

The role of information in pesticide management

As indicated in the editorial of the Pest Management Newsletter (2000), the need for in-depth information on pesticides at all levels in the

West African region is important since the flow of information on pesticide management between farmers, extension workers and researchers is far from adequate. Pest control and pesticide use in particular, is becoming increasingly complex and therefore require that all stakeholders and the general public have access to general and technical information as regards the subject. According to Grandstaff (1992), a farmer's lack of awareness is often seen as one major reason for pesticide management problems. Several studies about farmers' awareness conducted in Thailand in 1985 concluded that more than half of the farmers applied dosages higher than recommended on the label.

According to Jungbluth (2000) information is not free of charge, and that gaining access to information involves cost in the form of money or time. The author asserts that, if specific information is free, the farmer/producer would use information to a point E in order to maximize returns. However if costs are involved, information would be utilized to a point A where the optimal level of information would only be at a point where the difference between the expected returns and the cost of information is greatest (C-B). Uncertainty in the production process increase the value of information in so far as information reduces the likelihood of sub-optimal - decisions. It is however pointed out that the productivity impact of information will also depend largely on the initial situation.

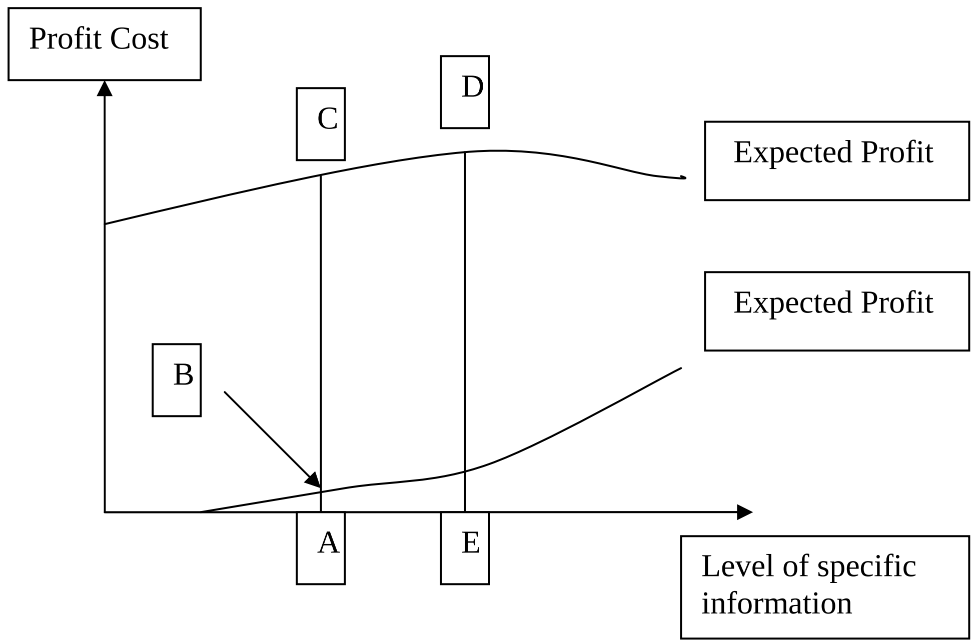


Figure 3.The optimal level of information

Source: Junkbluth (2000)

Jungbluth (2000) further explains that, if for example farmers already have reasonable estimates of the crop loss, small increments in information will have a negligible impact on net returns. However, those who consistently overestimate potential crop loss will stand to gain more from modest improvements in the availability of accurate information.

According to (Ajayi, 2000) theoretically, pesticide use practices and human health costs are expected to be influenced by the level of information farmers have on the potential hazards and the short and long term consequences of pesticide use. It is assumed that, under an improved information situation, farmers will probably use more protective clothing and /or spend more money for medical treatment than they are currently doing (Ajayi, 2000).The author further indicates that, information plays a vital role for decision making in crop protection. “It is one way to reduce risk in agriculture and also improve decision making, however, the usefulness of information depends on its quality” (Ajayi, 2000: 40).

Jungbluth, (2000: 35-36) asserts that, “information relating to plant protection varies significantly depending on the source. While private companies targeting to increase sales volumes present farmers with specific product information, promoting the quality of their products, crop protection agencies likely overestimate crop loss in order to minimize the perceived severeness if a pest outbreak actually occurs”. Such biases in the information “market” raises the cost of obtaining accurate and complete information (Jungbluth, 2000). Pearce and Tinch (1988) describe a situation where imperfect information about the future leads firms and regulators to be overly comfortable with the status quo leading to inefficiently low levels of investment in research and extension on alternatives to pesticides.

Jungbluth (2002) has also indicated that, price factors such as free supply of pesticide and tax exemptions encourage indiscriminate use of pesticides. According to the author, the tax structure related to pesticide has been favorable, compared to other inputs and has therefore helped to keep pesticide prices low. Jungbluth (2002) also established that the tax system favors pesticide use as import duties of pesticides do not consider the toxicity of the pesticides. It has been indicated by Kujeke (1999) that, the bulk of the technical information generated in the development of pesticides originates from developed countries whiles the relevant public and private institutions in less developed countries are generally less endowed with the necessary information and resources to participate fully in issues related to PM. According to Kujeke (1999: 89), “the debate on pesticide use has generally excluded the active participation of all stakeholders. When pesticide use is debated, the focus tends to be on costs and benefits. Information on health and safety tend to be secondary with minor obligations and liability on the manufacturers and retailers."

Sources of information on pesticide management

Gerken et al. (2001) have reported that farmers receive information mainly from extension staff. They indicated other sources of information in a descending order of importance as printed extension material, the farmers' own experience, other farmers, and labels on pesticides, retailers' materials, television/radio and the print media. They also reported that although there appears to be little variation in how farmers with different farm sizes obtained information on pesticides, there was a significant difference in the sources of information on pesticides among farmers with different educational backgrounds. The survey indicated MOFA's Directorates for Agricultural Extension Services and PPRS as the major sources of information on pest management while **p**esticide dealers supplied information to all categories of farmers, especially the illiterate small holders. Although other organizations such as NGOs did not play a significant role in information dissemination on pesticide use, experienced farmers played an important role. Gerken et al. (2001) reported that, the bigger the size of the farm, the more the farmer relied on advice from experienced farmers. Retailers of pesticides are usually sources of information on pesticide use. The sources of information for retailers are basically the same as for the farmers. Gerken et al. (2001: 107), further reported that "75 percent of the retailers depended on pesticide labels, 72 percent on personal advice, 56 percent on wholesalers, materials, 53 percent on extension materials, 42 percent on their own experience, 19 percent on the farmers' advice and 24 percent on other sources (Multiple answers)". In a study to analyse the ways in which farmers use information relating to pest populations, Carpentier and Weaver (1997b) as cited by Junkbluth (2000) reported, farmers do not use the information generated during the production process to update their beliefs concerning pest infestation.

Kujeke (1999) has indicated that, in Zimbabwe, most of the information available to extension staff is through person to person contact through sales representatives and printed materials, including labels. The author has also indicated that, pesticide companies usually produce technical and promotional materials that are targeted at end–users and support institutions. According to him, while the relevance and quality of these materials vary, it is typically slanted towards enhancing the companies' image and or the product image. A significant portion of the technical material disseminated by pesticide vending companies is usually biased. According to Kujeke (1999: 100), "Lack of information, uncertainty, and perceived risk have been shown to inhibit decision-making at farm level. In general, the farmers' main sources of pest management information are (a) research services, (b) government extension services, (c) the pesticide industry (d) other farmers and (e) the farmers own experience" (Farah, 1994).

Ajayi (2000: 75) indicated that in his study, "the majority of farmers interviewed (70 percent) obtain general news and information from two or more sources. The sources include fellow farmers, CIDT agents and the radio. For information on crop protection and agricultural practices, the cotton agency is the most important source, providing crop protection information for all households in the cotton zone. Informal farmer-to-farmer exchange of knowledge on crop protection takes place to a considerable degree (59 percent). Apart from a few posters, mounted in the village, the impact of agrochemical firms on pesticide information is quite small. This is because chemical firms do not have a direct link to individual farmers but usually go through the cotton agency (for insecticides) or the farmer cooperative groups (for herbicides). Most of the respondents were not aware of IPM and this could be traced to the restricted sources of crop protection information that farmers' have. Other sources of crop protection information are ANADER and farmer cooperative groups."

Dissemination of pesticide management information

Information dissemination is a complex process involving interplay of messages, symbols and contextual influence. Kujeke (1999) points out that, whiles person-to-person is media rich and the most ideal, it is not practical given the number of pesticide users on the ground. The author also stresses that, there are problems with the credibility of the extension agents who are better placed to provide pesticide use information to the small-scale farmers. Small-scale farmers in Zimbabwe, like others in the developing world, are constrained by illiteracy. Kujeke (1999), reports that, although product labels for products which are meant for small holder farmers are printed in vernacular languages, it has been proved by research that, messages carried in posters are usually not understood by the farmers. Again, the technical nature of some pesticide use information is yet another issue small scale farmers have to contend with. The need for mathematical skill to appreciate pesticide application procedures is a limiting factor to farmers. Kujeke, (1999), has also indicated that, although radio offers opportunity for low cost dissemination of general and awareness type of information, in Zimbabwe, media channels like radio and television are not used on a regular basis for dissemination of general and awareness creation type of information. Again, there is generally no formal systematic use of mass media channels for transmission of information. The author is of the opinion that, the effects of this gap are likely to increase as pesticide use expands in the small holder sector.

Ajayi (2000: 75-76) records that, "personal contact with farmers is used in 85 percent of cases to disseminate crop protection information. Other methods used are audio and training sessions. Booklets and other published materials are seldom used because most farmers can neither read nor write. About one quarter (24 percent) of household heads in the study area had attended formal training sessions before, for a cumulative average of five days. Almost all the training sessions (78 percent) were organized by CIDT, with some assistance from the chemical industry and some NGOs. The theme of about half of the training sessions centered on pesticides and spraying operations. Apart from formal training, CIDT resident village agents give training to farmers on an informal and ad-hoc basis. For so many years, the crop protection information available to farmers has been dependent on pesticides and based almost exclusively on the crop protection philosophy of the cotton agency".

Frequency of extension contacts and need for more information

From their study, Gerken et al. (2001) reported that, “the majority of farmers (about 75 percent of the respondents) sought technical advice whenever the need arose whiles five percent (5 percent) did not seek technical advice. About 20 percent sought advice from extension services staff once per season or once per month. There was little variation in how often farmers from different categories (farm size and educational level) sought technical advice. All the farmers indicated that, they needed more information on pesticide use. According to the authors, most of the large scale farmers (91 percent of the group) and illiterate farmers (90 percent of the group) wanted more information on dosage and most of the small-scale farmers and illiterate farmers needed more information on the “right type of pesticide”.

Training in the field of extension

Training is the process of providing knowledge and skills and bringing about, desired changes in attitudes in order to improve the competence of people being trained. Training can also be seen as a planned process for changing attitudes and for increasing knowledge and/ or skills through specific learning experiences which are called learning events, courses, workshops, seminars, modules or classes (Wascana Institute, 1993). As indicated by Van den Ban and Hawkins, (1996), training is a way of providing an organized and structured set of experiences to influence our perceptions. According to Youdeowei and Kwarteng (1995), the goal of training is to improve performance.

Adult learning

Trainers of adults must recognize that adults possess characteristics that make their learning different from that of children. Knowles (1984) made the following observations about adult learning:

a. Adults tend to be self-directing.

b. Adults have a rich reservoir of experience that can serve as a learning resource.

c. Adults' readiness to learn is affected by a need to know or do something.

On their part, Van den Bor and Van den Hoogen (1996) defined three factors as the:

1) Motivating factors: learner is motivated by hope of brighter future prospects.

2) Institutional factors: Here the learner is concerned with the atmosphere in the faculty or facility, material facilities, organization and timing of lessons, trainer-trainee relationships and quality of training. The learner is motivated by attractive training programmes.

3) Individual factors: Here the emphasis is on fear of failure, positive or negative experiences, style of learning, and a belief in personal capacities. The learner is self motivated

It has been noted by Knox (1977) that, adults engage in learning in order to increase their competence. He said much of effective adult learning circulate around recognition of discrepancies between learner's current and desired competencies. He also conceded that, past experiences do sometimes act as hindrance or as enhancer to new learning. Knox noted that, whereas adults would strive to improve their competencies, they tend to resist active learning when they cannot perceive any substantial benefit of the desired competency.

Training and training needs of stakeholders in pesticide use

In Costa Rica, educational programmes on sound management of pesticides have been developed for farmers, farm workers, housewives and children by Ministerio de Agricultura y Ganaderria (MAG) (Ministry of Agriculture and Livestock) in cooperation with the representatives of the chemical industry. The participating farmers are taught the basic techniques of pesticide application and sanitation (washing clothes after spraying, etc). According to Agne (2000) protective gear used in northern countries is not recommended because it is not considered suitable for tropical climates. Therefore sound management recommendations have been confined to judicious application and basic protective clothing such as rubber boots and gloves. Agne (2000: 14) has indicated that, 'Safe use has been taught on a relatively small scale'. The author has indicated that, since the commencement of the programme in 1986 until 1993, only 10 percent of the rural agricultural work force and less than 5 percent of the rural population had been reached. In most cases, information about the safe use of pesticides has been presented in full- day or half-day meetings without follow-up activities. The impact of these seminars has not been evaluated but, is likely to have been limited.

Gerken et al. (2001) in a nation wide study in Ghana to evaluate government policies and to give recommendations on the removal of political and administrative barriers to the introduction of integrated pest management policies found that, all retailers needed more information on pesticide use. The study revealed that 84 percent of the retailers need more information on new pesticides, 70 percent on safety and handling and 65 percent on application techniques, that is, spectrum of pests, dosage, waiting period etc. Another study by Okorley et al. (2005) to assess the training needs in pesticide use by vegetable farmers, agrochemical sellers and extension agents in the urban areas of the Central region of Ghana revealed that, pesticide sellers in the region have not had adequate training to understand the special nature of their work and the requirements that go with it. They also found that, vegetable farmers, pesticide sellers and extension agents in the region need information and training in the use and handling of pesticides in general, but more especially in integrated pest management (IPM), first aid in agrochemical poisoning, repair of pesticide application equipment, banned and restricted agrochemicals and agro-ecological systems analysis (AESA).

Research – extension – farmer – linkages

One of the most difficult institutional problems confronting ministries of agriculture in many developing countries is the lack of close working relationship with between national agricultural research and extension organizations, and with different categories of farmers and farm organizations (Swanson, 1998). At the Regional planning session for the Western Region, on the 24th of May 2007, Mr Setsofia, the National Research-Extension-Linkage Committee (RELC) coordinator indicated that the rate of dissemination of research results was rather poor, although research had done its part and released the necessary information (personal communication, 24th of May 2007).

Innovation diffusion

An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption (Rogers, 1983). Pesticide use may be seen as a practice that is “new” to the farmer. The practices involved in the safe use of pesticides might already be known to farmers, AEAs, and pesticide dealers, but adopting it is another issue altogether. According to Rogers (1983), newness in an innovation need not just involve new knowledge. According to the author, someone may have known about an innovation for sometime but not yet developed a favorable or unfavorable attitude towards it, nor have adopted or rejected it. Diffusion is defined as the process by which an innovation is communicated through certain channels over time among members of a social system (Rogers, 1983). The author asserts that, diffusion is a special type of communication in which the messages are concerned with a new idea. It is this newness of the idea in the message content of communication that gives diffusion its special character. More than just a beneficial innovation is necessary for its diffusion to occur. Technological innovations are not always diffused and adopted rapidly even when the innovation has obvious and proven advantages (Rogers, 1983).

“Safe use of pesticides” is a common training topic for the Plant Protection Directorate of the Ministry of Food and Agriculture. However, it appears that pesticides are still not being managed safely. According to Rogers (1983), getting a new idea adapted, even when it has obvious advantages is often very difficult. To get farmers, AEAs and pesticide dealers to change their perception about pesticide management is a long process. As reiterated by Benjamin Franklin 1781 and cited by Rogers, 1983), “To get the bad customs of a country changed and new ones, though better introduced, it is necessary first to remove prejudices of the people, enlighten their ignorance and convince them that their interests will be promoted by the proposed changes, and this is not the work of a day”. It takes more than training for an innovation to be adopted. When introducing an innovation, it is important to take the cultures, the local environment and the individuals in the target group into consideration. An important factor affecting the adoption rate of any innovation is its compatibility with the values, beliefs and past experiences of the social system (Rogers, 1983).

Technology innovation creates one kind of uncertainty in the minds representing an opportunity for reduced uncertainty in another sense (that of the information base of the technology) (Rogers, 1983). It has also been indicated by the author that, the innovation-decision process is essentially an information-seeking and information-processing activity in which the individual is motivated to reduce uncertainty about the advantages and disadvantages of the innovation. More effective communication occurs when two individuals are homophilous. When they share common meanings, a mutual sub-cultural language and are alike in personal and social characteristics, the communication of ideas is likely to have greater effects in terms of knowledge gain, attitude formation and change, and overt behaviour change. One of the distinctive problems in the communication of innovation is that, participants are usually quite heterophilous. The difference usually leads to ineffective communication. They simply do not speak the same language (Rogers, 1983). Farmer-to–farmer extension therefore has an important role to play in the diffusion of innovations in farming communities.

Concepts of agricultural technology

Theoretically, technology is the application of knowledge for practical purposes. According to Swanson (1998), technology is generally used to improve the human condition, the natural environment, or to carry out other socioeconomic activities. Technology can be classified into two major categories: (1) material technology where knowledge is embodied into a technological product such as tools , equipment , agrochemicals , improved plant varieties or hybrids improved breeds of animals (e.g., semen from progeny–tested sires used for artificial insemination) and vaccines; and 2) knowledge–based technology such as the technical knowledge , management skills and other processes that farmers need to successfully grow a crop or produce animal products.

The transfer of material technology to farmers generally involves the production, distribution and sale of seeds, implements, agrochemicals and other production inputs. Therefore the transfer process for material technology is generally simpler than training and disseminating technical knowledge and management skills to large numbers of poorly educated farmers who operate in different ecological zones (i.e. extension function). Also, the delivery of the delivery system needed for these different types of technologies are generally different. In most cases, the private sector is best suited to produce and distribute material technology. On the other hand, most knowledge-based technologies such as improved crop or livestock management practices, integrated pest management (IPM) and soil and water management practices are generally taught through vocational training programmes for rural young people or disseminated through a publicly funded extension system for adult farmers.

Swanson (1998), has also indicated that, most material technology requires technical knowledge so that, these products or tools can be used effectively. For example to properly use an agrochemical in pest management, farmers need to know the proper application rates, the time and conditions for application safety procedures and so forth. In addition, if farmers use a sprayer (another type of material technology) to apply agrochemicals then they need to know how to operate, adjust, calibrate, and clean the equipment to achieve the best results. Therefore material and knowledge - based technologies are generally closely intertwined. Private sector firms in developing countries have very limited technical capacity to train farmers in these product-related skills and knowledge; therefore the transfer of most knowledge-based technologies is by design or by default, left to the national or provincial extension system.

Age of farmers

Studies by La-Anyane (1985) and Dankwa (2005) have shown that, the average age of farmers in the farming communities of Ghana ranges from 50 to 60 years. They found that, a majority of the farmers were over 50 years of age. The advanced age of farmers is a possible limiting factor to productivity as health of individuals decline with age and can therefore not perform certain tasks on the farm effectively.

Sex of farmers

Nelson (1981) stated that, it is wrong to assume that, an effective development programme for males will automatically translate into an effective programme for women as well, whiles Gamble and Gamble (2002) have asserted that, men and women perceive different realities, have different expectations set for them and that while women are categorized as emotional, men are classified as rational. These perceived differences may influence the way the different sexes perceive their competencies in the SMP and even the way they are influenced by PUI.

Educational level of farmers

According to Byrness and Byrness (1978), education enhances one’s ability to receive, decode, and understand information. The authors claimed that, information processing and interpretation are important for performing many jobs. They also indicated that, the farmer’s level of education, to some extent, determines the types of tasks he can undertake in a programme, and therefore the level of participation.

Ajayi (2000) has also indicated that, the low educational level of farmers in the cotton growing areas of Côte d’Ivoire could limit the potential of alternative practices. Illiteracy poses a problem to the flow of agricultural information because only one quarter of the household heads had formal education. On the other hand Gamble and Gamble (2002) emphasized that, at times high level of education can become a barrier rather than a facilitator or aid to communication.

Aryeetey (2004) indicated that, individuals resident in urban areas are more likely to have attended school than in rural areas of Ghana. In rural areas where the majority are farmers, only 29.3 percent of their sample had attended school in 1992. The author also found that, only 32 percent of the rural sample could read and only 30 percent could write whiles 41 percent could do simple calculations. Gerken et al. (2001: 88) reported that, "literacy rate was found to be generally low among the interviewed farmers, About 17 percent of the small scale farmers, 42 percent of the medium scale farmers and 39 percent of the large scale farmers did not have any formal education".

Years of experience of farmers

From his survey, Dankwa (2005) found that, the majority (80.7 percent) of the farmers had worked between 10 and 40 years with an average experience of 23 years. The authors asserted that, this long period of experience in farming may foster the adoption of agricultural technologies if socio-economic problems are addressed adequately.

Social factors affecting farmers' use of extension technologies

Gyimah (2003) has indicated that, one of extension's main goals is to get farmers to adopt or adapt proven technological farming practices that produce best results. More importantly however, the main purpose of agricultural extension is not just to get people to adopt technologies, but to help strengthen their existing knowledge acquisition system on which true critical reflection can be built (Zinnah, 1999). When a farmer embraces a technology, he /she will show a clear evidence of using the technology.

CHAPTER THREE

METHODOLOGY

General overview

This chapter describes the procedures and techniques used in collecting, managing and analysing the data. It also presents the research design, the population studied, the sample, the sampling procedure, research instrumentation, the pilot study, data collection, processing and analysis that were used as well as the rationale behind the choice of these techniques for the study.

Research design

A descriptive - correlational survey design was used to ascertain the status of the variables of the study and their inter-relationships. This design was used because, according to Sarantakos (1998), it is a research design which is appropriate when a researcher attempts to describe some aspects of a population by selecting an unbiased sample of individuals who are asked to complete tests, questionnaires or respond to interviews. The design also allows the researcher to describe status and relationships among variables as well as determining the best predictor(s) of the dependent variable from the independent variables.

Again, Neuman (2003) has indicated that the design systematically asks many people the same questions about a situation or a programme and measures many variables which can infer temporal order from questions about past behaviour, experiences or characteristics, or test multivariate hypotheses. Neuman (2003) also indicated that surveys use controlled variables to approximate the rigorous tests for causality experimenters achieve through physical control over temporal order and alternative explanations. The use of a survey for the study has the added advantage of requiring fewer resources in terms of time, participants and funds.

As an assessment study, the survey method gathers data from a relatively large number of cases at a particular time. It is not concerned with the characteristics of individuals, it is rather concerned with the statistics that results when data are abstracted from a number of individual cases (Best and Kahn, 1998), hence the decision to use the survey method to gather data for the study since the method will effectively measure the experiences and perceptions of the individuals in the sample population. Again, a descriptive research (quantitative) according to Best and Khan (1998: 24), "uses quantitative methods to describe what is, describing, recording and analysing and interpreting conditions that exist. It involves some type of comparison or contrasts and attempts to discover relationships between existing non manipulated variables".

Study population

The population for the study was made up of small-scale farmers in the Ga East and Ga West districts of the Greater Accra Region of Ghana. The population size was 720 listed small-scale farmers who were registered with the Ministry of Food and Agriculture in the recently partitioned Ga district.

Sampling procedures

A combination of simple random sampling, and purposive sampling procedures were used for the study. Six (6) out of (8) zones were randomly selected for the field survey of small-scale farmers by picking from a collection of folded labeled sheets of paper in a basket. A total of 150 small-scale farmers were then selected by random sampling from a frame of 720 small-scale farmers using the table of random numbers. The study population was purposively sampled from the group of listed farmers in the study area.

Sample size

It is generally agreed by researchers that, larger sample sizes are better than smaller sample sizes. This is because, the larger the sample size, the smaller the magnitude of sampling error and the greater the likelihood of the sample being representative of the total population. This assertion however holds only when the sample is randomly selected. According to Isreal (1992), some researchers have gone a step further to give formulae and tables for estimating 'appropriate" sample size of populations given the confidence intervals, level of precision and the degree of variability in the attribute being measured. According to Best and Khan (1998: 17) however, "there is no fixed number or percentage of subjects that determine the size of an adequate sample". The authors argue that, the sample size may depend on the nature of the population of interest, the data to be gathered, and the type of analysis to be done and funds available for the study. The care with which the sample is selected is more important than the size of the sample. The authors recommend random selection of subjects.

Out of the (8) zones in the two (2) districts, six (6) were randomly selected for the field survey of farmers. A total of 150 farmers were then selected by random sampling from a frame of 720 farmers

Instrumentation

A structured and validated interview schedule was developed as instrument for the study to elicit information from respondents. Face validity of the of the research instrument was ensured by the researcher, while content validity was checked by the supervisors, lecturers in the Department of Agricultural Economics and Extension of the University of Cape Coast. Plant protection and extension experts at the Ministry of Food and Agriculture also ensured the content validity of the research instruments.

The farmers' interview schedule consisted of six (6) parts as follows:-

- Part 1- Background of the respondents: Apart from seeking information on the socio-demographic characteristics of the respondents. This part of the research instrument sourced for information on the kind of crops grown by the farmers, category of farming practised, and some farming practices carried out by the farmers.
- Part 2- Pesticide management practices by farmers: This section solicited for information on pesticide use practices by farmers and factors that affect their decisions to buy and use pesticides. A 3 point Likert scale (ranging from always to never) was used to determine how often spraying equipment and protective clothing were examined before use.

- Part 3- Perceived competencies of farmers in the sound management of pesticides (SMP): In this section, a 5 point Likert scale (ranging from very high to very low) was used to collect data on the perceived competencies of farmers in the sound management of pesticides (SMP
- Part 4-Perception of hazards associated with pesticide use: The section solicited for information on the environmental, safety and health awareness levels of farmers using a 5 point Likert scale which also ranged from very high to very low.
- Part 5- Awareness and use of alternative pest control methods: In this section a 5 point Likert scale (ranging from very high to very low) was used to assess farmers' awareness levels of alternative pest control methods.
- Part 6- Information support for pesticide management: The section was used to determine the availability of pesticide management information. It was also designed to collect data on the perceived effectiveness of the various sources of information, using a 3 point likert type scale ranging from "very effective" to "not effective". The section also solicited for information on training courses attended by the farmers.

A mixture of close-ended and open-ended questions were applied in all sections of the research instrument. Tables 13 and 14 show the Likert-type scales and their interpretations.

Table 12: Interpretations of Likert-type scales of awareness and competency levels of small-scale farmers

Ratings	Interval	Awareness level of stakeholders	Competencies of stake holders
5	4.45 –5.00	Very high	Very High
4	3.45 –4.44	High	High
3	2.45 –3.44	Moderate	Moderate
2	1.45– 2.44	Low	Low
1	1.00 –1.44	Very Low	Very Low

Source: Author's construct (2006)

Table 13: Interpretation of Likert-type scale of effectiveness of source of pesticide management information

Ratings	Intervals	Effectiveness of source of information
3	2.45 - 3.00	Very effective
2	1.45 – 2..44	Effective
1	1.00 – 1.44	Not effective

Source: Author's construct (2006)

Pilot study

Pilot-testing of the research instrument was done to ensure its reliability and validity. The quality of the instrument was tested in terms of readability, ease of understanding, relevance, and representativeness of the question items in the research instruments by both the interviewer and the interviewees. Pilot-testing helped the researcher to identify error(s) that arose from the research instrument. The necessary corrections and modifications were effected before the research instrument was finally administered. The Pilot testing ensured efficiency and effectiveness in the administration of the research instruments.

Interview schedules were pilot-tested in the Dangbe West district to determine the reliability of the instrument. With the help of the Statistical Products for Service Solutions (SPSS) version 12.0, Cronbach's alpha reliability co-efficients were calculated to describe the internal consistency of all items measured on Likert-type scales. These Cronbach's alpha co-efficients indicate that, the instrument was reliable since Pallant (2001) considers Cronbach's alpha co-efficients of 0.70 or more to be reliable. Table 14 shows reliability coefficients of the various sub-scales.

Table 14: Reliability co-efficients of sub scales in farmers' interview schedule

Subscales	Number of items	Cronbach's alpha scale
Farmers awareness levels in alternative pest control measures	7	0.79
Effectiveness of source of pesticide use information available to farmers	8	0.70
Perceived competence of farmers in sound management of pesticides	22	0.86
How often farmers/ pesticide applicators examine protective clothing and spraying equipment	8	0.75
Farmers' environmental, safety and health awareness levels of effects of pesticides	10	0.89

Source: Field data (2006)

Based on the outcome of the pilot test, the final research instrument was developed for the collection of the actual data. The pilot testing of the research instrument was done in July 2006.

Data collection

A research assistant and five interviewers were trained to help the researcher administer the interview schedules to the sampled farmers in the 6 zones that had been randomly sampled in the study districts. The trainees were AEAs in the study area. The validated research instruments for farmers was explained to the AEAs by the researcher in English but in the field, local dialects had to be used for farmers to understand the questions and respond to them appropriately. Local languages used were Ga, Twi and Ewe. Data collection was from 29^{th} September to 27^{th} November 2006. A total number of 147 out of 150 the administered interview schedules were received representing 98 percent response rate.

Data analysis

With the help of the Statistical Product for Service Solutions (SPSS) version 12.0, frequencies, percentages, means, standard deviations, Pearson product moment correlation coefficients, Spearman Brown correlation coefficients and Stepwise multiple regression were used to analyse the data.

Frequencies, percentages, means and standard deviations, were used to analyse data on sources, types, accessibility, cost and purposes for which pesticides are used. The same statistics were also used to describe pesticide management practices by farmers, sources of pesticide management information available to them, their environmental, safety and health awareness levels as well as the perceived awareness levels of farmers in alternative methods of pest control. Data on the perceived competencies of farmers in the sound management of pesticides were also analysed using frequencies, percentages, means and standard deviations.

Pearson product moment correlation coefficients was used to analyse the data for the relationship between the perceived competency level of small-scale farmers in the sound management of pesticides (SMP) and small-scale farmers' perceived awareness level of environmental, health and safety implications of pesticide management, their perceived awareness level of alternative pest control methods, their perceived effectiveness of sources of pesticide management information available to them, and the frequency of examination of spraying equipment and protective clothing in the study area as they were measured on Likert-type scales. Since the ages and years of farming experience were measured on continuous scales, the relationships were analysed using the Pearsons Product Moment correlations. The relationship between the competency levels of small-scale farmers in the sound management of pesticides and their educational level on the other hand was analysed using Spearman Brown correlation coefficients since it was measured on an ordinal scale. Stepwise multiple regressions were used to determine the predictors of small-scale farmers' perceived competency in the sound management of pesticides.

CHAPTER FOUR

RESULTS AND DISCUSSION

DEMOGRAPHIC AND OCCUPATIONAL CHARACTERISTICS OF SMALL-SCALE FARMERS

General overview

This chapter presents and discusses the results of the study in relation to the demographic and occupational characteristics of small-scale farmers in the study area. The chapter highlights the findings and discussions on the availability of pesticides and their management by the farmers.

Demographic and occupational characteristics of farmers in the study area

Objective one described the demographic and occupational characteristics of the small-scale farmers in the study area. The findings pertaining to this objective are as follows:

Sex of farmers

Table 15 shows the frequency distribution of sex of the small-scale farmers in the study area. The results of the study revealed that, about 30 percent of the small-scale farmers were females whiles the remaining 70 percent were males. These proportions show that farming in the study area is not the preserve of men. The sound management of pesticides in agriculture therefore becomes the shared responsibility of both men and women farmers.

Table 15: Frequency distribution of sex of farmers

Sex	f	%
Male	103	70.1
Female	44	29.9
Total	147	100

Source: Field data (2006)

Nelson (1981) stated that, it is wrong to assume that, an effective development programme for males will automatically translate into an effective programme for women as well. Gamble and Gamble (2002) have asserted that, men and women perceive different realities, have different expectations set for them and that while women are categorized as emotional, men are classified as rational. Most importantly, it is known in Ghana that women are often excluded from transfer of information/ knowledge through male extensionists as a result of traditional systems. These perceived differences may influence the way the different sexes perceive their competencies in the SMP and even the way they are influenced by PMI.

Age of farmers

Table 16 shows the frequency distribution of age of farmers at their last birthday. As can be seen from Table 16, the majority (59 percent) of the farmers were between the ages of 30 and 49 years. Only 21.2 percent of the farmers were less than 30 years old whiles 18.9 percent of them were over 50 years of age. The finding in this study is contrary to the observation of La-Anyane (1985) and Dankwa (2005) who reported that, the average age of farmers in the farming communities of Ghana ranges from 50 to 60 years, and that, the majority of the farmers were found to be over 50 years of age. In the current study, the average age of the small-scale farmers was found to be 40 years, which is far below the reported average age of farmers in the farming communities of Ghana. With a slightly younger generation of farmers in the study area it is expected that, they would be able to cope with certain farming activities effectively and therefore affect productivity positively.

Table 16: Frequency distribution of age of farmers as at last birthday

Age range (Years)	f	%	Cum. %
< 20	2	1.4	1.4
20 – 29	29	19.8	21.2
30 – 39	42	28.8	50.0
40 – 49	44	30.1	80.1
50 – 59	19	12.1	93.2
60 – 69	5	3.4	96.6
70 and above	5	3.4	100.0
Total	146	100.0	-

Mean = 40 years SD = 12.29 Min = 9 years Max = 76 years

Source: Field data (2006)

Ajayi (2000) reasons that, the majority of present day farmers are not well acquainted with traditional methods because the practitioners of that are no longer alive. A similar reason has been given for the near extinction of traditional knowledge of pest control in other places such as Sri Lanka (Ulluwishewa, 1993) and Kenya (Conelly, 1987). These assertions indicate that, with only 6.8 percent of the farmers being older than 59 years, one should not expect a majority of them to be familiar with traditional knowledge in crop protection practices which were well known by their forefathers.

Educational level of farmers

Table 17 shows the frequency distribution of the educational levels of small-scale farmers in the study area. The results of the study show that, 29.2 percent of the farmers have no formal education while 13.2 percent have received some level of primary school education. Majority (70.8 percent) of the farmers have however been educated up to primary school level.

The finding of the study compares favourably with Aryeetey (2004) who suggests that, individuals resident in urban areas are more likely to have attended school than those in the rural areas of Ghana. The finding of the study was however contrary to the finding of Gerken et al. (2001) who reported that, 17 percent of the small-scale farmers did not have formal education. It is of interest to note that as many as 29.2 percent of the farmers did not have any formal education and this would certainly affect their ability to receive, decode, and understand written information and those requiring calculation skills negatively. This group of farmers is likely to have problems with technical information that is encountered in the management of pesticides and therefore have an adverse effect on their competencies in pesticide management.

Table 17: Frequency distribution of educational background of farmers

Highest educational qualification	f	%
No formal education (NFE)	42	29.2
Primary school education (PSE)	19	13.2
Middle school leaving certificate (MSLC)	35	24.3
Basic education certificate (BEC)	24	16.7
General certificate of education (GCE).	8	5.6
Senior Secondary School Certificate (SSSC)	8	5.6
Technical School (TS)	6	4.2
Teachers' Training College (TTC)	1	0.7
Tertiary	1	0.7
Total	144	100.0

n=147 Source: Field data (2006)

According to Byrness and Byrness (1978), education enhances one's ability to receive, decode, and understand information. The authors claimed that, information processing and interpretation are important for performing many jobs. They also indicated that, the farmer's level of education, to some extent, determines the types of tasks he/she can undertake in a programme, and therefore the level of participation. The educational level of small-scale farmers in the study area will therefore affect their ability to receive, decode, and understand information. Under such educational conditions, small-scale farmers are likely to have problems with technical information that is encountered in the management of pesticides and therefore have an adverse effect on their competencies in pesticide management.

Ajayi (2000) has also indicated that, the low educational level of farmers in the cotton growing areas of Côte d'Ivoire could limit the potential for alternative practices. Illiteracy poses a problem to the flow of agricultural information because only one quarter of the household heads have formal education. As the majority (70.8 percent) of the small-scale farmers have some level of formal education, it should be possible for them to process and understand the information they receive about pest management to some extent. Their low competency level in understanding pesticide labels could be an indication of equally low levels of education. As can be seen from the results, as many as 54.2 percent of the respondents were only educated up to primary school (13.2 percent), middle school leaving certificate (24.3 percent) or basic education certificate (16.7 percent) levels. These are indications of low levels of education.

Again, this majority are likely to include the part time farmers who have other means of livelihoods and may not be that committed to farming and would therefore not bother about traditional or alternative methods of pest control. Gamble and Gamble (2002) have also emphasized that, at times, high level of education can become a barrier rather than a facilitator or aid to communication.

The finding of the study is however contrary to the assertion of Aryeetey (2004) who reported that, in rural areas where the majority is farmers, only 29.3 percent of their sample had attended school in 1992. The author also observed that, only 32 percent of the rural sample could read and only 30 percent could write whiles 41 percent could do simple calculations. One can however not underestimate the ability of un-educated farmers to grasp technical information and simple cause-effect relationships when they are presented well, with the exception of calculation of pesticide dosage.

Farming experience of farmers

The result of the study, as indicated in Table 18, shows that, the majority (68 percent) of the farmers have been in the occupation for 10 years or more, with an average of 16 years experience in farming.

Table 18: Frequency distribution of farming experience

Years of experience	f	%	Cum. %
Less than 10	47	32.0	32.0
10 – 19	46	31.3	63.3
20 – 29	29	20.7	83.0
30 – 39	20	13.6	96.6
40 – 49	2	2.6	98.0
50 or more	3	2.0	100.0
Total	147	100	

Mean = 16 years SD = 11.08 Min = 1 year Max = 56 years

Source: Field data (2006)

Although the average period of farming experience in the study area is lower than what was observed by Dankwa (2005), who reported that a majority (80.7 percent) of the farmers had worked between 10 and 40 years with an average experience of 23 years. This long period of experience in farming may foster the adoption of agricultural technologies if socio-economic problems are addressed adequately. However, on the basis of their assertion, a farming experience of 10 years or more should therefore be adequate for the majority of the farmers to acquire high competency levels in the sound management of pesticides.

According to Gyimah (2003) however, the years of experience alone may not translate into knowledge acquisition and subsequent competence development. Transfer of information from an efficient source through the right channel to the receiver is more likely to translate into knowledge acquisition and subsequent competency.

Major crops grown in the districts

The frequency distribution of major crops grown in the districts is presented in Table 19. The majority of the farmers indicated that, cassava and maize are the most important crops which they cultivate on their farms. While 30.6 percent of the farmers claimed cassava was their major crop, for 23.8 percent of them it was maize. The remaining 45.6 percent of the farmers cultivated various types of vegetables.

Table 19: Frequency distribution of major crops grown in the district

Crop	f	%
Cassava	45	30.6
Maize	35	23.8
Pepper	20	13.6
Cabbage	11	7.5
Carrot	8	5.4
Sweet pepper	6	4.1
Okro	5	3.4
Tomato	5	3.4
Others	12	8.1
Total	147	100.0

Source: Field data (2006)

The most important vegetables cultivated are, pepper (13.6 percent) cabbage (7.5 percent), carrot (5.4 percent), sweet pepper (4.1 percent), okro (3.4 percent), and tomato (3.4 percent). Other farmers cultivated garden eggs, water melon, tindal, groundnuts, pineapples, chillies, onions, cucumber and cauliflower as their major crops. The results of the study show that, apart from cassava and maize, the major crops grown in the district are vegetables.

Some occupational characteristics of farmers in the study area

Table 20 presents the frequency distribution of some occupational characteristics of farmers in the study area. The Table shows the percentage of farmers whose main means of livelihood was farming as compared to those who had other occupations to live on. Table 20 also shows the percentage of farmers who practised mixed cropping. Data from Table 20 shows that, the majority (78.9 percent) of the farmers depended on farming for their livelihoods. It is expected that, such farmers will be eager to accept information from AEAs to ensure optimum productivity from their farms in order to achieve sustainable livelihoods for their families.

Table 20: Frequency distribution of occupational characteristics of farmer

Occupational characteristics	f	%	n
Full time farmers	116	78.9	147
Part time farmers	31	21.1	147
Practice mixed cropping	84	57.1	145
Use other pest control methods	33	26.8	147
Use pesticides on their farms	118	80.3	123

n = 147 (Multiple responses)

Source: Field data (2006)

Although the majority (57.1 percent) of the farmers practiced mixed cropping, none of them said they did so as a pest management practice. The major reason given for mixed cropping was economic. The farmers said they practised mixed cropping to guarantee food security and also to maximize the benefits from a limited piece of land available to them as indicated by some farmers at Kweiman. “I practise mixed cropping to increase yield and incomes” was the reason given by a male respondent while a female respondent, on the other hand said “I practise mixed cropping to make use of scarce land”. It is however worthy of note that mixed cropping may be used to control pests and diseases. Farmers should be made aware of this benefit from an otherwise cultural farming practice which only appears to have limited advantages for small-scale farmers.

Farmers who use pesticides

From Table 20 it can be seen that, 80.3 percent of the small- scale farmers use pesticides. This finding is in line with the finding of Gerken et al. (2001) who reported that the majority (74.0 percent) of the small-scale farmers use chemical pesticides. The findings of this study also confirm that of Childs (1999) that, there was a significant difference in the extent to which pesticides were applied in the different agro-ecological zones. The author reported that, on the average, farmers in the coastal savanna and the forest zones applied more pesticides than farmers in other areas did. Childs (1999) reported that, pesticides were mainly applied to vegetables like cabbage, tomato, eggplant, sweet pepper and okra as well as to legumes such as cowpea and soybeans. These include crops grown by small-scale farmers in the study area. The author indicated that, other plant protection strategies like crop rotation, hand picking, biological control and traditional products were not widespread.

Farmers who use other pest control methods

The results of the current study (refer to Table 20) show that, 26.8 percent of 123 small-scale farmers interviewed used pest control measures other than pesticides. This finding gives an indication that, some of the pesticide- using farmers also depend on alternative pest control measures for controlling pests. The result of this study is in line with the finding of Gerken et al. (2001: 92) who reported that "about one quarter of the non-users of chemical pesticides chose alternative pest control measures including neem extract". The authors also cited the use of traditional products such as vegetable oils, wood ash, neem extracts and other mixtures as well known to farmers especially for the control of storage pests in cereals. They also reported that small scale farmers used traditional products for field pests.

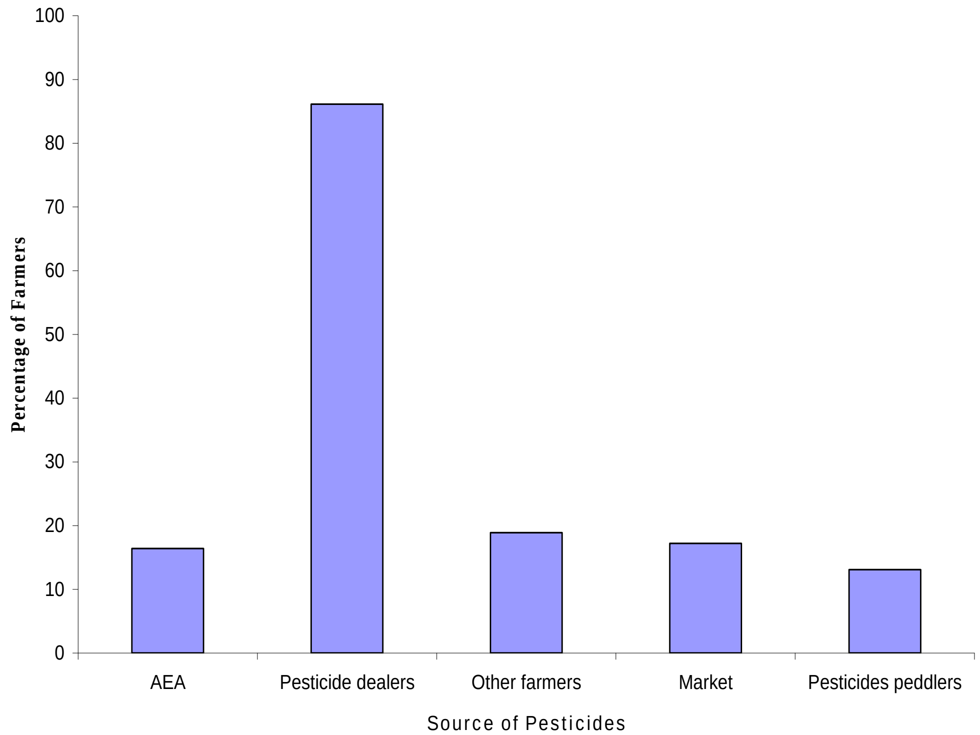
It was found from the study that, some farmers who used herbicides also used manual weeding to control weeds when they have crops in the field. As indicated by one farmer at Ayi Mensah, "the herbicide will kill the crop so I prefer to weed after the first herbicide application I normally do before planting"

Availability of pesticides to farmers

This section presents and discusses the findings of objective two which relates to the availability of pesticides to small-scale farmers in the study area.

Sources of pesticides for farmers

Figure 4 shows the frequency distribution of sources of pesticides to small-scale farmers in the study area.



n = 147 (Multiple responses)

Figure 4: Sources of obtaining pesticides for small-scale farmers

Source: Field data (2006)

Figure 4 shows that, small-scale farmers obtained pesticides from more than one source. However, their main source of pesticides is the pesticide dealer. The study showed that about 86.1 percent of the farmers obtained their pesticides from pesticide dealers. Farmers claimed they also obtained pesticides from other farmers (18.9 percent), the market (17.2 percent), AEAs (16.4 percent) and pesticide peddlers (13.1 percent). This finding is in line with the findings of Gerken et al. (2001) who reported that, about 90.0 percent of all respondents and 96.2 percent of small-scale farmers in their study acquired their pesticides from private retailers although government institutions such as MOFA and COCOBOD continue to offer retail services to farmers. The other sources of pesticides available to farmers are not very significant. It is however note worthy that, although there are more than three NGOs; Heifer International Adventist Relief Agency (ADRA) and World Vision among others, operating in the study area, none of them is mentioned as a source of pesticide supply or availability. This finding confirms the assertion of Gerken et al. (2001) that, NGOs are involved in the distribution of pesticides only to a small extent at the national level.

It is interesting to note that the next most important source of pesticides for farmers after the dealers is other farmers in the communities. In one community, Oyarifa, it was found that the farmers relied on the chief farmer as their only source of pesticides. According to the farmers, they relied on him for all their pesticide needs although he is not a retailer. The chief farmer has taken it upon himself to buy pesticides for the other farmers anytime the need arose. This is an indication that Farmer Based Organizations (FBO) could be of great help when it comes to procurement of pesticide requirements of farmers since a trusted member of the community could be relied upon to purchase pesticides on their behalf. It is clear from the results that although government makes provision for some supply of pesticides through MoFA and COCOBOD, the private sector continues to dominate as a major source of pesticides to the small-scale farmers.

The wide range of private sources of pesticide available to the farmers has implications as to the quality and appropriateness of pesticides used by the farmers and the access to information on pesticide use. Since it is necessary for the source of pesticide to have some expertise in the SMP, farmers should be encouraged to access the services of registered dealers for their pesticide needs. This situation makes it imperative for PPRSD to mount intensive training programmes for the pesticide dealers to ensure that farmers will be given appropriate information on the pesticides they obtain. It is also a point for the case of licensing only trained dealers. It has been indicated by Gerken et al. (2001) and also found in this study that, some farmers do not seek expert advice before they apply pesticides. The source of pesticides for such farmers should be in a position to provide them with the needed advice.

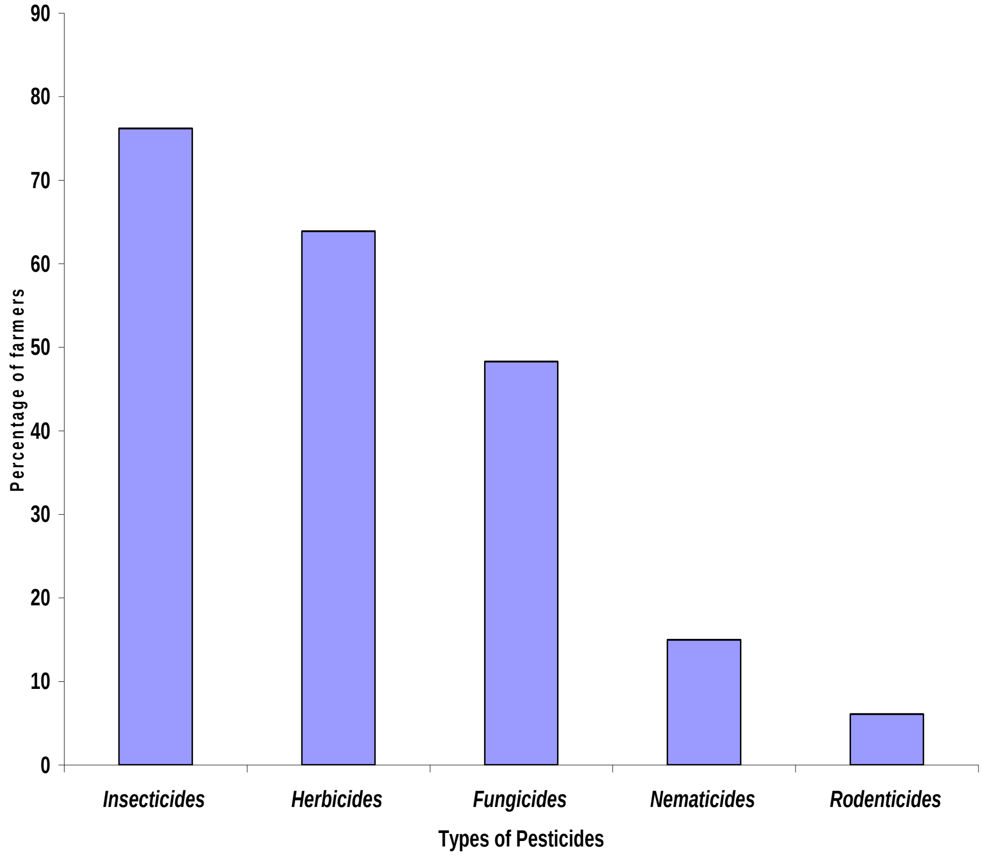
According to Williamson (2005: 177), “unapproved and sometimes illicit supplies may also be obtained via unauthorised cross-border trade. In Ghana such trade is common from Cote d’Ivoire and Togo, as evidenced by the widespread sale of pesticides labeled in French, violating one of the key labeling requirements of the FAO Code of conduct (FAO, 2002)”. In all four study areas of her study; Benin, Ethiopia, Ghana and Senegal, Williamson (2005) found that, there has been a proliferation of informal pesticide trading following liberalization during the past decade. The finding of this study confirms this assertion as the open market (17.2 percent) and pesticides peddlers (13.1 percent) also offer pesticides for sale to farmers in the study area.

Types of pesticides used by farmers

Figure 5 shows the types of pesticides used by farmers in the districts. The pesticides used in a descending order of importance are insecticides (76.2 percent), herbicides (63.9 percent), fungicides (48.3 percent) nematicides (15.0 percent) and rodenticides (6.1 percent). From the results it can be seen that, small-scale farmers in the districts mostly used insecticides as the main pesticide for pest control while very few of the farmers used rodenticides. The use of insecticides by the majority of small-scale farmers in the Ga East and Ga West districts could be explained by the fact that, most of them cultivate a wide range of vegetables both for sale and also for subsistence. The vegetables cultivated include pepper, garden egg, okro, tomato, carrot, sweet pepper, cabbage, lettuce, chillies, cauliflower and onion. Vegetable farmers usually go all out to present their customers with produce that have very little or no blemish at all. In the process they tend to apply a lot of insecticides to their crops.

These findings conform to the findings of Gerken et al. (2001) who reported that, the small-scale farmers applied a broader range of insecticides and more intensively compared to the medium- and the large-scale farmers. Gerken et al. (2001: 99) also reported that, “the situation was about the same with fungicides, though the level of intensity was lower”. According to the authors, there was an extensive use of fungicides among the small- and medium-scale farmers. They related this observation to the crop base of small-scale farmers. They also reported that in the case of vegetables which were mainly grown by small- and medium-scale farmers, there was intensive application of insecticides.

Although Gerken et al. (2001) said the observation could be attributed to the small- and medium- scale farmers not having a clear idea of which specific insecticide to use, and could have applied pesticides on a trial-and-error basis compared to the large-scale farmers who had more detailed knowledge of pests and the relevant pesticides, an observation of the situation in the current study area however, could not confirm their assertion.



n = 147 (multiple responses)

Figure 5: Frequency distribution of types of pesticides used by small-scale farmers

Source: Field data (2006)

In the current study, the majority (over 50 percent) of the small-scale farmers did not know the brand names of the pesticides they used while others had difficulty remembering or pronouncing the brand names of the pesticides they used. During the interviews, some farmers had to retrieve empty pesticide containers to indicate what they were referring to. "The problem of farmers not being able to pronounce names of pesticides resulted in an illiterate farmer being sold a tree killer instead of a selective herbicide. This unfortunate incident caused scorching of the farmer's five (5) hectare pineapple farm" (Kyei-Manu, 2006). The farmer had been advised to purchase Diuron and Harvar X. but was given 'Garlon 2' apparently because he mispronounced 'Diuron'.

The findings of this study confirm the assertion by Gerken et al. (2001) who have indicated that most small-scale farmers do not know the brand names of the pesticide formulations they use, though they know the class or category. The finding is also supported by Williamson (2005: 177) who reported that, "pineapple farmers admitted to often using products without knowing their identity, name or characteristics."

The use of herbicides by 63.9 percent of the small-scale farmers is also significant. Traditionally, weeds are controlled physically by weeding with hoes and or cutlasses. For such a high percentage of farmers to resort to the use of herbicides could be the result of labour stress for weed control. Labour stress could be in the form of unavailable labour or high cost of labour.

The least used pesticides are rodenticides. Figure 5 shows that, only 6.1 percent of the farmers in the district used rodenticides. This observation could have two implications. It could be an indication of rodents not being that much of a nuisance in the districts and therefore do not warrant any special control methods. It can also be inferred that traditional or alternative methods are the main means of controlling rodents in the districts. There are numerous methods for controlling rodents other than the use of pesticides. Besides some rodents are edible so farmers would prefer to control them without rendering them poisonous. This assertion is supported by the finding of Ajayi (2000) who has indicated that previous methods of crop protection that early progenitors in the cotton growing area of Côte d’ Ivoire have used in the past included soaking the bark of a local plant *Parkia biglobosa* in water for a few days and spraying the liquid solution on crops primarily to control rodents and other forest animals that destroy crops. The farmers believed that the bitter taste of these products made crops unattractive to ravaging animals. Ajayi (2000) also indicated that, scarecrows are a common traditional means by which birds and rodents are controlled in fields and that, most of the indigenous methods of pest control used in the cotton growing areas in the past were mainly directed against rodents and other forest animals. Other methods alluded to by Ajayi (2000) are; to fence the parcel of land against animals and to hunt animals or to set traps.

Distance to source of pesticides

The results of the study show that, almost all the farmers have to travel away from their immediate locations to purchase or have access to pesticides (refer to Table 21). The majority (60.4 percent) of them have to travel over 6 Km to obtain pesticides. Some small-scale farmers (8.3 percent) even have to travel over 20 Km to buy their pesticides, which shows that, small-scale farmers are prepared to travel long distances to obtain pesticides. The incentive for small-scale farmers to travel such long distances to obtain their pesticides could be the result of the knowledge they have about the effectiveness of pesticides.

Table 21: Frequency distribution of distances to source of pesticides

Distance (Km)	f	%
< 6	48	39.7
6 – 10	43	35.5
11 – 15	14	11.6
16 – 20	6	5.0
> 20	10	8.3
Total	121	100.0

n=147 Source: Field data (2006)

Farmers' perception of availability of pesticides

Table 22 shows farmers' perception about how readily pesticides are available to them. The results of the study show that, pesticides are never available to the majority (75.0 percent) of the farmers. According to the farmers, this situation does not necessarily mean that they cannot obtain pesticides but that, the pesticides are sold away from their communities and that they need to incur some cost to obtain them.

Table 22: Frequency distribution of availability of pesticides

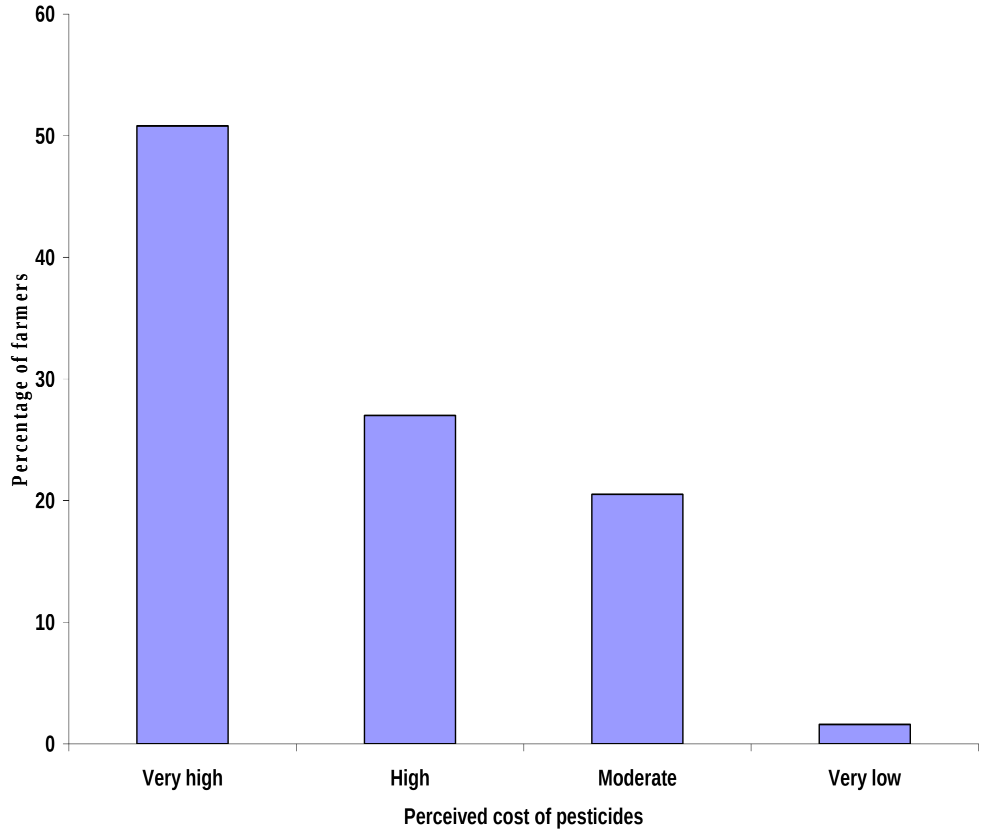
Availability	f	%
Always	11	9.2
Sometimes	19	15.8
Never/ Difficult	90	75.0
Total	120	100.0

n = 147 Source: Field data (2006)

Since perception is relative (Van den Ban and Hawkins, 1996), the farmers' view of pesticide availability is in terms of distance to source of the pesticides. As has been previously pointed out in the discussion under distance to the source of pesticides, the majority of the farmers have to travel up to 10 Km to obtain them. This situation means that pesticide dealers usually site their shops away from the farming communities where the pesticides are needed most. The cost of travel to obtain pesticides then becomes an added cost to the pesticides, hence the farmers' perception of the high cost of pesticides as discussed in the next section.

Farmers' perception of cost of pesticides

Figure 6 shows that, the farmers' perception of cost of pesticides that are available to them. As can be seen from the results, farmers' perception of cost of pesticides ranged from very high to very low. The majority of the farmers (50.8 percent) were of the opinion that the cost of pesticides is very high. As indicated by some of the small-scale farmers' perception of the cost of pesticides was in relation to the cost they incurred in applying pesticides to their farms before the sale of pesticides was privatized. They claimed that, in the era of free pesticide supply by MOFA, farmers hardly incurred any costs for applying pesticides apart from transportation. In later years, when it became government policy to retail pesticides to farmers, farmers did not have to pay as much as they have to do now (Kyei-Manu, 2006). Some farmers also related the cost of pesticides to the cost of farm produce. Generally, high value vegetable crop farmers did not perceive the cost of pesticides to be very high, but that category of farmers was very few in the study area.



n = 147

Figure 6: Percentage distribution of farmers' perceived cost of pesticides

Source: Field data (2006)

Small-scale farmers' perception of the high cost of pesticides is confirmed by Fleischer (1999) who has indicated that, the price factors in pesticide use include government selling or giving out pesticides. Fleischer also cites donor provision of pesticides at low or no costs as incentives for excessive pesticide use. It is always possible for small-scale farmers to use such situations as reference points when indicating their perception of the cost of pesticides after such facilities are withdrawn. This situation has been confirmed by Ajayi (2000) who indicated that, because pesticides are no longer free, small-scale farmers regard the cost of pesticides as being high. Small-scale farmers explained that, as agrochemical prices have increased, they look to obtain them via cheaper, informal sources.

Table 23: Cross tabulation of sex and small-scale farmers' perception of cost of pesticides

Sex	Farmers' perception of cost of pesticides									
	Very high		High		Moderate		Very low		Total	
	f	%	f	%	f	%	f	%	f	%
Male	49	53.8	27	29.7	15	16.5	0	0	91	100
Female	13	41.9	6	19.4	10	32.3	2	6.5	31	100
Total	62	50.8	33	27.0	25	20.5	2	1.6	122	100

n = 147 Source: Field data (2006)

The cross tabulation of sex and small-scale farmers' perception of cost of pesticides is presented in Table 23. The results showed that, while none of the male respondents perceived the cost of pesticides to be very low, 6.5 percent of the female respondents perceived the cost of pesticides to be very low. However, 53.8 percent and 41.9 percent of the male and female respondents respectively perceived the cost of pesticides to be very high.

The high cost of pesticides indicated by farmers in the current study confirms the finding of Williamson (2005: 177) who reported that, the advantage of the informal channel is that, it is quick, readily accessible and the cash outlay for small volumes is within their means. The low income level of the small-scale farmer then becomes a disadvantage and places him at the mercy of unscrupulous pesticide dealers who may only offer those adulterated products and unreliable or no information".

Purposes for which pesticides are used by farmers

Table 24 presents the uses to which farmers put pesticides in the Ga East and West districts of the Greater Accra Region. The major uses to which farmers put pesticides are two fold. The most important uses for pesticides are cropping (98.3 percent) and grain and legume preservation (20.5 percent). It is apparent from the results that, pesticides are not used for fishing by farmers in the district. The finding of this study is not in line with the general perception that farmers use pesticides for purposes other than farming activities. The result of the study is also an indication that, the use of pesticides for fishing although a reality, may not necessarily be the activities of farmers.

Table 24: Frequency distribution of purposes for which pesticides are used

Uses of Pesticides	f	%	n
Cropping	119	98.3	121
Fishing	0	0	0
Trapping Rodents	11	9.2	120
Public health	7	5.8	120
Animal health	4	3.3	120
Grain and Legume preservation	24	20.5	117

n=147 (Multiple responses) Source: Field data (2006)

Pesticide management practices by farmers

The third objective examined pesticide management practices by small-scale farmers in the study area. The following are the findings of the study with respect to the objective:

The results of the study showed that, 80.3 percent of the respondent small-scale farmers used pesticides in their farming activities but only 45.6 percent owned spraying machines. It was also found that, 26.8 percent of the farmers used other pest control methods apart from pesticides (Table 25).

Small-scale farmers who use protective clothing were 67.2 percent, whiles 83.8 percent of the people who apply pesticides examined their equipment and protective clothing before spraying. A very small proportion (4.5 percent) of the small-scale farmers said they used empty pesticide containers for domestic purposes, however, a quarter of the farmers (25.6 percent) claimed they keep pesticides in other containers. The study also revealed that, only 10.9 percent of the small-scale farmers have sought medical attention after being exposed to pesticides. It was also found that, only 21.3 percent of the small-scale farmers are aware of the EurepGAP protocol while 38.2 percent of those farmers apply it on their farms (see Table 25).

Table 25: Frequency distribution of pesticide management practices by farmers

Farmer practice	Yes		No		n
	f	%	f	%	
Own spraying machines	57	45.6	68	54.4	125
Apply pesticide mixtures (cocktail)	65	52.0	60	48.0	125
Use protective clothing	82	67.2	40	32.8	122
Examine equipment and protective clothing before spraying	93	83.8	18	16.2	111
Use empty pesticide containers for domestic purposes	5	4.5	107	95.5	112
Keep pesticides in other container	31	25.6	90	74.4	121
Have sought medical attention after being exposed to pesticides	14	10.9	114	89.1	128
Are aware of the EurepGAP protocol	30	21.3	111	78.8	141
Are applying it on their farms	13	38.2	17	50.0	34

n=147 Source: Field data (2006)

Farmers who apply pesticide mixtures (cocktail)

The results of the study, as indicated in Table 25 show that, 52 percent of 125 respondents used or applied pesticide mixtures. The finding of this study is contrary to the observation made by Gerken et al. (2001) who have indicated that, contrary to expert opinion, the use of pesticide mixture (cocktails) seemed to be low compared to single formulations. Mixtures of two or more pesticides may be applied by only 22 percent, 10 percent and 9 percent of small, medium and large scale farmers respectively (Gerken et al. 2001). It is however obvious from their study that, small- scale farmers applied more mixtures than the other groups. In the current study, some of the reasons given for the application of pesticide mixtures is that, “they augment each other’s effect”, while other farmers indulge in this practice to save time, effort and cost. However, some of the farmers who refrain from the use of pesticide mixtures do so because, they want to go strictly according to the recommendation given, as declared by a respondent at Ayi Mensah “No other practice apart from recommended usage.” While another small-scale farmer in the same community said “Once one type of pesticide has continued to work for me there is no need for me to mix them”. These assertions by farmers indicate that, small-scale farmers have varying views on the use of pesticide mixtures.

Farmers who keep pesticides in other containers

The majority (74.4 percent) of the farmers kept pesticides in their original containers (refer to Table 25). However, a few of them maintained that, they transferred pesticides into other containers. The transfer of pesticides has a lot of safety implications as far as sound management of pesticides is concerned. In transferring pesticides into others containers, farmers are likely to ignore the label. Identification of the pesticide then becomes a problem and this could result in its being misused. It is important to have all the information about a pesticide on any container it is transferred into.

Farmers' experiences from pesticide exposure

The results of the study show that, 10.9 percent (see Table 26) of the interviewed farmers had sought medical attention at one time or the other after exposure to pesticides. It can be seen from Table 26 that, the majority (60.0 percent) of the farmers had experienced one form of discomfort or the other during, immediately after or within 24 hours after their exposure to pesticides.

Table 26: Frequency distribution of farmers' experiences from pesticide exposure

Experience from Pesticides exposure	f	%	n
Burning sensation on the skin	43	37.1	116
Itchy or watery eyes	35	30.4	116
Very cold	8	7.0	115
Dizziness	24	20.9	115
Headache	30	26.3	114
Nausea or vomiting	8	7.0	115
Coughing	5	4.3	115
Breathing difficulties	16	13.8	116
None of these	46	40.0	115

n = 147 (Multiple responses)

Source: Field data (2006)

The results show that, most of the farmers suffered from burning sensation on the skin (37.1 percent), itchy or watery eyes (30.4 percent), headache (26.3 percent) and dizziness (20.9 percent). It is however surprising to note that only a small proportion of them (10.9 percent) ever sought medical attention. The results of this study compares with the results of Ajayi (2000) who reported that, sections of his respondents suffered from headache (25 percent), rhume (18 percent), cough (17 percent) skin rash (13 percent) and sneezing(11 percent) . Although 60.0 percent of the respondents in the current study said they had suffered from at least one symptom of ill health after spraying, only 10.9 percent of them said they had ever sought medical attention for such health related symptoms.

The results of this study is also in line with the finding of Ajayi (2000) who has reported that, in one out of five times (20 percent) when insecticides were sprayed on cotton fields, pesticide applicators reported a health symptom and also took special attention to seek treatment. The author indicated that, "this compares with the result of Kishi et al. (1995: 130) who reported that of all the respondents (pesticides applicators), only 24 percent took medication" (Ajayi, 2000: 123). It is however worthy of note that, in the current study only 10.9 percent of the affected farmers claimed they sought medical attention. Other affected farmers confessed that, they swallowed pain-relieving drugs because they attributed any form of pain after pesticide application to fatigue from the operation, instead of a pesticide related occurrence.

The farmers' attitude or reaction is in line with the assertion of Ajayi (2000) who emphasised that the symptoms that applicators reported are those they perceived to be the severe cases. "The majority of pesticide sprayers that were monitored (80 percent) reported that there was nothing so special ('rien a singuler') from pesticide spraying operations. According to Ajayi (2000: 123) "such pesticide applicators did not think that they encountered extra- ordinary health problems that are beyond normal levels during the pesticide application. This assertion may also hold for the large proportion of pesticide applicators who do not report or seek medical attention for pesticide related health problems.

According to Ajayi (2000), the official documentation of actual pesticides poisoning cases appears to be very low in many countries. Gerken et al. (2001) have also indicated that, there is a general lack of countrywide statistics on the extent of poisoning of farmers through pesticide application. This situation, they say has resulted because:-

1. Farmers seek medical attention only in cases of serious health problems due to the cost involved,
2. most of the farmers are not aware of the symptoms of pesticide poisoning,
3. the system of health statistics does not clearly specify cases of poisoning.

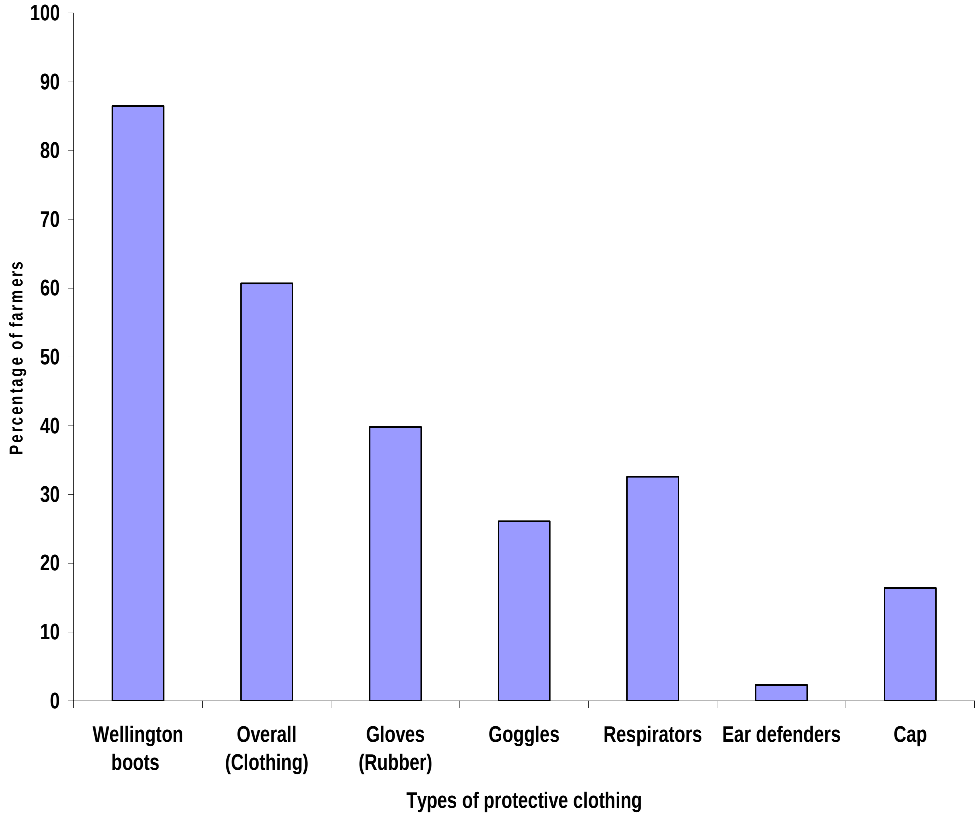
From the assertions of Ajayi (2000) and Gerken et al. (2001) it may be argued that the applicators are not aware of the symptoms of pesticide poisoning nor are they aware of health implications of pesticide management. Osorio and Travaglini (1999: 59) have also reported that, "another indicator for establishing the social costs of the indiscriminate use of pesticides is the number of people poisoned each year in the countryside". According to the authors, the health sector does not pay enough attention to this problem, mainly because they are unaware of the danger and there is no policy of conducting epidemiological monitoring programs in farming areas.

Farmers' awareness and practice of the EurepGAP protocol

It can be seen from Table 25 that, only a small proportion of the small-scale farmers (21.3 percent) said they were aware of the EurepGAP protocol which specifies Good Agricultural Practices in the field and pack houses as required by european markets. Although half of the farmers who are aware of the protocol indicated that they were not practising it, a few farmers who heard about it said they were interested in applying it in future. It is noteworthy that small-scale farmers in the Ga East and Ga West districts are interested in the EurepGAP protocol. The few farmers who apply it are likely to be doing so at the instance of exporters of agricultural produce.

Use of protective clothing by pesticide applicators

As indicated in Table 24, 67.2 percent farmers of who used pesticides used one form of protective clothing or the other whiles 32.8 percent of them did not use any. Figure 7 shows the frequency distribution of types of protective clothing farmers use when they apply pesticides in the field. The results of this study show that, there is general awareness of the need for pesticide applicators and/or users to protect themselves.



n = 147 (Multiple response)

Figure 7: Frequency distribution of types of protective clothing used by pesticide applicators

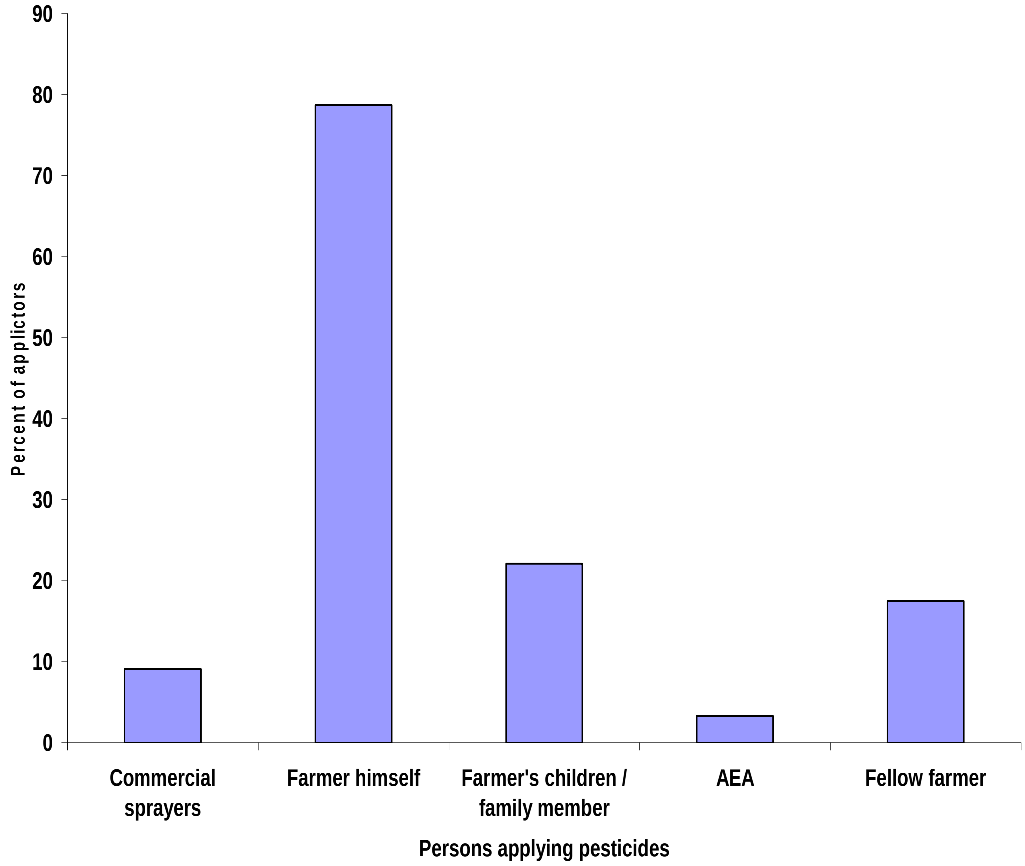
Source: Field data (2006)

It is interesting to note that wellington boots are still the main protective items used by farmers or pesticide applicators. As many as 86.5 percent of the farmers and or pesticide applicators used wellington boots while 60.7 percent of them used overalls or other forms of clothing to protect themselves from dermal contamination. This finding is indicative of the majority of the farmers being aware of the need to use protective devices and does not compare positively with the finding of Clarke et al. (1997) who reported that only 22 percent of their farmers used boots while applying pesticides and that, it was the main protective measure. Chivinge et al. (1999) have also indicated that, the majority of people applying, mixing, storing or dealing with pesticides in one way or the other do not wear appropriate protective clothing. The finding of this study is contrary to the earlier findings by Clarke et al. (1997) and Chivinge et al. (1999).

However, the use of goggles, respirators and gloves by the minority of pesticide applicators (26.1, 32.6 and 39.8 percent respectively) in the study area agrees with the findings of Chivinge et al. (1999) who indicated that the majority of people applying, mixing, storing or dealing with pesticides in one way or the other do not wear appropriate protective clothing. The wide range of protective clothing used among farmers in the district is however an indication of their knowledge and awareness of a need to use such devises while applying pesticides. It can be seen from the results of the study that, in confirmation of the assertion by Clarke et al. (1997) there was a general awareness of protective devises, but the transfer of knowledge into practice seemed to be weak especially for protective devices such as respirators, goggles, gloves and caps. Small-scale farmers in the Ga East and Ga West districts seem to have transferred their knowledge of the use of protective clothing into practice only to some extent. Although Clarke et al. (1997) indicated that, the common reason for non-utilization of protective equipment was unaffordable prices, there is a need to assess the awareness levels of the farmers in the use of protective clothing. The results of the study show that, farmers in the district indicated some awareness of the need for protection during the application of pesticides however, there are indications of a gap between their knowledge and their practice.

Persons applying pesticides in the field

Figure 8 shows the frequency distribution of the various people who apply pesticides on farms. The result of the study shows that, pesticide application is mainly done by the farmers themselves. They are however supported by their children and family members, fellow farmers, and commercial sprayers.



n=147 (Multiple responses)

Figure 8: Frequency distribution of persons applying pesticides in the field

Source: Field data 2006

It was found that 78.7 percent of the farmers applied pesticides themselves while 3.3 percent of them used the services of agricultural extension agents. Fellow farmers (17.5 percent) and children/ family members

(22.1 percent) also helped in applying pesticides on the farm and that, their services were employed more than the services of experienced commercial sprayers who offer only 9.1 percent of the spraying labour. In view of the health hazards associated with pesticide application, one would expect farmers to employ the services of commercial sprayers. This is an indication of farmers either not wanting to spend money on such services, or it could just be a solution to the absence of such services.

The results of this study is similar to the findings of Gerken et al. (2001) who found that, about 91 percent of the small-scale farmers in their study applied the pesticides themselves while 5 percent of them used the services of AEAs. It is worthy of note that, in their study, the authors indicated that, none of the small-scale farmers employed the services of commercial sprayers. The finding of the study is however contrary to their finding in that, 9.1 percent of the farmers employed the services of commercial sprayers. The role of fellow farmers (1.3 percent) is also on the low side as compared to the finding of this study in which 17.5 percent of the small-scale farmers used the services of other farmers for their pesticide application. The observation about the use of family labour for spraying services is also contrary to the finding of Gerken et al. (2001). While this study indicates that, as many as 22.1 percent of the small-scale farmers used family labour, the Gerken et al. reported that only 7.6 percent of them used family labour for applying pesticides on their farms. Although there is a lot of variation in the groups of persons who apply pesticides on the small-scale farms, it is very certain that the farmers carry out most of these exercises themselves. It is therefore very important that, farmers are facilitated to be competent in the application of pesticides while the importance of professionalism in the application of pesticides is encouraged.

Equipment used by farmers for the application of pesticides

Frequency distribution of equipment used by farmers for applying pesticides on the farm is presented in Figure 9. Equipment used by farmers includes mist blower machines, and lever operated knapsack sprayers. Only one farmer claimed that he applied pesticides with a broom while 97.6 percent of the farmers used knapsack sprayers The findings of the study is supported by Gerken et al. (2001) who have indicated that, knapsack sprayers were the most widely used spraying machines, especially among the small-scale farmers. According to the authors, only 13 percent of the small-scale farmers applied pesticides in the field by hand, using brushes, brooms, cups, bottles etc.

The study also showed that, only 32.6 percent of the farmers owned knapsack sprayers. This finding confirms what was found by Gerken et al. (2001) who indicated that spraying machines are capital intensive items and this affects their distribution among small-scale farmers who might not also have the technical know-how for their handling and maintenance. Gerken et al reiterated that poor distribution of spraying machines among farmers meant making payment to hire the services of a sprayer or delay in acquisition of services and therefore resort to manual application. According to Chivinge et al. (1999) however, the use of inappropriate spraying equipment has also led to excessive exposure to pesticides, especially to those applying the pesticides.

The popular use of appropriate spraying equipment therefore offers some amount of protection to the pesticide applicators in the study area.

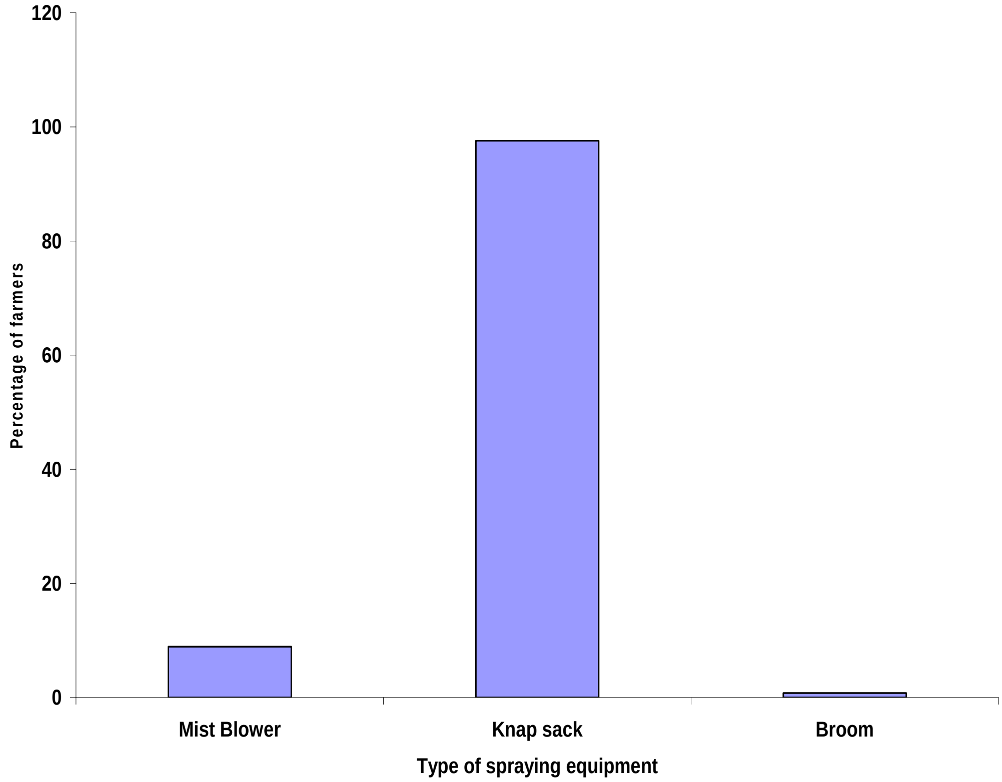


Figure 9: Frequency distribution of equipment farmers use for applying pesticides on the farm (multiple responses)

Source: Field data (2006)

It is interesting to note that, only a very small proportion of the farmers (8.9 percent) used the mist blower to apply pesticides on their farms. This practice is in line with the fact that small-scale farmers in the study area are mostly vegetable farmers. The use of the mist blower sprayer is usually associated with tree crop cultivation. It is however observed that only 32.6 percent of the farmers owned the lever operated knapsack sprayer (Figure 10).

Other farmers who use this equipment but did not own one may therefore have to rely on their friends and neighbours who have them. They may also have to hire from other sources which may include commercial sprayers. As indicated by Gerken et al. (2001), the spraying machine is capital intensive equipment which most small-scale farmers cannot afford to purchase as individuals. It is however interesting to note that, a few farmers (2.7 percent) own both the motorized as well as the lever operated knapsack sprayers. Such farmers are however few as compared to those who do not own any spraying equipment (61.22 percent). It is also interesting to note that, the low ownership of spraying equipment has not given rise to a situation that causes the farmers in the study area to use unprofessional means of applying pesticides on their farms as was asserted to by Gerken et al. (2001).

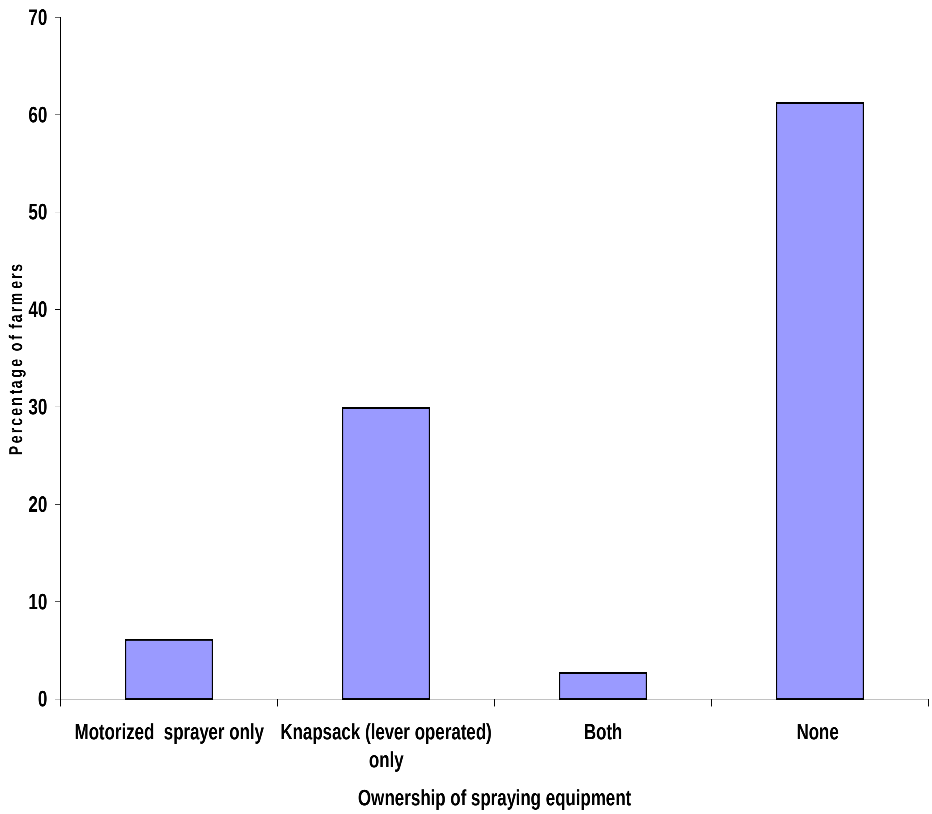
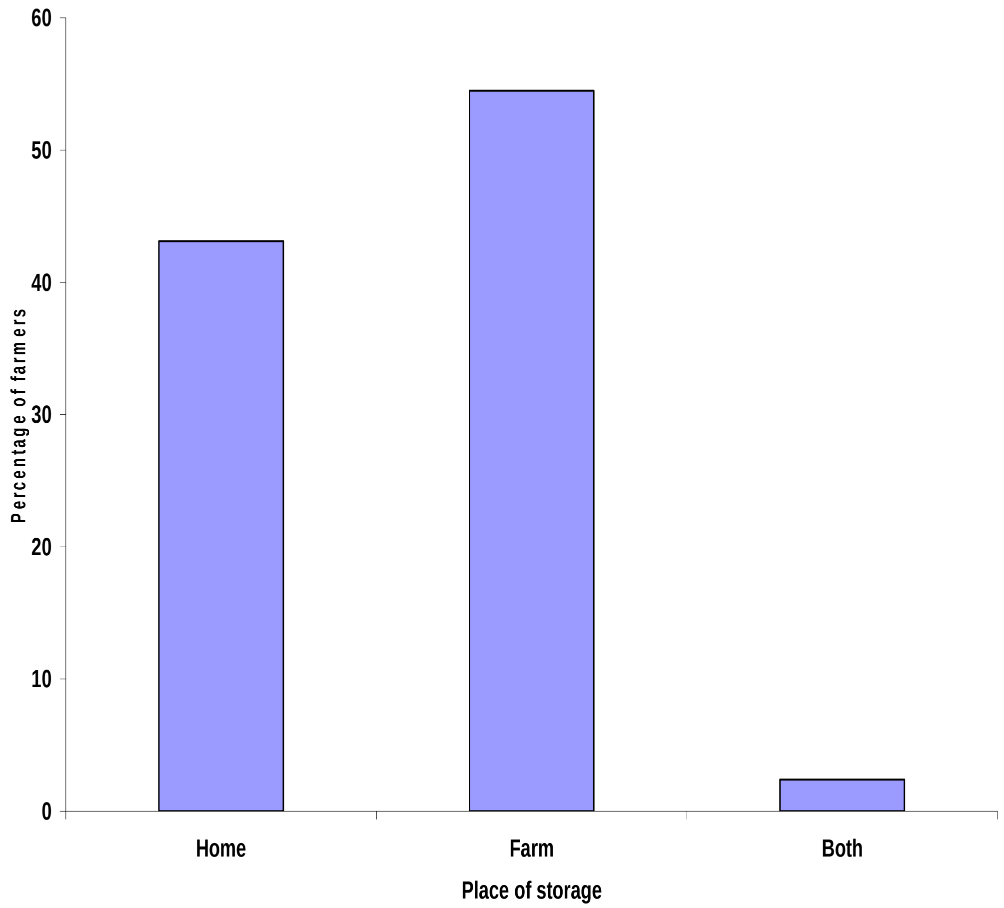


Figure 10: Frequency distribution of types of spraying machines owned by farmers

Source: Field data 2006 n=147

Storage of pesticides by farmers

The frequency distribution of pesticide storage sites are indicated in Figure 11. Generally, the majority of the farmers stored their pesticides at one place, either on the farm or at home. A very small proportion of the farmers (2.4 percent) however stored their pesticides at both places. The majority (54.5 percent) of small-scale farmers being aware of the need to keep pesticides out of reach.



n = 127

Figure 11: Frequency distribution of pesticides storage practices by farmers

Source: Field data (2006)

Some (four) respondents kept pesticides under dried farm debris while a few (two) claimed they kept them in polythene bags and buried them in the ground. Those who went to this extent said they did so to prevent theft. Some of those who kept pesticides on the farm were conscious of the poisonous nature of the pesticides and did not want them to be kept at home. A couple of farmers indicated that, if they sent the pesticide home, there is the likelihood of their children getting poisoned. This is an indicator that accidents must have happened already in the village or family. Farmers who kept their pesticides at home also kept them at varying places. The result of this study is in line with the findings of Clarke et al. (1997) also reported that most farmers stored their pesticides in their bedrooms or other rooms.

Disposal of empty pesticide containers by farmers

Figure 12 shows the frequency distribution of how farmers disposed of empty pesticide containers. From Table 31, it can be seen that the majority of the farmers (60.5 percent) simply throw away their empty pesticide containers. Among the vegetable growers it was common practice to see the empty containers scattered on the field. During the survey at a vegetable growing site at Adenta Down in the Ga East district, farmers rushed to their fields to retrieve empty pesticide containers to confirm names of the types they had used. Generally, the majority (65.0 percent) of the farmers in the study area did not seem to see any health or environmental implications in the method of disposal of empty pesticides containers.

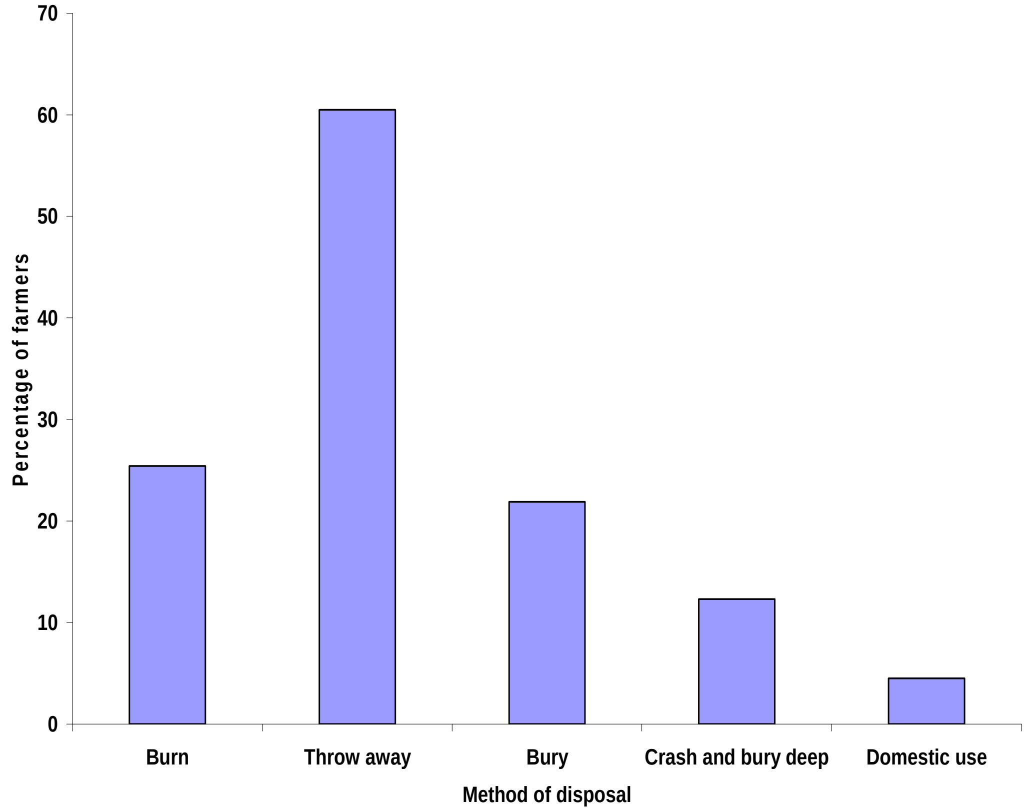


Figure 12: Frequency distribution of how farmers dispose of empty pesticide containers

Source: Field data (2006)

The results of the study show that, very few farmers (4.2 percent) said that they used empty pesticide containers for domestic purposes. All the farmers who reused empty pesticide containers used them for storing kerosene. However, one of them said he used them for storing water. Contrary to the finding of Gerken et al. (2001) that, about 20 percent of the farmers said they used empty pesticide containers for storing pesticides again or for other purposes such as storing fuel, water and seeds, only a very small proportion of the farmers in the study area used empty pesticide containers for such purposes. Although Gerken et al. indicated that, farmers also sold or disposed of them in other ways without destroying them, the results of this study did not indicate that such containers were sold. The finding of this study is also contrary to the finding of Ajayi (2000) who found from his study in the cotton growing region of Cote d'Ivoire that, in 13 percent of the cases, pesticide containers are reused by the household or by other persons (i.e. when sold). Ajayi's observation in households in the Long History region however compares favourably with trends in the Ga East and Ga West districts which performed far better (containers are reused in only 5 percent of the cases) compared with their counterparts in the short history region where about one in every five empty containers (16 percent) ends up being used by humans in one way or the other.

CHAPTER FIVE

RESULTS AND DISCUSSIONS: AVAILABILITY OF PESTICIDE MANAGEMENT INFORMATION (PMI) TO SMALL-SCALE FARMERS

General overview

Objective four examined current sources of pesticide management information (PMI) available to small-scale farmers in the Ga East and Ga West districts. This chapter presents and discusses the results of the study in relation to the current sources of pesticide management information (PMI) available to the farmers in the study area.

Sources of pesticide management information (PMI) available to farmers

Table 27 is a presentation of the frequency distribution of sources of pesticide use information available to small scale farmers in the study area. The results of the study show that, most farmers obtained pesticide management information from more than one source. The most important sources of pesticide use information for small-scale farmers in the district in a descending order of importance are, other farmers (85.2 percent), farmer's own experience (85.1 percent), extension (AEAs) (76.9 percent), pesticides dealers (66.0 percent), radio (48.6 percent) and, extension demonstrations (method / result demonstration) (47.1 percent). The finding of this study is contrary to the finding of Gerken et al. (2001) who reported that farmers receive information mainly from extension staff. They indicated other sources of PMI available to farmers in a descending order of importance as printed extension material, the farmers' own experience, other farmers, and labels on pesticides, retailers' materials, television/radio and the print media.

Table 27: Frequency distribution of available sources of Pesticide Management Information to farmers

Information source	f	%	n
Other farmers	121	85.2	142
Farmer's own experience	120	85.1	141
Extension (AEAs)	110	76.9	143
Pesticides dealer	93	66.0	141
Radio	68	48.6	140
Extension demonstration (Method / Result demonstration)	66	47.1	140
Television	45	32.4	139
Plant Protection and Regulatory Services	42	29.8	141
Pesticide company	40	28.8	139
Researchers and Universities	25	17.9	140
Print Media (Newsletters/Journals)	20	14.4	139

n =147 Source: Field data (2006)

The results of the current study indicate that, farmers in the district rely a lot on PMI which they have gained through their farming experience and also on the experiences of other farmers. It is quite apparent that, it is after these two close sources of PMI have been exhausted that, they consult the others. The important role played by other farmers' and farmer's own experience can be harnessed for the dissemination of PMI. The finding of this study however does not support the finding of Carpentier and Weaver (1997b) as cited by Jungbluth (2000) who in a study to analyse the ways in which farmers use information relating to pest populations, found out that, farmers do not use the information generated during the production process to update their beliefs concerning pest infestation.

The next important information sources are extension (AEAs), pesticides dealers, radio and, extension demonstrations (Method / Result demonstrations) in a descending order of importance. Considering the formal sources of PMI, the findings of this study confirm the finding of Gerken et al. (2001) who reported that, farmers received PMI mainly from extension staff. It is however interesting to note that, in the study by Gerken et al. (2001), printed extension material was a more available source of PMI than the farmers' own experience, and other farmers' experience.

Although Gerken et al. (2001) reported that, MOFA's Directorates of Agricultural Extension Services and PPRS are the major sources of information on pest management only 29.8 percent of the farmers interviewed in the current study area claimed they received PMI from PPRSD. The finding of this study is therefore contrary to the assertion of the authors. It is however worthy of note that, pesticide dealers were acknowledged as the next major source of PMI. The finding of this study therefore confirms the assertion by Gerken et al. (2001) that, pesticide dealers supplied information to all categories of farmers, especially the illiterate small holders. It is also very interesting to note that according to Gerken et al. (2001) although other organizations such as NGOs did not play a significant role in the dissemination of PMI, experienced farmers played an important role. This assertion has also been confirmed by the current study which indicates other farmers (85.2 percent) as being a major source of PMI, which means that such farmers should be targeted by extension campaigns.

The results of the study also confirm the finding of Ajayi (2000: 75 ho indicated that in his study, “The majority of farmer interviewed (70 percent) obtain general news and information from two or more sources. The sources include fellow farmers, CIDT agents and the radio. Informal farmer-to-farmer exchange of knowledge on crop protection takes place to a considerable degree (59 percent)”. The minor role played by agrochemical firms is also confirmed by the finding of Ajayi (2000) who reported that, apart from a few posters, mounted in the village, the impact of agrochemical firms on pesticide information is quite small. The author explained that, this is because chemical firms do not have a direct link to individual farmers but usually go through the cotton agency (for insecticides) or the farmer cooperative groups (for herbicides). A similar situation pertains in Ghana in that, pesticide firms do not usually develop a direct link to individual farmers. Products are introduced to farmers through PPRS and Agricultural extension offices.

According to Kujeke (1999: 100), in Zimbabwe, “lack of information, uncertainty, and perceived risk have been shown to inhibit decision–making at farm level. In general the farmers’ main sources of PMI are (a) research services, (b) government extension services, (c) the pesticide industry (d) other farmers and (e) the farmers own experience”. From the findings of this study, the role of research as a source of PUI to farmers is contrary to the assertion of Kujeke (1999) although the roles of government extension services, the pesticide industry, other farmers and the farmers’ own experience are confirmed.

Perceived effectiveness of available sources of PMI to farmers

Although farmers receive PMI from different sources, they perceived some as being more effective than others. Farmers’ perception of effectiveness was based on how useful they found the information they were given by the various sources. Table 28 shows the frequency distribution of the perceived effectiveness of the various sources of PMI available to the farmers while Table 29 shows the means and standard deviations of farmers’ perceived effectiveness of the various sources of pesticide use information. The results of the study indicate that, farmers perceive AEAs (mean = 2.79; SD = 0.43) as being a very effective source of PMI.

The small-scale farmers rated extension demonstrations (Method/Result demonstration) (mean = 2.36; SD = 0.65), other farmers (mean = 2.34; SD = 0.61), farmers’ own experience (mean = 2.32; SD = 0.66), PPRS (mean =

2.27; SD = 0.71) and pesticide agents (mean = 2.23; SD = 0.61), as being effective in a descending order of importance. The small standard deviations indicated that, the farmers were consistent in their ratings of the effectiveness of the various sources of PMI. These findings confirm the assertion by Jungbluth (2000) that, information relating to plant protection varies significantly depending on the source. While private companies targeting to increase sales volumes present farmers with specific product information promoting the quality of their products, crop protection agencies likely overestimate crop loss in order to minimize the perceived severeness if a pest outbreak actually occurs. Such biases in the information "market" raises the cost of obtaining accurate and complete information. Pearce and Tinch (1998) also described a situation where imperfect information about the future leads firms and regulators to be overly comfortable with the status quo leading to inefficiently low levels of investment in research and extension on alternatives to pesticides.

The results of the study indicated that, print media (mean = 1.73; SD = 0.66) was the least available source of PMI to the farmers and was also rated as the least effective source in the group. This finding confirms the finding of Gerken et al. (2001) who reported that print media is the least available source of PMI to farmers. The farmers' perception of print media being the least effective can be related to the low educational level of the small- scale farmers in the district which does not facilitate their sourcing for PUI from print media. This assertion is confirmed by Kujeke (1999) who indicated that, small-scale farmers in Zimbabwe, like others in the developing world are constrained by illiteracy.

Table 28: Frequency distribution of perceived effectiveness of available sources of PMI to farmers

Source	Very effective		Effective		Not effective		n
	f	%	F	%	f	%	
Extension	87	79.8	21	19.3	1	0.9	109
Plant Protection and Regulatory services	20	41.7	21	43.8	7	14.6	48
Pesticides dealer	30	33.0	52	57.1	8	9.9	91
Pesticide company	17	40.5	17	40.5	8	19.0	42
Other farmers	47	40.9	60	52.0	8	7.0	115
Radio	18	27.7	36	55.4	11	16.9	65
Television	10	23.3	25	58.1	8	18.6	43
Print Media (Newsletter / Journals	3	11.5	13	50.0	10	38.5	26

Table 28: continued

Source	Very effective		Effective		Not effective		n
	f	%	F	%	f	%	
Researchers and Universities	6	17.1	20	57.1	9	25.7	35
Farmer’s own experience	48	42.1	54	47.4	12	10.5	114
Extension Demonstration	29	45.3	29	45.3	6	9.4	64

Source: Field data (2006)

Table 29: Mean perceived effectiveness of available sources of pesticide management information (PMI) to farmers

Information source	n	Mean	SD
Extension (AEAs)	109	2.79	0.43
Extension demonstration	64	2.36	0.65
Other farmers	115	2.34	0.61
Farmer's own experience	114	2.32	0.66
Plant Protection and Regulatory Services	48	2.27	0.71
Pesticide agents	91	2.23	0.62
Pesticide company	42	2.21	0.75
Radio	65	2.11	0.66
Television	43	2.05	0.65
Researchers and Universities	35	1.91	0.66
Print Media (Newsletters/Journals)	26	1.73	0.67

n = 147   Source: Field data (2006)

Scale: 3 = Very effective   2 = Effective   1 = Not effective

The finding of this study is also supported by Kujeke (1999) who reported that, although product labels for small holder farmers are printed in vernacular languages, it has been proved by research that, messages carried in posters are usually not understood by the farmers. The author also asserts that, the technical nature of some PMI is yet another issue that small-scale farmers have to contend with. Kujeke (1999) further indicated that, the need for mathematical skill to appreciate pesticide application procedures is a limiting factor to farmers. The low rating of the effectiveness of print media by the small-scale farmers in the study area confirms the assertion by Swanson (1997) that the transfer process for material technology is generally simpler than training and disseminating technical knowledge and management skills to large numbers of poorly educated farmers.

Kujeke (1999) has indicated that, although radio offers opportunity for low cost dissemination of general and awareness type of information, in Zimbabwe, media channels like radio and television are not used on a regular basis for dissemination of general and awareness creation type of information. Again, there is generally no formal systematic use of mass media channels for transmission of information. The effects of this gap are likely to increase as pesticide use expands in the small holder sector. In Ghana, however, although the radio is a major means of awareness creation, the results of this study confirms the assertion of Kujeke (1999) in that, the radio is not indicated as a major source of PMI for small-scale farmers in the study area.

In terms of effectiveness of the PMI available to the farmers, the finding of this study confirms the finding of Gerken et al. (2001) who reported that, farmers receive information mainly from extension staff. Although the authors indicated other sources of information in a descending order of importance as printed extension material, the farmers' own experience, other farmers, and labels on pesticides, retailers' materials, television/radio and the print media, this study indicates that, farmers perceived extension demonstration (method/result demonstration), other farmers, farmer's own experience, PPRS, pesticide agents, pesticide companies, radio, TV, researchers and universities and print media (Newsletters/Journals) to be effective sources of PMI in a descending order of importance (refer to Table 29).

Other farmers are effective sources of PMI to their colleagues. This finding gives import to the assertion of Rogers (1983) that one of the distinctive problems in the communication of innovation is that, participants are usually quite heterophilous. The difference usually leads to ineffective communication. Participants in the communication process simply do not speak the same language and that, farmer-to-farmer extension therefore has an important role to play in the diffusion of innovations in farming communities as more effective communication occurs when two individuals are homophilous. A higher competency of farmers in SMP is therefore likely to improve the perceived effectiveness of other farmers as sources of PMI.

Relationship between sex and availability of pesticide management information to small-scale farmers

The results of the study, as indicated in Table 30 also showed that, the chi square significance levels ranged between 0.303 for pesticide agents and/or companies and 0.989 for television. The difference between sources of PMI for male and female small-scale farmers for the various sources of PMI in the study area were therefore not significant as all levels of significance were higher than 0.05. This finding indicates that, there is no significant difference between the sources of PMI available to small-scale male and female farmers in the study area.

Data in Table 30 shows that there was no significant difference between the gender of the farmers and the availability of the sources of information on PMI in the study area at 0.05 level of significance. This implies that both men and women farmers could be effectively reached with PMI in the study area through any of the identified sources. It could also imply that men and women farmers in the study area both sourced PMI from these sources freely when needed. Hence gender may not be a barrier in utilizing any of these sources in disseminating PMI in the study area.

Table 30: Cross tabulation of sex and availability of pesticide management information to small-scale farmers

Source	Sex	n	Availability of pesticide management information						
			Available		Not Available		χ^2	df	Sig.
			f	%	f	%			
Government AEAs	Male	101	78	77.2	23	22.8	0.018	1	0.893
	Female	42	32	76.2	10	23.8			
	Total	143	110	76.9	33	23.1			
Plant Protection	Male	100	30	30.0	70	70.0	0.070	1	0.931
and Regulatory	Female	41	12	29.3	29	70.7			
Services	Total	141	42	29.8	99	70.2			
Pesticide dealers	Male	99	67	67.7	32	32.3	0.438	1	0.508
	Female	42	26	61.9	16	38.1			
	Total	141	93	66.0	48	34.0			

Table 30 continued

Source	Sex	n	Availability of pesticide management information						
			Available		Not Available				
			f	%	f	%	χ^2	df	Sig.
Pesticide Agents/	Male	99	26	26.3	73	73.7	1.061	1	0.303
Companies	Female	40	14	35.0	26	65.0			
	Total	139	40	28.8	99	71.2			
Other farmers	Male	101	89	84.2	16	15.8	0.308	1	0.579
	Female	41	36	87.8	5	12.2			
	Total	142	121	85.2	21	14.8			
Radio	Male	100	50	50.0	50	50.0	0.286	1	0.593
	Female	40	18	45.0	22	55.0			
	Total	140	68	48.6	72	51.4			

Table 30 continued

Source	Sex	n	Availability of pesticide management information						
			Available		Not Available				
			f	%	f	%	χ^2	df	Sig.
Television	Male	99	32	32.3	67	67.7	0.00	1	0.989
	Female	40	13	32.5	27	67.5			
	Total	139	45	32.4	94	67.6			
Print media	Male	99	16	16.2	83	83.8	0.878	1	0.349
(Newsletters/	Female	40	4	10.0	36	90.0			
Journals	Total	139	20	14.4	119	85.6			
Researchers and	Male	99	17	17.2	82	82.8	0.108	1	0.742
Universities	Female	41	8	19.5	33	80.5			
	Total	140	25	17.9	115	82.1			

Table 30 continued

Source	Sex	n	Availability of pesticide management information						
			Available		Not Available				
			f	%	f	%	χ^2	df	Sig.
Farmers own	Male	99	17	87.0	82	13.0	0.973	1	0.324
experience	Female	41	8	80.5	33	19.5			
	Total	140	25	85.1	115	14.9			
Extension	Male	100	42	42.0	58	58.0	3.715	1	0.054
demonstrations	Female	40	24	60.0	16	40.0			
	Total	140	66	47.1	74	98			

Source: Field data (2006)

Participation of farmers in pesticide management training courses

The number of pesticide management training courses attended by farmers is presented in Table 31. The results of the study show that, the majority (72.3 percent) of the farmers have never attended any training program on pesticide use whiles only 9.9 percent, 14.2 percent and 2.1 percent of the farmers respectively had attended 1, 2, and 3 of such trainings.

Table 31: Frequency distribution of number of pesticide management training courses attended by farmers

Number of courses attended	f	%
None	102	72.3
One	14	9.9
Two	20	14.2
Three	3	2.1
Four	2	1.4

Source: Field data (2006) n = 146

The low participation of farmers in pesticide management training programmes may be attributed to two major causes. Illiteracy is a limiting factor when it comes to participation of farmers in formal training programmes. With 42.4 percent of the farmers being either illiterate or only having primary school education, they have very little chance of participating in formal training programmes. Secondly, the AEAs who are the main source of PMI for the farmers are constrained by resources and this may limit the number of training programmes on pesticide management conducted for the farmers.

The finding of this study conforms to the assertion of Kujeke (1999) who has indicated that, small-scale farmers in Zimbabwe, like others in the developing world are constrained by illiteracy. For instance, the need for mathematical skills to calculate pesticide dosage is a limiting factor to farmers and will therefore reduce the number that will be invited for such training courses. It is worthy of note that, only a limited number of farmers (3.5 percent) attended more than two training courses. It is clear from the result of the study that, training courses on pesticide management do not play a major role in PMI dissemination to farmers. Contrary to the situation found in this study area, Ajayi (2000: 75) has indicated that, "in the cotton growing area of Cote d'Ivoire, about one quarter (24 percent) of household heads in the study area had attended formal training sessions before, for a cumulative average of five days. Apart from formal training, CIDT resident village agents give training to farmers on an informal and ad-hoc basis". In view of the educational level of the farmers in the Ga East and West districts, a more informal approach can be given to their training in pesticide management.

The low participation of the small-scale farmers in the study area in pesticide management training is confirmed by Agne, (2002: 14) who reported that, in Costa Rica, "educational programmes on safe use of pesticides have been developed for farmers, farm workers, housewives and children by Ministerio de Agricultura y Ganaderria (MAG) (Ministry of Agriculture and Livestock) in cooperation with the representatives of the chemical industry. The participating farmers are taught the basic techniques of pesticide application and sanitation (washing clothes after spraying, etc)". The author however found out that, even then, the programme covered only 10 percent of the rural agricultural work force and less than 5 percent of the rural population had been reached between 1986 and 1993

Training can be seen as a planned process for changing attitudes and for increasing knowledge and/or skills through specific learning experiences (Wascana Institute, 1993). Gamble and Gamble (2002) have indicated that, past experience and training do influence our selectivity of perception. According to Van den Ban and Hawkins (1996), training can provide an organized and structured set of experiences to influence our perception whiles Youdeowei and Kwarteng (1995) asserted that, the goal of training is to improve performance. These assertions indicate that, farmers' perception of their awareness levels and actual pesticide management practices can be influenced by the effectiveness of the information and training they receive in pesticide management.

It must also be noted that, as indicated by (Rogers, 1983) it usually takes more than training for an innovation to be adopted. When introducing an innovation, it is important to take the cultures, the local environment and the individuals in the target group into consideration. Agricultural extension agents must therefore understand that, an important factor affecting the adoption rate of any innovation is its compatibility with the values, beliefs and past experiences of the social system within which they are operating. This concept should be taken into account in their effort to develop the competencies of farmers in SMP in order to have a positive impact on the decision making and pesticide use practices of the farmers.

Factors influencing farmers' decision to use a pesticide

Table 32 is a presentation of the frequency distribution of factors that influence farmers' decision to use a pesticide. From the results, it can be seen that the major factors that influence farmers' decision to use pesticides in a descending order of importance are, the knowledge or information about the effectiveness of pesticides (68.3 percent), recommendation from extension worker (54.9 percent) and pest occurrence in former years (48.4 percent). As far as farmers in the study area are concerned, products neighbours or friends are using and crop loss assessment influence farmers' decision to use pesticides equally (46.3 percent).

The fact that, knowledge or information about effectiveness of pesticides ranks highest among the factors that influence farmers' decision to apply pesticides shows that information plays a very important role in the use of pesticides by small-scale farmers. The results of the study show that, small-scale farmers rely strongly on information they have previously received or at the time of pest infestation about the effectiveness of pesticides as well as information they receive from extension workers at the time the decision to control the pest is made. To the small-scale farmers however, information from sources such as radio and newspapers do not rate highly among the factors that influence their decision to use pesticides.

Table 32: Factors influencing farmers' decision to use a pesticide

Factors	f	%	n
Knowledge or information about effectiveness of pesticides	84	68.3	123
Recommendation from extension worker	67	54.9	122
Pest occurrence in former years	59	48.4	122
Products neighbours or friends are using	57	46.3	123
Crop loss assessment	57	46.3	123
Recommendation by dealer	46	38.0	121
Management system successful over long time	43	35.2	122
Price of farm produce	33	27.3	121
Information from other sources e.g. radio, newspaper etc	32	26.0	123
Price of pesticide	31	25.4	122
Recommendation by trader	21	17.5	120
Knowledge about hazardousness of pesticide chosen	19	15.7	121
Recommendation from other people (CBO, FBO or NGO)	18	14.8	122
Promotion of chemical industry	13	10.7	121

n = 147 Source: Field data (2006)

Contrary to the finding of Gerken et al. (2001) that only 8.0 percent of farmers applied pesticides based on expert advice in the form of recommendation from extension workers, as many as 54.9 percent of the farmers in the study area indicated that, their decision to use a pesticide depends on recommendation from extension workers . Although Gerken et al. (2001) reported that, expert advice in the form of recommendation from MOFA's extension service, PPRSD staff, produce buying companies, staff of NGOs or other service organisations, ranked third as a factor that influenced the farmers' decision to use pesticides for the control of pests, recommendation from extension workers alone is the second most important decision making factor for farmers in the Ga East and Ga West districts. This finding shows that, farmers in the districts rely very much on information they receive from agricultural extension officers.

Fleischer (1999: 211) has also indicated that in Zimbabwe, "Farmers' decision–making on the type and amount of pesticide to use depends on several considerations, i.e. type of pest, expected crop loss, price ratio of input and output prices, risk attitude and availability of input resources" Although Fleisher does not indicate the order of importance, of these factors in farmers' decision making in pesticide use, farmers in the Ga East and Ga West districts put other considerations above these during their decision to use pesticides. In the current study, pest occurrence in former years (48.4 percent) and crop loss assessment (46.3 percent) rank third and fourth respectively as factors that influence the decision of farmers in their pesticide use. Fleischer (1999) has however indicated that, with regard to human resources, the type and level of information on different crop protection strategies is decisive for the over- and misuse of pesticides as well as the under utilization of non–chemical alternatives. The finding of the study, which indicated knowledge or information about effectiveness of pesticides and recommendation from extension worker as the two major factors cited by the farmers as influencing their decision making, confirms the assertion by the author.

From the results of the study, it is quite apparent that, in the farmer' decision to use pesticides, pest factors are secondary to knowledge or information about effectiveness of pesticides. According to Fleischer (1999: 211), "the decision making of the actual pesticide user, whether to apply pesticides or to use alternative protection methods is influenced also by some other reasons which are acting indirectly and are frequently hidden. Biases towards chemical solutions in institutional settings, such as the agricultural educational system, priorities in the research programs and organization of the extension service, have an important influence on the generation and the direction of technical progress and its implementation at the field level".

It is also very interesting to note that knowledge about hazardousness of pesticides does not play a significant role in influencing the farmers' decision to use a pesticide to control pests. The results of the study show that, only 15.7 percent of the farmers consider the hazardousness of pesticides when making their decision to use them. This may be an indication that although farmers know that pesticides are hazardous, they do not consider that aspect of pesticides as being very important when they make the decision on controlling of pests. Their knowledge about the effectiveness of pesticides takes precedence over their knowledge about the hazardousness of pesticides.

Factors influencing farmers' decision on which pesticides to buy

In the case of farmers' decision on which pesticide to buy, knowledge or information about the effectiveness of pesticides (71.1 percent) and recommendation from extension workers (55.8 percent) are still the two major factors that influence their decision making (Table 33). The importance of information in the decision making of farmers is once again observed. The results also show that, the most important information source compared to other sources of information such as radio, newspapers, recommendation from CBO, NGO & FBO, and promotion of chemical industry which influenced 24.2, 12.6 and 9.2 percent of the farmers respectively is the extension worker. This finding is in line with the assertion by Gerken et al. (2001), that, farmers in their survey depended mostly on the advise of experts who are the extension workers.

It is also very interesting to note that in deciding on which pesticides to buy, knowledge about hazardousness of the pesticide was considered by only 14.3 percent of the farmers whiles the knowledge or information about the effectiveness of the pesticide was considered by 71.1 percent of the small-scale farmers. They do not appear to place as much emphasis on the hazardousness of the pesticides as they do on their effectiveness. Farmers may not be that concerned about the hazardousness of the pesticides in their decision making on which pesticide to buy because, they may not be highly aware of hazardousness of pesticides or even if they are, enough emphasis have not been placed on the hazardousness of pesticides as an important element in pesticide management

Table 33: Factors influencing farmers' decision on which pesticide to buy

Factors	f	%	n
Knowledge or information about effectiveness of pesticides	86	71.1	121
Recommendation from extension worker	67	55.8	120
Products neighbours or friends are using	66	55.0	120
Pest occurrence in former years	54	45.0	120
Management system successful over long time	53	44.2	120
Recommendation by dealer	52	43.3	120
Crop loss assessment	50	42.0	119
Price of pesticide	43	36.1	119
Price of farm produce	37	30.8	119
Information from other sources e.g. radio, newspaper	29	24.2	120
Knowledge about hazardousness of pesticide chosen	17	14.3	119
Recommendation by trader	15	12.9	116
Recommendation from other people (CBO, FBO or NGO)	15	12.6	119
Promotion of chemical industry	11	9.2	119

n = 147 Source: Field data (2006)

It is worthy of note that, farmers regard products being used by neighbours or friends as the next important factor after recommendation from extension worker in their decision making on which pesticide to buy. This finding is an indication of farmers relying on other farmers' experience for pesticide management information (PMI). It may also be an indicator for farmers feeling insecure in their own decision making. It is also interesting to note that, while 25.4 percent and 27.3 percent of farmers considered the price of pesticides and prices of farm produce respectively in their pesticides-use decision as many as 36.1 percent and 30.8 percent of them respectively took the price of the pesticides into consideration when they had to decide on which pesticide to buy. This shows that, farmers in the study area are more concerned about the price ratio of input and output prices when they have to make decisions on which pesticide to buy.

CHAPTER SIX

RESULTS AND DISCUSSION

AWARENESS AND COMPETENCY LEVELS OF SMALL–SCALE FARMERS IN THE SOUND MANAGEMENT OF PESTICIDES

General overview

The chapter presents and discusses the findings of the study in relation to the environmental, health and safety awareness levels of small-scale farmers in pesticide management (PM) in the Ga East and Ga West districts of the Greater Accra Region. It also presents the findings and discussions on small-scale farmers' perceived awareness levels of alternative pest control measures. The findings and discussions on the competencies of small-scale farmers in the sound management of pesticides in the study area are also presented. Furthermore, the chapter presents and discusses the relationship between the perceived competencies of small-scale farmers in the sound management of pesticides and other independent factors of the study and finally discusses the best predictor(s) of the competencies of small-scale farmers in the sound management of pesticides.

Farmers' environmental, health and safety awareness levels of PM

Objective five was to examine the environmental, health and safety awareness levels of farmers in pesticide management (PM). This section presents the findings of the study with respect to the objective. Table 34 shows the frequency distribution of farmers' perceived awareness levels of environmental, health and safety issues in pesticides management. As indicated in Table 35, the mean perceived awareness levels of environmental, health and safety issues of small-scale farmers in the Ga East and Ga West districts ranged between 3.20 and 2.23, indicating that the farmers perceived their awareness levels to range between moderate and low. It is however note worthy that, standard deviations varied from 1.26 to 1.37 which is an indication of a wide variation in the perceived awareness levels of the farmers as can be seen from the frequency distribution in Table 34.

Farmers in the study area perceived that they were moderately aware of waiting periods after pesticides application before harvesting (mean = 3.20 SD = 1.31), effects of pesticides on livestock, bees and other pollinating insects, (mean = 3.00; SD = 1.26), environmental hazards (mean = 2.97 SD = 1.37) and effects of pesticides on game and wildlife (mean = 2.92; SD = 1.27). It is noteworthy that, though farmers' highest awareness level was in waiting periods (mean = 3.20 SD = 1.31) after pesticide application before harvesting, at the same time they perceived to be only moderately aware of this very important aspect of pesticide management. However, the relatively large standard deviation (1.31) is indicative of a wide variation in the responses of farmers as can be seen from the frequency distribution in Table 34. This finding confirms the assertion of Chivinge et al. (1999) that, there is failure to observe the safe period between times of spraying and harvesting especially in the case of leafy vegetables. Thus, many people unknowingly eat vegetables bought from the market which contain pesticide residues.

The finding of this study also confirms the observation made by Gerken et al. (2001) who reported a case of poisoning from pesticides when three children died from possible overdose of carbamates in fruits in March 1999. The authors suspect that the farmer did not observe the necessary waiting period between pesticide application and harvesting**.**

In view of recent reports on pesticide residues in vegetables, waiting periods before harvesting is a very essential area of pesticide management which needs to be brought to the attention of farmers while efforts are made to ensure their competence in this area of PM. The relatively large standard deviation of 1.31 for farmers' awareness level of waiting period is however indicative of a wide variation in the responses of farmers as can be seen from the frequency distribution in Table 34. In view of the health implications of waiting periods a moderate level of awareness by farmers is inadequate to enhance the competency of farmers in SMP while ensuring the safety of the consuming public.

The other environmental health and safety issues of which farmers were moderately aware of included effects of pesticides on public health, pesticide residues in agricultural produce, effects of pesticides on non-target organisms and effects on natural enemies of pests in a descending order of importance (refer to Table 35). Although farmers were moderately aware of the effects of pesticides in these areas, it was observed that, their responses were not consistent and only a minority of the farmers had high awareness levels of these issues. The management of pesticides affects the environment and other forms of live to an extent that it is important for the major end-users of these agricultural inputs to be highly aware of them.

Table 34: Frequency distribution of farmers' perceived environmental, health and safety awareness levels of effects of pesticide management in agriculture

Awareness area	Very high		High		Moderate		Low		Very low		n
	f	%	f	%	F	%	f	%	f	%	
Environmental hazards from pesticide use	28	20.0	19	13.6	40	28.6	27	19.3	26	18.6	140
Pesticide residues in agricultural produce	23	16.4	20	14.3	31	22.1	37	26.4	29	20.7	140
Effects of pesticides on public health	20	14.4	23	16.5	38	27.3	32	23.0	26	18.7	139
Effects of pesticides on game and wildlife	21	15.2	24	17.4	35	25.4	39	28.3	19	13.8	138

Table 34: Continued

Awareness area	Very high		High		Moderate		Low		Very low		n
	f	%	f	%	F	%	f	%	f	%	
Effects of pesticides on livestock, bees and other pollinating insects eg. butterflies and ants	21	15.1	29	20.9	36	25.9	35	25.2	18	12.9	139
Effects of pesticide on natural enemies of pests	16	11.8	16	11.8	26	19.1	39	27.9	40	29.4	136
Effects of pesticides on development of resistance	15	11.1	14	10.4	23	17.0	39	28.9	44	32.6	136
Effects of pesticides on resurgence of pests	13	9.6	15	11.0	16	11.8	38	27.9	54	39.7	136

Table 34: Continued

Awareness area	Very high		High		Moderate		Low		Very low		n
	f	%	f	%	F	%	f	%	f	%	
Waiting periods after pesticide application before harvesting	31	22.6	23	16.8	43	31.4	23	16.8	17	12.4	137
Adverse effects of pesticides on non-target organisms	17	12.7	11	8.2	22	24.6	43	32.1	30	22.4	134

n = 147 Source: Field data (2006)

Table 35: Farmers' perceived mean environmental, health and safety awareness levels of effects of pesticide management in agriculture

Environmental, health and safety awareness areas	n	Mean	SD
Waiting periods after pesticide application before harvesting	137	3.20	1.31
Effects of pesticides on livestock, bees and other pollinating insects e.g. butterflies and ants	139	3.00	1.26
Environmental hazards from pesticide use	140	2.97	1.37
Effects of pesticides on game and wildlife	138	2.92	1.27
Effects of pesticides on public health	139	2.85	1.31
Pesticides residues in agricultural produce	140	2.79	1.37
Adverse effects of pesticides on non-target organisms	134	2.57	1.28
Effects of pesticide on natural enemies of pests	136	2.49	1.34
Effects of pesticides on development of resistance in pests	135	2.39	1.33
Effects of pesticides on resurgence of pests	136	2.23	1.33

n = 147 Mean = 2.75 SD = 0.99

Scale: Very High = 5 High = 4 Moderate = 3 Low = 2 Very Low = 1

Source: Field data (2006)

The finding of this study lends support to the results of an earlier study by Osafo and Frempong (1999). According to investigations they carried out for the National Profile to Assess Chemical Management in Ghana, the level of concern for water pollution and soil contamination is considered to be quite high. Osafo and Frempong (1999) reported that analysis of water and fish showed low levels of lindane but had no residues of Endosulfan in 1993. Similar analysis in 1995 revealed significant residue levels for both pesticides. However, they found that the residues of the pesticides found in fish were higher than those in water and that, the residues in fish were below the lethal dose. The results of this study showed that, farmers' awareness levels of such issues are not high enough to stop or reduce the increasing levels of pesticides in the environment. It is important to make farmers aware of such research findings to facilitate the development of a more responsible attitude towards PM. In the current study, there was reliable information that, pesticide applicators wash their spraying machines in one of the rivers in the study area. This practice is a sure way of contaminating the water way and living organisms in it.

The results of the study also confirm the assertion of Chivinge et al. (1999) that, lack of awareness of many people of the effects of pesticides on human health has led to most people adopting a casual attitude towards the use of protective clothing .The results of the study show that, the majority (69.0 percent) of the farmers had awareness levels between moderate and very low. This could explain the observation that, although 67.2 percent of farmers said they or other pesticide applicators used protective clothing, they do not wear the full gear that would give them complete protection from contamination. The main protective clothing used were wellington boots (86.5 percent) and overall or clothing (60.7 percent). As indicated by Ajayi (2000), the level of awareness and knowledge of households are key issues in efforts of agricultural households to attain optimum and proper pesticide use. These include the knowledge about health cost, the perception and the importance that households attach to pesticide related health issues.

It is note worthy that farmers had low awareness of effects of pesticides on the development of resistance (mean = 2.39, SD = 1.33) and resurgence (mean = 2.23, SD = 1.33) of pests. Resistance of pests is caused by frequent application of pesticides and farmers' pressurised into selecting pesticides with a specific effect (Osorio and Travaglini, 1999). The low awareness level of farmers of the development of resistance by pests and possible resurgence of pests does not auger well for the SMP. In Ghana, carboxylase analysis of *Plutella xylostella* population collected around Accra indicated a probable incidence of insecticide resistance in the population (Kaiwa, 2000). Low awareness level of development of resistance by pest and resurgence of pests can easily result in such problems.

The overall perceived mean of 2.75 is an indication of farmers' moderate awareness level of environmental, health and safety effects of PM in agriculture. This situation could account for the use of pesticide mixtures or over use in cases where pests have developed resistance. Some farmers in the study area indicated that, they use pesticide mixtures because they augment the effect of each other. The farmers' perceived awareness level of environmental, health and safety issues in PM is an indication of how they see and understand PM around them, their own judgment of the PM situation, their impression or opinion about PM and the way they interpret what they see concerning PM. The perceived moderate awareness levels indicate that, although farmers know, they do not see these environmental, health and safety issues as major concerns in their farming activities.

As indicated by Grandstaff (1992), a farmer's lack of awareness is often seen as one major reason for pesticide problems. The author also claimed that, several studies about farmers' awareness conducted in Thailand in 1985 concluded that more than half of the farmers applied dosages higher than recommended on the label. Apart from possible environmental effects, the overuse of pesticides can result in a whole range of adverse effects on humans and other forms of life. From the results of the study, it is quite clear that farmers' perceived awareness level of environmental health and safety issues in pesticides use is not enough to ensure or facilitate SMP. This shows that, current education and training are inadequate to prevent side effects of inappropriate PM by farmers. The results of this study have confirmed the assertion of Chivinge et al. (1999) that, pesticide abuse which is rampant in Zimbabwe is partly due to ignorance and that, there is the need for more effort to make people aware of the dangers of pesticides by training the grass root level. The results of the study also confirm the assertion of Kujeke (1999: 89) that, "the debate on pesticide use has generally excluded the active participation of all stakeholders. When pesticide use is debated, the focus tends to be on costs and benefits. Information on health and safety tend to be secondary with minor obligations and liability on the manufacturers and retailers". The farmers applying pesticides are particularly excluded obviously.

Farmers' perceived awareness levels of alternative pest control methods

Objective six examined the farmers' perceived awareness levels of alternative pest control measures. The findings pertaining to this objective are as stated below:

Table 36 is a presentation of the frequency distribution of farmers' perceived awareness level of alternative pest control methods while Table 3 shows the farmers' mean perceived awareness level of alternative pest control methods. The highest perceived awareness level of farmers in alternative pest control methods was in physical methods (means = 3.30; SD = 1.33). However, the small-scale farmers perceived their awareness level was least for the use of biopesticides (means = 1.83; SD = 1.18). It is interesting to note that, farmers perceived their awareness levels for hygiene (means = 3.21; SD = 1.40) and cultural methods (means = 3.02; SD = 1.35) of pest control to be moderate. The large standard deviations however indicate large variations in the perceptions of the farmers.

Table 36: Frequency distribution of farmers' perceived awareness level of alternative pest control methods

Alternative methods of pest control	VH		H		MH		L		VL		n
	f	%	f	%	f	%	f	%	f	%	
Biological methods	13	10.8	9	7.5	17	14.2	22	18.3	59	49.2	120
Physical methods of pest control (removal, burning)	25	20.7	36	29.8	29	24.0	12	9.9	19	15.7	121
Cultural (Crop rotation, mixed cropping) methods	20	16.3	28	22.8	34	27.6	16	13.0	25	20.3	123
Indigenous methods	6	5.0	11	9.1	25	20.7	24	19.8	55	45.5	121
Integrated pest management (IPM) methods	8	6.7	11	9.2	11	9.2	25	21.0	64	53.8	119

Table 36: continued

Alternative methods of pest control	VH		H		MH		L		VL		n
	f	%	F	%	f	%	f	%	f	%	
Use of Biopesticides	7	6.0	7	6.0	9	7.7	30	25.6	64	54.7	117
Hygiene methods (removal of dead plants and harvest residue)	30	24.8	23	19.0	32	26.4	15	12.4	21	17.4	121

n = 147 Scale: Very High = 5 High = 4 Moderate = 3 Low = 2 Very Low = 1

Source: Field data (2006)

Table 37: Farmers' means perceived awareness level of alternative pest control methods

Alternative methods of pest control	n	Mean	SD
Physical methods of pest control (removal, burning)	121	3.30	1.33
Sanitation (removal of dead plants and harvest residue) methods	121	3.21	1.40
Cultural (crop rotation, mixed cropping) methods	123	3.02	1.35
Biological methods	120	2.12	1.38
Indigenous methods	121	2.08	1.21
Integrated pest management (IPM) methods	119	1.94	1.27
Use of biopesticides	117	1.83	1.18

n = 147 Mean = 2.55 SD = 0.97

Scale: Very High = 5 High = 4 Moderate = 3 Low = 2 Very Low = 1

Source: Field data (2006)

Physical methods include removal and destruction or burning of pests and diseased plant parts while sanitation methods involve the removal of dead plant parts and harvest residues. Cultural practices on the other hand involve farming practices such as crop rotation, and mixed cropping. The perception of the farmers as to their being moderately aware of physical and cultural control methods of pest control conforms to the assertion of Ajayi (1999: 74) who reported that, "some traditional agricultural practices that farmers employ in the cotton growing area of Côte d 'Ivoire incidentally reduce the build up of pest populations and infestation and therefore provide a crop protection function. Such farm practices include intercropping, shifting cultivation, crop rotation and the slash- and- burn system. During land preparation, farmers usually uproot the previous year's cotton stalks, gather them and burn them off in the field. This provides a way of getting rid of soil borne pathogens which may have been 'carried over' from the previous year into the next season.

Similar unintentional pest control practices through farmers, traditional practices have been reported from other parts of Africa (Conelly, 1987). The traditional practices help to control pests even though the pest control is not the original intention of farmers". The finding of this study is also confirmed by Agne, (2000) who recorded that, in Costa Rica, a cultural strategy to delay the transmission of the gemini virus to tomatoes has been successfully tested. However, Childs (1999) indicated that, other plant protection strategies like crop rotation, hand picking, biological control and traditional products were not widespread. It is therefore not surprising that farmers perceived their awareness level to be highest though only moderate in physical, sanitation and cultural methods of pest control in a descending order of importance (refer to Table 37).

In any case, one would have expected farmers to have very high awareness levels of such methods but unfortunately, these methods were obviously only regarded as regular farming practices. The results of the study show that, there has not been any effort to educate small scale farmers to use these regular farming practices as a means of controlling pests in their fields or as part of an IPM strategy. Agricultural extension agents tend to place more emphasis on the use of chemical pesticides to control agricultural pests.

Farmers perceived their awareness level of biological methods (mean = 2.12; SD = 1.38), indigenous methods (means = 2.08; SD = 1.21), integrated pest management (IPM) (mean = 1.94; SD = 1.27) and the use of biopesticides (means = 1.83; SD = 1.18) as being low. Once again, farmers' ratings were not consistent as can be seen from the large standard deviations. Farmers' perceived low awareness level of indigenous methods of pest control is also confirmed by investigations conducted by Ajayi (2000) in the cotton growing area of Côte d'Ivoire. Ajayi's investigations of previous methods of crop protection that early progenitors in the cotton growing area have used in the past revealed that most of these methods were primarily directed against rodents and forest animals that destroy crops. It was however indicated that virtually no mention is made of specific corresponding traditional methods to protect crops against insects which are the most important pests these days. Currently, indigenous methods of crop protection against insects and even rodents have been abandoned in favour of chemical pest control since the availability of free pesticides in the region.

It is also reported by Ajayi (2000) that, another reason for abandoning indigenous methods of crop protection was that, traditional methods were labour intensive especially given the increases in field sizes. This finding is in line with others found elsewhere in Africa. According to Atteh (1987) in Nigeria, where pesticides are distributed free of charge or subsidized up to 67 percent, many traditional pest control practices by farmers have been displaced. In Ghana, the situation is not different. Farmers were controlling termites by truncating ant hills on the farm and putting salt in them. The sprinkling of wood ash on leafy vegetables to control lepidopterous larvae which was a well known traditional method of pest control is rather on the decline. These changes have come about as a result of the introduction of pesticides which are fast acting and easier to use. The results of the study which indicate low awareness level of indigenous pest control methods on the part of farmers (Table 37), is a confirmation of these assertions.

In Ghana, the use of biological control has been limited to pests on cassava and mangoes. Gerken et al. (2001: 93-4) have indicated that "technically the most threatening pest of cassava (e.g. Cassava Mealy Bug) were managed with classical bio-control measures." It is interesting to note that although cassava is a common crop in the districts, the farmers appear to have such low awareness level of biocontrol for its best known pests. This is an indication of the limited knowledge and participation of the farmers for whom the biocontrol programme has been carried out. It also shows how information about innovation and issues that concern their interest may not be communicated or transmitted to farmers. The perception of the farmers as regards their awareness levels can also be viewed in relation to their awareness of chemical methods of pest control. According to Van den Ban and Hawkins (1996), perception is governed by general principles such as relativity, selectivity, organization, direction and cognitive style. The authors have also indicated that, our perceptions do change with new encounters and that our perceptions are also selective. It is therefore possible that farmers' encounter with pesticides has changed their perception towards the use of these long standing but not so radical methods of pest control.

According to Gamble and Gamble (2002), individuals select only those experiences that reaffirm existing attitudes, beliefs and values and tend to ignore or diminish the significance of those experiences that are inconsistent or in dissonance with their existing beliefs and values. The use of pesticides is the order of the day, so farmers would rather be associated with that, than be associated with old methods that are no longer being promoted. The authors have indicated that, past experience and training do influence our selectivity of perception. Training can provide an organized and structured set of experiences to influence our perception. This result also indicates that, farmers' perception of their awareness levels could have been influenced by training they had received in PM. The assertion by Williamson (2003) that, pesticides were considered to be an essential element of increasing food production in Africa but experience has shown that they are causing more problems than they solve is a reality. In her opinion, alternative methods to pest control are needed if the damaging social and environmental impacts are to be reduced. It is therefore necessary to pursue alternative methods of pest control to prevent the situation from getting worse for farmers and communities in this region. To this end, many countries have found a need to introduce the concept of IPM.

The finding of the study which shows that farmers perceive their awareness level of IPM as being low (mean = 1.94; SD =1.27) (refer to Table 37) conforms to the assertions made by Kujeke (1999), Ajayi (2000) and Agne (2000). It has also been asserted by Kujeke (1999) that, little application of IPM strategies in most developing countries has been attributed to a variety of factors including a general lack of information and know-how of IPM practices within service institutions and at the user level. Ajayi (2000) has also pointed out that, the history of the free distribution of pesticides and the narrow base of crop protection makes it hard for farmers to know about other crop protection methods apart from pesticides. As a result, farmers take pesticides as a “reference point” against which they would evaluate alternative crop protection methods. According to the author, improving the awareness of farmers of other methods will be necessary for their adoption. The results of his study showed that, farmers will most likely adopt alternative crop protection methods based on their perceived evaluation of the performance of alternative methods in comparison to pesticides.

The findings of this study show a moderate level of perception for alternative pest control measures by the farmers (Mean = 2.55; SD = 0.97). This means that, farmers’ perceived awareness levels of alternative pest control measures is not adequate to make a positive impact on their competencies in the sound management of pesticides. This result confirms the indication by Gerken et al. (2001) that, spread of IPM extension has negative effect on pesticide use. Their assertion is also confirmed by the fact that majority of the farmers in the study area continue to use pesticides without the application of other methods of pest control. Farmers have also indicated that their main reason for not using other methods of pest control apart from chemical pesticides is lack of knowledge. As many as 63 percent of those who rely solely on chemical control said they do not have enough knowledge in other alternative means of pest control. The second most important reason farmers (26.3 percent) gave for not using other pest control methods is that, they involve too much labour. These findings confirm the findings of Ajayi (2000) among other researchers. The farmers who indicated that they do not use other methods of pest control because they find them too expensive (16.3

per cent) also confirm the assertion by Ajayi (2000) who has pointed out that, the history of the free distribution of pesticides and the narrow base of crop protection makes it hard for farmers to know about other crop protection methods apart from pesticides.

As a result, farmers take pesticides as a “reference point” against which they would evaluate alternative crop protection methods. At a rice seed production training programme held on the 22nd and 23rd August, 2007, an AEA of MOFA in the Wassa West District of the Western Region of Ghana, reiterated that, “There is a need to intensify education of our farmers in IPM. They should be taught to identify and differentiate between beneficial arthropods and pests” This AEA claimed he had succeeded in training his farmers to identify beneficial insects and arthropods in rice fields.

The findings of the study also confirm the assertion of Agne (2000) who indicated that, in Costa Rica, official recommendations on crop protection were chemical based for many years. In recent years however, the extension service has been looking for effective methods for farmer training in IPM. The author claims it has been difficult to convince Costa Rican farmers of the advantages of IPM mainly because:

- In many cases, the economic incentives for farmers to switch from purely chemical to integrated pest management methods are relatively small.
- Information about chemical use is available more easily, in any shop, at almost any time of the day whereas it may be more difficult to contact an extensionist.

- A change to IPM requires an investment in learning while simple methods of chemical treatment are readily available.
- Farmers prefer to rely on what they have done previously and what is still promoted by the chemical industry.

Farmers' reasons for not using other pest control methods other than pesticides.

Table 38 shows the frequency distribution of farmers' reasons for not using methods other than pesticides to control pests. A majority of the farmers, (63.0 percent) indicated that they do not have enough knowledge about alternatives to the use of pesticides for pest control.

Table 38: Frequency distribution of farmers' reasons for not using other pest control methods

Reason	n	f	%
Not enough knowledge	81	51	63.0
Too much labour	80	21	26.3
Too expensive	80	13	16.3
Lower yields	81	11	13.6
Does not work	81	9	11.1
Too risky	81	5	6.2
Not interested	81	7	8.6
AEA or pesticides dealers advice	79	4	5.1

n = 147 (Multiple responses)

Source: Field data (2006)

The next most important reason given by farmers for their not using other methods than chemicals to control pests is that they involve too much labour (26.3 percent). It is interesting to note that advice from AEAs and pesticides dealers is the least important reason given for farmers' not using other means of pest control. Only 5.1 percent of the farmers indicated that they did not use other control methods as a result of AEAs' or pesticides dealers' advice. This shows that AEAs are not a major influencing factor when it comes to farmers not using alternative pest control methods. Since recommendations by AEAs have been indicated among the major factors that influence farmer' decision on the use of pesticides, it stands to reason that, increased knowledge of AEAs in alternative pest control methods would also influence farmers' decision to use alternative or other pest control methods. The major reason for farmers not using other methods of pest control is mainly attributed to their not having enough knowledge in such methods of pest control. This finding is in line with others found elsewhere in Africa.

Ajayi (2000) indicates from his study that virtually no mention is made of specific corresponding traditional methods to protect crops against insects which are the most important pests these days. According to Ajayi, indigenous methods of crop protection against insects and even rodents, has been abandoned in favour of chemical pest control since the availability of free pesticides in the region. The author reports that it is in only a few cases that farmers continue to use some of these traditional methods, and that, the use of such methods was limited to root and tuber crops. Ajayi (2000) reasons that, the majority of present day farmers are not well acquainted with traditional methods because the elderly progenitors with the traditional knowledge are no longer alive. A similar reason has been given for the near extinction of traditional knowledge of pest control in other places such as Sri Lanka (Ulluwishewa, 1993) and Kenya (Conelly, 1987).

The second most important reason given by farmers for their not using other methods than chemicals to control pests is that they involve too much labour (26.3 percent). This finding is a confirmation of the report by Ajayi (2000) that, another reason for abandoning indigenous methods of crop protection was that, traditional methods are labour intensive especially given the increases in field sizes. As mentioned earlier, labour for farm activities is an important factor. The current labour drift from farming communities to urban areas has limited the availability of farm labour, so that, a farmer will always select a less labour intensive activity in place of a more labour intensive one. Only a small proportion of the farmers were of the opinion that alternative control methods are either too risky (6.2 percent) or do not work (11.1 percent), while 8.6 percent were just not interested. The sum total of farmers with a passive attitude towards alternatives to the use of pesticides is however appreciable. This gives an indication of the farmers' lack of information on the use of alternatives to pesticide use. It could also be the outcome of previous policies that facilitated the free distribution of pesticides. The trend of indifference towards the use of alternatives to pesticides therefore lends support to the assertion of Atteh (1987) that in Nigeria where pesticides were distributed free of charge or subsidized up to 67 percent, many traditional pest control practices by farmers were displaced.

Perceived competencies of farmers in sound management of pesticides

Objective seven examined the perceived competencies of farmers in the sound management of pesticides. The findings pertaining to this objective are presented and discussed in this section. Table 39 is a presentation of the frequency distribution of perceived competencies of farmers in the sound management of pesticides while Table 40 shows the mean perceived competencies of farmers in extension information support areas for the sound management of pesticides.

Table 39: Frequency distribution of perceived competencies of farmers in the sound management of pesticides

Extension information support areas for sound pesticide management	VH		H		M		L		VL		n
	F	%	f	%	f	%	f	%	f	%	
Identification of pests and diseases	35	25.5	37	27.0	47	34.3	12	8.8	6	8.8	137
Identification of beneficial insects/ arthropods	13	9.7	20	14.9	27	20.1	31	23.1	43	32.1	134
Determination of possible pest damage	24	17.9	30	22.7	40	29.9	22	16.4	18	13.4	134
Identification of pesticides	16	11.9	29	21.6	46	34.3	18	13.4	25	18.7	134
Classification of pesticides	11	8.1	15	11.1	16	11.9	32	23.7	61	45.2	135

Table 39: Continued

Extension information support areas	VH		H		M		L		VL		n
	f	%	f	%	f	%	f	%	f	%	
Pesticide selection	15	11.4	21	15.9	41	31.1	26	19.7	29	22.0	132
Dosage determination	11	8.5	29	22.3	37	28.5	20	15.4	33	25.4	130
Calibration of spraying machines	9	6.8	10	7.6	22	16.7	17	12.9	74	56.1	132
Reading pesticide labels	17	13.1	17	13.1	26	20.0	23	17.7	47	36.2	130
Understanding pesticide labels	16	12.3	16	12.3	21	1.2	28	21.5	49	37.7	130
Understanding pictograms on pesticide labels	15	11.4	18	13.6	43	32.6	31	23.5	25	18.9	132
Proper handling of pesticides	18	14.0	21	16.3	43	33.3	30	23.3	17	13.2	129
Use of protective clothing	19	14.5	23	17.6	28	21.4	29	22.1	32	24.4	131

Table 39: Continued

Extension information support areas	VH		H		M		L		VL		n
	F	%	f	%	f	%	f	%	f	%	
Precautions when spraying	17	13.1	31	23.8	31	23.8	29	22.3	22	16.9	130
Maintenance of personal hygiene	33	25.0	23	17.4	40	30.3	22	16.7	14	10.6	132
Maintenance of spraying machines	21	15.9	17	12.9	26	19.7	23	17.4	45	34.1	132
Storage of pesticides	29	21.8	25	18.8	28	21.1	34	25.6	17	12.8	133
Disposal of pesticide containers	22	16.7	19	14.4	27	20.5	32	24.2	32	24.2	132
First Aid in pesticide poisoning	9	6.8	11	8.3	21	15.8	38	28.0	54	40.6	133

Table 39: Continued

Extension information support areas	VH		H		M		L		VL		n
	F	%	F	%	f	%	f	%	f	%	
Alternative pest control methods	13	9.8	10	7.5	31	23.3	32	24.1	47	35.3	133
Decision on when to use pesticides	15	11.4	30	22.7	37	28.0	24	18.2	26	19.7	132
Food safety issues	11	8.2	9	6.7	21	15.7	17	12.7	76	56.7	134

n = 147 Scale: Very High = 5 High = 4 Moderate = 3 Low = 2 Very Low = 1
Source: Field data (2006)

Table 40: Farmers' mean perceived competencies in the sound management of pesticides.

Extension information support areas	n	Mean	SD
Identification of pests	137	3.61	1.09
Maintenance of personal hygiene	132	3.30	1.30
Determination of pest damage	134	3.15	1.28
Storage of pesticides	133	3.11	1.35
Identification of pesticides	134	2.95	1.26
Proper handling of pesticides	129	2.95	1.22
Precautions when spraying	130	2.94	1.29
Decision on when to use pesticides	132	2.88	1.28
Use of protective clothing	131	2.76	1.38
Disposal of pesticide containers	132	2.75	1.41
Understanding pictograms	132	2.75	1.24
Pesticide selection	132	2.75	1.28
Dosage determination	130	2.73	1.29
Maintenance of spraying machine	132	2.59	1.47
Reading pesticides labels	130	2.49	1.43
Identification of beneficial insects/ arthropods	134	2.47	1.34
Understanding pesticide labels	130	2.40	1.41
Alternative pest control methods	133	2.32	1.29
Classification of pesticides	135	2.13	1.32

n = 147 Mean = 2.68 SD = 0.89

Table 40: continued

Extension information support areas	n	Mean	SD
First aid in pesticide poisoning	133	2.12	1.22
Food safely issues	134	1.97	1.32
Calibration of spraying machines	132	1.96	1.29

Scale: Very High = 5 High = 4 Moderate = 3 Low = 2 Very Low = 1

Source: Field data (2006)

The results of the study show that, farmers perceived their competencies in the various areas of pesticides management as ranging between high and low (mean= 3.61–1.96) as indicated in Table 40, however, they perceived themselves to be only moderately competent in most areas of pesticide management. The large standard deviations however, indicate varied levels of perceived competence. This is an important finding to target extension campaigns/ training.

The only pesticide management area in which farmers perceived their competence as being high was in the identification of pests and diseases (mean = 3.61; SD = 1.09). A majority of the farmers perceived their competence as being high (27.0 percent) or very high (25.5 percent) in the identification of pests and diseases. Further more as many as 34.3 percent of the farmers said they were moderately competent in the identification of pests and diseases. This finding is in line with the assertion of Ajayi (2000) that in Côte d'Ivoire, years of farming experience have helped most farmers to learn to identify the different species of insects in their fields. In more than 80 percent of the cases, farmers in his study area claimed they can distinguish between mites, leaf eating, piercing/sucking and fruit boring insects. Hillock et al. (1999) have also reported a high degree of awareness of pests and diseases (described by their symptoms) by coffee farmers in Malawi. The importance of pest identification has been emphasised by Chivinge et al. (1999) who have indicated that, failure to identify pests has also led to the wrong use of pesticides. For instance, in citrus, application technique requirements for pest control depends on the distribution and behavior of the insect and mite pest (Mabbett, 2004b).

The results of the study show that, small-scale farmers perceived their competencies in understanding pesticide labels (59.2 percent), (mean = 2.40; SD = 1.41), alternative pest control methods (59.4 percent), (mean = 2.32; SD = 1.29), classification of pesticides (68.9 percent), (mean = 2.13; SD = 1.32), first aid in pesticide poisoning (68.6 percent), (mean = 2.12; SD = 1.22), food safely issues (69.4 percent), (mean = 1.97; SD = 1.32) and calibration of spraying machines(69.0 percent), (mean = 1.96; SD = 1.29) as low or very low. However they perceived their competence in the other remaining areas of pesticide management investigated for the purpose of this study as being moderate. The perceived moderate level of competence in maintenance of personal hygiene (mean = 3.30; SD = 1.30) (25.0 per cent, very high; 17.4 percent, high and 30.3 percent, moderate) is an indication of the farmers' knowledge about the hazardousness of pesticides and the danger it poses to them. However, for small-scale farmers to be only moderately competent in this important area shows that the knowledge they have might not have been translated into practical use. It could also be an indication that small-scale farmers do not have enough information for them to see or know and appreciate the relationship between the hazardousness of pesticides and their own personal hygiene during PM. It is however worthy of note that their perceived competency in personal hygiene ranks highest amongst the other pesticide management areas in which they perceive their competence to be moderate. This is an indication that, farmers will be more competent in personal hygiene during PM if they get more information on acute and chronic health effects of pesticides.

. The results of the study also revealed that, small-scale farmers in the study area perceived their competence in the determination of possible pest damage as moderate (mean = 3.15, SD = 1.28). The finding of the study confirms what was observed by Gerken et al. (2001) who reported that, Ghanaian farmers claim they have limited information on pest levels and the nature of the damage they caused, yet only a few of them made the effort to contact experts before applying pesticides.

Farmers' perceived competence in the storage of pesticides

It was observed from the study that the perceived competence of farmers in the storage of pesticides is moderate, Mean = 3.11 SD = 1.35 as shown in Table 40. The results of the study showed that, 54.5 percent of the farmers kept their pesticides on the farm, 43.1 percent kept theirs at home while 2.3 percent kept them at both places (Figure 11). This finding is comparable to the findings of Gerken et al. (2001) who indicated that about 53 percent of the farmers stored their pesticides in farm huts or in their houses. The current finding also supports the assertion by Clarke et al. (1997) who reported that, most farmers stored their pesticides in their bedrooms or other rooms.

Farmers in the study area claimed they kept pesticides on the farm to keep them away from their children. This finding supports the assertion of

Gerken et al. (2001) who indicated that storage of pesticides has safety implications. There is however hardly any record of farmers storing their pesticides under lock and key. The fact that farmers keep pesticides in farm huts and at home without keeping them under lock and key shows that, there are limitations in their competence to store pesticides safely. The pesticide storing practices of farmers in the study area is also an indication of farmers not relating the hazardousness of pesticides to safe storage.

Farmers' perceived competence in the decision on application of pesticides

It can be seen from the results of the study that, small- scale farmers perceived their competence in the decision on when to use pesticides as moderate (mean = 2.88 SD = 1.28) (refer to Table 41). This finding conforms to the finding of Gerken et al. (2001) who reported that 40.9, 52.9 and 6.2 per cent of the small-scale farmers based their decision to spray on calendar spraying, curative spraying and on advice of experts respectively. However, only 8.4 percent of all farmers based their decision to apply chemical pesticides on the advice of experts (refer to Table 3). Farmers must have developed this approach to their decision on when to apply pesticides because of their limited perceived competence. A majority of the farmers with moderate competence would practice calendar or curative spraying without doing a proper crop loss assessment or determining the economic threshold of the pest. The finding also confirms the assertion of Chivinge et al. (1999) who reported that in Zimbabwe, establishment of threshold levels before pesticide application is still a problem. It will be necessary for farmers to be given more information in these areas if their competence in decision-making on when to use pesticides is to be improved.

Farmers' perceived competence in the use of protective clothing

The perceived competence of farmers in the use of protective clothing (mean= 2.76; SD = 1.38) was also moderate. The results of the study indicate that, farmers did not use the full compliments of protective clothing. The main protective items used were, wellington boots (86.5 per cent), overall (clothing) (60.7 per cent), gloves (rubber) (39.8 per cent), goggles (26.1 per cent), respirators, (32.6 per cent), cap (16.4 per cent) and ear defenders (2.3 per cent). The results of this study confirms the finding of Gerken et al. (2001) who indicated that only 12 per cent of their respondents did not use any protective equipment and that, farmers normally did not use the complete set of protective gear that was technically desirable. Chivinge et al. (1999) have indicated that, the majority of the people applying, mixing or dealing with pesticides in one way or the other do not wear appropriate protective clothing whiles spraying or while going through sprayed fields.

The results of the study also confirms the observation made by Clarke et al. (1997) who reported that, there was a general awareness of protective devices, but the transfer of knowledge into practice seemed to be weak. The extensive use of wellington boots is however contrary to the finding of Clarke et al. (1997). From their study, they found that only 22 percent of them used boots while applying pesticides and this was the main protective measure. The finding of the study also confirms Ajayi's (2000) assumption that, under an improved information situation, farmers will probably use more protective clothing and /or spend more money for medical treatment than they are currently doing.

Farmers' perceived competence in understanding symbols on pesticide containers

The results of the study showed a moderate understanding of the pictograms (mean = 2.75; SD = 1.24) on pesticide labels (refer to Table 40). This finding is confirmed by Ajayi (2000: 116) who indicated from the results of his study in Côte d'Ivoire that "farmers in the study area demonstrated some level of understanding of symbols on pesticide containers that warn against the potential dangers of pesticides". According to the author, results from the two study areas showed that farmers understood some symbols very well while others were interpreted wrongly. Ajayi (2000: 116) also reported that "symbols that instruct pesticide users to protect themselves were the best understood".

Farmers' perceived competence in dosage determination of pesticides

The perceived competence of farmers in dosage determination and competence in maintenance of spraying machines though moderate was still lower than the other pesticide management areas in which farmers perceived their competence to be moderate. The moderate competence level of farmers in dosage determination is exhibited by the very high and very low pesticide dosages used by the farmers. According to Grandstaff (1999) farmers' lack of awareness is often seen as one major reason for pesticide problems. The author claimed that, several studies about farmers' awareness conducted in Thailand in 1985 concluded that more than half of the farmers applied dosages higher than recommended on the label. Apart from possible environmental effects and economic waste, the overuse of pesticides can result in a whole range of adverse effects on humans and other forms of life. It has also been indicated by Ajayi (2000) that cotton farmers in Cote d'Ivoire in an attempt to avoid carrying debts from one cotton season to the other reduce the number of sprays required in the field or apply sprays under windy conditions in order to cover larger areas with smaller quantities of pesticides. This practice also shows that dosage used by farmers is price dependent and not solely based on recommendation.

Farmers' perceived competence in the maintenance of spraying machines

Small-scale farmers in the study area perceived their competence in the maintenance of spraying machines to be moderate (mean = 2.47 SD = 1.33). The result of this study confirms the finding of Okorley et al. (2005) who found out from another study to assess the training needs in pesticide use by vegetable farmers, agrochemical sellers and extension agents in the urban areas of the Central region of Ghana that, pesticide sellers in the region have not had adequate training to understand the special nature of their work and the requirements that go with it. The incompetence of pesticide dealers who farmers depend on for PMI will certainly affect the competencies of farmers in PM practices adversely.

Farmers' perceived competence in reading and understanding of pesticide labels

It is note worthy that small-scale farmers in the district do not perceive their competence in reading of pesticide labels and understanding of the labels to be equal. Although they perceive their competence in reading of the labels to be moderate (mean= 2.49; SD = 1.42) their understanding was rated as low (mean = 2.40 SD = 1.41) (refer to Table 40). This finding is the result of the relatively low rate of literacy among the small-scale farmers. The technical nature of information on the labels could also be part of the reason why farmers have low competence in understanding the labels. The low perceived competence level of farmers in the understanding of pesticide labels could explain why Gerken et al. (2001) reported that although farmers sought information from pesticide labels, it is not the most important source of pesticides use information among them. Farmers' perceived low competence in understanding the labels could be the reason why as indicated by Gerken et al. (2001), and also confirmed in this study, farmers received information on pesticide use mainly from extension staff. If extension staff are to fulfill their role as a major source of PMI for farmers, they should have a higher competence level than the farmers.

Illiterate farmers can neither read nor understand the labels whiles the literate farmers can read but may not understand because of the technical nature of PMI usually found on pesticide labels. The finding of this study confirms the assertion of Kujeke (1999) who has indicated that, small scale farmers in Zimbabwe, like others in the developing world are constrained by illiteracy. The author also reports that, although product labels for products which are meant for small holder farmers are printed in vernacular languages, it has been proved by research that, messages carried in posters are usually not understood by the farmers. Again, Kujeke, (1999) stressed that, the technical nature of some PMI is yet another issue small scale farmers have to contend with. The need for mathematical skill to calculate proper pesticide dosages is is also a limiting factor to farmers. It is apparent from this finding that, the level of education of farmers plays a major role in their understanding of pesticide labels. Some farmers in the study area strongly indicated their need for knowledge in label reading. When asked for additional information and services required to boost the SMP in her farming activities a respondent at Kweiman said, "Intensify knowledge of label reading".

In situations where farmers cannot read, AEAs and pesticide dealers who have higher levels of education than most of the farmers should develop the competency to give the relevant information on pesticide labels to the farmers. Small-scale farmers should also be ready to consult these experts anytime it becomes necessary. Unfortunately, (Kujeke, 1999) has indicated that, typically, small scale users of pesticides are unlikely to access more technical, health and safety information than that provided on the label. Since the majority (70.8 percent) of the farmers have some level of formal education, the implications of the moderate competence are that, their educational levels are not high enough to help them understand the technical nature of the information on the labels.

Farmers' perceived competence in calibration of spraying machines

The low perceived competence of farmers in the calibration of spraying machines as presented in Table 41, (mean = 1.96; SD = 1.29) confirms the assertion of Chivinge et al. (1999) that there are problems with pesticide application machinery which relate to calibration, worn out nozzles and inappropriate and/ or faulty nozzles. The inability of small-scale farmers to calibrate spraying machines is an indication of low competencies in the SMP. The inability of farmers to calibrate the spraying machines coupled with the use of improper nozzles, are indications of low actual competencies in the SMP. It is therefore not very surprising that the perceived competence of farmers in the calibration of spraying machines is low.

Farmers' perceived competence in first aid during pesticide poisoning

The results of the study show that, the perceived competence of small-scale farmers in administering first aid for pesticide poisoning was low (mean = 2.12; SD = 1.22) (refer to Table 40). This finding confirms the information released by the Director of PPRS in July, 2007 as indicated in Table 8. Some of these deaths could have been prevented if the farmers were more competent in the administration of first aid to the victims at the time of the accidents.

Farmers are exposed to pesticides at different levels of farm operations. Considering the hazardous nature of pesticides, high competence of farmers in first aid is a necessary requirement. The perceived low competence of farmers has also been alluded to by Gerken et al. (2001) when they reported the possible poisoning of three children in March 1999. According to Gerken et al. (2001) the majority (58 percent of all the respondents) of the farmers they interviewed knew of health problems associated with pesticides. The most serious problems farmers associated with pesticide use were general ill health, acute poisoning, and phytotoxicity in the treated crops. Gerken et al. indicated that, poisoning was a phenomenon more common among illiterate farmers and that small and medium scale farmers generally experienced more problems with pesticides than large scale farmers.

Competence of stakeholders in sound management of pesticides

It is quite clear from the low to moderate perceived competence level of the small-scale farmers in the SMP that, they have not received adequate information to give them the needed competence. On the other hand, the perceived competencies of the AEAs might not be high enough to impact or influence the competence of the farmers positively. Besides, facilities for the dissemination of PMI to farmers may also be limited. If AEAs are the major source of PMI to farmers, then this limitation will certainly affect the farmers' competence adversely and result in mediocre levels of farmer competence in the sound management of pesticides. Knox (1977) noted that, whereas adults would strive to improve their competencies, they tend to resist active learning when they cannot perceive any substantial benefit of the desired competency. Small-scale farmers should therefore be trained to appreciate the benefits of higher competencies in SMP.

.

Relationship between the perceived competencies of farmers in the sound management of pesticides and other independent factors of the study

Objective Eight was to determine the relationship between the perceived competencies of farmers in the sound management of pesticides and other independent factors of the study. The findings pertaining to this objective are as presented below:

Table 41 shows the Pearson product–moment correlation co-efficients (r) which indicate the relationships between the perceived competencies of farmers in the sound management of pesticides and other independent variables of the study; small-scale farmers' perceived environmental health and safety awareness levels of the effects of pesticide use in agriculture, small-scale farmers' perceived awareness level of alternative pest control methods, perceived effectiveness of the available source of pesticide use information, farmers' examination and use of pesticide application equipments and protective clothing, Table 41 also shows Spearman Brown Correlation co-efficients (r) which indicate relationships between the perceived competencies of farmers in the sound management of pesticides and age, education, and farming experience of farmers.

Table 41: Correlation Matrix of perceived competence of farmers in sound management of pesticides and selected independent characteristics of farmers

Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	-						
X_2	0.773**	-					
X_3	0.768**	0.654**	-				
X_4	0.235**	0.268**	0.254**	-			
X_5	0.244*	0.292**	0.186	0.064	-		
X_6	0.051	0.033	0.022	0.271**	0.144	-	
X_{7a}	0.417**	0.298**	0.367**	0.017	0.092	0.043	-
X_8	0.030	0.050	-0.015	0.293**	0.048	0.607**	0.217**

Source: Field data (2006) *p< 0.05 (2-Tailed) **p < 0.01 (2-Tailed)

Table 42 continued

X_1= Competence in sound management of pesticides

X_2= Environmental Awareness

X_3= Awareness of Alternative method

X_4= Effectiveness of Source of information

X_5= Examination and use of equipment and protective clothing

X_6 = Age

X_7 = Education

X_8 = Farming experience

a = Spearman Brown Correlation

The Pearson correlation co-efficients presented in Table 41 show positive relationships between the perceived competence of farmers in the sound management of pesticides and some of the selected independent variables of the study. Using the Davis' convention which describes the magnitude of correlation coefficients for the interpretation of correlation co-efficients (Davis, 1971), the results show that, the strengths of the relationships ranged between very high and low. The study showed; direct (positive) and highly significant relationships between the small-scale farmers' perceived competence in the sound management of pesticides and their perceived environmental, safety and health awareness levels of the effects of pesticide management in agriculture (r = 0.773), direct and very high significant relationship between farmers' perceived competence in the sound management of pesticides and farmers' perceived awareness level of alternative pest control methods (r = 0.768), a direct and moderate relationship between the perceived competence of farmers in the sound management of pesticides and the educational level of farmers (r = 0.417), a direct but low relationship between the perceived competence of farmers in the sound management of pesticides and the perceived effectiveness of the source of pesticide use information (r = 0.235) even under 0.1 alpha level and finally, a positive but low relationship between the perceived competence of farmers in the sound management of pesticides and the examination and use of equipment and protective clothing (r = 0.244).

As the study showed a direct (positive) and highly significant relationship between the small-scale farmers' perceived competence in the sound management of pesticides and their perceived environmental, safety and health awareness levels of the effects of pesticide management in agriculture (r = 0.773), the first null hypothesis which stated that there is no significant relationship between the perceived competence of farmers in the sound management of pesticides and their perceived awareness levels of environmental, health and safety implications of pesticides is rejected and the alternative hypothesis is therefore accepted. This means that, the higher small-scale farmers' perceived their awareness level of environmental, health and safety implications of pesticide management the more they will perceive their competence in SMP to increase. The implications are that, pesticide training needs to be multi-factorial. Such training for small-scale farmers should not only be technical, but also take environmental, health and safety implications into consideration. It also means that farmers should think about pesticide management in complex ways.

Since the results of the study showed a direct and very high significant relationship between small-scale farmers' perceived competence in the sound management of pesticides and farmers' perceived awareness level of alternative pest control methods, (r = 0.768), the second null hypothesis which stated that there is no significant relationship between the perceived competence of farmers in the sound management of pesticides and their perceived awareness levels of alternative pest control methods is rejected and the alternative hypothesis is therefore accepted. The implication of this is that, farmers will perceive their competence in SMP to increase if their perceived awareness level of alternative pest control methods increases.

The third null hypothesis which stated that there is no significant relationship between the perceived competence of farmers in the sound management of pesticides and the perceived effectiveness of the sources of pesticide management information available to farmers is also rejected. The alternative hypothesis is therefore accepted as a direct but low relationship (r = 0.235) was established between them. This means that, the more useful farmers perceive the sources of pesticide management information available to them, the more they will perceive their competence in SMP to increase.

The fourth null hypothesis which stated that there is no significant relationship between the perceived competence of small-scale farmers in the sound management of pesticides and the examination and use of equipment and protective clothing (r = 0.244), is also rejected and the alternative hypothesis is therefore accepted because a direct relationship was established between the perceived competence of small-scale farmers in the sound management of pesticides and the examination and use of equipment and protective clothing (r = 0.244) by farmers and other pesticide applicators. The implication of this then is that, the more small-scale farmers make it a regular exercise to examine the equipment and protective clothing they use while handling pesticides, the higher their competence in the SMP will be.

It was, analysed that, there was no relationship between the perceived competence of farmers in the sound management of pesticides and the age of farmer (r = 0.051). The fifth null hypothesis which stated that there is no significant relationship between the perceived competences of farmers in the sound management of pesticides and the ages of farmers is therefore accepted and the alternative hypothesis is rejected. This means that the age of small-scale farmers in the district did not make any positive contribution to their perceived competence in the sound management of pesticides.

Furthermore, as a direct and moderate relationship was established between the perceived competence of farmers in the sound management of pesticides and the educational level of farmers (r = 0.417), the sixth null hypothesis which stated that there is no significant relationship between the perceived competence of farmers in the sound management of pesticides and their educational level is rejected and the alternative hypothesis is therefore accepted. This means that, the higher the educational level of the farmers, the higher will be their perceived competence in the sound management of pesticides. The implication of this is that, farmers will acquire higher competence in the SMP if they have higher levels of education.

There was no relationship between the perceived competence of farmers in the sound management of pesticides and their years of farming experience (r = 0.030). Therefore, the seventh null hypothesis which stated that there is no significant relationship between the perceived competences of farmers in the sound management of pesticides and the years of farming experience of farmer is therefore accepted and the alternative hypothesis rejected. This means that the years of farming experience of farmers in the district did not make any positive contribution to their perceived competence in the sound management of pesticides. Although years of farming experience did not show any relationship with the perceived competencies of the farmers in SMP, it has been found to increase the competence of farmers in the identification of different species of insects in their fields. According to Ajayi (2000), in Côte d'Ivoire, years of farming experience have helped most farmers to learn to identify the different species of insects in their fields. In more than 80 percent of the cases, farmers in his study area claimed that, years of farming experience have helped most farmers to learn to identify the different species of insects in their fields. From the results of the study it can also be seen that, the most important factors that determine the competence of farmers in the sound management of pesticides are, environmental, safety and health awareness levels of the effects of pesticide management in agriculture, awareness level of alternative pest control methods and the educational level of farmers in a descending order of importance.

Predictors of perceived competence of farmers in the sound management of pesticides

Objective nine determined the best predictors of perceived competence of small-scale farmers in the sound management of pesticides. The findings pertaining to this objective are as presented and discussed below:

Five independent variables of the study; perceived environmental health and safety awareness levels of the effects of pesticide management in agriculture, perceived awareness levels of alternative pest control methods, effectiveness of sources of pesticide management information, examination and use of equipment protective clothing and educational level of farmers were used to determine the best predictors of farmers' perceived competence in the sound management of pesticides because they all had significant relationship with competence in the sound management of pesticides (refer to Table 42). Collinearity (otherwise referred to as multicollinearity) tests also showed that, there was no significant collinearity (linear relationships among those independent variables) that could bias the prediction. The existence of significant collinearity between any two of the factors would require that, one of the pair is dropped.

It has been indicated by Gupta (2000) that, significant collinearity exists between independent variables if:

1. the correlation coefficient between any two variables is greater than 0.8 (in absolute terms).
2. R- square is greater than 0.75 and only few t- values are significant.

As can be seen from the correlation matrix in Table 41, there is no significant collinearity among the selected independent variables that may bias the prediction so the five independent variables, that were correlated to the farmers' perceived competence in the sound management of pesticides were used for the prediction (i.e. correlations are less than 0.8, R-square is less than 0.75 and all t – values of the beta are significant).

Table 42 shows the stepwise multiple regressions of selected independent variables on farmers' competence in the sound management of pesticide.

Table 42: Stepwise Multiple Regression of selected independent variables on competence of farmers in sound management of pesticides

Predictors	Step of entry	Beta (standardised)	R2	Adjusted R2	Adjusted R2 change	S.E.E.	F Regression	F Sig
X_1	1	0.460	0.597	0.593	0.593	0.570	134.8	0.000
X_2	2	0.421	0.718	0.711	0.118	0.480	144.37	0.000
X_6	3	0.126	0.731	0.722	0.011	0.471	80.71	0.000

$p < 0.05$

Dependent Variable (Y) = Perceived competence of small-scale farmers in sound management of pesticides

X_1 = Awareness of environmental, safety and health effects of pesticides

X_2 =Awareness of alternative means of pest control methods

X_6 = Education

Regression Equation (from unstandardised Beta)

$Y = a+bX_1 + bX_2 + b X_6)$

$Y = 370 + 0.414 (X_1) + 0.388(X_2) + 0. 062 (X_6)$

Source: Field data (2006)

The results of the regression analysis show that, three of the five independent variables account for 72.2 percent of all the variance in the perceived competence of small-scale farmers in the sound management of pesticides as indicated in the last row of adjusted R square column of the stepwise regression (Table 42). The degree of contribution made by each of the three independent factors towards the 72.2 per cent variance in the farmers' perceived competence in the sound management of pesticides is indicated in the "Adjusted R2 Change" column in Table 42. Farmer's perceived awareness of environmental, health and safety effects of pesticides was the overall best predictor, and accounted for 59.3 per cent of the variance in the farmers' perceived competence in the sound management of pesticides. Farmers' perceived awareness of alternative means of pest control methods was the next best predictor, contributing 11.8 percent in explaining the variance in farmers' perceived competence in the sound management of pesticides. Farmers' educational level was the last in contributing only 1.1 per cent in explaining the variance in farmers' perceived competence in the sound management of pesticides.

It can be deduced from the result of the study that, obtaining pesticides is not a problem to the farmers although they complain about cost and distance. However, the knowledge–based aspect of the technology and disseminating which will translate into sound management of pesticides continues to be a problem. This finding is supported by the assertion of Swanson (1998) that, the transfer process of material technology is generally simpler than training and disseminating technical knowledge and management skills to large numbers of poorly educated farmers.

CHAPTER SEVEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

General overview

This chapter presents the summary, conclusions and recommendations of the study. The chapter also outlines suggested areas for further studies.

Summary

This study was undertaken to assess the pesticide use practices and competencies of small-scale farmers in the sound management of pesticides in the Ga East and West districts of the Greater Accra Region of Ghana.

The study was specifically guided by the following objectives:

1. Describe the demographic and occupational related characteristics of small-scale farmers.
2. Describe pesticides available to farmers in the districts.
3. Describe pesticide management practices by farmers.
4. Describe the current sources of pesticide management information available to farmers.
5. Examine the environmental, safety and health awareness levels of farmers.

6. Examine the perceived awareness levels of farmers in alternative methods of pest control.

7. Describe the perceived competencies of farmers in the sound management of pesticides.

8. Determine the relationship between the perceived competencies of farmers in the sound management of pesticides and:

- Farmers' perceived environmental, safety and health awareness levels.
- Farmers' perceived awareness levels of alternative pest control methods
- Farmers' perceived effectiveness of pesticide management information (PMI) available to them.
- How often farmers examined equipment and protective clothing when handling pesticides.
- Selected demographic characteristics (age, educational level and farming experience).

9. Determine the best predictor(s) of the competencies of farmers in the sound management of pesticides.

A descriptive correlational survey was used to interview 147 small-scale farmers in the Ga East and West districts of the Greater Accra region of Ghana. The statistical tools used in the analysis of the data were; measures of central tendencies and dispersion (means and standard deviations), frequencies and percentage distributions, Pearson product–moment correlation co-efficient, Spearman Brown correlation coefficient and stepwise multiple regression. The following is a summary of major findings of the study as related to the specific objectives.

Demographic and occupational related characteristics of farmers

Sex of farmers

The results of the study revealed that, about 30 per cent of the farmers were females while the remaining 70 per cent were males.

Age of farmers

A majority of the farmers were between the ages of 30 and 49 years. Only 21.2 per cent of the farmers were less than 30 years old while 18.9 per cent of them were over 50 years of age. The average age of the farmers was found to be 40 years.

Educational level of farmers

The results of the study showed that, 29.2 per cent of the farmers had no formal education while 13.2 per cent had received some level of primary school education. The majority (70.8 per cent) of the farmers had however been educated up to primary school level.

Farming experience of farmers

The results of the study show that, the majority (68 per cent) of the farmers have been in the occupation for 10 years or more with an average of 16 years experience in farming. The majority (57.1 per cent) of the farmers practiced mixed cropping but none of them said they did so as a pest management practice.

Pesticides available to farmers and sources of pesticides for farmers

The findings of this study indicate that farmers have varied sources for the supply of their pesticide requirements. The sources include mainly pesticide dealers (86.1 per cent), followed by other farmers (18.9 per cent) market (17.2 per cent), AEAs (16.4 per cent) and pesticides peddlers (13.1 per cent).

Types of pesticides used by farmers

The results of the study revealed that the types of pesticides used by farmers in the district in a descending order of importance are insecticides (76.2 percent), herbicides (63.9 percent), fungicides (48.3 percent) nematicides (15.0 percent) and rodenticides (6.1 percent). From the results, it can be seen that, small- scale farmers in the districts mostly use insecticides as the main pesticide for pest control. Very few of the farmers (6.1 percent) use rodenticides. The results of the study also revealed that the majority of the small-scale farmers did not know the brand names of the pesticides they used while others had difficulty remembering or pronouncing the brand names of the pesticides they used.

Distance to source of pesticides

A majority of the farmers travel long distances to obtain pesticides. A large number of them (39.7 percent) have to travel at least 6 Km to obtain pesticides, while 35.5 percent of them travel a distance of 6 to 10 Km for such inputs. Some sources of pesticides were located at distances beyond 15 Km away from the location of the farmers however, only 8.3 percent of the farmers have to travel over 25 Km to obtain their pesticides.

Availability of pesticides

As regards the availability of pesticides, the majority (75.0 percent) of the farmers claimed pesticides were never available to them because they were difficult to get. On the other hand, 15.8 percent and 9.2 percent respectively said pesticides were either sometimes or always available to them.

Farmers' perception of cost of pesticides

Generally, farmers perceived the cost of pesticides to be high. The majority (50.8 percent) of the farmers said the cost was very high, while 27.0 percent and 20.5 percent of the farmers respectively perceived the cost of pesticides to be high and moderate. A minority (1.60 percent) of the farmers however claimed the cost of pesticides was very low. The results showed that, while none of the male respondents perceived the cost of pesticides to be very low, 6.5 percent of the female respondents perceived the cost of pesticides to be very low. However, 53.8 percent and 41.9 percent of the male and female respondents respectively perceived the cost of pesticides to be very high.

Purposes for which pesticides are used

Farmers in the study area used pesticides mainly for agricultural purposes. The majority (98.3 percent) of the farmers used pesticides for cropping whiles 20.5 percent used them for grain and legume preservation. A minority of the farmers however used pesticides for trapping rodents (9.2 percent), public health (5.8 percent) and animal health (3.3 percent). None of the farmers claimed to use pesticides for fishing.

Pesticide management practices by farmers

The results of the study showed that, 80.3 percent of the respondents farmers used pesticides in their farming activities but only 45.6 percent own spraying machines. It was found that 67.2 percent of the farmers used some protective clothing whiles 83.8 percent of the people who apply pesticides examine their equipment and protective clothing before use. A very small proportion (4.5 percent) of the farmers claimed they used empty pesticide containers for domestic purposes. Furthermore, a quarter of the farmers (25.6 percent) claimed they keep pesticides in other containers. The results of the study show that, 52.0 percent of 125 respondents used or applied pesticide mixtures. It was also found that, only 26.8 percent of the farmers used pest control methods other than pesticides. Only 21.3 percent of the farmers claimed they are aware of the EurepGAP protocol and 38.2 percent of those farmers claimed they apply it on their farms.

Use of protective clothing by farmers and pesticide applicators

The results of the study also revealed that, 67.2 percent of the farmers who used pesticides used one form of protective clothing or the other while 32.8 percent of them did not use any at all. About 86.5 percent of the farmers and or pesticide applicators used wellington boots while 60.7 percent of them used overalls or other forms of clothing to protect themselves from dermal contamination. The use of goggles, respirators and gloves was by a minority of pesticide applicators (26.1 percent, 32.6 percent and, 39.8 percent respectively). None of them used the full complement of protective clothing. However, 83.8 percent of those who used protective clothing indicated that, they examined all or some of their protective clothing and spraying equipment before spraying.

Farmers experiences from pesticide exposure

The results of the study show that only 10.9 percent of the interviewed farmers had sought medical attention at one time or the other after exposure to pesticides, although most of the farmers had suffered from burning sensation on the skin (37.1 percent), itchy or watery eyes (30.4 percent), headache (26.3 percent) and dizziness (20.9 percent) after a pesticide handling exercise.

Persons applying pesticides in the field

The main source of labour for pesticide application was the farmer himself. It was found that 78.7 percent of the farmers applied pesticides themselves while children and family members (22.1 percent) and fellow farmers (17.5 percent) also helped in applying pesticides on their farms. Only 9.1 percent of the farmers employed the services of professional pesticide applicators.

Equipment for the application of pesticides

Lever operated knapsack sprayers were the main equipment used for the application of pesticides by farmers in the study area. The result of the study showed that, 97.6 percent of the 125 farmers interviewed used this type of spraying equipment whiles 8.9 percent of them claimed they used the mist blower in applying pesticides on their farms. Only one farmer applied pesticides on his farm with a broom. Out of the 125 respondents however, 59.2 percent did not own pesticide application equipment.

Pesticide storage practices by farmers

From the results of the study it was found that the majority (54.5 percent) of the farmers stored their pesticides on the farm while 43.1 percent of them did so at home. There were however a few farmers who stored their pesticides at both sites.

Disposal of empty pesticide containers

The results of the study revealed that a majority (60.5 percent) of the farmers claimed to throw away their empty pesticide containers as a way of disposing of them while 25.4 percent of them burnt the empty containers. Farmers who buried empty containers were 21.9 percent as against the 12.3 percent and 4.5 percent of them who crashed and buried deeply and those who used the empty containers for domestic purposes respectively. All the five farmers who reused the empty containers for domestic purposes claimed they used them as receptacles for kerosene. Only one farmer however claimed he used them for holding water.

Sources and effectiveness of pesticide management information available to farmers

The most important sources of pesticide use information available to small-scale farmers in the district in a descending order of importance are, other farmers (85.2 percent), farmer's own experience (85.1 percent), extension (AEAs) (76.9 percent), pesticide dealers (66.0 percent), radio (48.6 percent) and, extension demonstrations (method / result demonstration) (47.1 percent). Sources of least importance were researchers/universities and print media (newsletters/journals) which were available to 17.9 percent and 14.4 percent of the farmers respectively. The results show that, there is no significant difference between the sources of PMI available to small-scale male and female farmers in the study area.

Results of the study indicate that, farmers perceived AEAs (mean = 2.79; SD = 0.43) as being a very effective source of PMI. The farmers rated extension demonstrations (method/result demonstrations) (mean = 2.36; SD = 0.65), other farmers (mean = 2.34; SD = 0.61), farmers' own experience (mean = 2.32; SD = 0.66), PPRS (mean = 2.27; SD = 0.71) and pesticide agents (mean = 2.23; SD = 0.61) as being effective in a descending order of importance. The few farmers who had access to PMI through researchers/ universities (mean = 1.91; SD = 0.66) and print media (newsletters/journals) (mean = 1.73; SD = 0.67) also rated them to be effective.

Pesticide management training attended by farmers

The results of the study show that, the majority (72.3 percent) of the farmers have never attended any training program on pesticide management while only 9.9 percent, 14.2 percent and 2.1 percent of the farmers had attended 1, 2, and 3 of such trainings respectively.

Factors influencing farmers' decision to use a pesticide

The results of the study revealed that the majority (68.3 percent) of the farmers based their decision to use pesticides on their knowledge or information, that is, their own experience they have about the effectiveness of pesticides whiles 54.9 percent of them based their decision on recommendations from extension workers. It was also established that pest occurrence in former years influenced the decision of 48.4 percent of the small-scale farmers to use pesticides, whiles 46.3 percent of them were influenced by products neighbours or friends are using as well as their own crop loss assessment. On the other hand, recommendations by dealers and their own management system successful over a long period were factors that influenced 38.0 percent and 35.2 percent of the farmers respectively. The results of the study also revealed that the price of farm produce influenced only relatively few farmers (27 percent) in their decision to use pesticides. The other factors that influenced the decision of farmers to a lesser extent were, information from other sources e.g. radio and newspapers (26.0 percent), price of pesticide (25.4 percent), recommendation by traders (17.5 percent), knowledge about hazardousness of pesticide chosen (17.5 percent), recommendation from other sources such as CBOs, FBOs or NGOs (14.8 percent) and promotion of chemical industry (10.7 percent).

Factors influencing farmers' decision on the type of pesticide to buy

The results of the study showed that major factors which influenced farmers' decision on the type of pesticide to buy included farmers' own experience about effectiveness of pesticides, recommendations from extension workers and products being used by neighbours or friends. The results revealed that, these major factors influenced 71.1 percent, 55.8 percent and 55.0 percent of the farmers respectively when they needed to take a decision on which pesticide to buy.

Other factors which influenced the farmers' decision on the type of pesticide to buy, in a descending order of importance were, pest occurrence in former years (45.0 percent), management system successful over long time (44.2 percent), recommendations by pesticide dealers (43.3 percent) and own crop loss assessment (42.0 per cent). It was also found that, the prices of pesticide and farm produce influenced the decision of 36.1 per cent and 30.8% of the farmers respectively in their decision on the type of pesticide they bought.

Information from the media, e.g. radio, newspaper etc influenced 24.2 percent of farmers in their decision on the type of pesticide to buy, whiles knowledge about hazardousness of pesticide chosen influenced only 14.3 percent of the farmers. Factors that influenced a minority of the farmers in their decision on the type of pesticide to buy were recommendations by traders (12.9 percent), recommendations from other sources such as CBOs, FBOs or

NGOs (12.6 percent), and promotional activities of chemical industry (9.2 percent).

Farmers' perceived environmental, health and safety awareness levels of effects of pesticide use in agriculture

The results of the study revealed that, farmers' perceived environmental, health and safety awareness levels of effects of pesticide use in agriculture for the selected issues to be between moderate and low. Farmers in the study area perceived that they were moderately aware of waiting periods after pesticide application before harvesting (mean = 3.20; SD = 1.31), effects of pesticides on livestock, bees and other pollinating insects, (mean =.00; SD = 1.26), environmental hazards (mean = 2.97; SD = 1.37) and effects of pesticides on game and wildlife (mean = 2.92; SD = 1.27).

Again, perceived moderate awareness levels were indicated for effects of pesticides on public health (mean = 2.85; SD = 1.31), pesticide residues in agricultural produce (mean = 2.79; SD = 1.37), effects of pesticides on non-target organisms (mean = 2.49; SD = 1.28) and effects of pesticides on natural enemies of pests (mean = 2.48; SD = 1.34) in a descending order of importance. The perceived competence of farmers was however low in awareness of effects of pesticides on development of resistance in pests (mean = 2.39; SD = 1.33) and on resurgence of pests (mean = 2.23; SD = 1.33). The overall farmers' perceived mean environmental, health and safety awareness level of effects of pesticide use in agriculture was moderate (mean = 2.75; SD = 0.99).

Farmers’ perceived awareness level of alternative pest control methods

The results of the study revealed that, the highest perceived awareness level of farmers in alternative pest control methods was in physical methods of pest control (means = 3.30; SD = 1.33). While the farmers perceived their awareness level to be least for the use of biopesticides (means = 1.83; SD = 1.18). Farmers indicated moderate levels of awareness for physical methods (mean = 3.30; SD = 1.33), sanitation methods (mean = 3.21; SD = 1.40) and cultural methods (mean = 3.02; SD = 1.35) of pest control, while their awareness level of biological methods (mean = 2.13; SD = 1.38), indigenous methods (mean = 2.08; SD = 1.23), integrated pest management (IPM) (mean = 1.94; SD = 1.27) and the use of biopesticides (mean = 1.83; SD = 1.18) in pest control were however perceived to be low. Farmers’ overall perceived awareness level of alternative pest control methods was moderate (Mean = 2.55; SD = 0.97).

Farmers’ reasons for not using other pest control methods

It was also found from the study that, the majority of the farmers (63.0 percent) did not use other pest control methods because they do not have enough knowledge about alternatives while 26.3 percent claimed they used only pesticides because other methods involved too much labour. Other reasons given by the small-scale farmers for not using other pest control methods in a descending order of importance were; ‘Too expensive’ (16.3 percent), ‘Lower yields’ (13.6 percent), ‘Does not work’ (11.1 percent) and ‘Too risky’ (6.2 percent). However, 6.2 percent of the farmers claimed their decision against other pest control methods was influenced by AEA or pesticide dealers’ advice.

Relationship between the perceived competencies of farmers in the sound management of pesticides and other independent factors of the study

The study showed positive and very high significant relationship between the farmers’ perceived competence in the sound management of pesticides and their perceived environmental, safety and health awareness levels of the effects of pesticide use in agriculture (r = 0.773). The results also showed positive and very high significant relationship between farmers’ perceived competence in the sound management of pesticides and farmers’ perceived awareness level of alternative pest control methods (r = 0.768) whiles a positive and moderate relationship was revealed between the perceived competence of farmers in the sound management of pesticides and the educational level of farmers (r = 0.417), However, a positive but low relationship was found between the perceived competence of farmers in the sound management of pesticides and the perceived effectiveness of the source of pesticide use information (r = 0.235) under 0.1 alpha level. Finally, a positive but low relationship was revealed between the perceived competence of farmers in the sound management of pesticides and the examination and use of protective clothing (r = 0.244). All correlations were significant at the 0.5 alpha levels. It was however, observed that, there was no relationship between the perceived competence of farmers in the sound management of pesticides and their age (r = 0.051) and their years of farming experience (r = 0.030).

Predictors of perceived competence of farmers in the sound management of pesticides

The results of the regression analysis show that, three independent variables account for 72.2 per cent of all the variance in the perceived competence of farmers in the sound management of pesticides. These variables are, farmers perceived awareness level of environmental, health and safety effects of pesticides, farmers' perceived awareness of alternative means of pest control methods and farmers' educational level. Farmers perceived awareness level of environmental, health and safety effects of pesticides was the overall best predictor, and accounted for 59.3 per cent of the variance in the farmers' perceived competence in the sound management of pesticides. Farmers' perceived awareness of alternative means of pest control methods was the next best predictor, contributing 11.8 per cent in explaining the variance in farmers' perceived competence in the sound management of pesticides. Farmers' educational level was the least and it contributed 1.1 per cent in explaining the variance in farmers' perceived competence in the sound management of pesticides.

Conclusions

The following conclusions can be drawn from the findings of the study:

Even though the government makes provision for some supply of pesticides through MoFA and COCOBOD, the private sector continues to be the major source of pesticides to small-scale farmers. This situation has implications as to the types of pesticides that are being used by small-scale farmers and the type of PMI they receive at the sales point. They depend on what is available in the shops of pesticide dealers.

The major pesticides used by small-scale farmers in the districts are insecticides, herbicides and fungicides which are mainly used for agricultural purposes. Most farmers travel about 10 kilometers to obtain pesticides because the private dealers are not located within the farming communities.

The majority of small-scale farmers consider the cost of pesticides to be high. The implication of this is that, farmers may readily use cheaper pesticides if they are available. However, farmers went for "proven" pesticides and not only for cheap ones.

The use of different brand names of pesticides for the same generic compound creates confusion for small-scale farmers. The implication of this are poorly informed choices according to brand names instead of active ingredient and in case of contamination or poisoning, confusion on active ingredient of pesticide involved in the problem.

Lever operated knapsack sprayers are the main equipment used for the application of pesticides by farmers in the study area. However, the majority of the farmers do not own this facility. The implication of this is that, pest control activities may be delayed or that improper methods may be used for pesticide application.

Small-scale farmers in the study area claim to dispose of empty pesticide containers in various ways. The majority of them throw away the empty containers in the field without regard to the environmental and health implications. The implication of this is that, farmers are not aware of the environmental and health risk implications of liberal disposal of empty pesticide containers. The use of empty pesticide containers for domestic purposes however seemed to be minimal.

Most small-scale farmers use only pesticides for pest control simply because they do not know other methods of pest control. The next important reason given by the farmers for the non-use of other methods is that, such alternative methods are too labour intensive. The implication of this is that, there is a need to make farmers aware of efficient alternatives and then, train farmers in alternative pest control methods with emphasis on the benefits of such methods.

Although the AEAs were only the third most important and readily available source of pesticide management information to the farmers, they were rated as the most effective source of PMI. This was followed by extension demonstrations (method/result demonstrations). Researchers and universities and print media (Newsletters/Journals) were rated as the least effective source of PUI available to the small-scale farmers. The implication of this is that, AEAs are effective change agents in the field of PMI and they must be well informed in the SMP.

The moderate level of farmers' perceived environmental, health and safety awareness of effects of pesticide use in agriculture was basically below what is required for the SMP. In order to ensure the judicious management of pesticides, farmers must develop higher levels of competence in the indicated environmental, health and safety areas of pesticide management. The implication of this is that, awareness creation and subsequent training are needed.

The younger generation of farmers in the study area is also an indication of the gradual replacement of the older generation of small-scale farmers. The younger, not well experienced farmers taking over may lead to a gradual replacement of traditional pest control methods. The implication of this is that knowledge about traditional pest control methods will gradually fade away.

The proportion of male to female farmers strongly suggests that, farming in the study area is not the preserve of men. The sound management of pesticides in agriculture therefore becomes the shared responsibility of both men and women so pesticide management information should be available to all of them. The implication is that extension workers, as the most effective source of skills and knowledge in PMI, need to target women farmers especially.

Although the majority of the farmers in the study area had some amount of education, their educational level of a majority of them was too low for them to read and understand pesticide information on labels. Only a few of the educated small-scale farmers could therefore receive, decode, and understand written information on pesticide management as could be found on labels.

On the average, farming experience of farmers in the districts is adequate for the majority of the farmers to acquire some competence in the sound management of pesticides. Since their overall competence is only moderate, it is necessary to find out why they have not developed the needed competencies for the sound management of pesticides. The challenges facing the farmers can then be addressed by extension and media.

Farmers in the districts have so far not received adequate training in pesticide management. The implication of this is that, farmers have not acquired high competency in SMP. This situation does not auger well for awareness and competency development in pesticide management among farmers. Both formal and informal training programmes will therefore be required for the farmers to update themselves on current issues in pest management.

There are positive and significant relationships between farmers' perceived competence in the sound management of pesticides and their perceived awareness level of alternative pest control methods, and perceived environmental, safety and health awareness levels of the effects of pesticide management in agriculture. This means that, farmers' perceived competence in the sound management of pesticides will increase if their perceived awareness level of alternative pest control methods and their perceived environmental, safety and health awareness level of the effects of pesticide management in agriculture increases. The implications are that, pesticide training needs to be multi-factorial and should not only be technical. This is quite important for planning extension measures and campaigns.

There is also a positive and significant relationship between the perceived competences of farmers in the sound management of pesticides and their educational level as well as their perceived effectiveness of the sources of pesticide use information available to them. The implications of these finding are that, the perceived competence of farmers in the sound management of pesticides depends to a large extent on their educational level and the perceived effectiveness of the sources of pesticide use information available to them. This means that, farmers' perceived competence in the sound management of pesticides will increase if their educational level and the perceived effectiveness of the sources of pesticide use information available to them increase.

There is no relationship between farmers' perceived competence in the sound management of pesticides and their age or farming experience. The implication of this finding is that even young farmers may feel and are competent and that extension training and PMI needs to be made available to all age groups.

The main predictors of SMP by farmers were their perceived environmental, safety and health awareness levels of the effects of pesticide use in agriculture, awareness of alternative pest control methods and their educational level.

Obtaining pesticides is apparently not a problem to the farmers although they complain about cost and distance. However, the knowledge – based aspect of the technology which will translate into sound management of pesticides continues to be a problem. This implies that, the Directorates of PPRS and Agricultural Extension must intensify the training of small-scale farmers in the sound management of pesticides in order to increase their competence. It also implies that the competencies of AEAs and pesticide dealers who are major sources of pesticide management information to small-scale farmers need be high in this area.

Recommendations

Based on the findings of the study and discussions, the following recommendations are being made to improve the actual competences of small-scale farmers in the Ga East and West districts of the Greater Accra Region of Ghana:

Considering the different products on the pesticide market, it is recommended that, there should be limitations on the brand names for the same generic products. This will ensure that, small-scale farmers, AEAs and pesticide dealers can keep up with the wide range of products now available on the market. There is a need for PPRSD in collaboration with EPA to make available to stakeholders, a list of registered products, listing brand names, active ingredients, the manufacturing and or distributing company and registration number annually. Pesticide dealers and their staff need to understand the names of brands/ products and of active ingredients and their properties.

Existing farm practices such as mixed cropping can help control pests on the field. A large percentage of the farmers practice mixed cropping without knowing the role it plays in pest management. There is a need for AEAs to educate farmers in the scientific and environmental benefits of such practices.

It is necessary for pesticide manufacturing companies to include the possible signs and symptoms of ill health on pesticide labels/ by-packs to alert applicators on health related signs and symptoms. Health facilities should also be adequately equipped to handle pesticide cases and not just treat them as ordinary ailments. There is an urgent need to train health facilities in the countryside in recognizing and treating pesticide poisoning cases.

Agricultural extension, like other rural development programmes, require peoples' participation, hence the need to bring on board other stakeholders such as NGOs, FBOs and CBOs in the extension delivery of pesticide management information.

Since it is legally necessary and a competitive advantage for the source of registered pesticide dealers to have a minimum expertise in the SMP, farmers should be encouraged to access only registered dealers for their pesticide needs. This situation makes it imperative for PPRSD to mount more intensive training programmes for the pesticide dealers to ensure that farmers will be given appropriate information on the pesticides they obtain and to close non-registered shops.

Since farmers appear to rely more on themselves, family members and friends for pesticide application services, there is a need to intensify training in this area for them. Farmer-based–organisations can collaborate with PPRSD to train some of their members to render professional spraying services to them. This will minimize incidences of over-exposure to pesticide applicators.

Since, small-scale users of pesticides are unlikely to access more technical, health and safety information than that provided on the label, information on the appropriate method of disposal should be indicated on pesticide labels or by-packs by pesticide manufacturing companies. Alternatively, the pesticide companies/ dealers should offer channels for proper disposal, as is done in other countries.

Farmer training programmes on pest management should put an emphasis as well on alternative pest control methods. There is an urgent need for AEAs to clarify their advantages in order to disabuse the minds of farmers about negative assumptions they have about such methods.

As the main source of PMI to farmers, it is recommended that, steps are taken to develop the competencies of AEAs in SMP systematically so that, they will be better resourced to provide the needed information and skills on pesticide management to their clientele.

As farmers' knowledge about hazardousness of pesticides does not appear to play a significant role in influencing their decision on whether or how to use a pesticide, training programmes for farmers in pesticide management should lay emphasis on informed decisions-making in pesticide management.

It behooves on the Directorates of Agricultural Extension, Plant Protection and Regulatory Services, Pesticide companies and agricultural as well as Food Research to conduct training programmes that will increase the actual awareness levels of farmers for alternative pest control methods, as well as their actual awareness levels of environmental, safety and health implications of pesticide use in agriculture. These are major factors with positive impact on farmers' perceived competence in the sound management of pesticides.

In view of the relatively low awareness levels of farmers in the environmental, health and safety implications of pesticide use, there should be a policy of conducting epidemiological monitoring programmes in the study area on periodic bases by PPRSD. Results of these studies will then be better understood by trained farmers.

Information and research on traditional methods of pest control in the study area should be gathered as a matter of urgency. Such information can be used in IPM programmes to facilitate the sound management of pesticides by the farmers. Existing scientific information on traditional methods of pest control require evaluation, adaptation and extension of such methods.

Experienced farmers who are well educated must be trained in SMP to assist their colleagues to understand the technical issues involved in pesticide management since such farmers were cited as sources of PMI. These farmers can also be used as local trainers for illiterate farmers. Since they have a lot in common with the other farmers, the advantages of homophily will easily facilitate awareness creation and competence development among the trainees.

In view of the high illiteracy rate among farmers, both formal and informal training programmes should be organized by AEAs for the farmers to update them on current issues in pesticide management. The use of local dialects and more method and result demonstrations are recommended. As mentioned before, the training should not be only technical but include social, environmental and health aspects as well in order to improve learning and understanding.

There is need for researchers in collaboration with AEAs to monitor the results of technology transfer in the management of pesticides. This is the only way to gauge the efficiency of research and extension efforts. It will also improve the effectiveness of interactions with other institutions. Monitoring technology transfer in pesticide management is a way of eliciting feedback from farmers. This will make future activities in pesticide research and information dissemination more effective and will help to focus health services on the most frequent pesticide poison cases.

As radio and TV offer opportunities for low cost dissemination of general awareness type of information, these media channels can be used by the Directorates of Agricultural Extension, Plant Protection and Regulatory Services, for dissemination of simple information and for awareness creation on sound pesticide management practices.

Since farmers perceived themselves to be only generally moderately competent in most areas of pesticide management, extension campaigns/ training can rely on this gap as sufficient motivation for farmers to participate in pesticide management trainings.

The levels of self perceived competencies of stakeholders in pesticide management should be monitored regularly by the Directorates of Agricultural Extension and Plant Protection and Regulatory Services so that, training programmes are evaluated and planned as well as executed accordingly.

Suggested areas for further studies.

1. An evaluation of current and past pesticide management trainings for farmers, AEAs and pesticides dealers in the district should be conducted as basic inputs for subsequent trainings.
2. In view of farmers' inability to observe the required waiting periods after the application of pesticides to vegetables, it is important for Food Research Institute in collaboration with EPA to have periodic monitoring of pesticide residue levels in vegetables on the market to ensure the safety of consumers.
3. There is the need for a study on the posters, promotional materials and other types of information disseminated by pesticide companies and evaluate them for relevance and usefulness in raising the awareness levels of farmers and other stakeholders in the environmental, safety and health implications of pesticide management. They may also be critically reviewed for correctness of information and steps being taken to withdraw inappropriate information.
4. A study to evaluate the various modes of information dissemination used by AEAs for the dissemination of pesticide management information among farmers in the study area should be carried out to determine their effects on the awareness level of small-scale farmers and to identify the most efficient methods.
5. Training needs assessment of AEAs, pesticide dealers and farmers in the SMP needs to be carried out to facilitate the drawing of a programme for their training.

REFERENCES

Agne, S. (2000). *The Impact of Pesticide Taxation on Pesticide Use and Income in Costa Rica's Coffee Production.* Hannover, Germany. Pesticide Policy Publication Series, (4), University of Hannover.

Ajayi, O. O. C. (2000). *Pesticide Use Practices, Productivity and Farmers' Health: The Case of Cotton-Rice Systems in Côte d'Ivoire, West Africa.* Hannover, Germany. Pesticide Policy Publication Series, (2), University of Hannover.

Al-Hassan, R. & Jatoe, J. B. (2005*). Socio Economic Study of Pesticides in Ghana. (Implications for Development of Biopesticides).* Draft Final Report.

Aryeetey, E. (2004). Household Asset Choice among Rural Poor in Ghana. *Proceedings of workshop for the Project on Understanding Poverty in Ghana*. Institute of Statistical, Social and Economic Research (ISSER).

Atteh, O. D. (1987). Pesticide Flow and Government Attitude to Pests and Pesticides in the Kwara State, Nigeria In: Tait, J. and B. Nappompeth (eds) *Management of Pests and Pesticides : Farmers' Perceptions and Practices*., Boulder and London. West View Press.

Best, J. W. & Kahn, J. V. (1998). *Research in Education*. (8th ed.) Boston. London. Toronto. Sydney. Tokyo. Singapore. Allyn and Bacon.

Biney, P.M. (2001). *Pesticide Use Pattern and Insecticide Residue Levels in Tomato (Lycopersicum esculentum Mill.) in some selected Production Systems in Ghana*. Unpublished M. Phil Thesis. University of Ghana, Legon, Ghana.

Boadu-Ayebosafoh, Y. (ed.) (2004, Friday, 23 July Edition). Food and Drugs Board Warn against Vegetables from Tarkwa Area. News Extra. *The Daily Graphic*. Accra. p. 23.

Bosompem, M. (2006). *Cocoa Farmers' Perceived Impact of the Cocoa High Technology Programme on Their Livelihoods in the Eastern region of Ghana.* Unpublished M. Phil. Thesis. University of Cape Coast. Ghana

Bryness, F.C. and Bryness, K. J. (1978). Agricultural Extension and Education in developing countries. *Rural Development in a Changing World.* pp. 54-67.

Childs, F.J. (1999). *Improvement of Neem and Its Potential Benefits to Poor Farmers in Developing Countries.* (Project ZFO121/R7348) UK. Department for International Development.

Chivinge, O. A., Sithole, S. Z. & Keswani, C. L. (1999). Trends in Agricultural Pest Problems and management strategies in Zimbabwe. In G. D. Mudini, H Waibel & G. Fleischer (eds.) *Pesticide Policies in Zimbabwe. Status and Implications for Change.* (pp 1-15). Hannover, Germany. Pesticide Policy Publication Series, No. 4, University of Hannover.

Clarke, E. E. K., Levy, I. S., Spurgeon, A. & Calvert, I. A. (1997) The Problem Associated with Pesticide Use by Irrigation Workers in Ghana. *Journal of occupational Medicine. 47*(5), 301-308.

Conelly, W.T. (1987). Perception and Management of crop pests among subsistence farmers in South Nyanza, Kenya. In Tait, J. and B.

Napompeth (ed.), *Management of pests and pesticides: farmers perception and practices.* Boulder and London: West View Press.

Critchley, B. R. (1996). Pests of vegetables: their Identification and control in Ghana. Natural Resources Institute, University of Greenwich.

Dankwa, J.B. (2005). *Factors Affecting the Adoption Levels of Cocoa Technologies in the Ashanti Region of Ghana*. Department of Agricultural Economics and Extension Unpublished doctoral dissertation University of Cape Coast, Ghana.

Davis, J. A. (1971). *Elementary Survey Analysis*. Englewood, NJ. Prentice-Hall

Davis, M. (1997) Ghana goes for IPM, *http//www.pa-uk.org/articles/pn38p4.html*

Dixon, G. A. (1995) *Chemical Pest Control: Its impact on the Environment and Challenges in Ghana*. Unpublished doctoral dissertation, Pacific Western University, USA.

Editorial. (2000, December). *Pesticide Management for West Africa*. p. 1.

FAO. (1986b). *FAO Production year book. 39* Rome. Food and Agricultural Organization of the United Nations.

FAO (1990). Overview of vegetable IPM in Asia, *FAO Plant Protection Bulletin* 38 (2): 63 – 86.

FAO (2002). *International Code of Conduct on the Distribution and Use of Pesticides.* Rome. Food and Agricultural Organization of the United Nations.

Farah, J. (1994) *Pesticide Policies in Developing Countries. Do they encourage Excessive use?* World Bank Discussion Paper No. 238. Washington DC.

Fleisher, G. (1999). The Role of Economic Analysis of Pesticide Use and Policy – Experiences from Country Case Studies. In: G. D. Mudini, H. Waibel & G. Fleischer (eds.) *Pesticide Policies in Zimbabwe. Status and implications for change.* (pp. 208-220) Hannover, Germany. Pesticide Policy Publication Series, No. 4, University of Hannover.

Gamble, T. K. & Gamble, M. (2002). *Communication Works*. (7th ed) McGraw Hill /Irvin. Inc. New York. pp. 82-107.

Gerken, A., Suglo, V. & Braun, M. (2001). *Crop Protection Policy in Ghana*: An Economic Analysis of Current Practices and Factors Influencing Pesticide Use. Pokuase/Accra, Ghana. Integrated Crop Protection Project PPRSD/GTZ,

Ghana Statistical Services (2002), *2000 Population and Housing Census*. Accra, Ghana. Ghana Statistical Services.

Grandstaff, S. (1992) *Pesticide policy in Thailand*. Bangkok, Thailand. Thailand Development Research Institute.

Gupta, Vijay (2000). *Regression explained*. VJ Books Inc. Georgetown, Washington, DC. p. 190

Gyimah, N. A. (2003). *Perceived impact of Three Years of Extension Training on the Competence of Agricultural Extension Agents and Farmers in the Kwahu-South and Suhum-Kraboa –Coaltar Districts in the Eastern Region of Ghana.* Unpublished M. Phil Thesis. University of Cape Coast. Ghana

Hanshi, J. A. (2001) Use of Pesticides and Personal Protective Equipment by Applicators in a Kenyan District. *African Newsletter on Occupational Health and safety. 11* (3) 74-76

Hillocks, R. J., Phiri, N.A. & Overfield, D. (1999). Coffee Pest and Disease for Small Management Options for Smallholders in Malawi. *Crop Protection 18*: 199 – 206

Isreal, G. D. (1992). *Sampling: The Evidence from Extension Program Impact.* Gaineville, FL: University of Florida.

Joint Committee on Administrative Rules (1988) Illinois Administrative code 250 Illinois Pesticide Act. Section 250. 110 General Competency Standards to be covered on the tests.

Jungbluth, F. (2000). *Economic Analysis of Crop Protection in Citrus production in Central Thailand.* Hannover, Germany. Pesticide Policy Publication Series, No. 4, University of Hannover.

Kaiwa, F. (2000). *Studies on the Biology and Activity Level of Carboxylesterase as an Indicator of Insecticide Resistance in Populations of Diamond-back Moth, Plutela xylostella (L). (Lepidoptera: Plitellidae) on Cabbage in Ghana.* Unpublished M.Phil Thesis, University of Ghana, Legon. Ghana.

Kannan, K. S.; Tanabe, A; Ramesh, A; Subramanian, S & Tatsukawa, R. (1992). Persistent Organochlorine Residuals in Foodstuffs from India and their Implications on Human Dietary Exposure. *Journal of Agricultural and Food Chemistry. 40,* 518 – 524.

Kishi, M., Hirschon, N. Djajadisastra, M. , Saterlee, L. N. , Strowman, S. and Dilts, R. (1995). Relationship of Pesticide Spraying to Signs and

Symptoms in Indonesian farmers. <u>*Scand. J. Work Environ. Health*</u> <u>*21*</u>, 124-133.

Knox, A. B. (1977). Adult development and learning. *A Handbook of Industrial Growth and Competency in the Adult Years*. San Francisco. Jossey –Bass.

Kujeke, R. (1999) Pesticide use Information Flows in Zimbabwe. In: G. D. Mudini, H. Waibel & G. Fleischer (eds.) *Pesticide Policies in Zimbabwe. Status and implications for change.* Hannover. Germany. Pesticide Policy Publication Series, No. 4. Hannover.

Kyei-Manu, M. (2006). Personal communication, May, 11, 2006.

Kumar, R. (1986) <u>*Insect Pest Control with special reference to African Agriculture.*</u> ELBS /Edward Anolds.

La-Anyane, S. (1985) *Economics of Agricultural Development in Tropical Africa.* London. John Wiley.

Mabbett, T. (2004a, July/ August). IPM the African Way. *African Farming and Food Processing.* pp. 15-16.

Mabbett, T. (2004b, November/December). Safe Spraying for Citrus. *African Farming and Food Processing*. p. 12-13

Majule, A.E, Topper, C.P. & Nortchiff, R. (1997). The Environmental effects of Dusting Cashew (*Anarcardium accidentale* L.) Trees with Sulphur in Southern Tanzama. Tropical Agriculture (Trinidad), 74 (1) January 1997 p. 25.

Matthews G., Wiles, T. & Baleguel P. (2003). A Survey of Pesticide Application in Cameroon. *Crop Protection 22*, 707-714.

National Agricultural Research Project, (NARP) (1993), Plant Protection and Pesticide Regulation, A report by the Commodity Committee of NARP Appendix V1. Vol. 9. p. 73.

Nelson, N. (1981). *African Women in the Development Landscape*. London. Case and Company Ltd.

Neuman, W.L (2003) *Social Research Method: Qualitative and Quantitative Approaches.* 5th ed. New York. Pearson Education Inc.

Ntifo-siaw, E. (1993). *Managing Agricultural Extension: Perceived Performance of the T & V and General Extension Approaches in Ghana.* Unpublished doctoral dissertation, Ohio State Unversity.

Ntow, J. W. (2001) Organochlorines Pesticides in Water, Sediments, Crops and Human Fluids in a Farming Community in Ghana. *Arch. Environ. Contamination. Toxicol. 40,* 557-563.

Okorley, E.L. & Kwarteng, J. A. (2002). An Investigation into the Use of Pesticides by Urban and Peri-urban Vegetable Growers in the Central Region of Ghana. Sustainable Food Security in Central West Africa. Working Papers Series No. 19: SADOAC. Conference Internationale de Bamako les 9 – 11, September 2002. http://www.sadaoc.bf/francais/ComBko.htm

Okorley, E. L., Kwarteng, J. A. & Mensah, A.O. (2005). Extension Training Needs in Pesticide use by Urban and Peri-Urban Vegetable Growers in The Central Region of Ghana. *Journal of Extension Systems 21* (1): 14-30.

Osafo, S. & Frempong F. (1999). Lindane and Endosulfan Residual in Water and fish in the Ashanti Region of Ghana. *Journal of the Ghana Science Association 1*, 1

Osorio L. G. & Travaglini A. L. (1999, September) Pesticides in Peru's Highlands. *ILEIA Newsletter*. p. 5.

Pallant, J. (2001). *SPSS Survival Manual-A step by step guide to data analysis using SPSS for windows* (Version 10). Australia. Allen and Urwin. p. 136.

Pearce, D. & Tinch, R. (1998). The True Price of Pesticides. In: Vorley, W., Keeney, K. (eds.) Bugs in the System. Redesigning the Pesticide Industry for Sustainable Agriculture. Earthscan, London.

Pidwirny, M. J. (2002). Pesticide Use and Abuse. Land Use and Environmental Change in the Thompson – Okanagan. Royal British Museum.

Rogers, E. M. (1983). *Diffusion of Innovations.* (3rd ed.). New York. The Free Press. A Division of Macmillan Publishing Co Inc,

Rubin, R. B. (1985). The Validity of the Communication Competency Assessment Instrument. *Human Communication Research 18,* 625 – 636.

Sarantakos, S. (1998) *Social Research*. 2nd ed. Australia. Macmillan Press Ltd.

Spitzberg, B. H. (1993). The Dark Side of (in) Competency. Paper presented at the Western Speech Communication Association Conference. Albuguergue. NM.

Spitzberg, B. H. and Cupach, R. (1989). *Handbook of Interpersonal Competency Research.* New York. Springer- Verlag.

Swanson, B. E. (1998). Strenghtening Research-Extension-Farmer Linkages. In: B. E. Swanson, R. P. Bemtz & A. J. Sofranko (eds.) *Improving Agricultural Extension. A Reference Manual:* Rome. FAO.

Tayaputch, N. & Mahittikurin, S. (1980) Pesticide Residues in Birds. Toxic Substances in: *News and Reports. 11*: 162-172

Ulluwishewa, R. (1993). Indigenous Pest Control Methods in Sri Lanka. *Honey Bee 4*(1): 3-4

Van den Ben, A .W. and Hawkins, H. S. (1996). *Agricultural Extension* (2nd ed). London. Blackwell Science Ltd.

Van den Bor, W. and Hoogen J. (1996). Didactic skills: Resource book and reader. Wageningen, The Netherlands. Wageningen Agricultural University.

Wascana Institute (1993). Training for the Development and Delivery of Short Courses. Saskatchewan Institute of Applied Science and Technology (SAST) Winnipeg, USA.

WHO (1990) *Public Health Impact of Pesticide Use in Agriculture.* Geneva, World Health Organisation.

Wiemann, J.M. (1997). Explication and Test of Model of Communication Competency. *Human Communication Research, 3.* 195-213

Williamson, S. (2003, February) The Dependency Syndrome: Pesticide Use by African Smallholders. *Pesticide Action Network PAN* UK, London pp 126-128.

Williamson, S. (2005). Breaking the Barriers to IPM in Africa: Evidence from Benin, Ethiopia, Ghana and Senegal. In: J. Pretty (ed). *The Pesticide Detox.* London. Sterling VA. EARTHSCAN.

Youdoewei, A. & Kwarteng, J.A. (1995). Development of Training Material in Agriculture. Hong Kong. Clorcraft.

Zhang, Z. (1992). Extension Educator: *Practical Application and Experience in China.* Paper presented at an International Seminar on Important trends in Agricultural Extension, PRC: Beijing

Zinnah M. M. (1999) Lecture Notes in Extension communication on the Topic: Facilitating adoption/Adaptation and Diffusion of Agricultural Innovations – An Experiential Learning Approach. U.C.C. Cape Coast.

APPENDICES

Appendix 1

Davis' Convention for Describing Magnitude of Correlation Coefficients

	Magnitude of Correlation Coefficients (r)	**Description**
1	1.0	Perfect
2	0.70 - 0.99	Very High
3	0.50 - 0.69	Substantial
4	0.30 - 0.49	Moderate
5	0.10 - 0.29	Low
6	0.01 – 0.09	Negligible

Source: Davis (1971)

Appendix 2

INTERVIEW SCHEDULE FOR SMALL-SCALE FARMERS

PESTICIDE USE BY SMALL SCALE FARMERS AND EXTENSION INFORMATION SUPPORT FOR PESTICIDE MANAGEMENT IN THE GA EAST AND WEST DISTRICTS OF THE GREATER ACCRA REGION OF GHANA

INTRODUCTION

Thank you for your willingness to participate and share your precious time with us in an effort to bring to light some issues on pesticide use by small scale farmers in your area. Your ideas and experience in pesticides use, comments and suggestions are very important to this study.

Information from the study will be useful for planning, promoting and making decisions related to improving pesticide management in the district and also to enhance farmers' food safety and security. Furthermore, the results will be used to assist top management of the Ministry of Food and Agriculture (MOFA), the District Assemblies, NGOs, research institutions and other public and private sector development partners to make informed decisions for improvements in agricultural training and development programmes for small scale farmers.

General Guidelines

1 .Please respond to this interview schedule in terms of your most sincere beliefs.
2. Please, most of the answers may require only one answer but there may be few instances whereby more than one answer may be appropriate.
3. Some of your answers will be recorded in tabular form.
4. There are no right or wrong answers.
5. The information you provide will be handled confidentially
.

Thank you.

PART 1
BACKGROUND OF FARMER

1. District: ____

2. Village/ Town: ___________________________________

3. Sex: a) [ ] Male b) [ ] Female

4. Age at your last birthday in years ____________________________

5. Please indicate your highest educational qualification by ticking [ ].
   - a) [ ] No formal education (NFE)
   - b) [ ] Middle school learning certificate (MSLC)
   - c) [ ] Basic education certificate (BEC)
   - d) [ ] General certificate of education (GCE).
   - e) [ ] Senior Secondary School Certificate (SSSC)
   - f) [ ] Technical School (TS)
   - g) [ ] Teachers' Training College (TTC)
   - h) [ ] Tertiary.
   - i) [ ] Other (Specify)

   ____

6. For how long have you been farming? _________________________ years.

7. Please indicate your category of farming:
   - a) [ ] Full time
   - b) [ ] Part time

8. Please indicate your major occupation if you are not a full time farmer

   ____

9. What are the five (5) major crops on your farm? (List in order of importance).

   ____

   ____

   ____

   ____

   ____

   ____

10. Do you practice mixed cropping?
    - a) [ ] Yes
    - b) [ ] No

11. If "Yes" why do you practice mixed cropping?

    ____

PART TWO

PESTICIDE USE

12. Please indicate whether you use pesticides to control pests and diseases on your farm.

a) [ ] Yes
b) [ ] No

13. What are your main reasons for using methods other than chemical control?

____
____
____
____
____

14. If no other method than chemical control is used, why are they not used? (Multiple response possible).

a) [ ] Too risky
b) [ ] Does not work.
c) [ ] Lower yields
d) [ ] Not enough knowledge.
e) [ ] Not interested.
f) [ ] Too expensive.
g) [ ] Too much labour
h) [ ] AEA or pesticide dealer, advice.
i) [ ] Others
(specify)____

15. If you use pesticides in your farming operations, please indicate the types of pesticides you use. (Multiple response possible).

a) [ ] Insecticides.
b) [ ] Rodenticides.
c) [ ] Herbicides.
d) [ ] Fungicides.

16. What do you use pesticides for? (Multiple response possible).
a) [ ] Cropping.
b) [ ] Fishing.
c) [ ] Trapping of rodents
d) [ ] Public health (household).
e) [ ] Animal health
f) [ ] Grain and legume preservation

17. What are your sources of obtaining pesticides? (Multiple response possible).

a) [ ] A.E.A
b) [ ] Agrochemicals dealer
c) [ ] Other farmers
d) [ ] Market
e) [ ] Pesticide peddlers
f) [ ] Others

18. Are Pesticides available to you when you need them?
a) [ ] Always
b) [ ] Rarely
c) [ ] Never

19. Distance to source(s) of pesticides from your farm.
a) [ ] < 6 miles
b) [ ] 6–10
c) [ ] 11–15
d) [ ] 16 – 20
e) [ ] 21 – 25
f) [ ] > 25 miles

20. What is your perception of the cost of pesticides?
a) [ ] Very high
b) [ ] High
c) [ ] Moderate
d) [ ] Low
e) [ ] Very low

21. Please indicate how much of the following pesticides were used in the last farming season.

TYPE OF PESTICIDE	**Quantity (litres/ Kg.)**
Insecticides	
a) Liquid	
b) Powdered	
Herbicides	
a) Liquid	
b) Powdered	
Rodenticides	
a) Liquid	
b) Powdered	
Fungicides	
a) Liquid	
b) Powdered	
Others	
a) Liquid	
b) Powdered	

22. Which factors influence your decision of applying a pesticide? (Please tick).

Factors	Choice
a) Products neighbours or friends are using	
b) Knowledge or information about effectiveness of pesticides	
c) Pest occurrence in former years	
d) Crop loss assessment	
e) Management system successful over long time	
f) Price of pesticide	
g) Promotion of chemical industry	
h) Recommendation (from extension worker)	
i) Recommendation from other people (CBO, FBO or NGO)	
j) Knowledge about hazardousness of pesticide chosen	
k) Information from other sources like radio, newspaper, magazines, etc.	
l) Price of farm product	
m) Recommended by input dealer	
n) Recommended by trader	
o) Others (specify)	

Which factors influence your decision on which pesticide to buy? (Please tick).

Factors	Choice
a) Products neighbours or friends are using	
b) Knowledge or information about effectiveness of pesticides	
c) Pest occurrence in former years	
d) Crop loss assessment	
e) Management system successful over long time	
f) Price of pesticide	
g) Promotion of chemical industry	
h) Recommendation (from extension worker)	
i) Recommendation from other people (CBO, FBO or NGO)	
j) Knowledge about hazardousness of pesticide chosen	
k) Information from other sources like radio, newspaper, magazines, etc.	
l) Price of farm product	
m) Recommended by input dealer	
n) Recommended by trader	
o) Others (specify)	

24. Please indicate whether you use cocktail (pesticide mixtures) for spraying.

a) [ ] Yes
b) [ ] No

25. Give reasons for your answer.

____

____

26. Who recommended it to you? (Multiple response possible).
a) [ ] A.E.A
b) [ ] Pesticide dealer
c) [ ] Salesman from pesticide company
d) [ ] Other farmers
e) [ ] Own experience only.

27. Who applies the pesticides on your farm? (Multiple response possible).
a) [ ] Professional Sprayer
b) [ ] The farmer himself
c) [ ] Farmer's Children/ Family member
d) [ ] A.E.A
e) [ ] Fellow farmer
f) [ ] Others
(specify)____

28. Do you use protective clothing when you apply pesticides?
a) [ ] Yes
b) [ ] No

29. If your answer is "Yes", please indicate which of these resources are used when you apply pesticides. Multiple response possible)
a) [ ] Spraying machine
b) [ ] Wellington boots
c) [ ] Overall (Clothing)
d) [ ] Gloves (Rubber)
e) [ ] Goggles
f) [ ] Respirators
g) [ ] Ear defenders

30. Do you examine your equipment and protective clothing before usage?
a) [ ] Yes
b) [ ] No

31. If 'Yes' please indicate how often you examine them
a) [ ] Always
b) [ ] Sometimes
c) [ ] Never

Equipment	**Always**	**Sometimes**	**Never**
a) Spraying machine			
b) Wellington boots			
c) Overall (Clothing)			
d) Gloves			
e) Goggles			
f) Respirators			
g) Ear defenders			
h) Cap			

PART 3
Perceived competencies of farmers in safe use of pesticides

32. Please indicate the extent to which you believe your competency level is in the various areas for safe use of pesticides by using the scale below:

Very High (VH) = 5
High (H) = 4
Moderately High (M) = 3
Low (L) = 2
Very Low (VL) = 1

Competencies needed for safe use of pesticides	**VH 5**	**H 4**	**M 3**	**L 2**	**VL 1**
a) Identification of pests and diseases					
b) Identification of beneficial insects / arthropods					
c) Determination of possible pest damage					
d) Identification of pesticides					
e) Classification of pesticides					
f) Pesticides selection					
g) Dosage determination					
h) Calibration of spraying machines					
i) Reading pesticide labels					
j) Understanding pesticide labels					
k) Understanding pictograms					
l) Proper handling of pesticides					
m) Use of protective clothing					
n) Precautions when spraying					
o) Maintenance of personal hygiene					
p) Maintenance of spraying machine					
q) Storage of pesticides					
r) Disposal of pesticide containers					
s) First Aid in pesticide poisoning					
t) Alternative pest control methods					
u) Decision on when to use pesticides					
v) Food safety issues e.g. EurepGAPs, MRLs.					
w) Others (specify)					

33. If you do not understand the labels, who helps you to understand the information on the label? (Multiple response possible).

a) [ ] AEA
b) [ ] Other farmers
c) [ ] Agro-chemical sellers
d) [ ]
Others(specify____

33 Which equipment do you use in applying your pesticides? (Multiple response possible).

a) [ ] Mist blower
b) [ ] Knapsack
c) [ ] Broom
d) [ ] Others (specify)______________________________________

34. Do you own a spraying machine?

a) [ ] Yes
b) [ ] No

If your answer to Q 34 is "No" please go to Q 37

35. If 'Yes' which type of spraying machine do you have?

a) [ ] Motorized Knapsack
b) [ ] Lever operated knapsack
c) [ ] Both
d) [ ] Other

36. Who services the spraying machine? (Multiple response possible).

a) [ ] Self
b) [ ] Mechanic
c) [ ] AEAs
d) [ ] Input dealer
e) [ ] Others (specify) ___________________________

37. Where do you store your pesticides? (Give details)

a) At home____

b) On the farm____

c) Others (specify____

38. Do you keep the pesticides in containers other than the original containers?

a) [ ] Yes
b) [ ] No

39. How do you dispose of the empty containers of pesticides? (Multiple response possible).

a) [ ] Burn
b) [ ] Throw away
c) [ ] Bury them
d) [ ] Crash and bury deep
e) [ ] Domestic use
f) [ ] Any other (specify) _____________________________

40. If for domestic use, please indicate what you use the empty containers for. (Multiple response possible).

a) [ ] Kerosene
b) [ ] Palm wine
c) [ ] Drinking water
d) [ ] Others (specify) ___________________________________

Part 4
Environmental, safety and health awareness level

41. Has somebody in your community suffered from pesticide contamination before?

a) [ ] Yes
b) [ ] No
c) [ ] Not aware

42. What do you do in case of pesticide poisoning?

____
____
____

43. Have you ever suffered from any of the following during and/or after application of pesticides? (Multiple response possible).

a) [ ] Burning sensation on skin
b) [ ] Itchy or watery eyes
c) [ ] Very cold
d) [ ] Dizziness
e) [ ] Headache
f) [ ] Nausea or vomiting
g) [ ] Coughing
h) [ ] Breathing difficulties
i) [ ] None
j) [ ] Others (specify)

____

44. Have you ever sought medical attention (including conventional or traditional medicine or self-medicated) for any of the above conditions?

a) [ ] Yes
b) [ ] No

45. Are you aware of the EUREPGAPs protocol?

a) [ ] Yes
b) [ ] No

46. If "yes", do you apply it on your farm?

a) [ ] Yes
b) [ ] No
c) [ ] Plan to apply it in future

47. How long do you wait after applying a pesticide before harvesting?

a) [ ] same day
b) [ ] a day after application
c) [ ] a week after application
d) [ ] depends on the type of pesticide used

48. Please indicate your environmental, safety and health awareness levels during
pesticide use by using the following ratings:

Very High (VH) = 5
High (H) = 4
Moderately High (M) = 3
Low (L) = 2
Very Low (VL) = 1

Environmental, safety and health awareness of effects of pesticides	**VH 5**	**H 4**	**M 3**	**L 2**	**VL 1**
a) Environmental hazards from pesticide use					
b) Pesticide residues in agricultural products					
c) Effects of pesticides on public health					
d)Effects of pesticides on game and wildlife (birds and fish)					
e) Effects of pesticides on livestock, bees and other pollinating insects e.g. butterflies and ants.					
f) Effects of pesticides on natural enemies of pests					
g) Effects of pesticides on development of pest resistance					
h) Effects of pesticides on resurgence of pests					
i) Waiting periods after pesticide application before harvesting					
j) Adverse effects of pesticides on non-target organisms					

Part 5
Alternative pest control methods

49. Are you aware of alternative pest control measures other than the use of pesticides?
a) Yes [ ]
b) No [ ]

50. If your answer to the above is "yes" please indicate your level of awareness of the various alternative methods by using the following ratings:
Very High (VH) = 5
High (H) = 4
Moderately High (MH) = 3
Low (L) = 2
Very Low (VL) = 1

Alternative means of pest control	**VH 5**	**H 4**	**MH 3**	**L 2**	**VL 1**
a) Biological					
b) Physical (removal, burning)					
c) Cultural (crop rotation, mixed cropping					
d) Indigenous					
e) Integrated Pest Management (IPM)					
f) Biopesticides					
g) Hygiene (removal of diseased plants and harvest residue)					
h) Others (specify)					

Part 6

Information support for pesticides management

51. Please indicate the sources of pesticide use information available to you by ticking Available (A) or Not Available (NA).

Information source	A	NA
a) Extension		
b) PPRS		
c) Pesticides dealer		
d) Pesticide company		
e) Other farmers		
f) Radio		
g) TV		
h) Print Media (Newsletters/Journals)		
i) Researchers and Universities		
j) Farmer's own experience		
k) Extension demonstration (Method / Result demonstration)		
l) Others		

52. Please indicate your perceived effectiveness of the underlisted sources of pesticide use information using the adjectives below:

Very effective (VE) = 3
Effective (E) = 2
Not effective (NE) = 1

Information source	Perceived effectiveness		
	VE	E	NE
a) Extension			
b) PPRSD			
c) Pesticides agents			
d)Pesticide company			
e)Other farmers			
f) Radio			
g) TV			
h) Print Media (Newsletters/Journals)			
i) Researchers and Universities			
j) Farmer's own experience			
k) Extension demonstration (Method / Result demonstration)			
l) Others			

53. How many training courses have you attended on pesticide management in the last two years?

a) [ ] 0 b) [ ] 1 c) [ ] 2 d) [ ] 3

e) [ ] 4 f) [ ] 5 g) [ ] > 5

54. Who are organizing the training?

a) [ ] Extension

b) [ ] Plant Protection and Regulatory Services Directorate

c) [ ] Pesticide company

d) [ ] Other (Please specify)

55. List additional information and services you require on pesticides and pesticide use.

____

58. Make recommendations for improvement of information support for pesticide management (e.g. information channel used, frequency of training etc.)

____

End of schedule