ASSESSMENT OF OCCUPATIONAL AND ENVIRONMENTAL SAFETY CONCERNS IN PESTICIDE USE AMONG SMALL-SCALE FARMERS IN SAGANA, NYERI DISTRICT, KENYA

By

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Declaration

This thesis is my original work, and has not been presented for a degree or any other award in any other University.

Signed________________________ Date 01/12/08

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This thesis has been submitted for examination with our approval as University supervisors:

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Dedication

To my mother Mary Njambi, who though she lacked formal education taught me values that are and will remain a source of eternal inspiration.

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Above all this, work is dedicated to almighty God whose kindness and mercy lasts forever.

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ATSDR	Agency for Toxic Substances and Disease Registry
CBS	Central Bureau of Statistics
DDE	Dichloro-diphenyl-ethane
DDD	Dichloro-diphenyl-dichloro-ethane
DDT	Dichloro-diphenyl-trichloro-ethane
EMCA	Environmental Management and Coordination Act
EUREP GAP	European Retailers Protocol on Good Agricultural Practice
FAO	Food and Agriculture Organization of the United Nations
GAP	Good Agricultural Practice
GOK	Government of Kenya
ILO	International Labour Organization
LCA	Life Cycle Approach
MRLs	Maximum Residue Limits
NEMA	National Environment Management Authority
PCPB	Pesticides Control Products Board
PHI	Pre-Harvest Interval
POPs	Persistent Organic Polutants
PRA	Participatory Rural Appraisal
UKPAN	United Kingdom Pesticides Action Network
UNEP	United Nations Environmental Programme
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation
WRI	World Resource Institute

Abstract

The purpose of this study was to examine whether farmers' perceptions, attitudes and behaviour with respect to handling pesticides in Sagana Nyeri district Kenya predisposed them and their environment to pesticide-related hazards. The objectives of the study were: a) to determine the farmer's attitudes, perceptions and behaviour towards pesticides at Sagana, b) to assess the potential occupational safety hazards associated with such attitudes, perceptions and behaviour, and c) to determine the potential hazards to the environment resulting from observed farmer-pesticide interactions at farm level. The study adopted a Life Cycle Approach where hazards to human health and the environment were evaluated at all stages of pesticide handling including purchasing phase, transportation, storage, mixture preparation, application and disposal. Data were both qualitative and quantitative in nature and were collected using questionnaire surveys, interview schedules, participatory rural appraisals, field observations and content analysis for secondary data. Descriptive and inferential statistics were used for data analysis. Person's correlation coefficient was particularly useful in determining the relationships between selected key variables. Results showed that farmers had high levels of perceived vulnerability, perceived severity and perceived benefits of taking action to mitigate pesticide hazards. However, barriers to taking safety measures included perceived high cost of personnel protection gear, apathy and resignation to fate, and low levels of training in pesticide management. Most farmers engaged in activities hazardous to human health such as spraying in windy weather (96%), storing pesticides in the main houses (96%) thus exposing particularly children to danger, not changing clothes after work (84%) and eating or smoking while handling pesticides (83%). Farmer activities hazardous to the environment included failure to calibrate pesticide application equipments (89%), spraying during windy weather (97%), lack of appropriate pesticide measuring equipment (84%) and disposing empty containers and excess mixes to the environment. Trained farmers engaged less in hazardous pesticide handling activities than untrained farmers. Further, contrary to conventional thinking, formal education did not play a significant role towards adoption of safety behaviour. Highly hazardous products banned in many developed countries like DDT were still in use. Over 69% of farmers took no action to protect themselves from pesticide hazards resulting in potentially risky operator exposure. There was evidence that significant poisoning was occurring as 79% reported signs of ill health associated with pesticide exposure. These included breathing problems (25%) skin problems (18%) and chest pains (14%). Therefore, for pesticide safety to be raised and inculcated among low-income farmers, extension, training and education must urgently address issues predisposing farmers to pesticide hazards along the pesticide-handling life cycle as described above. Changes in perceptions and attitudes and hence behaviour when dealing with pesticides are the most important policy and action challenges. Policy interventions should also encourage collective responsibility among all stakeholders in the pesticide life cycle in minimising the hazards. Investment in alternative technologies should also be emphasised, given the growing importance of biotechnology and eco-products in the global market.

CHAPTER ONE: INTRODUCTION

1.1 Background

The explosion of global demographic growth in the last century and the average increase in the standard of living in most countries has led to an increase in food needs and higher demand for food products of impeccable quality. The main possibilities for increasing production are increasing the surface area cultivated or improving the productivity per unit area. In practically all regions of the world, farmers are faced with the limitation of available arable land, and a decrease in soil fertility. Therefore, the option for farmers in the medium and long-term production is agricultural intensification and hence the use of agrochemicals. As a result, preventing, minimising and controlling occupational health and environmental hazards associated with pesticide use remain an important concern in such agro ecosystems.

For the last few years, the pesticide market has grown considerably. Worldwide trading figure for chemicals was valued at 1700 billion Euros in the year 2000 (Bruno, 2006). According to UNEP (1985), 2-3 million tonnes of pesticide products are scattered all over the environment each year in an attempt to control pests and diseases. Although this results in the consumer having better supply of food, inappropriate and/or excessive use of pesticides, has various undesirable side effects especially regarding the environment and human health. ILO (1999) estimates that there are some 3 million acute cases of pesticides related poisoning in the world each year, seventy percent of which take place in developing countries and 340,000 results to death.

Generally, in the developing world, pesticides use is by farmers with generally low literacy level and poor knowledge of their safe use and handling procedures. Even where there is knowledge of the hazards involved, their reduction measures like use of proper personal protective equipments are not put in place. Farmers have accepted the hazards because of the perceived economic gains derived from farming with little consideration of the danger involved especially when pesticide are mishandled or used for the wrong purpose. The resultant undesirable effects have led many international organizations such as FAO, UNEP and WHO, to develop codes of practices that encourage governments to revise their regulations for safe production, purchasing, marketing and use of pesticides. The whole of chapter 19 of agenda 21 addresses the need for environmentally sound management of toxic chemicals. For more effective implementation of this chapter, UNEP (1994) identified among other key areas the following needs. (a) Accelerated assessment of chemical risks (b) Establishment of risk management programmes and (c) Strengthening capacities and capabilities for chemical management. Pesticides constituted nine out of the 12 persistent organic pollutants (POPs), which the Stockholm convention to which Kenya became a party in May 2001 sought to regulate to protect human health and the environment from their adverse effects (GOK 2007).

In Kenya, Pests Control Products Board (PCPB) is the statutory organization that oversees all matters pertaining to pesticides. PCPB operates under the pesticides control products act (CAP 346), which regulates the manufacture, importation, exportation distribution and use of pesticides. Importation of pesticides in Kenya does not have a definite trend over the last ten years (Figure 1.1). According to NEMA (2005), the lowest importation volume was in 1994 (4,000 tons) worth Kenya shillings 1.283 billion while the highest was in 1998 (7,600 tons) worth Kenya shillings 3.114 billion, placing the country among the highest pesticide users in sub-Saharan Africa (Farah, 1994).

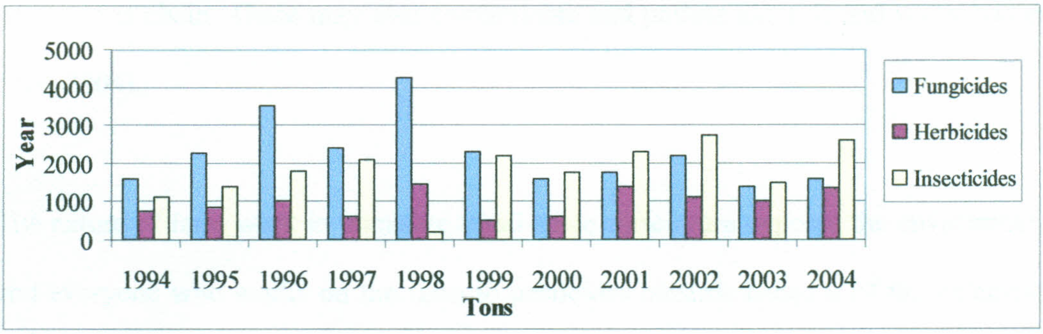


Figure 1.1 Kenya's pesticide imports from 1990 to 2004 (Source: NEMA, 2005)

NEMA further estimates that Pesticides poison 7% of agricultural sectors population in the country every year and a quarter of farmers in major horticultural areas regularly suffer from pesticides related illnesses. However, these figures are conservative and mainly derived from large-scale agriculture where workers seek poisoning compensation from their employers. In small-scale rural set-up like Sagana, with poor monitoring and reporting systems, more cases could be going unreported. According to Strohmer *et al.* (1993), even in developed states like California, some researchers estimate that as much as 80% of the pesticide illnesses are unreported. Environmental Management and Coordination Act (EMCA, 1999) Sections 94 to 100 offer national guidelines for safe use and handling of pesticides in Kenya.

The health effects of pesticide exposure can be immediate and include rashes, headaches, nausea and vomiting, disorientation, shock, respiratory failure, coma, and in severe cases, death (Moses *et al.*, 1993). Long-term effects on health include cancer, neurological and reproductive problems (Garcia, 1998). Chemical pesticides, and the strategies by which they are applied to fight crop pests, can also have unintended harmful consequences to the environment (WRI, 1994). This can be attributed to use of persistent pesticides that build up in living organisms polluting a whole food chain. These may also contaminate and pollute air, soil and water bodies (PIP, 2004).

The nature of farm work in intensive small-scale agriculture exposes the environment and everyone who works on the farm to pesticides hazards because of the extensive hand labour that most farmers perform. In addition, most farmers have limited information on the effects of exposure to pesticides to influence safe use and handling practices. Others do not perceive pesticides to be dangerous since some effects of exposure are not immediate. In some cases, farmers lack money to buy appropriate personnel protective gears, while others attribute pesticide poisoning to fate or forces beyond their own control.

1.2 Problem Statement and Justification

Sagana area in Nyeri district forms an island of an intensively cultivated region with one of the most severe land and population pressure in the country. More than 90% of the farmers are small scale with an average farm size of 0.6 hectares per household (GOK, 2003). In order to maximise yields from the characteristic small farms, farmers have to use increased amounts of pesticide and fertilizers. Due to limited safety information, farmers' perceptions, attitudes and pesticide handling practices have led to potentially high environmental and human health hazards. Since many pesticides present minimal or no hazards when used properly, this study sought a social approach to the analysis of the problem with the aim of informing scientific and policy decisions towards safe use and handling of pesticides. Available studies focus on detection of pesticide residues in human and animal body systems and the environment with little emphasis on exposure routes at farm level, the focus of this study.

1.3 Assumptions

Farmers in Sagana are at high risk of occupational safety and environmental hazards because of their perceptions, attitudes and behaviour when handling pesticides.

1.4 Research Objectives

The broad objective of this study was to examine farmers' perceptions, attitudes and behaviour with respect to handling and using pesticides with an aim of suggesting measures that would inform policy interventions towards safe use of pesticide at the farm level. The specific objectives were:

i. To determine the farmers attitudes, perceptions and behaviour towards pesticides at Sagana

ii. To assess the potential occupational safety hazards associated with such attitudes, perceptions and behaviour

iii. To determine the potential hazards to the environment resulting from observed farmer-pesticide interactions

1.5 Conceptual Framework

The majority of small-scale farmers in most rural agro-ecosystems in Kenya are generally resource-poor and of low education. Their behaviour, which is determined by inherent attitudes and perceptions towards pesticides often translates into potentially high hazards to both themselves and the environment. Even where personnel protective measures do not require money, they sometimes are not taken.

This leads to hazardous effect of pesticides to the community and the environment. Community health and the ability of the environment to produce goods and services are compromised especially in the case of safe food and clean water. This leads to poverty, human ill being and pesticide dependence. In an attempt to increase food production, more pesticides are used resulting to more hazards to people and the environment, leading to a vicious cycle of pesticide dependence, high occupational health and safety risks and enhanced human ill being (Figure 1.2)

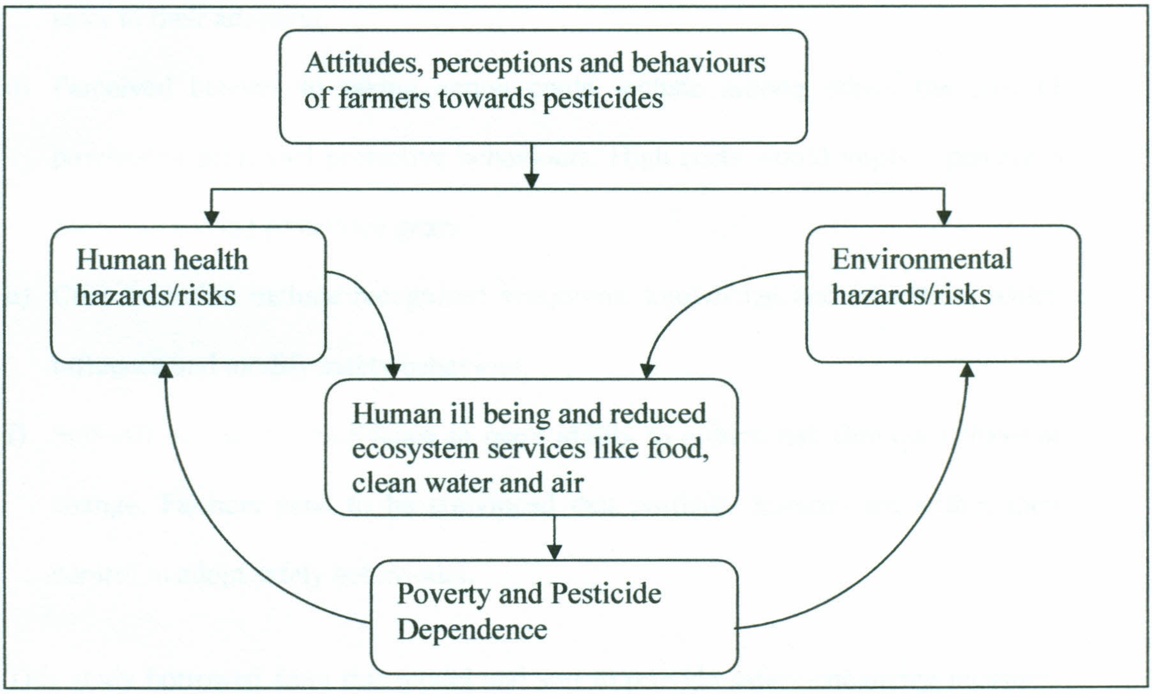


Figure 1.2 Sustainable pesticide use conceptual framework (Source: Researcher)

The Health Belief Model (Janz and Becker, 1984) is useful for the study of farmer pesticide handling safety behaviour in Sagana settlement scheme because of its simplicity and parsimony. It sees behaviour as a function of people's subjective value of an outcome and their expectation that particular health behaviour will result in that outcome. The health belief model has six key concepts which when interpreted in the Sagana scenario describe behaviour as determined by:

a) Perceived susceptibility: Individuals need to belief that they are at risk of pesticide hazards in order to adopt mitigation behaviour.

b) Perceived severity modifies the relationship of perceived susceptibility to taking a health action; if the perceived outcome is seen to be more severe, safety behaviour is likely to be adopted as opposed to outcomes perceived to be less severe.

c) A perceived benefit of health behaviour in mitigating pesticide hazards means that individuals need to understand precisely the benefits of adopting safety behaviours prior to their adoption.

d) Perceived barriers to taking action could include among others the cost of purchasing personnel protective behaviours. High costs would imply a perceived barrier to buying protective gears

e) Cues to action include recognized symptoms, knowledge and education, which influence and modify safety behaviour.

f) Self-efficacy is the confidence in one's ability to reduce risk through behaviour change. Farmers need to be convinced that pesticide hazards are within their control to adopt safety behaviours.

This study borrowed from this model and sort to provide safety-enhancing measures along life cycle thinking approach in pursuit of sustainability solutions.

1.6 Scope

This study was carried out at Sagana in Nyeri district (Figure 1.3), which is an upper highland I and II tea and dairy agro-ecological zone. The area has a permanent cropping possibility, long cropping season followed by a medium one. The lowest altitude is over 3000 meters above sea level with annual mean temperature of 16.8^0C and annual rainfall 2200-2400 mm per year, distributed twice in a year (Jaetzold and

Schmidt, 1983). The long rains start from mid March to May and the short rains start from mid October to December. The upper areas neighbouring mount Kenya forest are very wet and act as important water catchments for many streams and rivers, which join together to form the River Tana. These streams flow through intensively cultivated farmlands with high risk of contamination from agricultural activities in the surrounding farms.

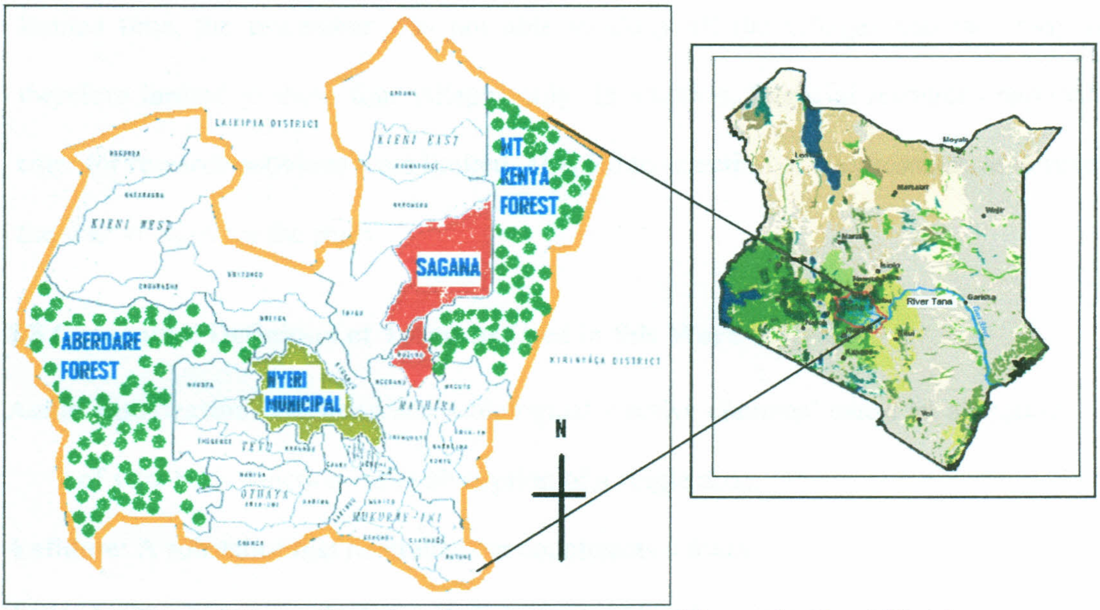


Figure 1.3 Map of Kenya Showing Sagana Settlement Scheme in Nyeri District
Source: GOK, 2001

The area was chosen because it forms an island of an intensively cultivated region with one of the most severe land a population pressure in the country (GoK, 2003) The study area has an estimated population of 18,300 and an average population density of 202 persons per kilometre squared. The soils are *mollic andosols*, well-drained, very deep dark reddish brown to dark brown, very friable and smeary silty clay loams with humic top soils. This combined with the high rainfall, moderate temperatures and high population density leads to intensive cultivation through use of pesticides on a wide range of crops mainly vegetables, fruits, tea and coffee for export. The crops according to GOK (2003) contribute 53% of household incomes in the area. No formal study has been done in this area to understand the perceptions of farmers towards pesticides in the area and the resultant hazards to the environment and human health as a basis for sound management of pesticides.

1.7 Limitation of the Study

The study was carried out in four of the ten villages in Sagana settlement scheme. Due to limited time, the researcher was not able to study all the villages and the study was therefore limited to these four villages only. In addition, financial resources required to cater for research activities were limited. This led to selection of a representative sample of the four villages for the study

1.8 Conceptual Definition of Terms as Used in this Work

Acute Intoxication: Occurs when a biologically active chemical cause an alteration of vital body functions after absorption of a single dose.

Antidote: A substance that neutralizes or counteracts a toxin

Attitude: The extent to which people believe an object has attributes or consequences that they evaluate as pertinent. Beliefs, and feelings as well as dispositions towards actions

Behaviour: Actions, activities, practice, or conduct, a range of which is often derived from a person's attitude and perceptions (Blake *et al.*, 1983)

Chronic Intoxication: Occurs after repeated exposure to low chemical doses over an extended period causing an alteration of vital body functions. It is typically a long-term hazard due to repeated absorption of a substance in small amounts.

Chronic effects: Health influence of exposure to low chemical doses over an extended period and includes alteration of vital body functions.

Community Health: A state of complete public physical mental and social well-being

Dose: The amount or portion of an active ingredient or preparation applied per unit of treated material. A unit may be a length (metre), an area (hectare etc)

Eco-Products and Services: Are products and services generated in environment friendly ways tend to guarantee consumers less health risks.

Environmental Impacts: Any adverse impacts on the environment a pesticide handling activity may have

Environmental Risk Assessment: A systematic analysis of the probability of adverse effects to the environment following exposure to a pesticide; usually a function of hazards and exposure

Hazard: The likelihood that a pesticide will cause an adverse effect (injury) under the conditions in which it is used

Hazard Assessment: A systematic analysis of the likelihood that a pesticide will cause an adverse effect (injury) under the conditions in which it is used

Human Health Risk Assessment: A systematic analysis of the probability of adverse effects to human health following exposure to a pesticide; usually a function of hazards and exposure

Life Cycle Assessment: An environmental management tool for assessing the comprehensive environmental impacts of products, processes and activities (Cowell, 1998).

Maximum Residue Limits (MRLs): The maximum concentration of a residue that is legally permitted on a food, agricultural commodity or animal feedstuff.

Perception: Ones awareness or biased opinion of objects and events in the environment acquired through senses (Blake et l. 1983).

Persistence (of a substance in the environment): The length of time for which the active ingredient of a pesticide or its active metabolites can be detected in an environment

Pest: An organism that lives directly on food plants and damages them as a result

Pesticide: Any substance or mixture of substances intended for preventing, destroying or controlling any pest.

Pre-harvest interval: The minimum number of days that must pass between the last application of a pesticide and the start of harvesting

Risk: A function of the probability of adverse effects following exposure to a pesticide

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews documented literature that is related to the problem studied from global to local scenario. The chapter specifically documents a global overview of pesticide hazards in selected countries and agro ecosystems. Farmers' attitudes, perceptions and behaviour while handling pesticides and its implication to environmental and human health is reviewed as documented in other parts of the world. Finally, the chapter highlights the state of pesticide use in Kenya's agro ecosystems highlighting the results of pesticide risk assessment carried out by various scholars.

2.2 Global Overview of Pesticide Hazards in Agriculture

Agriculture employs half of the world labour force and an estimated 1.3 billion workers are active in agricultural production worldwide with almost 60% concentrated in developing countries (ILO, 1999). While approximately 70% of the US$30 billion pesticides markets are consumed in industrialised countries, the majority of acute and fatal poisonings occur in developing countries (WHO, 1989). This has been attributed to the average low level of understanding of the hazards associated with their use especially in small-scale rural setup like Sagana area. According to FAO (2000), the technology used to spray pesticides in most developing countries reflects technical standards of 40 years ago. This results to pesticides waste human health and environmental damage, and reduced capacity of the agro ecosystem to supply goods and services like safe food and clean water.

On average 3% of agricultural workers in developing countries, suffer an episode of pesticide poisoning a year (WHO, 1989). This means that for the 830 million agricultural workers in the developing world (ILO, 1999), there are about 25 million cases of occupational pesticide poisoning. In Africa, Kenya is among countries, which record the highest number of cases of pesticide poisoning per year (Figure 2.2).

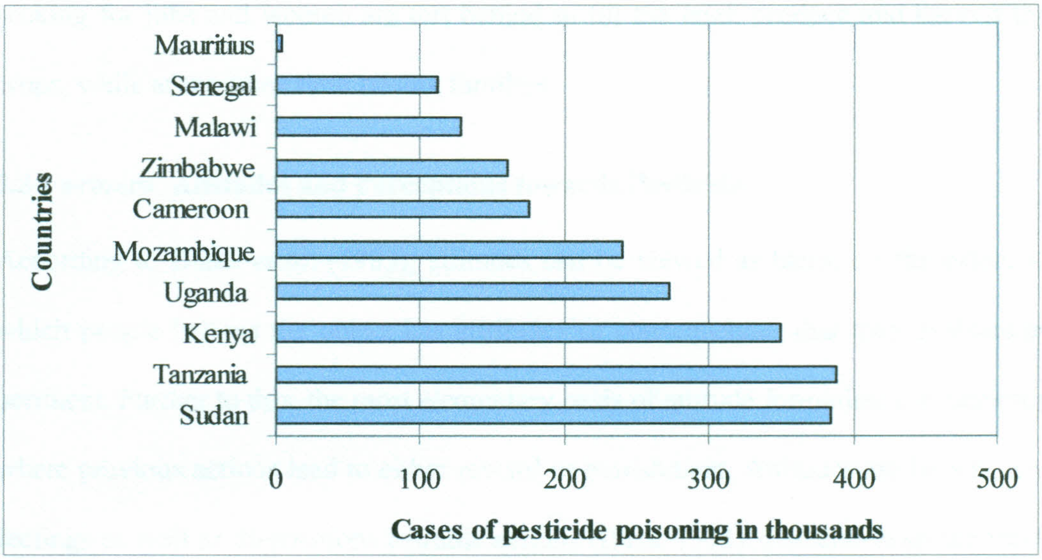


Figure 2.1 Estimated cases of pesticide poisoning in some African countries
Source: WHO, 1989

This however does not account for poisoning cases in informal self-employment agricultural undertakings like Sagana where accidents are not likely to be compensated, knowledge of safe use and handling of pesticides poor and farmers have low income to afford self-protective gears. The bulk of these episodes of poisoning are not recorded, as they are considered minor often self-limiting, and most of the patients do not seek medical attention (WHO, 1989). In addition, most work-related poisonings in agriculture are underestimated because they are not identified, diagnosed and treated unless they cause acute poisoning or death (ILO, 1999). Chronic cases therefore may take long to manifest and are often modified by multiple exposures to different pesticides smoking and alcohol.

In small-scale agriculture, work is often carried out on a family basis, involving largely the farmers' whole family. Public health and infrastructure services are generally insufficient in rural areas where most farming activities are concentrated. Women and children are more vulnerable because most men emigrate to urban centres seeking for jobs and women are left behind to till the land, produce and harvest the crops, while at the same time raising families.

2.3 Farmers' Attitudes and Perceptions towards Pesticide

According to Blake *et al.* (1983), attitudes can be viewed as based on the extent to which people believe the object has attributes or consequences that they evaluate as pertinent. Further to this, the most elementary basis of attitude formation is experience where previous actions lead to either reward or punishment. Attitudes are beliefs, and feelings as well as dispositions towards actions (Buss, 1973). Perception on the other hand can be viewed as awareness of objects and events in the environment, which one acquires through senses (Blake *et l.*, 1983). It is thus ones biased opinion regarding events and objects and is shaped by among other factors, experience.

Several studies have addressed farmers' attitude and perceptions towards pesticide exposure risk. Lantz *et al.* (1994) used focus group data to examine Latino farmer perceptions of pesticide exposure and their beliefs about its causing cancer. Farmers were found to know that pesticide exposure could cause health problems but did not link pesticide exposure to cancer. This indicates a lack of full information regarding pesticides by the farmers that influence perceived hazards and consequent handling behaviour. Quandt *et al.* (1998) in his analysis of in-depth interview data collected with farmers in eastern North Carolina found several major themes that reflect farmers' pesticide exposure perceptions.

i. Susceptibility to the effects of chemicals is highly individualized; some persons are sensitive and experience ill effects, and others are inherently more resistant.
ii. Most farmers are concerned with the immediate or acute effects of exposure. Very few are aware of potential long-term consequences of exposure to pesticides.
iii. Farmers were divided as to whether pesticides are dangerous to humans or not

Elmore and Arcury (2001) found that most of the farmers they interviewed knew that pesticides could be harmful, but the workers varied in their levels of knowledge regarding routes of exposure, specific health effects of pesticides, and ways to avoid and reduce exposure. They concluded that a perceived lack of control among farmers and health beliefs were salient factors that decreased workers' use of safety practices.

Grieshop *et al.* (1996) in his study of North Carolina farmers observed that control is a significant issue to pesticide safety. Farmers in better economic circumstances were more likely to perceive themselves as having control over exposure (Vaughan, 1993). Farmers perceived many preventive measures to be outside their control. Having greater information and training did not predict a greater sense of control in the North Carolina study.

In Kenya little has been done to understand farmers attitudes, perceptions and behaviours towards pesticide and their implication on environment and human health as a basis of informing policy interventions towards safe use and handling of these chemicals; the focus of this study.

2.4 Pesticide Handling Behaviours and their Implication to the Environment

At the 1992 United Nations Conference on Environment and Development in Rio, governments agreed to 'increase food production in a sustainable way and enhance food security' (Chapter 14 of Agenda 21). At the 1996 World Food Summit hosted by FAO, the Plan of Action presented to governments emphasised modern strategies and technology transfer, which could result in increased pesticide use. Pesticide hazards were barely addressed.

Pesticides safe use and instructions are usually borne on manufacturers' labels. In most cases, they are written in scientific and foreign languages difficult for low literate farmers to understand. This combined with lack of proper measuring equipments puts doubt as to whether recommended doses are applied in small scale farming agro ecosystems. Overdoses may be applied contaminating natural ecosystems. When a pesticide is used, there is always a probability that some of the product will contaminate an area outside the targeted area, due to either negligence or insufficient knowledge. Spray far from target without considering the possibility of drift in windy weather, and careless preparation of mixture can lead to environmental contamination. Pesticide mixtures transferred without use of funnels, make spillage and splashes almost unavoidable. Workers spraying with and against the wind increase the possibility of inhaling pesticides. Poor conditions for storing and transporting pesticides may lead to accidental spills. Inappropriate techniques for disposing of empty packaging, excess mixtures or expired products all pose serious hazards to the environment.

In Kenya, studies have shown presence of many pesticides in water bodies as well as animal tissues. Pesticides were detected in the black bass and Nile perch from Lake Victoria (Harper *et al*., 2002, Mitema and Gitau 1989). Mugachia *et al*. (1992), in a study on catfish, common carp and tilapia from the Athi River estuary and Masinga Dam, found DDT residues. Munga (1990) found DDT in the muscle, liver and eggs, of birds from the Hola Irrigation Scheme. Frank *et al*. (1977) studying organochlorine residues in Kenyan birds of prey, reported that most raptors from agricultural areas (including central Kenya) contained residues of DDT metabolites, whereas those from non-agricultural areas did not contain detectable levels of any pesticide residues. Use of non-selective pesticides may kill beneficial insects like pollinators, other wildlife and predators that naturally can reduce pests' populations.

Many organochlorine compounds are very persistent in the environment and have a tendency to bioaccumulate significantly through food chains (UNEP, 1985). DDT and its breakdown products have widespread persistence in the environment, and a high potential to bio accumulate (Tomlin, 1997). Many governmental and inter-governmental organisations regard DDT as a major hazard to the environment due to its high toxicity to fish, lowering reproductive rates of birds, causing eggshell thinning which leads to egg breakage and causing embryo deaths (WHO 1979). Predatory birds are the most sensitive. The use of DDT was banned in the U.S. in 1972 because of the damage it caused to wildlife such as the near extinction of the bald eagle. However, it is still used in many developing countries (ATSDR, 2002). According to research by the USEPA (1993), birds in remote locations can also be affected by DDT contamination. DDT was introduced in Kenya as an acaricide in 1956 to combat tick menace. It was banned for use in livestock in 1976 and subsequently banned for agriculture in 1986. However, it was restricted for use in disease vector control and only by the Ministry of health. The banning and restriction were occasioned by the adverse health and environmental effects implicated in its use (GOK, 2007).

The toxicity of Dimethoate for aquatic organisms and birds is moderate to high, and is highly toxic to bees on an acute contact basis (WHO, 1992). One study found that it causes temporary physiological alterations in some seed-eating bird species. Though these effects may not be fatal, they were found to be critical for the feeding ability of the birds making them more vulnerable to predators (Brunet and Cyr, 1992).

According to WHO (1991), Paraquat binds rapidly and tightly to clay materials in soils, and when adsorbed it is biologically inactive. It also binds to humus and other organic material: this results in no, or very low soil residues or leaching into water sources. In sandy soils with low organic content, Paraquat may be more readily released into ground water

(USEPA, 1999) reported that Diazinon has been found in rivers across the US including the Mississippi and the Rio Grande and is one of the most commonly detected insecticides in air, rain and fog. Analysis by the Environment Protection Agency of Wales Rivers revealed that during 1999, 57% of 111 river sites monitored recorded positive results for Diazinon (USEPA, 1999). The primary wildlife concern with Diazinon results from its extremely high acute risk to birds (Tomlin, 1997). In the United States of America, it has caused more documented avian deaths than any other pesticide except Carbofuran (USEPA, 1999).

Furadan, commonly known as Carbofuran (World Health Organisation class IB) is characterized as highly toxic to coldwater and warm water fish, freshwater invertebrates and very highly toxic to birds. In United States of America, it has caused the highest number of avian deaths than any other pesticide (USEPA, 1999).

Pyrethroids are generally less toxic to birds and mammals. However, they are highly toxic to aquatic organisms and fish as well as to bees, with the same mode of action in each organism (Class, 1992). Although the direct acute toxicity towards birds is small, they are affected via the food chain. In a treated wood, only 20% of the nestlings of the blue tit, a beneficial bird, survived (Pascual 1992). Other beneficial organisms that can be affected by Cypermethrin include beetles, spiders and centipedes living on the soil and predatory mites.

2.5 Pesticide Handling Behaviours Hazardous to Community Health

A study by Crisman et al. (1978) found that during pesticide applications most farmers (73%) wet their skin, in particular the back and hands (87%). Field exposure trials showed that during foliage applications on mature crops, considerable dermal deposition occurred on legs and that additional exposure occurs in the field during meal breaks, when only limited hand washing is done. Excess mixed product may be applied to other tuber crops, thrown away with containers in the field or applied around the house. Clothing worn during application is used repeatedly before washing. Usually contaminated clothing is washed in the same area as family clothing. Separate locked storage facilities for application equipment and clothing are also uncommon.

Vast majority of pesticides are bought by commercial names. Vendors who are always after increasing their sales cannot be trusted to give unbiased information on occupational and environmental hazards associated with their use. Pesticide storage occurs close to farmhouses because of fear of robbery. Farmers usually mix pesticides in large barrels with bare hands, resulting in considerable dermal exposure (Merino and Cole, 2002). Farmers apply pesticides using backpack sprayers sometimes on hilly terrains increasing chances of spillage and self-contamination. Few use personal protective equipment for a variety of reasons: including availability and perceived high cost of the equipment.

Human health hazards from pesticide exposure arise from the fact that synthetic pesticides are biologically active. According to Aspelin (1994), of the 25 most heavily used agricultural pesticides, five are toxic to the nervous system. Morgan (1989) noted that 18 are skin, eye or lung irritants. Further 11 of these pesticides have been classified by the U.S. Environmental Protection Agency (USEPA, 1993), as cancer causing, 17 as causing genetic damage, and 10 as responsible for reproductive problems in laboratory animals (U.S. Department of Health and Human Services, 1993).

Mera (2000) noted that poisonings and deaths among young children were common in communities using pesticides in Ecuador. According to Crissman *et al.* (1998) human health effects included poisoning through ingestion, which accounted for 171 in every 100,000 exposure cases, dermatitis (48% of applicators), pigmentation disorders (25% of applicators), while neuro-psychological mortality due to pesticides accounted for 21 in every 100,000 exposures.

A survey of couples seeking treatment at an infertility clinic in California found that when couples sought treatment because of low sperm counts, the men were ten times as likely to be agricultural workers as were men from couples seeking treatments for other reasons. The men with low sperm counts reported long-term (5-21 years) exposure to insecticides and other pesticides (Strohmer *et al*., 1993). Among the most widely used pesticides, paraquat otherwise known as gramaxone is herbicide usually used as a weed killer. It is of relatively low hazard in normal use but may be fatal if it enters the body through the skin or the mouth. This pesticide is among the products that are possibly carcinogenic to human beings (WHO, 1992). Malathion and Diazinon are moderately toxic (World Health Organisation class II) and known cholinesterase inhibitors (Schetter, 1996). Cholinesterase is an enzyme needed for the proper functioning of the nervous systems of humans, other vertebrates and insects. Known poisoning signs include anxiety, nausea, salivation, vomiting, abdominal pains, diarrhoea, blurred vision, and excessive tears secretion.

Pyrethrum derivatives otherwise known as Pyrethroids include Bifethrin, alpha Cypermethrin, beta Cyfruthrin and Deltamethrin. Known symptoms resulting from exposure to Pyrethroids include lack of coordination, convulsions, muscle paralysis, rapid heart rate, irritability, numbness, itchiness in the extremities, unusually runny nose, ringing, clicking or pulsation in the ears; blurred vision, headaches; tremors; vomiting, burning sensation and asthma (Paul, 1993). Where humans are exposed to Dimethoate, there are many effects: when inhaled, the first effects are usually respiratory problems and may include a bloody or runny nose, coughing, chest discomfort, difficult or short breath, and wheezing due to constriction or excess fluid in the bronchial tubes. Skin contact may cause skin sensitisation (WHO, 1992). Eye contact will cause pain, bleeding, tears, pupil constriction and blurred vision.

2.6 Pesticide Use in Kenya's Agro Ecosystems

There has been widespread use of pesticides in Kenya in the last four decades. The country has been rated among the highest pesticide users in Africa (Farah, 1994). This is because agriculture has been the backbone of Kenya's economy. Organochlorines have been extensively used particularly DDT and Endosulfan for the control of maize and cotton pests (Munga, 1990). Lindane, Dieldrin, Aldrin, endrin and heptachlor have also had wide usage in Kenya, which has made their presence ubiquitous in the environment (Wandiga, 1996). Wandiga *et al.* (2002) reported pesticide residues in water (Figure 2.2), sediments and fish samples from Sabaki, Kilifi, Mombasa and Ramisi in Kenyan coast where Tana River and Athi River drains to after traversing intensively cultivated areas in Kenya's highlands including Sagana. Fake pesticides especially powder or dust pesticides are widely available and raising awareness remains a challenge. These fake formulations were responsible for the mass spoilage of maize grain in 1998 (GOK, 1999).

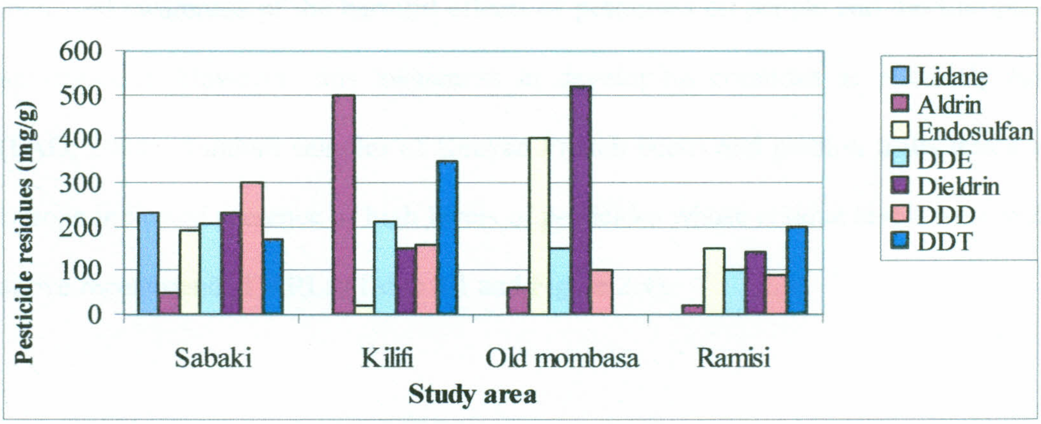


Figure 2.2 Pesticide residues in water from selected sites in Kenyan coast
Source: (Wandiga *et al.*, 2002)

Although many human exposure cases go unreported especially non-acute cases in rural farming, high pesticide levels have been found in Kenyan human milk (Figure 2.3) as compared to the corresponding levels in other countries (Kanja *et al.,* 1986). This places high health burden to households who are already resource poor.

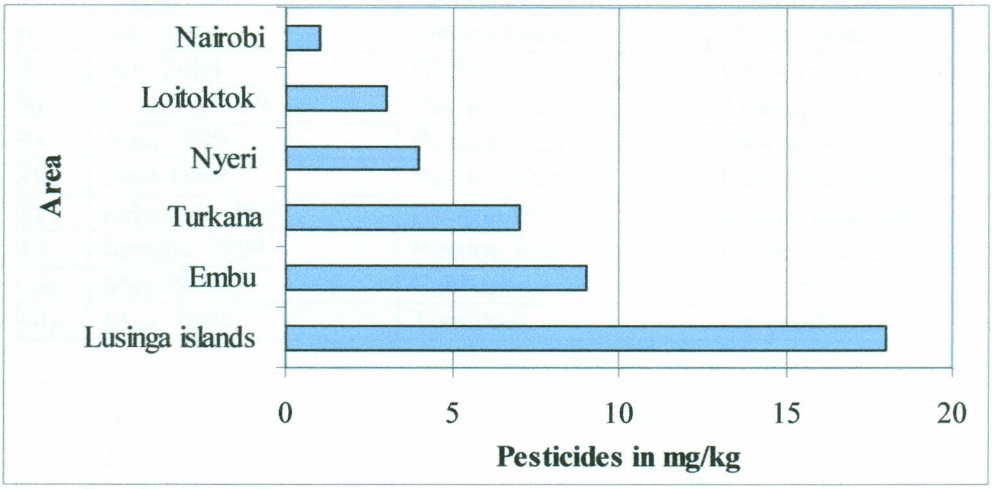


Figure 2.3 DDT pesticide in human milk from different areas of Kenya
Source: (Kanja *et al.*, 1986)

Kenya's horticultural sector has been under special pressure from international governments especially Europe where it has been the largest exporter of horticultural produce for a decade to address pesticide hazards (Jaffee *et al.*, 2005). This is due to increased awareness of the harmful effects of pesticides on people and the European environment. However, this awareness in developing countries is relatively low (FAO, 2000). Random samples of Kenyan French beans and passion fruits tested in Europe indicated presence of high levels of pesticides whose residue levels were well above recommended MRLs (Table 2.1 and Figure 2.4).

Table 2.1 Pesticides detected in Kenyan food products in the year 2004 and 1999

	Date	Food Sample	Pesticide Found
1)	September 2004	French beans	Diomethoate
2)	September 2004	French beans	Diomethoate
3)	September 2004	French beans	Diomethoate
4)	August 2004	French beans	Diomethoate
5)	August 2004	French beans	Chlorpyrifos
6)	July 2004	French beans	Diomethoate
7)	July 2004	Chillies	Carbofuran
8)	October 1999	Passion fruits	Triazophos
9)	June 1999	Passion fruits	Diomethoate
10)	June 1999	Passion fruits	Carbendazim
11)	February 1999	Passion fruits	Dithiocarbamates
12)	January 1999	Passion fruits	Carbendazim
13)	May 2005	Cabbages	Diomethoate
14)	May, 2005	Tomatoes	Carbendazim

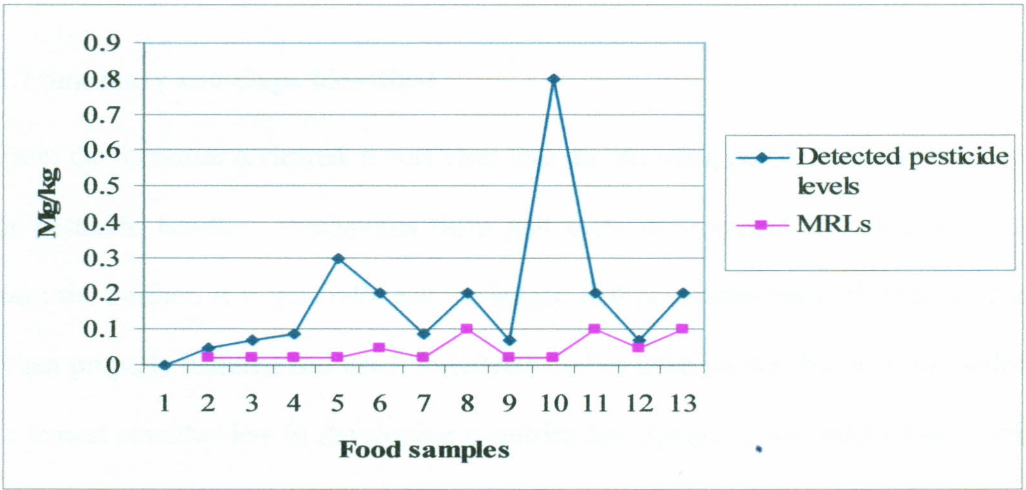


Figure 2.4 Pesticide residues detected (Table 2.1) and their recommended MRLs
Source: (UK Pesticide Residue Committee, 2005)

Maitai *et al.* (1998) analyzed poisoning by various chemical substances in 19 Kenya hospitals between 1991 and 1993. From the analysis, it emerged that organophosphates pesticides poisoned 27% of the victims. Poisoning cases in which the victims died were more likely because of suicide. The major cause of deaths resulted from handling of the pesticides by users who were untrained on safe use and handling of hazardous chemicals. An analysis of further 1888 cases of poisoning showed that children between the ages 0 and 14 were more affected (40%) than teenagers (19%) and adults (34%)

Wandiga (2001) identified various factors that contribute to lack of full endorsement of international conventions that seek to address human health and environmental safety in pesticide use especially in developing countries like Kenya. These included among others low farmer education and thus lack of understanding of safety regulations, easy availability of hazardous expired pesticides with no proper disposal procedure, high cost of safer alternatives and improper advice given to farmers by their fellows, extension agents and friends

2.7 Summary and Gaps Identified

From the literature reviewed, it was clear that the attitudes, perceptions and behaviour of pesticide handlers predisposes them and their environment to pesticide related hazards. Further, it is generally acknowledged that pesticides cause little or no harm when properly handled and used. Industrial studies have shown that it is not realistic to expect smallholders in developing countries like Kenya to use safely highly toxic and other highly dangerous products otherwise deemed safe under industrialized world conditions (Atkin and Leitziger, 2000). While available studies are mainly focussed on detecting pesticide residues and their effects to people and the environment, little has been done to understand the attitudes, perceptions and behaviours of farmers towards pesticides as a basis of policy formulation towards occupational and environmental safety, hence the focus of this study at the farm level in Sagana intensive agro-ecosystem.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

This chapter presents the research design, target population, sample size, sampling procedure and data collection methods used in investigating the study problem. Finally, under data management and analysis, the chapter discusses the techniques that were used to analyse the data collected and generate valuable conclusions and recommendations for the study.

3.2 Research Design

The study design entailed a life cycle approach (LCA), which examines selected variables at all stages of the life of a product or an event (Cowell, 1998). In this case farmers' attitudes perceptions and behaviour when dealing with pesticides were assessed starting from choice of pesticides, purchase, transport and storage, mixture preparation, use, and disposal. Environmental and occupational health and safety concerns will also be assessed at each of these stages.

Both primary and secondary data were instrumental in this research. Questionnaires (Appendix 1) and field observation checklists (Appendix 2) were used to collect quantitative data. Each item in the questionnaire was to address the specific objectives of the study. The instruments were pre-tested at Gitaraga village, which is among the four villages studied. It emerged during the pre-testing that the language of the questionnaires lost vital meaning when translated into the local Kikuyu language. This yielded data that was hard to analyse. For example, farmers could not make a clear-cut difference between frequencies of a given behaviour termed as seldom or sometimes. The questionnaires were revised carefully, language simplified for understanding, and the questions were asked in a different manner without distorting the intended meaning. The researcher administered the questionnaires. The meaning of the questions and key concepts were explained to respondents in their local language.

3.3. Target Population and Sampling Procedure

The farmers who used pesticides on their farms in the area constituted the target population. With an estimated 90% of the total population engaged in small-scale intensive farming and an average farm size of 0.6 hectares per household (GOK, 2003), it was assumed that the same 90% used pesticides. Four villages, Gitaraga, Igaka, Mitero and Hobe were randomly selected for the study. The unit of analysis was a household and the unit of observation was a household head. The sample size of 140 was calculated using the following formula for determining sample size in social science research as recommended by Mugenda and Mugenda (1999).

$$n = \frac{z^2 pq}{d^2}$$

Where:

n = the desired sample size since the total population is greater than 10000

z = the standard normal deviate at 95% level of confidence which is 1.96

p = the proportion in the target population estimated to have the characteristics being measured. Over 90% of the total population in the area are small-scale farmers who practice intensive farming using pesticides (GOK, 2001).

q = 1- p

d = level of statistical significance, in this case 95%

n = $[(1.96)^2 (0.9) (0.1)]/ (0.05)^2 = 139$

Simple random sampling was used to select a representative sample of 35 households from each of the four villages in Sagana to make a total sample size of 140. This size is also consistent with normal distribution and standard statistical procedures as discussed by among others Saleemi (1997). Purposive sampling was used to select key informants who included local leaders, both public and private agricultural extension officials; sales agents of pesticide firms, provincial administration and local health staff.

3.4. Data Collection Methods

Both qualitative and quantitative approaches were used for data collection. Quantitative approaches involved the researcher-administered questionnaires (Appendix 1) with both open and closed ended questions on a sample of households from the local community using pesticides on their farms. This was adopted since the population consisted of subjects of generally low literacy levels and hence unable to interpret the questions. Items were read in the local language (Kikuyu) plus their response categories and the farmers' responses were written down (Appendix 4, plate 6). Open-ended questions were used to allow farmers personal response on issues regarding their perceptions and behaviours towards pesticide and reasons for the response given. Closed ended questions on the other hand were used where definite answers were required for example in probing whether the farmers engage in certain pesticide handling behaviours.

Observation checklists (Appendix 2) were used to record various pesticides handling practices with negative implication to human health and the environment as practiced by farmers in the field and as observed by the researcher during the study. These included use of personnel protective equipments, storage of pesticides, reuse and disposal of empty containers, condition of the application equipment, and disposal of surplus mixes among others.

Data on the existing pesticides, safe use and handling practices, hazards and challenges involved in the use and handling of pesticides was collected using participatory approaches. These included Participatory Rural Appraisal (PRA) techniques such as key informant interviews, focus group discussion and case studies.

Key informant interviews targeted specific individuals with specialised information on issues of human health and the environment. In this regard, local health officers, agricultural extension officers and regional environmental management officers were interviewed. These were selected based on having worked in the community for over five years and therefore possessing a significant topical knowledge that other people may not have like health and environmental impacts of using pesticides for farming in the area. Unstructured questions (Appendix 3) were used as interview guides to ensure that data collected met the objectives of the study. According to Mugenda and Mugenda (1999), interview schedules are useful in standardising the interview situation so that the interviewer can ask the same question in the same manner. The interview schedule was useful in gaining a thorough insight into the activities of the farmers regarding pesticides crosschecking some of the responses, which were given in the questionnaires and offering explanation on some observations made on the farms. Walker (1985) notes that interview rely on the fact that people are able to offer accounts of their behaviour, practices and actions to those who ask them questions. It gives people an opportunity to make a reflective account of their own actions. This places some authority on the subjects that to some extent make the accounts given have some truth-value. Interviews allow interviewers to follow up on respondent's answers to obtain more information and clarify vague statements. They also build rapport and trust with the respondents thus making it possible to obtain information that the individual probably would not reveal by any other data collection method (Meredith *et al.,* 1973).

Data on unreported cases of pesticide poisoning as well as the factors that make the farming community vulnerable to pesticide hazards was obtained through focussed group discussions. These were held at Mutaga centre and were attended by various stakeholders dealing with or affected by pesticides. The participants included agricultural extension officers from the government and the private sector, pesticide sales agents from Osho, City farming and Farmchem companies, and community leaders from farming self-help groups in the area. Deliberate effort was made to ensure equal representation of men and women and avoid gender bias. Specific topics discussed included pesticide handling practices in the area and their potential impacts to the environment and community health.

To assess farmers' attitudes towards pesticides, a modified likert scale with 3 points which included agree, neutral and disagree was used. Seven statements regarding pesticides use and their implication to the environment and community health were read to the respondents. They were then asked to choose the option best representing their position on each statement.

Secondary data was obtained from secondary sources such as environmental impact assessment reports from the area and health records from three health centres serving the area, one at Mutaga centre and two at Kiamariga shopping centre.

3.5. Data Management and Analysis

To ease analysis, data from questionnaires was first cleaned, coded and grouped into themes consistent with the study objectives. Coded data was entered into a Microsoft excel worksheet and imported into statistical package for social sciences (SPSS) for analysis. Both descriptive and inferential statistics were used. To determine various relationships among selected variables, descriptive statistics such as frequency distributions, percentages modes and means were used.

To evaluate the relationship between farmers characteristics such as education level and their attitudes towards pesticides associated hazards, Pearson correlation coefficient (r) values were calculated with absolute figure indicating the strength of the relationship and positive (+) or negative (-) signs showing the direction of the relationships as discussed by Gary (1996).

Non-quantifiable data derived from qualitative data collection techniques was analysed subject to content and in-depth analysis in order to come up with useful conclusions and recommendations. Detailed information regarding pesticides handling behaviours, attitudes and perceptions was obtained put under themes consistent with the research objectives and patterns trends and relationships established to make conclusions.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Introduction

This chapter presents the findings of the study based on the data collected from the respondents and as per the research objectives. These include a) determining the farmers' attitudes, perceptions and behaviour towards pesticides at Sagana, b) to assess the potential occupational safety hazards associated with such attitudes, perceptions and behaviours, and finally c) to determine the potential hazards to the environment that result from the observed farmer-pesticide interactions. Related findings form other studies have been incorporated to enrich the discussion of the results

4.2. General Characteristics of the Sampled Population

Out of the 140 households, 135 (96%) used pesticides as the first choice in pest management (Table 4.1). The remaining 4% used either cultural methods such as crop rotation and mulching or integrated pest management strategies. Of the studied households, 21% were female headed while the remaining 79% were male headed. While pesticide handling and application was generally perceived as a man's job in the area, women from female headed households were forced to handle pesticides even when pregnant endangering the unborn children

Over 71% of the population studied had lived in the area for over 10 years and thus had wide knowledge and experience of pesticides handling practices in the area and the resultant hazards to the environment and community health. The highest proportion of the sample studied (77%) consisted of farmers between the ages of 18-40. This is the most productive age group in the community both sexually and economically yet the most exposed to pesticides hazards.

Table 4.1 General characteristics of the sampled population

	Frequency	% frequency
Pest control method most frequently used		
Chemical	134	96
Cultural	3	2
IPM	3	2
Own appropriate pesticides application equipments		
Yes	50	36
No	90	64
With the list of approved pesticides from PCPB		
Yes	24	17
No	116	83
Average farm size		
<1 acres	69	49
1-2 acres	63	45
>2 acres	8	6
Length of stay in Sagana		
<5 years	13	9
5-10 years	28	20
Over 10 years	99	71
Income level per month (Thousands)		
< 5 thousands	39	28
5-10 thousands	71	51
Over 10 thousands	30	21

The average farm size was 0.35 acres far below the district average, which is 0.6 hectares (GOK, 2003). The area is thus one of those with the highest population density in Nyeri district. This resulted into intensive farming and the inevitable use of pesticides. All households interviewed grew subsistent crops as well as having excess for the local market. These crops mainly included maize, beans potatoes, bananas, kales and cabbages. Up to 98% of the households grew cash crops for export market, which included coffee; French beans, passion fruits, snow peas, sugar snaps and flowers. Farming communities and consumers both local and international were thus at risk should pesticides handling behaviours result to human exposure through food crops contamination or exceeding MRLs. The nature of working environment in these agro ecosystems made workers vulnerable to pesticide related hazards. This explains why it was important to assess these hazards in order to inform policy decisions towards safe use and handling of pesticides.

About 79% of the households earned an income of less than 10,000 per month. Farming in the area contributes about 53% of total household income (GOK, 2003). Other sources included wage employment, rural and urban self-employment. High-income farmers were generally less vulnerable to pesticide hazards than low-income farmers were (Table 4.2). They were less likely to use pesticide without labels (r=-0.17, p=0.05, n=140) possibly because they could afford higher volumes of pesticides with no need to repackage. They were less likely to reuse work clothes (r=-0.18, p=0.01, n=140), smoke, eat or drink while handling pesticides (r=-0.22, p=0.01, n=140) and not to take bath after work (r=-0.20, p=0.01, n=140).

Table 4.2 Pearson's correlation values for farmers income against risky pesticide handling behaviours

Behaviour	**r (n=140)**
Use pesticides without labels	**-0.17***
Reuse work clothes	**-0.18***
Mix work clothes with other clothes	**-0.22****
Smoke or eat while handling pesticides	**-0.22****
Not take bath after work	**-0.20***
Spray during windy weather	**-0.17***

*= (r) values significant at p=0.05; **= (r) Values significant at p=0.01

About 64% of the total respondents had appropriate pesticides application equipment. The equipment was interpreted as 'a true identity of a farmer' which one could sacrifice everything to acquire. Sharing of pesticides application equipments among neighbours and relatives was reported by up to 36% of respondents. Appropriate pesticide application equipment is necessary to ensure proper pesticide dosage and safety of its operator. However, observation of application equipments revealed that most of them were worn out, spilt contents during use endangering their users and the environment. Only about 17 % of the total respondents knew of and had the recommended list of pesticides for use in the crops they grew. This means that up to 83% of respondents used any pesticides including banned and highly persistent ones as long as they solved the pest problem at hand. This exposed the environment and the community to pesticides related hazards.

4.3 Social Cultural Factors Affecting Safe Use of Pesticide in the Study Area

Various Social Cultural factors were found to have direct influence in safe use and handling of pesticides in the study area (Table 4.3). These included education level and training, of the pesticide handlers, gender and sources of information on pesticides.

Table 4.3 Social cultural characteristics of the sampled population

Item	Frequency	Per Cent
House head gender		
Male	111	79
Female	29	21
Age structure		
Under 18	3	2
18-40	108	77
Over 40	29	21
Education level of the respondents		
Pre Primary	13	9
Primary	80	57
Secondary	39	28
Post secondary	8	6
Trained on safe use and handling of pesticides		
Yes	31	22
No	109	78

4.3.1 Education Level of the Respondents

Over 66% of the farmers interviewed had not acquired more than primary education. Approximately 9% did not know how to read and write while only about 22% have had formal training on safe use and handling of pesticides (Figure 4.4). Education is important in creating awareness on a broad range of issues including causes of environmental and human health hazards associated with pesticide use. This is because the major way in which manufacturers communicate to the final product users on safety matters is through written instructions. Pesticides users therefore need to know how to read and write if they are to get undiluted information directly from the manufacturers. There was however no any significant relationship between the level of education of the respondents and adoption of pesticide safe use behaviour. This indicated that in adoption of pesticide safe use and handling practices, more is required that education especially in impacting specific practical safe use skills.

Table 4.4 Pearson's correlation values for farmers' education against behaviours hazardous to human health and the environment

	Farmers Education
Behaviour	**r-values where n=140**
Spray during windy weather	-0.1
Touch pesticides with bare hands	-0.09
Wet self with pesticide mixtures	-0.14
Touch crops after spraying	-0.05
Use unlabeled pesticides	-0.09
Breath pesticides in the air	-0.14
Swallow sweat during pesticide application	-0.04

All (r) values not significant at p=0.05

According to PCPB Act CAP 346 laws of Kenya (1985), no pest control product should be distributed or sold without a label written in English and Swahili. However, to guarantee safe use and handling of pesticides, the farmer needs more than just the ability to read the label. It should be accompanied by Knowledge of their chemistry, toxicology, efficacy and general use and handling precautions. While farmers with primary education or less may not be expected to understand the chemistry and toxicology of pesticides, general use and handling precautions can be easily understood especially if conveyed at farm level using practical local examples. Towards this end, technical assistance is required.

4.3.2 Training

Trained farmers constituted 21% of the respondents and were mainly from companies exporting farmers' produce to Europe where stringent regulations demand that pesticides handlers be trained on safe use and handling of pesticides. These regulations arose from concerns by consumers in Europe following detection of highly persistent and toxic pesticides residues in fresh food produce from developing countries including Kenya, which posed danger to produce consumers and the environment (Eurep GAP, 2003). Fresh produce exporting companies had organised training for their out grower farmers to comply with these regulations. With about 78% of the respondents untrained, this group of farmers had no adequate pesticides handling skills to ensure safety of the environment and community health.

These farmers were more likely to adopt pesticide-handling behaviours safe to human health and the environment than untrained farmers were (Table4.5). There was a significant relationship between training of the respondents and adoption of pesticide safe use behaviour. Trained farmers were more likely to calibrate their pesticide application equipment and therefore ensure the correct pesticide dosage ($r = 0.23$, $p=0.01$, $n=140$). In addition, there was a negative correlation between training and engagement in behaviours dangerous to human health and the environment, meaning that trained farmers were less likely to engage in such behaviours (Table 4.4).

Table 4.5 Pearson's correlation values for farmers' training against behaviour hazardous to human health and the environment

	Farmers' Training
Behaviour	**r-values where n=140**
Spray during windy weather	-0.18*
Touch pesticides with bare hands	-0.21*
Wet self with pesticide mixtures	-0.26**
Touch crops after spraying	-0.18*
Use unlabeled pesticides	-0.21*
Breath pesticides in the air	-0.26**
Swallow sweat during pesticide application	-0.17*

*= (r) values significant at p=0.05, **= (r) Values significant at p=0.01

Training aims at imparting specific pesticide safe use and handling skills. In Sagana this would include among others practical measures to take to safeguard human health and the environment from pesticide hazards and the cost implication of pesticides overdose. Others include calibration of application equipment, proper measurement of recommended pesticides doses, timing of application with special emphasis on weather and drift and scouting to ensure pesticides are used when pest strike and not on speculation. Important aspects regarding human health that training should cover wearing appropriate personnel protective gear while handling pesticides, appropriate storage to avoid food contamination, need to read the safety instructions borne on the labels and emergency procedures in case of poisoning.

4.3.3 Gender Aspects

a) Sex

Pesticides hazards affected different gender groups in Sagana in different ways. Up to 42% of pesticide, handlers were women and children (Figure 4.1). Women and children formed the core of household agricultural labour force and were particularly at risk of pesticides hazards because they lacked negotiation and decision making power for their own safety precaution. They often handled pesticides as prescribed by the house-heads who were mainly male members of the household. Whether involved in spraying or not, women had to wash contaminated clothes for their husbands. In case of training and field school, women's tightly packed daily calendars limited their time to attend. They reported lagging behind in terms of learning new skills often having their fellow farmers as their main source of diluted pesticide information. Women from female-headed households reported handling pesticides even when expectant due to lack assistance or resources to afford hired labour endangering the unborn children. More men (57%) were involved in pesticide application. Their vulnerability to exposure was through smoking while handling pesticides. All farmers who reported to be smoking while handling pesticides were male.

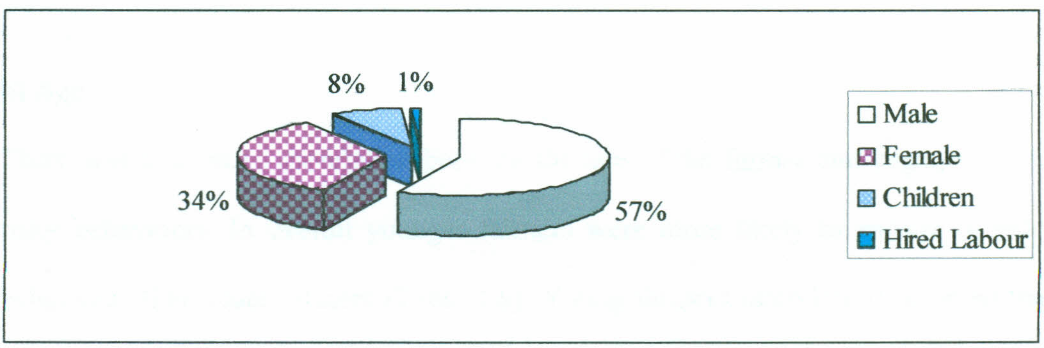


Figure 4.1 Gender groups involved in pesticides spraying

Due to lack of information, children often played in fields, which had just been sprayed with pesticides endangering their own health. Since pesticides were expensive, they were stored in living houses to avoid theft. Bearing in mind that most of these substances were already repackaged into food bottles, younger children were at a higher risk of ingesting the chemicals mistaking them for food. Data from key informant interviews with doctors from the three local health centres serving the area indicated that in about half of the acute cases of poisoning attended to, the victims were infants.

In a related study carried out in Brazil by United Kingdom pesticides action network (UKPAN, 1999a) almost three-quarters of the women working in rural agricultural areas where pesticides were used, 71% reported miscarriages, and 11% reported having mentally and/or physically impaired offspring. Symptoms of minor psychiatric disturbances were observed in 44% of women and 56% of men surveyed. In a further test 20% of those observed, principally men, demonstrated symptoms of alcoholism. In all food samples, they grew and ate analysed for pesticides at least each sample had one or more MRLs for pesticides active ingredients exceeded.

b) Age

There was a negative correlation between the age of the farmer and engagement in risky behaviours. In overall younger farmers were more likely to engage in risky behaviours than older farmers (Table 4.6). Young farmers interviewed believed that they were strong enough to overcome the effects of pesticides. Older farmers on the other hand felt more vulnerable and tried hard to avoid risky pesticide handling behaviours.

Table 4.6 Pearson's correlation values for farmers age and various behaviours hazardous to human health

Behaviour	Pearson's (r) (n=140)
Breath pesticides in the air	-0.36**
Wet self with pesticides	-0.36**
Use pesticides without labels	-0.38*
Touch crops after spraying	-0.36**
Touch pesticides with bare hands	-0.38**
Bring home unwashed crops from field	-0.35**
Use pesticides without labels	-0.38**
Step on pesticides with bear feet	-0.34**
Not bath after work	-0.17*
Swallow sweat during spraying	-0.33**
Mix work clothes with other clothes	-0.31*
Smoke or eat while handling pesticides	-0.18*

* = (r) values significant at p=0.05; **= (r) Values significant at p=0.01

4.3.4 Sources of Information Regarding Pesticides Use

Only about 24% of the farmers interviewed received information through technically trained personnel (Figure 4.2). These included government and private agricultural extension officers from fresh produce exporting companies such as Sunripe and Homegrown.

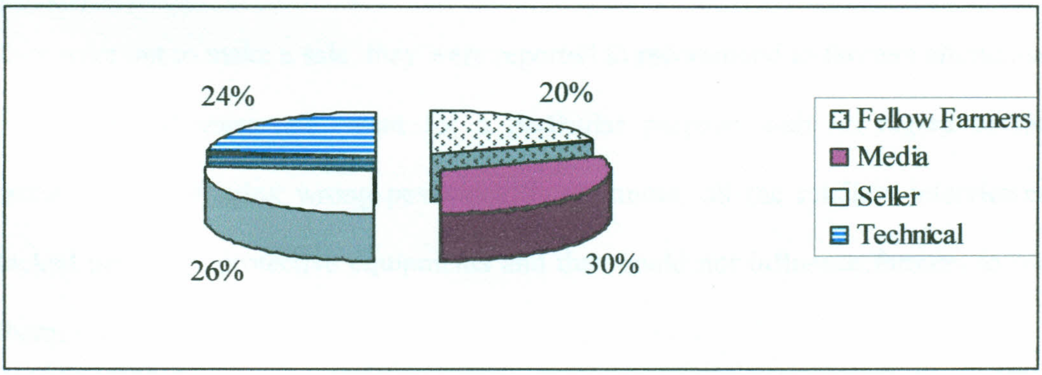


Figure 4.2 Sources of information regarding pesticides by farmers in Sagana area

Government agricultural extension officers lacked adequate facilities like transport to cover the large number of farmers. Therefore, the media constituted the major source of information regarding pesticide use for farmers in Sagana area (30%). These included newspapers, magazines, radio programmes and label instructions. The media was termed by farmers as least effective as it was not interactive and farmers could not clarify with the information providers any contentious issues regarding pesticide use.

Farmers receiving information and technical assistance from private companies exporting their fresh produce to Europe had been trained on safe use and handling of pesticides. This is because stringent regulations demand evidence of safe use and handling of pesticides before fresh produce can be allowed for sale in Europe. These farmers demonstrated a high level of skills in the subject as compared to those not contracted who lacked access to technical assistance and thus were not only at risk but also exposed the environment to pesticides hazards.

Pesticide retailers emerged to be significant sources of information regarding pesticides to a large number of farmers (26%). This included advice on the best products for a particular purpose, and guidance on how to use those products. Since they were out to make a sale, they were reported to recommend to farmers alternative pesticides that were not meant for a particular purpose with no regard to the consequences of using wrong pesticides. Furthermore, all the retailers interviewed lacked personnel protective equipments and thus could not influence farmers to use them.

About 20% of the respondents received information on pesticides from fellow farmers. These farmers indicated that farmer-to-farmer consultation offered an excellent opportunity for learning since they could easily learn by action and results from their fellow farmers with whom they shared similar social economic and cultural characteristics. Model farmers can therefore be targeted for training from whom others can learn pesticides safe use and handling technologies.

In recognition of the existing pesticide hazards, International development agencies such as United Kingdom Department for International Development (DFID) had liaised with exporting companies to initiate what most farmers termed as the most effective communication and capacity-building programme for safe use and handling of pesticides. Farmers were encouraged to form common interest groups through which technical and economic assistance was channelled. With only one set of personnel protective gear and one pesticide application equipment, 20-50 farmers could hire one trained member of the community to spray pesticides on their crops at a fee. They also made appropriate group storage mixing and empty container disposal facilities as well as being able to purchase bulk pesticides with no need to repackage. The exporting companies provided technical assistance through trained agricultural extension officers. Though this arrangement had only managed to reach a handful of farmers, there was a clear indication of the far small scale farmers could go when assisted to mitigate pesticides related hazards and to comply with the requirements of the PCPB Act CAP 346 laws of Kenya (1985).

Pesticide users are more likely to stop mishandling and misusing pesticides when they understand the hazards involved and how to avoid them. While there was no distinct information channel through which the majority of farmers received information, there is need to utilize all available channels to pass pesticide safe use and handling information from manufacturers and researchers to the final consumers of pesticide products.

4.4. Farmers Attitudes towards Pesticides

About 64% of respondents interviewed agreed that pesticides could be sprayed during any weather (Table 4.7). This attitude was common among farmers with larger farm sizes. This was attributed to the fact that farmers with larger farm sizes handled higher volumes of pesticides with a tight application programme often disregarding weather condition. It emerged that farmers spraying pesticides during any weather did not believe that the harm pesticides cause to the environment was severe. They cited that pests strike any time and thus their remedies should be taken immediately regardless of the nature of weather.

Table 4.7 Farmers attitudes towards pesticides

Statement	Level of Importance		
	Disagree (%)	Undecided (%)	Agree (%)
a) Pesticides can be sprayed during any weather	34	2	64
b) Animal pesticides can be used to eliminate crop pests and vice versa	45	2	53
c) It is okay to smoke while handling pesticides	60	1	39
d) It is okay to eat while handling pesticides	79	1	20
e) Increased pesticides dosage per unit area increases the effectiveness of a pesticide	29	1	70
f) Empty containers can be used to contain household food products	51	2	47
g) Washing the body after applying pesticides reduces harm to humans	16	0	84

About 70 % of the farmers interviewed were of the opinion that increased doses per unit area increased pesticide effectiveness. Since belief id dispositional, these farmers were likely to be exceeding dosage to increase pesticide effectiveness. Farmers who believed that it was okay to use animal pesticides to control crop pests (53%) had a tendency to belief also that increased dosage led to increased effectiveness ($r=0.27$, $p=0.01$, $n=140$). Farmers argued that when pests strike suddenly in large numbers, they were always desperate to get rid of them. They thus tried any potential control measure available such as using crop pesticides to get rid of ticks and animal pesticides to spray crops often increasing recommended application rates. For pesticides to be effective, they must not only be applied at the right time to the right pests but at the right doses. This means that recommended volumes per unit area should be measured accurately to avoid under or over dose. Since pesticide labels bear instructions for their recommended purpose, their users for wrong purposes do not have safety guidelines regarding dosage and safety precautions. In addition, post harvest intervals cannot be determined on a wrong use. This leads to vulnerability of the community and the environment to hazards associated with wrong pesticide use.

Up to 60% of respondents strongly disagreed that it was okay to smoke while handling pesticides. They cited that smoking increased the chance of one inhaling pesticides since it involves breathing more air than normal. On the other hand, 39 % of the respondents agreed that it was okay to smoke while handling pesticides. The major reason given was that cigarettes were addictive and one could not wait until the end of spraying to smoke. A number of respondent disclosed that cigarettes helped them to offset strong smelling fumes from pesticides mixtures. Smoking to them was a safety precaution to guard against fumes since respiratory masks were too expensive to afford. Tobacco smoking by itself is generally known to pose enough hazards to human health (WHO, 2002a). Smoking cigarettes while handling pesticides can only be more hazardous.

Centrally to opinions on smoking, many respondents (79%) disagreed when asked whether it was okay to eat while handling pesticides. They cited eating as a channel of ingesting poison and should only be after one is done with pesticides handling. Those who thought it was okay to eat while handling pesticides argued that they had been doing it over a long time without any ill feeling. This indicated that most farmers were only aware of acute effects of pesticides exposure and largely ignorant of the effects that took long to manifest (chronic). Since belief by definition is depositional, these constituted a population at risk of ingesting pesticides through eating activities.

About 47% of the respondents believed that empty containers could be used as receptacles for household food products without any health hazard. There was a strong correlation between this attitude and actual behaviour ($r=0.74$, $p=0.01$, $n=140$). Taking a bath after pesticides application is a well-known hazard mitigation strategy (PIP, 2004). It was also highly appreciated by the local farmers since 84% of the respondents agreed that it could help reduce pesticides hazards. However, 82 % did not take a bath after handling the chemicals, a clear case of inconsistence between belief and actual behaviour.

4.5. Farmer's Perceptions towards Pesticides

The six key perception concepts of the health believe model that affect safety behaviour according to Janz and Becker (1984)), were translated into 13 statements, which the farmers were asked, and their responses recorded (Table 4.8). Implications of farmers' perceptions are discussed in sections 4.6.1 to 4.6.6.

4.5.1 Perceived Susceptibility

Generally, farmers in Sagana were aware that pesticides are harmful to both environment (91%) and human health (92%). Some farmers cited death of unintended insects like butterflies and bees. Others cited constant failure of beehives in the area because of pesticide application. Use of pesticides as baits on animals raiding farms was also common. Others suspected that the increased decline in land productivity could be attributed to change in soil characteristics because of pesticides overuse an observation confirmed by UKPAN (1999b). Harm to human health was attributed to cases of ill health experienced after handling pesticides, suicide and infant poisoning. Up to 88% of the respondents perceived pesticides as hazardous to unborn children. They explained that inhaling pesticide fumes could poison the unborn baby causing death and miscarriage.

Table 4.8 Farmers perceptions regarding pesticides use

Statement	Perceptions		
	Yes (%)	No (%)	Unaware (%)
a) Pesticides can cause harm to the environment	91	8	1
b) Pesticides can persist in water and pollute ecosystems	12	76	12
c) Pesticides can harm livestock	91	8	1
d) Pesticide can harm human health	92	8	1
e) Pesticides are dangerous to unborn children's health	88	11	1
f) The harm caused by pesticides to the environment is severe	87	11	2
g) The harm caused to human health is severe	91	8	1
h) Pesticides increase food production from my farm	74	25	1
i) Eliminating pesticide hazards would improve your health	93	7	0
j) Eliminating pesticides hazards is beneficial to the environment	89	10	1
k) Available pesticide safe use solutions are too costly.	85	12	3
l) I have insufficient information to make safe use decisions	69	19	12
m) Suggested safe use methods are too complicated	49	49	2

Majority of the respondents (91%) agreed that pesticides are harmful to livestock. They cited various cases of livestock poisoning when grazed in previously sprayed crops or pastures. Farmers who used pesticides intended for crops on livestock or used the same knapsack sprayers reported blindness in exposed livestock. Those who thought pesticides could persist in water (12%) cited instances where animals were poisoned and died after drinking water from streams running through farming areas.

4.5.2 Perceived Severity

There was a high-perceived severity of pesticide hazards to the environment (87%) and human health (92%). Severity to human health was associated with cases where death or long-term illnesses were experienced after exposure. Severity of hazards to the environment was linked to cases where livestock deaths occurred when grazed in pastures contaminated with pesticides. According to the health belief model discussed earlier, perceived severity modifies the relationship between perceived susceptibility to taking health safety actions.

4.5.3 Perceived Benefit of Health Behaviour in Mitigating Pesticide Hazards

There was a high-perceived benefit of adopting safety behaviour among the respondents. About 89% of the respondents felt that eliminating pesticides hazards would safeguard the environment while 93% felt the same in the case of human health. The farmers argued that the many ill health symptoms and signs experienced due to pesticides exposure would not be there if pesticides hazards were eliminated. They cited integrated pest management as an important option in minimizing the amount of pesticides used by combining different methods of pest control such as cultural, biological and mechanical. However, the availability of these alternative pest control methods and technical assistance to make them effective was cited as lacking.

4.5.4 Perceived Barriers to Taking Action

Perceived barriers to taking action such as cost or complexity were high. Up to 85% of the respondents perceived the recommended pesticides safe use and handling solutions as too costly such as purchasing personnel protective gears and construction of prescribed storage, incineration and disposal facilities. The use of full personnel protective gears was thus extremely low.

Though 75% of the respondents agreed that use of pesticides increased their farm production, others felt that it was purely psychological and routine. A key informant farmer narrated that whenever he bought seeds, they had to be accompanied by pesticides. He viewed pesticides use as a must whether pests attacked crops or not. He said that in his household, sometimes his family could go without basic needs to help him save money for pesticides because they were expensive. This kind of dependency made farmers cling desperately to use of pesticides even without evident benefit from their use, a psychological barrier to adopting safer pesticide management techniques

4.5.5 Cues to Taking Action

Lack of training, knowledge and education was identified as the single most important factor determining adoption of safety behaviours when handling pesticides. Over 69% of the respondents felt that they had no adequate information regarding pesticides hazards to be able to make safe use decisions. Some perceived pesticide safe use methods and procedures as difficult to understand indicating the need for frequent training. Pesticides promoters were biased in their training and emphasized on how to maximize economic returns from pesticides other than reducing their associated hazards.

4.5.6 Self-efficacy

The respondent farmers were characterised by low self-efficacy. About 49% of respondents thought that pesticide safe use methods were too complicated to understand and that there was no need to attend training. These farmers felt that they had no control over pesticide-associated hazards leaving everything to "God" and fate. Such perceptions hindered any efforts to adopt safe use and handling strategies increasing community and environmental vulnerability.

4.6. Pesticides Handling Behaviours and their Implication to Environmental Safety

Farmers in Sagana area engaged in pesticide handling behaviours hazardous to the environment (Figure 4.3).

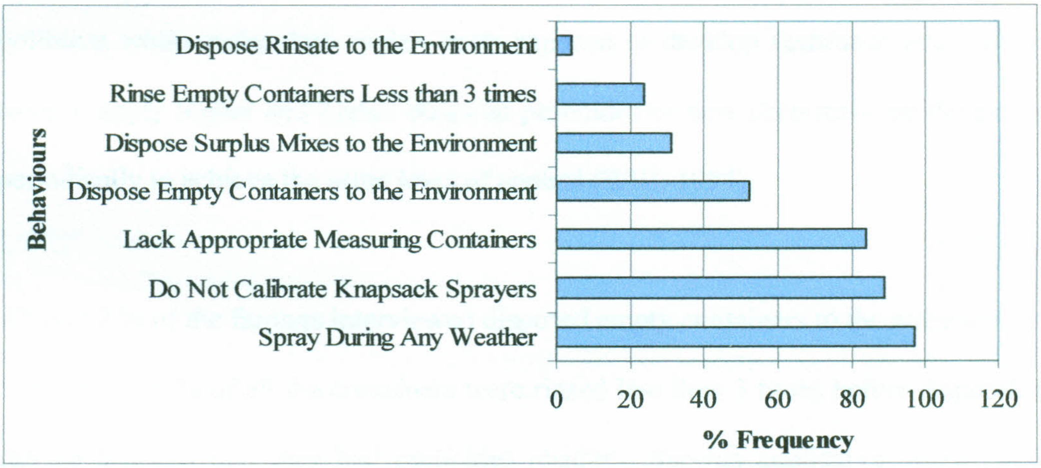


Figure 4.3 Farmers pesticides handling behaviour hazardous to the environment

Regarding timing of application, at least 64% of the respondents sprayed pesticides in any weather conditions. Spraying of pesticides during windy weather often led to drift and spraying off the target. When spraying was done in rainy weather, pesticides were washed to the environment before they were attached to plants. All these resulted to wastage, contamination of soil and water bodies without meeting their intended objective.

Only about 11% of the farmers interviewed were involved in calibration of their application equipments. This coupled with the fact that up to 84% lacked proper pesticides measuring containers raise questions on the accuracy of pesticides measurement in the area. Calibration and general maintenance of pesticides application equipments is very important in ensuring proper dosage of pesticides as per manufacturer's recommendations. With age, discharge nozzles tended to expand allowing for higher discharge rates than originally intended. Most knapsack sprayers observed spilled their contents, had loose fitting caps, and others leaked from below discharging contents to the environment. Pesticide overdose may cause environmental pollution while under dose makes pests exposed to develop resistance and farmers have to apply higher and higher doses of pesticides or new chemicals are developed periodically to achieve the same level of control (WRI, 1994).

About 52 % of the farmers interviewed disposed empty containers to the environment. Since up to 24% of all the containers were rinsed less than 3 times before disposal, it can be deduced that they had pesticides residues. Surplus application mixes were disposed off to the environment and knapsack sprayers washed near the rivers and streams contaminating them. Empty pesticides containers are environmental hazards especially when they are not well rinsed. These had become ubiquitous especially along the river Hobe basin where pesticides' mixing was mainly done. Eventually, they were washed off to the river when it rained contaminating both soil and watercourses. According to the residents, laboratory analysis has identified nine different pesticide residues in this river.

A related study by WRI, (1994) indicated that pests exposed to pesticides can develop resistance, which means that higher and higher doses of pesticides must be applied or new chemicals developed periodically to achieve the same level of control. Resistance was found in more than 500 insect and mite pests, over 100 weeds, and in about 150 plant pathogens. This led to a vicious cycle of pesticide dependence. A study by NRC, (1989) indicated that populations of the natural enemies of pests and beneficial microorganisms are reduced by heavy pesticide use leading to explosions in prey numbers. In California in the 1970s, for instance, 24 of the 25 most important agricultural pests had increased due to overuse of pesticides. Harper *et al.* (2002) observes that indiscriminate pesticide use has resulted in acute and chronic ecological damage, either by direct injury to non-target organisms such as birds and fish, or by indirect effects such as elimination of natural enemies.

4.7. Pesticides Handling Behaviours Dangerous to Community Health

A variety of pesticide pesticides handling practices dangerous to community health were practiced by Sagana farmers (Figure 4.4). The majority of respondents (96%) sprayed during windy weather. which led to increased pesticide fumes inhalation and wetting self with application mixtures exposing the pesticide handlers to both acute and chronic poisoning.

Due to the high cost of pesticides, 96 % of farmers stored them in living houses as indicated (Plate 3 appendix 4) or in granaries (Plate 2, appendix 4). This posed danger of poisoning unsuspecting household members contaminating households, and suicide. Young people were reported to be more prone to committing suicide than other community members, which were blamed on increased poverty, unemployment levels and easy access to poisons like pesticides.

The containers used were largely from alcoholic drinks identified as 'Kane' as shown in pesticide repackaging point (Plate 1, Appendix 4), and were generally not labelled when containing the new contents.

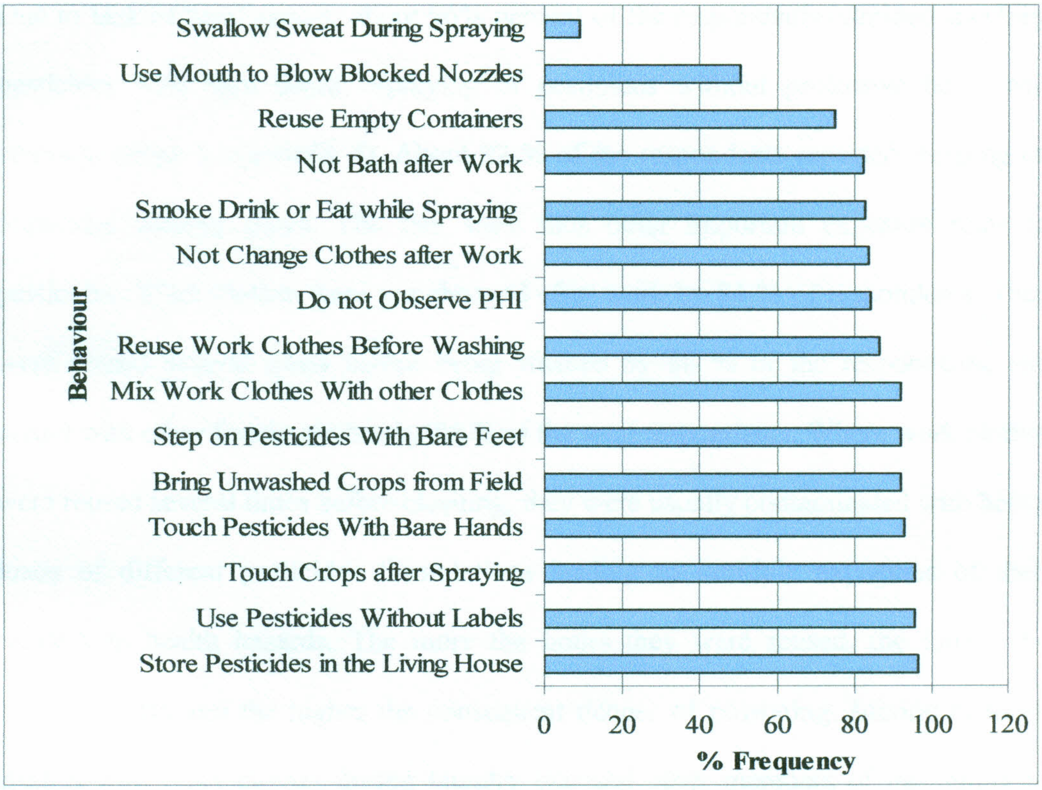


Figure 4.4 Pesticides handling behaviours dangerous to community health

About 96% of the respondents reported using pesticides without labels. This was attributed to many cases where pesticide vendors repackaged products into plastic bags or bottles for sale in small quantities (Plate 4, Appendix 4). The product label is generally the only means by which a pesticide can be clearly identified. Important information on efficacy, dosage, modes and timing of use, hazards associated with the product and precautions that users should take is usually contained in the pesticide labels. In their absence, end users do not have such essential information. Household members may not realize that an unlabelled bottle contains pesticide, and may unknowingly expose themselves to serious hazards. PCPB regulations stipulated in the PCPB Act CAP 346 (1985) offers guidelines for labelling pesticides in Kenya.

Due to lack of hand gloves, about 96% percent of the respondents admitted touching pesticides with bare hands. Spraying of pesticides without protective boots was common (Plate 5, appendix 4). About 92 % of the respondents reported stepping on pesticides without shoes. The feet were thus other important exposure route to pesticides. Work clothes were not changed after work by 84 % of respondents. They were reused several times before being washed by 86 % of the respondents, and mixed with other family clothes by 84 % of the total respondents. Where work clothes were reused several times before cleaning, they were usually contaminated with heavy loads of different pesticides formulations leading to multiple exposures of their wearers to health hazards. The more the hours they were reused, the longer the exposure time and the higher the consequent danger of poisoning. Mixing of work clothes with other clothes during laundry exposed other members of the family to pesticides hazards. Children whose immune systems are less developed and whose skins are more sensitive were more vulnerable.

Over 83 % of the interviewed respondents ate food, smoked or carried out both activities during pesticides handling. These constituted major exposure routes through which pesticides could be ingested into human body. It is generally agreed that smoking is harmful to human health. Little is however known of the effects of combined exposure to both products.

Failure to observe Pre Harvest Intervals (PHI) was reported by up to 84% of the respondents. This is the number of days that must pass after pesticide application on crops before such crops are harvested for consumption. After the days are over, the pesticide is expected to have disintegrated into a state that is not likely to cause harm to the consumer of the crops. The implication of not observing PHI is that the crops were harvested when the pesticides applied were still in their active forms and capable of causing harm to the consumers of the crops.

Reuse of empty containers as receptacles for household food products was practiced by 75% of all respondents. These containers were mainly used to contain milk sugar and salt in the households. Though farmers claimed to wash them well, some designs were hard to clean with ordinary soap and water especially when containing suspensions insoluble in water. This is another exposure route since pesticide residues could be ingested in sugar milk and salt or any other food material in the containers. Interviews with the local health centre officials indicated that they were ill equipped to diagnose and treat cases of pesticides poisoning and thus treated them as per symptoms.

Over 51% of the respondents unblocked knapsack nozzles using the mouth leading to pesticide ingestion through the mouth. This is a direct exposure route, which can lead to both acute and chronic poisoning. Only 9% of the respondents swallowed sweat after spraying crops with pesticides another direct human exposure route especially where pesticide handlers had wet themselves with pesticide mixes.

There was a positive correlation between farmers spraying during windy weather and practicing other risky behaviours (Table 4.9). Farmers engaging in one hazardous pesticide handling behaviour were therefore more likely to engage in another leading to multiple pesticide exposure.

Table 4.9 Pearson's correlation values for farmers spraying during windy weather and practicing other risky behaviours

Behaviour	r (n=140)
1. Breathed pesticides in the air	0.83
2. Wet self with pesticides	0.83
3. Used pesticides without labels	0.91
4. Touched crops after spraying	0.83
5. Touched pesticides with bare hands	0.91
6. Brought home unwashed crops from field	0.76
7. Reused work clothes	0.42
8. Not changed work clothes	0.46
9. Stepped on pesticides with bear feet	0.86
10. Not bathed after work	0.50
11. Swallowed sweat during spraying	0.67
12. Mixed work clothes with other clothes	0.59
13. Smoked or ate while handling pesticides	0.37

All (r) values significant at p= 0.01 level of confidence

Findings on pesticides handling behaviours hazardous to human health are related to those of Rust (1990). In his study on migrant workers involved in pesticide application in America noted that almost all had skin contact with pesticides when mixing and soaked clothing after spraying. Almost none wore gloves, and 22% cleared blocked nozzles with their mouths. Soap, drinking water or field sanitation was never available to pesticide workers during spray operations. Most workers tended to postpone washing-up until in the evening exposing them to spills for a long period. Equipment used were generally in a poor condition, with leaks common and dirty water frequently used for mixing clogging spray nozzles. A great number of pesticide containers were left in the fields, disregarding disposal recommendations. Pesticide application equipments were generally washed in the work environment, without protective clothing.

4.8. Farmers Self Protection Practices

The level of adoption of personal protective practices in the area was very low (Figure 4.5). Over 69 % of the total respondents took no action to protect themselves or the environment from pesticides hazards leaving everything to fate and "God". As discussed earlier, this was attributed to low self-efficacy among farmers and thus little confidence in their own ability to control the pesticide related hazards.

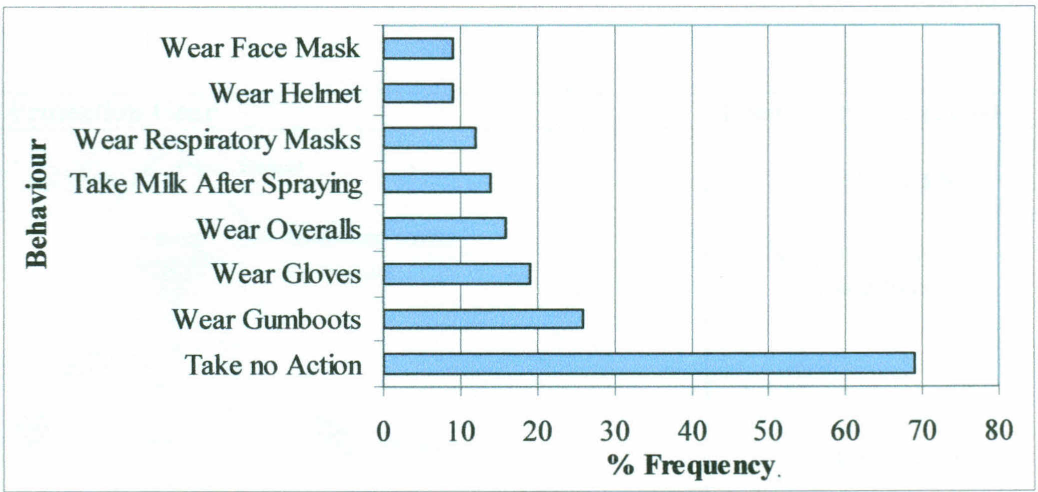
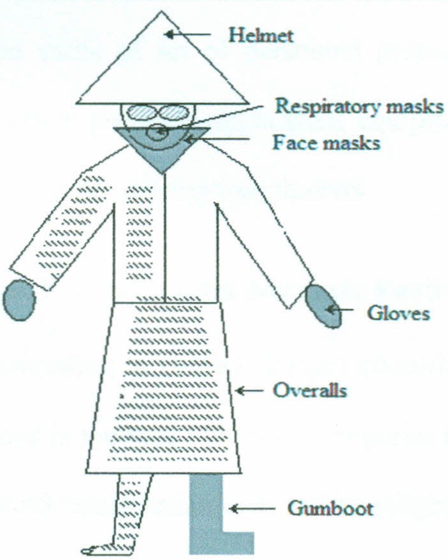


Figure 4.5 Farmers self-protection practices

Related studies by Grieshop *et al.* (1996) found that North California farmers attributed more control over workplace safety to factors outside of themselves such as in God and luck than to factors they could control. Although they thought about ways to stay safe in the workplace, they deliberately engaged in hazardous behaviours like not wearing protective equipments.

About 14% of respondents took milk after ingesting pesticides with an aim of neutralising their hazardous effect. Studies have however shown that pesticides especially derivatives of POPs resist degradation in all environmental media (air, water and soil), and are highly soluble in fat (WHO, 2003). Ubiquitous low-level exposures therefore resulted from consumption of food products relatively high in fat content like milk.

Among the farmers who used various self-protection gears, none used a complete set (Figure 4.6). Gumboots at 26% were the most frequently used notably to protect the farmers from mud during rainy seasons and not necessarily from pesticides exposure through the feet.

<table>
<tr><th>Protection Gear</th><th>Frequency of use (%)</th></tr>
<tr><td>


</td><td>Helmet 9

Respiratory masks 12
Face masks 9

Gloves 19

Overalls 16

Gumboots 26</td></tr>
</table>

Figure 4.6 Sagana farmers' personal protective equipment data summary

Hand gloves were used by only 19% of respondents protecting them from exposure through hands while overalls were used by 16% of the respondents. These two personnel protective equipments were in many cases torn and in bad condition to guarantee protection. Some were made of cloth material, which allowed pesticides to penetrate through to the skin of their users. The skin and the head region were the most exposed body parts of a pesticide handler. Only 16 percent of respondents wore overalls, 12% wore respiratory masks and 9% of the respondents wore helmet and facemask.

Personnel protective gears are intended to cover pesticide exposure routes such as the mouth, nose, eyes and the skin to protect their users from the dangers of pesticides. However, their general ownership in Sagana was low owing to the perceived high cost of owning them. However, there was no significant relationship between farmers' income and ownership of personnel protective gears. It was observed that many farmers owned pesticides application equipments, whose cost was almost four times the value of set of personnel protective gear. This was attributed to the fact that owning pesticide application equipments was seen as prestigious and a community way of identifying true farmers

4.9. Pesticides Used and their Environmental and Human Health Hazards

According to (WHO, 2002b) classification of pesticides by hazards, most pesticides used in the area fell into 3 categories (Table 4.10). These are IB (highly hazardous), II (moderately hazardous) and III (slightly hazardous). It was also observed that farmers occasionally applied pesticides on wrong pests due to either lack of money to by recommended ones, or lack of information on recommended use of pesticides. The resultant misuse posed hazardous to human health when animal pesticides like Triatix was used on crops or livestock health when crop pests were used to control ticks, mites or fleas. Cases of blind cows were witnessed which respondents attributed to use of crop pests to control parasites like ticks in cows.

Table 4.10 Pesticides used in Sagana area as at October 2006 and their WHO hazard classification

Pesticide Brand	Common Name	WHO Class	Recommended Use	Current Use at Sagana
Dimethoate	Diomethoate	II	Cutworms, Leaf miner	Bean fly, Cutworms Aphids, Ticks, Blight
Gramaxone	Paraquat	II	Broad leafed weed	Broad leafed weed
Fastac	Cypermethrin	II	Aphids	Aphid, Beanfly
Wetsulf	Copper sulphate	II	Powderly mildew	Powdery Mildew, blight
Brigade	Bifenthrin	II	Red spider mites, Fruitworms	Red spider mites, Fruitworms, Blight, Aphids, Cutworms
DDT	DDT	II	Banned	Aphids, Cutworms, Caterpilars
Triatix	Amitraz	III	Ticks	Ticks, Aphids, Caterplars
Bestox	Cypermethrin	II	Cutworms	Blight , Cutworm
Bulldock	Beta cyfruthrin	II	Fruit worms, Aphids, Thrips	Aphids, Fruit worms, Cutworms, Thrips
Confidor	Imidacroprid	II	Aphids, Bean fly	Bean fly, cutworms
Malathion	Malathion	III	Fruit worms , Caterpilars	Fruit worms, Aphids, Caterpilars
Keshet	Deltamethrin	II	White flies, Aphids Caterpillars, Thrips	White flies, Aphids Caterpillars, Thrips, cutworms, Fleas
Furadan	Carbofuran	1B	Leaf miner, Nematodes, Cutworms	Leaf miner, Cut worms
Diazinon	Diazinon	II	Aphids, lice, fleas	Aphids, Bean fly
Ortiva	Azoxysrobin	II	Aphids	Aphids, Blight
Actara	Thiometoxam	II	Aphids, Bean fly	Aphid, Bean fly

Dimethoate, a systemic insecticide used against a wide range of pests such as thrips, caterpillars and leaf miner. Its recommended application rate is 0.7-1 litre per hectare. It is moderately toxic (World Health Organisation class II). Its mode of action is through contact as well as ingestion. Exposed farmers reported breathing/ respiratory problems, runny nose, coughing, and chest discomfort. Skin contact was reported to cause skin sensitisation. Eye contact caused pain, bleeding, tears and blurred vision. The toxicity of Dimethoate for aquatic organisms and birds is moderate to high, and it is highly toxic to bees on an acute contact basis (WHO, 1992).

Dimethoate was reported to be responsible for the highest number of symptoms of ill health in the study area (Figure 4.7). In appreciation of its rapid knockdown effect, local farmers used it in almost every pest though it is recommended for use in cutworms and leaf miner. The resultant misuse could be the reason behind its being attributed the highest number of poisoning cases in the area. Farmers in the area reported constant failure of beehives, due to death of bees, which they attributed to use of Dimethoate.

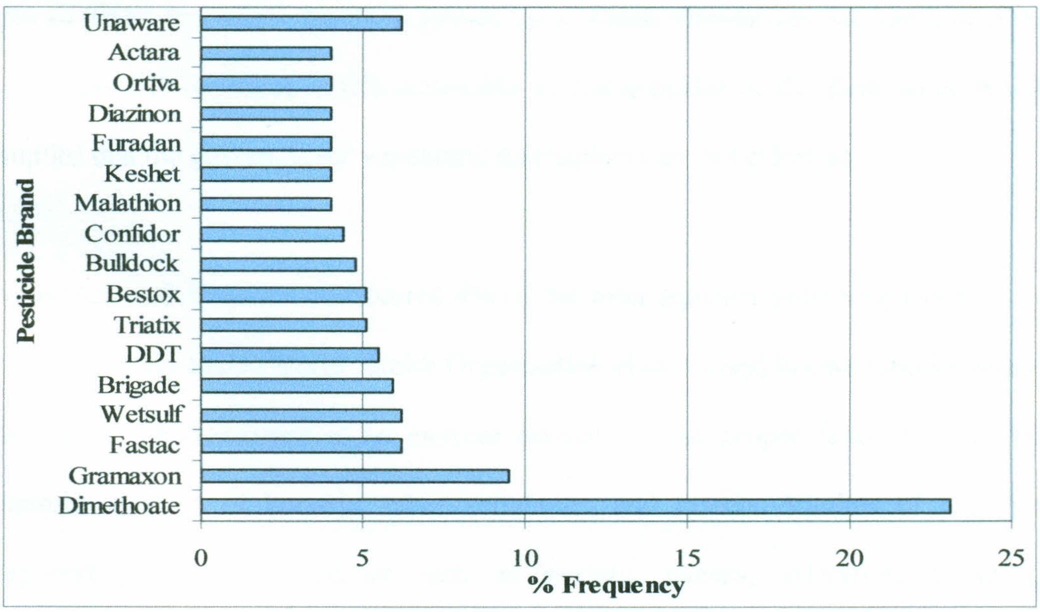


Figure 4.7 Number of poisoning cases attributed to pesticides used in Sagana area

Paraquat otherwise known as Gramaxone was a widely used herbicide in the area usually as a weed killer. It constituted 10% of reported poisoning cases. Paraquat was used to destroy both broad-leaved weeds and grasses when preparing land for planting in combination with no-till agricultural practices, which minimised ploughing and helped prevent soil erosion. Treatment is recommended when the weeds are actively growing for best results. Domestic animals and wildlife poisoning were reported especially when these animals grazed in treated fields. This pesticide is among the products that are possibly carcinogenic to human beings (WHO, 1992). No antidote for poisoning exists. Exposed farmers reported skin problems such as mild irritation, blistering, peeling of the outer layer of the skin, nail damage and eye problems.

DDT, a persistent organic pollutant whose use should be prohibited (WHO 1992) constituted 6% of total reported poisoning cases. Exposure victims cited health problems like headache and shivering. By ratifying the Stockholm convention on POPs in May 2001, Kenya in its implementation plan committed itself to restrict the use of DDT for public health purposes only where alternatives are not available. However, this chemical is still accessible to communities at the farm level, which implies that the governments' regulation mechanisms are not effective.

Malathion and Diazinon constituted 4% of the total reported poisoning cases. They are moderately toxic (World Health Organisation class II) and known Cholinesterase inhibitors. Cholinesterase is an enzyme needed for the proper functioning of the nervous systems of humans, other vertebrates and insects. Victims of exposure reported poisoning symptoms such as anxiety, nausea, salivation, vomiting, abdominal pains, diarrhoea, blurred vision and excessive tears secretion.

Pyrethrum derivatives otherwise known as pyrethroids included Bifethrin, Alpha Cypermethrin, Beta-cyfruthrin and Deltamethrin, which together contributed 16% of the total, reported poisoning cases. Symptoms resulting from exposure to pyrethroids included convulsions, muscle paralysis, rapid heart rate, numbness or itchiness, unusually runny nose, ringing or pulsation in the ears, blurred vision, headaches, tremors, vomiting, and asthmatic conditions. Over 6% of the farmers had felt ill after exposure to pesticides but could not attribute this to any specific one. This either was due to lack of awareness of the pesticides brands or because of multiple exposures where many brands were mixed together in one application as farmers claimed it improved their effectiveness.

From the farmers' responses, it can be said that Sagana community experienced a range of signs and symptoms of ill health associated with pesticides exposure (Figure 4.8). However, only 8% of all cases were reported to the nearest health centres. High-income farmers were less likely to have ever been poisoned by pesticides (r=-0.19, p=0.05, n=140). This is possibly because low-income farmers were more likely to practice risky behaviours as discussed earlier like using pesticide without labels and reusing work clothes.

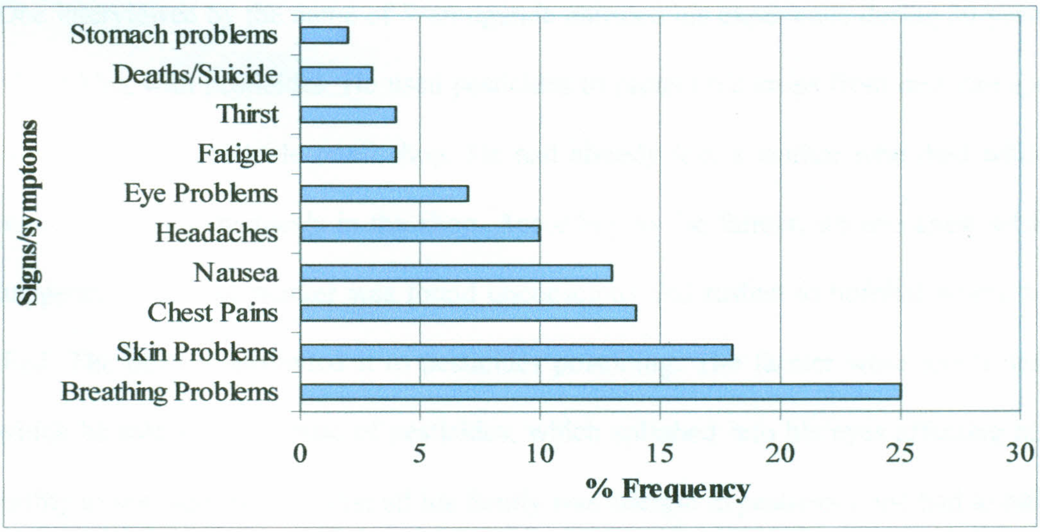


Figure 4.8 Symptoms experienced by farmers in the year 2006 after handling pesticides

Due to low use of respiratory masks, it was no surprise that the highest number of respondents (25%) experienced breathing problems after exposure to pesticides. Others included skin problems (burns and abrasions) and eye cataracts, which they attributed to chronic exposure. Skin problems rated second among the symptoms experienced with 18% of reported symptoms/signs. This could be attributed to the low numbers of farmers using protective gear as discussed earlier. Chest pains, nausea, headaches, fatigue thirst and stomach problems were also reported and were associated with pesticide ingestion to the body systems.

The three health centres, one at Mutaga and two at Kiamariga shopping centre confirmed having attended to some cases of suicide, which they said might have been facilitated by poor storage and easy access to pesticides. Death from acute poisoning was reported to have occurred to three members of the households interviewed. Reporting rate of cases of pesticide poisoning was estimated at below ten percent

One interviewee by the name of Wamugunda narrated his experience during 30 years of working with pesticides. He used pesticides to protect his crops from pest damage and operated a pesticide retail shop. He had already lost a worker who died while repackaging the chemicals in the shop. According to the farmer, no one knew what happened, since the worker was found unconscious and rushed to hospital where he died. The doctors attributed it to pesticides poisoning. The farmer wore spectacles, which he said were because of pesticides, which splashed into his eyes affecting his ability to see well. He said that all his family was allergic to pesticides and had to hire a casual labourer for their application. Since they helped improve his crops yield and quality for the export market, the farmer concluded by saying that pesticides had both advantages and disadvantages on his farm and that he was in a dilemma whether to continue using them or not.

There was very little awareness of the long-term effects (chronic) of pesticides exposure. Victims sought medication for either acute poisoning cases or where chronic exposure led to serious illnesses that prevented the victims from going on with their day-to-day activities. The major reason given for not going to seek medical attention is that the symptoms are inconsequential, lasts for a short time, and are not serious.

CHAPTER FIVE:SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Using a Life Cycle Approach, the study set out to determine the farmers' attitudes, perceptions and behaviour towards pesticides at Sagana, the occupational safety hazards associated with such attitudes, perceptions and behaviour and the potential hazards to the environment resulting from observed farmer-pesticide interactions. Hazards to human health and the environment were identified at all stages of pesticide use and the results are summarised in table 5.1.

Table 5.1: Summary of pesticide related hazards to human health and the environment sing LCA

Stage	Practice/ behaviour	Hazard
1.Purchase	• Repackaging of pesticides into differ rent containers in some cases beverage containers • Loss of labels and safety instructions	• Spillage and contamination of environment • Danger of mistaking pesticides with beverages where 'Kane' bottles are used • Failure to follow label instructions endangering human health and the environment
2.Transport	• Touching containers with bare hands • Lose fitting bottle toping • Mixing pesticides with other purchased products	• Human exposure through the hands • Environmental contamination through spillage • Contamination of other household products especially foodstuffs
3.Storage	• Storing pesticides in the living house • Storing pesticides in granaries	• Danger of mistaking pesticides with beverages where 'Kane' bottles are used • Contamination of other household products especially foodstuffs • Suicide due to easy access of pesticide poisons

Stage	Practice/ behaviour	Hazard
4. Mixture preparation	• Lack of personnel protective gear • Use Pesticides Without Label • Do Not Calibrate Knapsack Sprayer • Lack Appropriate Pesticide Measuring Container	• Human exposure to pesticides through the skin or mouth or breathing • Failure to follow label instructions endangering human health and the environment • Possibility of pesticide overdose and environmental contamination
5.Pesticide application	• Spray during windy weather • Touch pesticides with bare hands • Touch crops after spraying • Step on pesticides with bare fee • Smoke drink or eat while applying pesticides • Swallow sweat during spraying • Use mouth to blow blocked nozzle	• Possibility of drift and inhaling of pesticide fumes • Exposure to people not involved in pesticide application • Human exposure to pesticides through the skin, mouth, breathing or ingestion with food or smoke • Failure to follow label instructions endangering human health and the environment
6. Post pesticide application	• Bring unwashed crops from field • Do not observe PHI • Mix work clothes with other clothes • Reuse work clothes before Washing • Not change clothes after work • Not bath after work	• Human exposure to pesticides through the food • Human exposure to pesticides through the skin • Exposure to family members not involved in pesticide application like children • Prolonged exposure where bath is not taken after pesticide application
7.Disposal of empty containers	• Rinse empty containers less than 3 time • Reuse empty containers • Dispose empty containers and rinsate to the environment	• Possibility of pesticide residues contaminating the environment • Human exposure to pesticides through the food contained • Exposure to community members such as unsuspecting children

5.2 Conclusions

Although Sagana farmers were aware of the environmental and human safety hazards associated with the use of pesticides and their severity, most lacked adequate information about safety precautions, particularly appropriate dose indications and handling procedures. Perception of the protective gear as expensive and lack of training on safe use and handling of pesticides made farmers hindered adoption of self-protection measures while handling pesticides.

A significant proportion of the farming population deliberately exceeded recommended pesticide dosage in an attempt to increase their effectiveness despite spraying during any weather, and disposing surplus mixes and empty containers to the environment. This made human health and the environment vulnerable to pesticide related hazards. Hazards to human health included failure to use personal protective equipments, eating and smoking while handling pesticides, reuse of pesticide empty containers to contain food products and mixing pesticides with bare hands. There was prolonged exposure as few used overalls, boots respiratory masks and gloves while majority wore unwashed, contaminated clothing. Further, the use of highly hazardous and prohibited products made the situation serious.

Training was the single most important factor that influenced adoption of pesticide safe use and handling practices. Trained farmers were more likely to adopt pesticide safe use and handling practices than untrained ones. Education however had little impact on adoption of pesticide safe use and handling practices, as there was no significant relationship between education and adoption of safe practices in pesticide use.

5.3 Recommendations

The following recommendations were thus advanced from the findings of the study:

i) Agricultural extension by the Ministry of Agriculture should be targeted at increasing safety awareness among farmers through training. This awareness should address users' perceptions attitudes and behaviour at all stages of pesticide life cycle from choice purchase use and disposal. However for this to be effective there is need to capacity build agricultural extension agents in terms of resources to improve their coverage and skills to address emerging hazards.

ii) Pesticide manufacturers should be required by law to assist the government and the farmers in mitigating pesticides related hazards to human health and the environment at farm level. Smaller packaging of pesticides to discourage repackaging, training of farmers and awareness creation on safe use and handling of the pesticides they produce can have a big impact in this regard. Special emphasis should be given to local social cultural economic and environmental conditions so that this awareness is culturally appropriate, acceptable and effective in mitigating human and environmental hazards at a local level.

iii) The Ministry of Environment and Natural Resources in collaboration with the ministries of agriculture and NEMA should take deliberate steps to support the use of IPM principles such as scouting and use of non-chemical measures to keep pest populations below damaging levels.

iv) The government should promote the use of appropriate technology such as biotechnology and selective breeding which have the potential of reducing pesticide use by developing crop varieties that are resistant to diseases and pest damage.

v) Due to increase in entry of banned hazardous pesticides in Kenya, the government should institute adequate participatory monitoring systems down to the farm level so that hazardous pesticides and handling practices are noted before a lot of damage to the environment occurs or a large number of people are affected.

5.4 Recommendation for Further Studies

Further studies on the other hand should focus on the following items:

i) From the observed behaviour of farmers at Sagana, there is a high possibility of increasing pesticide residues in that environment, which calls for the need to collect countrywide data concerning pesticide residue levels in the ecosystem as an important step towards informing policy with regard to safe use and handling of pesticides.

ii) There is need to carry out pesticide risk assessment so that policy formulation on pesticide use is based on accurate scientific data.

iii) More research effort should be directed to environment and community friendly pesticides such as bio-pesticides and other alternative approaches to break the dependency on chemical control of pests.

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Appendices

1. Individual Farmer Questionnaire

Questionnaire Number.____________	Interviewer________________
Location/Place__________________	Date_____________________

Section 1

1. General Information

i. Gender: Male [ ] Female [ ]

ii. Land size owned (acres): [ ]

iii. Length of stay in Sagana area (years): 0-5 [ ] 5-10 [ ] Over 10 [ ]

iv. Type of farming: Subsistence [ ] Local market [ ] Export [ ]

v. Total income level per month (Thousands): 0-5 [ ] 5-10 [ ] Over 10

vi. Level of education

Pre-primary [ ] Primary [ ] Secondary [ ] Post secondary [ ]

vii. Have you been trained on safe use and handling of pesticides: Yes [ ] No [ ]

vii. If yes, by who_______________________________________

2a) Which pest control method/ techniques do you use in your farm?

4- Very Important; 3-Important; 2-not Important; 1-Unaware

Method		Level of importance			
		4	3	2	1
a)	Cultural / Agronomic control				
b)	Chemical control				
c)	Biological control				
d)	Genetic control				
e)	Mechanical				
f)	IPM				
g)	Others (specify)				

3. Which are the 5 most used pesticides on your farm

	Brand Name	Pests
a)		
b)		
c)		
d)		
e)		

4a) Which is your most reliable source of information regarding Pesticides__________

b) Are they trained in safe use and handling of pesticide: yes [ ] No [ ]

c) Who is responsible for pesticides application in your farm?

d) Man [ ] Woman [ ] Children [ ] Sourced Labour [ ] Undefined [ ]

e) Level of education

f) Pre-primary [ ] Primary [ ] Secondary [ ] Post secondary [ ]

g) Age (years): Under 18 [ ] 18- 40 [ ] over 40 [ ]

h) Are they trained in safe use and handling of pesticide: yes [ ] No [ ]

i) Any records: Yes [ ] No [ ]

j) Which equipment is used in pesticide application on your farm?

i) Own knapsack sprayer [ ] ii) Borrowed knapsack sprayer [ ]

iii) Hand application [ ] iv) Use of twigs [ ] Others (specify) ______________

Section 2

Probing Attitudes Perceptions and Behaviour towards Pesticides at Sagana

5. To what extent do you agree with the following statements about pesticide use?

5-Strongly Agree; 4- Agree; 3-Undecided; 2- Disagree 1; Strongly Disagree

Statement		**Level of Importance**				
		1	**2**	**3**	**4**	**5**
a)	Pesticides can be sprayed during any weather					
b)	Animal pesticides can be used to eliminate crop pests and vice versa					
c)	It is okay to smoke while handling pesticides					
d)	It is okay to eat while handling pesticides					
e)	Increased pesticides dosage increases its effectiveness					
f)	Empty containers can be used to contain food products					
g)	Washing the body after applying pesticides reduces harm to human health					

6. What are your perceptions regarding the following statements

Statement		**Perceptions**		
		Yes	**No**	**Unaware**
a)	Pesticides can cause harm to the environment			
b)	Pesticides can persist in water			
c)	Pesticides can harm livestock			
d)	Pesticide can harm human health			
e)	Pesticides are dangerous to unborn children's health			

f)	The harm caused by pesticides to the environment is severe			
g)	The harm caused to human health is severe			
h)	Pesticides increase food production from my farm			
i)	Eliminating pesticide hazards would improve your health			
j)	Eliminating pesticides hazards is beneficial to the environment			
k)	Available pesticide safe use solutions are too costly.			
l)	I have insufficient information to make safe use decisions			
m)	Suggested safe use methods are too complicated			

7. Do you engage in the following activities when dealing with pesticides?

Behaviour		No	Unaware	Yes
a)	Breath Pesticides in Air			
b)	Store Pesticides in the Living House			
c)	Spray During Windy Weather			
d)	Wet Self with Pesticides			
e)	Use Pesticides Without Labels			
f)	Touch Crops after Spraying			
g)	Touch Pesticides With Bare Hands			
h)	Bring Unwashed Crops from Field			
i)	Step on Pesticides With Bare Feet			
j)	Mix Work Clothes With other Clothes			
k)	Reuse Work Clothes Before Washing			
l)	Not Change Clothes after Work			
m)	Smoke Drink or Eat while Spraying			
n)	Not Bath after Work			
o)	Reuse Empty Containers			
p)	Use Mouth to Blow Blocked Nozzles			
q)	Swallow Sweat During Spraying			

Section 3

Probing Environmental Hazards

8. How do you protect the environment from hazards while applying/handling pesticides?

a.	
b.	
c.	
d.	
e.	

9a). How do you know that the pesticide application equipment applies recommended doses ____

b). Do you take your spray equipment for independent calibration?

Yes [ ]   No [ ] If yes, any records______________________________

10a). Where do you dispose off:

i. Surplus application mix or tank washings ____________________

ii. Empty pesticide containers ______________________________

b). How many times do you rinse empty containers?

1 time [ ]   2 times [ ]   3 times [ ]   Over 3 times [ ]

c). Where is the rinsate from empty containers applied? ________________

Section 4

Probing Human Health Hazards

11. How do you protect yourself from hazards while applying/handling pesticides?

a)	
b)	
c)	
d)	
e)	

12a). Have you ever experienced any health problems this year that you think are associated with pesticides poisoning? Yes [ ]   No [ ]   No idea [ ]

b). If yes, list the causal pesticides below and the stage they occurred where:

1=Buying 2=Transport 4= Mixing 5=Use 6=Storage 7=Disposal

	Causal Pesticide	**Poisoning stage**
a)		
b)		
c)		
d)		
e)		

13. What were the signs/symptoms and remedial action you took for the above cases

	Signs/symptoms	**Remedial action (s) taken**
a)		
b)		
c)		
d)		

14a). Do you observe registered pre-harvest intervals? Yes [ ] No [ ]

b) Why____

c) If yes, any records Yes [ ] No [ ]

d) Why____

e) What do you think are the effects of exceeding maximum residue levels (MRLs)? ____

15. To what extent do you agree with the following statements? Community members wish to take recommended pesticide safe use and handling actions but:

1-Strongly Agree; 2- Agree; 3-Undecided; 4- Disagree 5; Strongly Disagree

Statement		**Level of importance**				
		5	**4**	**3**	**2**	**1**
a)	Available solutions are too costly					
b) c)	Suggested safe use methods are too complicated					
d) e)	Have insufficient information to make decisions					
f) g)	Constrained by health, age, personal circumstances					
h)	Others (specify)					

2. Human and Environment Vulnerability Assessment Checklist

		Household Number						
	Pesticides storage and handling							
1.	Does the farmer have a list of pesticides approved for use by PCPB?							
2.	Are pesticides stored in a manner that does not endanger the environment?							
3.	Are pesticides stored in manner that does not pose risk to human health?							
4.	Are pesticides stored away from food materials?							
5.	Are there facilities for measuring pesticides?							
6.	Is the clothing used for spraying stored separately from others?							
7.	Are pesticide handlers equipped with suitable personal protective gears in accordance with label instructions?							
8.	Are all pesticides stored in their original package?							
9.	Are pesticide application equipments kept in good condition?							
10.	Are pesticide labels in good condition and clearly legible?							
11.	Are surplus pesticides and empty containers disposed off In a manner that avoids environmental and human contamination?							

1= Yes.0=No

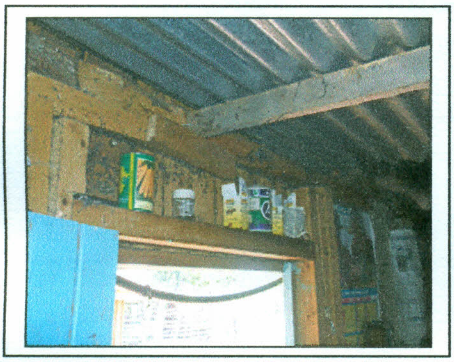
3. Key Informant Interview Guide

1. Which pest control methods/ techniques are common in Sagana area?
2. Which are the five most used pesticides the farms in Sagana area?
3. Which are the sources of information regarding pesticides for farmers in the area?
4. What is the general attitude and perception of farmers in Sagana towards pesticides as a method of pest management?
5. Have you ever heard of any cases of environmental contamination with pesticides in the area? Please explain.
6. Have you heard of any cases of human poisoning resulting from pesticides in the area? Please explain.
7. What pesticide handling behaviour by farmers have you observed at Sagana that is harmful to the environment and human health?
8. How do farmers in the area protect the environment from hazards while applying/handling pesticides?
9. How do farmers in Sagana protect themselves from hazards while applying/handling pesticides?
10. What constraints do farmers, sellers and other pesticide handlers in Sagana area face in mitigating hazards related to pesticide use?
11. In your opinion, what intervention measures should be put in place at all levels of pesticide handling to make pesticides safe to humans and the environment

4. Plates

1. Repackaging pesticides into liquor bottles and polyethylene bags

2. Pesticide application equipment stored together with food crops in the granary



3. Hazardous pesticide storage on top of the door of the living house

4. Repackaged pesticides captured from a farmer on transit with missing labels

5. Pesticide application without protective gear

6. Researcher administering an interview

5. Data Summary

a) Social Economic Data (n=140)

Variable	Category	Frequency
a) House head Gender	Male	109
	Female	31
b) Farm size	<1 Acre	68
	1-2 Acres	63
	> 2 Acres	9
c) Length of stay in the area (years)	0-5	12
	5-10	25
	>10	103
d) Income per month (Kshs)	0-5	37
	5-10	74
	>10	28
e) Education level attained	Pre-Primary	16
	Primary	70
	Secondary	45
	Post Secondary	9
f) Type of farming practiced	Subsistence	1
	Subsistence and Local Market	6
	Subsistence, Local Market and Export	133
g) Pest control method Most frequently used	IPM	3
	Cultural/Agronomic	3
	Chemical	134
h) Trained on safe use and handling of pesticides	Yes	31
	No	109
i) Ownership of appropriate pesticide application equipment	Yes	50
	No	90
j) Major source of information regarding pesticides	Fellow Farmers	28
	Self	43
	Seller	36
	Technical Assistants	33
k) With list of approved pesticides from PCPB	Yes	24
	No	116
l) Household member frequently involved in pesticide handling	Male	79
	Female	47
	Children	11
	Hired	1

b) Farmers Attitudes towards Pesticides (n=140)

Statement	Disagree	Unaware	Agree
a) Pesticides can be sprayed during any weather	52	3	85
b) Animal pesticides can be used to eliminate crop pests and vice versa	68	5	67
c) Its okay to smoke while handling pesticides	84	2	54
d) Its okay to eat while handling pesticides	105	4	31
e) Increasing pesticides dosage improves their effectiveness	39	2	99
f) It is okay to use pesticide containers to contain household food products	71	5	64
g) Washing the body after applying pesticides reduces harm to human health	22	0	118

c) Farmers Perceptions towards Pesticides (n=140)

Statement	No	Unaware	Yes
Pesticides can cause harm to the environment	11	2	127
Pesticide can harm human health	18	14	108
Pesticides are dangerous to unborn children's health	10	3	127
Pesticides can harm livestock	10	3	127
Pesticides can persist in and pollute water ecosystem	18	2	120
The harm caused by pesticides to environment is severe	15	2	123
The harm caused to by pesticides human health is severe	10	2	128
Eliminating pesticides hazards is beneficial to the environment	35	2	103
Eliminating pesticides hazards is beneficial to human health	11	0	129
Pesticides increase food production from their farms	14	1	125
Available pesticide safe use solutions are too costly	20	2	118
Farmers sufficient information to make safe use decisions	26	20	94
Suggested safe use methods are too complicated	64	12	64

d) Pesticide handling behaviours hazardous to the environment (n=140)

Behaviour	Category	Frequency
Spray during any weather	Yes	135
	No	3
Do not calibrate knapsack sprayers	Yes	8
	No	130
Lack appropriate pesticide measuring containers	Yes	18
	No	119
Point of disposal of empty containers	Environment	92
	Toilet	41
	Stored in the house	5
Point of disposal of surplus mixes	Reapply	45
	Environment	78
	Other crops	7
	Stored in the House	7
Number of times empty containers are rinsed	Once	28
	Twice	19
	Three times	14
	Four times	77
Disposal of rinsate	Knapsack	132
	Environment	6

e) Pesticide Handling Behaviours Hazardous To Human Health (N=140)

Behaviour	No	Yes
a) Breath Pesticides in Air	3	135
b) Store Pesticides in the Living House	3	135
c) Spray During Windy Weather	3	135
d) Wet Self with Pesticides	3	135
e) Use Pesticides Without Labels	4	134
f) Touch Crops after Spraying	4	134
g) Touch Pesticides With Bare Hands	8	130
h) Bring Unwashed Crops from Field	9	129
i) Step on Pesticides With Bare Feet	9	129
j) Mix Work Clothes With other Clothes	9	129
k) Reuse Work Clothes Before Washing	17	121
l) Do not observe PHI	20	118
m) Not Change Clothes after Work	21	117
n) Smoke Drink or Eat while Spraying	22	116
o) Not Bath after Work	23	115
p) Reuse Empty Containers	33	105
q) Use Mouth to Blow Blocked Nozzles	67	71
r) Swallow Sweat During Spraying	125	13

f) Farmers Self Protection Practices (n=140)

Practice	No	Unaware	Yes
a) Take no Action	70	0	70
b) Wear gumboots	105	2	33
c) Wear Gloves	122	2	16
d) Wear Overalls	121	2	17
e) Take Milk After Spraying	80	-	60
f) Wear Respiratory Masks	129	2	9
g) Wear Helmet	131	2	7
h) Wear Face Mask	127	2	11

g) Number of Ill Health cases Attributed to Commonly Used Pesticides (n=140)

Pesticide Brand	Common Name	Cases of Ill Health Reported After Exposure	% Frequency
Dimethoate	Diomethoate	63	23
Gramaxone	Paraquat	26	10
Fastac	Cypermethrin	17	6
Wetsulf	Copper sulphate	17	6
Brigade	Bifenthrin	16	6
DDT	DDT	15	6
Triatix	Amitraz	14	5
Bestox	Cypermethrin	14	5
Bulldock	Beta cyfruthrin	13	5
Confidor	Imidacroprid	12	4
Malathion	Malathion	11	4
Keshet	Deltamethrin	11	4
Furadan	Carbofuran	11	4
Diazinon	Diazinon	11	4
Ortiva	Azoxysrobin	11	4
Actara	Thiomethoxam	11	4
Total		**273**	**100**

h) Signs/Symptoms of Pesticide Exposure Experienced in the Year 2006 (n=140)

Signs/Symptoms	Frequency	% Frequency
a) Breathing Problems	35	25
b) Skin Problems	26	18
c) Chest Pains	20	14
d) Nausea	18	13
e) Headaches	14	10
f) Eye Problems	10	7
g) Fatigue	6	4
h) Thirst	6	4
i) Deaths/Suicide	5	3
j) Stomach problems	3	2
Total	**143**	**100**