# SOCIO-ECONOMIC FACTORS INFLUENCING ADOPTION OF SAFE USE OF PESTICIDES IN HORTICULTURAL CROP PRODUCTION AT HOUSEHOLD LEVEL IN MBOGOINI DIVISION, NAKURU NORTH DISTRICT, KENYA





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A Thesis Submitted to the Graduate school in Partial Fulfilment for the Requirements of the Award of the Degree of Master of Science in Environmental Science of Egerton University.

EGERTON UNIVERSITY

FEBRUARY, 2010

# DECLARATION AND RECOMMENDATION

## DECLARATION

I hereby declare that the work presented in this thesis is my original work and has not been presented for an award of a degree or diploma in this or any other university.

Signature ............................................Date ....24/2/2010...........................

Nderitu C. Macharia

## RECOMMENDATION

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

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## COPYRIGHT

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# ACKNOWLEDGEMENT

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## DEDICATION

To my wife Gladys Njeri Kaguamba who continue to astonish me with her resilience, patience and love.

## ABSTRACT

Small scale farmers in Mbogoini division of Nakuru North district grow horticultural crops that include tomatoes, cabbages, onions and French beans. During the production of these crops they use many types of pesticides to control pests and diseases that attack them. The farmers are bound to observe safe use of pesticides practices while handling pesticides. Adoption level of safe use of pesticides has raised serious environmental concern particularly in Mbogoini division where approximately 82% of the farmers use pesticides in horticultural crop production at household level. This study investigated the influence of the following socio economic factors on adoption level of safe use of pesticides; farmer's level of knowledge on safe use of pesticides, farmer's education level, household head gender, frequency of extension services delivery and farm size. A sample size of 289 households was drawn through a combination of stratified sampling and systematic random sampling techniques from a population of 1170 small scale farmers practicing irrigated horticultural crop production. Data was collected by interviewing the respondents using administered questionnaires. Descriptive and inferential statistics were used to analyze the data at alpha 0.05 levels. From the results the respondents were categorized in three adoption level categories; high adopters (8.3%), moderate adopters (62.6%) and low adopters (29.1%). From the study results; farmer's education level, household head gender; farm size and frequency of extension services delivery have no significant relationship with the level of adoption of safe use of pesticides at house hold level. Knowledge on safe use of pesticide was isolated as an important and significant factor positively influencing the adoption of safe use of pesticides. Extension packages aimed at enhancing knowledge on safe use of pesticides need to be developed and disseminated to the farmers. These results can contribute to the reformulation of pesticide policy for safe use and effective use of pesticides. In conclusion the effects of environmental pollution of one farmer not adhering to safe use of pesticides may be overlooked but the cumulative effect of several farmers in a localized area is an issue of concern to environmental managers. This calls for a strategic environmental assessment that identifies impacts and accompanying mitigation measures for the negative impacts resulting thereof.

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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AIC: | -Agricultural Information Services |
| DO: | -District Officer |
| EARO: | -Ethiopia Agricultural Research Organization |
| EC: | -Emulsifiable Concentrate |
| FAO: | -Food Agricultural Organization |
| GCPF: | -Global Crop Protection Federation |
| GOK: | -Government of Kenya |
| IILR: | -Internal Institute for Rural Reconstruction |
| IOCU: | -International Organization of consumer Union |
| KOAN: | -Kenya Organic Agriculture Network |
| MOA: | -Ministry of Agriculture |
| MPND: | -Ministry of Planning and National Development |
| OP: | -Office of the President |
| PCPB: | -Pest Control Product Board |
| TA: | -Technical Assistant |
| UNDP: | -United Nations Development Programme |
| UNEP: | -United Nations Environmental Programme |
| UON: | -University of Nairobi |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the Study

Majority of horticultural farmers in Kenya use chemical pesticides as control strategies for pests and diseases in horticultural crops production because they demonstrate efficacy. When handling chemical pesticides there is need to adhere to recommended safe use of pesticides practices to avoid chances of poisoning the user, cause environmental pollution, pests resistance development and destruction of natural pests enemies hence leading to economic losses.

In 2005 alone, Kenya imported pesticides worth approximately US $50 million placing it among the highest pesticides users in the sub-Saharan Africa (PCPB, 2005). This indicates very high usage of pesticides in the country. It would be unwise to encourage this high pesticide usage where extension services are not readily available coupled with insufficient monitoring and evaluation of impacts (David, 1991). In Kenya, extension services are thinly spread at the grass root level with high extension officer -farmer ratio hence making safe use of pesticides an issue of great environmental concern

Lack of safe use practices of pesticides causes environmental degradation through negative impacts on human welfare, the health of flora and fauna, water systems and soils. Evidence shows that commercial fisheries have been destroyed or become tremendously less productive and birds' species endangered by pesticides (Vandervack and Koeman, 1988). Essential predatory insects have also been wiped out as a result of uncontrolled and excessive pesticides treatments (Vandervack and Koeman, 1988). For example, insecticides use on cotton has directly been related to reduced numbers and acute mortality of several birds' species in Egypt. Most insect species are not only beneficial to human being but have an important place in the ecological systems and need to be protected from destruction. Pesticides kill beneficial insects and pests alike hence disturbing the natural balance and leading to surges in some pest species populations. The continuous use of pesticides leads to resistant pest populations' development. Combating these resistant populations with higher doses of pesticides leads to poisoned soil and water. Lack of safe use of pesticides compound ecological imbalance in the already existing fragile ecosystems. According to Jersen et al (1985) pesticides have detrimental long impact on the environment. This clearly indicates that there is need of safe use of pesticides in crop production. It is important to note

Pesticides affect not only the location of their application but also ecosystems that are far removed due to their mobility in air and water (Yusuf, 1982). There is need for farmers to practice safe use of pesticides in order to protect the total environment.

The World Health Organization estimates that at global level, three million severe pesticides poisoning episodes occur annually out of which a minimum of 300,000 people die with 99% of these cases being from low and middle income countries. There are no precise estimates of the health impacts resulting from the longer-term exposure to pesticides (Konradsen, 2007).

According to Mwanthi and Kimani (1992), 62% of the people in Kenya stored chemicals within their living quarters which expose the occupant to occupational hazards. The study also indicated that pesticides poisoned 7% of the Kenya population annually leading to considerable economic losses. According to Forget et al (1994) pesticides impacts heavily on the health of the people in developing countries due to non-adherence to safe use of pesticides recommendations.

According to Kenya's National development plan 2002-2008, misuse of chemicals has now become an issue of global concern because of its negative environmental and health impacts. This has lead to global control programmes on chemicals use and wastes (MNDP, 2002).

Human beings are naturally impressed by diseases, which have obvious manifestations yet some of their worst enemies creep into them unobtrusively. This holds for the long-term effect on people's health by the continued exposure to small amounts of pesticides.

The need to ensure food security in low and middle income countries demands usage of pesticides to combat losses occasioned by pests. The role of protecting the population against the health impacts following exposure to pesticides have emerged as a major global public health challenge due to the low levels of adoption of safe use of pesticides.

## 1.2 Statement of the Problem

Adoption level of safe use of pesticides has raised serious environmental concern particularly in Mbogoini Division of Nakuru North District where approximately 82% of the farmers use pesticides in horticultural crop production at household level. There is evidence to the fact that most open water bodies are polluted with pesticides in the study area. In addition some farmers have reported ill health conditions related to pesticides poisoning. Despite various efforts by the Ministry of Agriculture and other extension services providers in promoting safe use of pesticides the problem has persisted. It is not clear which factors influence the level of adoption of safe use of pesticides. This study endeavoured to find out some of the factors that influence the adoption of safe use of pesticides in horticultural crop production at household level in Mbogoini division of Nakuru North district.

**1.3 The Purpose of the study**

The purpose of this study was to measure the level of adoption of safe use of pesticides in horticultural crop production at household level and the socio-economic factors that influence the same in Mbogoini Division of Nakuru North District.

**1.4 The Objectives of the Study**

The study was meant to achieve the following specific objectives:

i. To measure the level of adoption of safe use of pesticides in horticultural crop production at household level.
ii. To find out whether adoption of safe use of pesticides at household level is affected by farmer's level of knowledge of safe use of pesticides practices.
iii. To find out whether adoption of safe use of pesticides at household level is affected by the farmer's education level.
iv. To find out whether adoption of safe use of pesticides at household level is affected by gender of the house hold head.
v. To find out whether adoption of safe use of pesticides at household level is affected by frequency of delivery of extension services.
vi. To find out whether adoption of safe use of pesticides at household level is affected by the farmer's farm size.

**1.5 Hypotheses**

The following hypotheses guided the study:

Ho1: There is no significant relationship between farmers' knowledge level on safe use of pesticides and the adoption of the same at household level.

Ho2: There is no significant relationship between farmers' level of education and the adoption of safe use of pesticides at household level.

Ho3: There is no significant relationship between adoption of safe use of pesticides and gender of household head.

Ho4: There is no significant relationship between frequency of extension Services delivery and the adoption of safe use of pesticides at household level.

Ho5: There is no significant relationship between farmers' farm sizes and the adoption of safe use of pesticides at household level.

## 1.6 Significance of the Study

Farmers in Mbogoini division rely on horticultural crops production for income generation. Horticultural crops demands great volumes of pesticides to keep pests and crop diseases at bay. Pesticides are toxic substances that require to be handled with extreme care to avoid contamination of the user and environmental pollution.

Pesticides cause ill health in human beings leading to some of the conditions listed here below:

- Loss of eye sight/blurred vision
- Damage internal organs
- Impotence
- Birth defects( abortions, still births and congenital deformities)
- Mental disorders
- Suspected to cause cancer
- Decreased body immune system (displaying symptoms similar to HIV/AIDS)

Non observance of safe use of pesticides is also detrimental to the total environment because of localized and non localized pollution. Safe use of Pesticides in Horticultural crop production is a major must and cannot be ignored in environmental management.

The information gathered through this research will provide useful information feedback to the stakeholders in the pesticides industry enabling them to understand the field situation as far as adoption of recommended safe use of pesticides practices are concerned. Extension agents and environmental managers will use the information herein to design appropriate strategies to enhance adoption of safe use of pesticides. This will in the long run benefit the horticultural crops growing farmers who are the ultimate consumers of the enhanced extension packages developed resulting thereof.

### 1.7 Scope of the Study

The study investigated the influence of some selected socio-economic factors on the adoption of safe use of pesticide at household level by horticultural crops growing farmers in Mbogoini division of Nakuru North district. It covered small-scale farmers undertaking irrigated horticultural crop production and focused on the adoption level of safe use of pesticides. They are many factors that can influence the level of adoption of safe use of pesticides by farmers; however this study restricted itself to the following factors:

- Farmer's knowledge on recommend practices of safe use of pesticides
- Farmer's education level
- Household head gender
- Frequency of extension services delivery and
- Farm size

### 1.8 Limitations of the study

The study was confined to horticultural small scale farmers in Mbogoini division, Nakuru North District. Mbogoini division is a small geographical area and thus the results should be generalized with caution. Some of the respondents were not in season as production of horticultural crops are concerned hence relied on past season practices on safe use of pesticides to answer the question posed to them. The extraneous factors that affect the adoption of safe use of pesticides were not controlled in this study hence could have affected the results; to reduce their effect random sampling was used.

### 1.9 Assumptions of the Study

During the study the following assumptions were made

i. The respondents were honest in their responses to questions asked during the data collection stage.
ii. The period of data collection would coincide with the production season of the horticultural crops
iii. That the extraneous factors such as methods of pesticides application, farmers' toxicity perception, cost of pesticides did not greatly affect the adoption of safe use of pesticides at household level.

**1.10 Operational Definition of Terms**

**Adoption**: Decision to make continued use of an innovation as best course of action towards achieving a goal. (Adams, 1992). In this study the safe use of pesticides is taken as the adoption.

**Farm Size:** In this study it refers to the portion of farmers land under horticultural crop production.

**Innovation:** This is a new idea, method practice or technique, which provides means of continued increase in farm production and income (Adams, 1992).

**Knowledge**: Expertise and skills acquired by a person through experience and education.

**Pest**: any organism which injures or annoys man, his property or his environment e.g. insects, nematodes, fungi, weeds, rodents, and birds.

**Pesticides**: According to UNEP, (1999) pesticides are any substance or mixture of substances used to prevent, destroy or mitigate insects, rodents, nematodes, fungi, weeds and organisms that are perceived as a problem, Pesticides are classified as insecticides, fungicides, herbicides, acaricides etc.

**Safe Use of Pesticides**: Observance of safety precautions during buying, transport, storing, the preparation of spray solution, the spraying and post spray activities to avoid contamination of the user and the pollution of the environment.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1 Introduction

Adoption of innovations by farmers has been widely studied by scholars. However contradicting outcomes have continuously been generated. New technologies introduced into farming systems are perceived differently by potential adopters hence different levels of adoption. The features that lead to either failure or success in adopting an innovation is influenced by factors that could be categorized as personal factors of the farmers, social economic factors affecting a given community and technological factors regarding the innovation. According to Otieno (2000) only 30% of horticultural farmers in Peri urban areas in Kenya practice safe use of pesticides.

## 2.3 Types of chemical pesticides used in horticultural crop production in Kenya

Chemical pesticides used in horticultural sector in Kenya are classified according to their active ingredients. The most common ones are:

i. Organo phosphate pesticides.
ii. Carbamate pesticides.
iii. Organo chlorines and
iv. Pyrethroid pesticides

Examples of commonly used pesticides in Mbogoini division include bull dog, Karate, Dimethoate, Ridomil, Acrobat, Polytrin and Atom.

## 2.4 Types of Pesticides Poisoning

Pesticides poisoning is classified into two broad categories

a) Acute poisoning:

This is caused by pesticides following a single high dose exposure. It happens when

- A concentrated formulation spills on the skin
- Pesticide is eaten or drunk by accident or during suicide attempts.
- Pesticide fumes are inhaled in large quantities.

In most cases of acute poisoning the results are fatal.

iv Chronic poisoning

This results from pesticide exposure over a long period of time. The pesticide does not present an immediate danger in the short term but in the long term the person may experience:

- Increased sensitivity to pesticides
- Skin disorders
- Loss of eye sight/ blurred vision
- Damage of internal organs e.g. the liver
- Effects on progeny
- Disorders such as nervous, mental, sterility, impotence and birth defects which manifest themselves as abortions and still births.

Chronic pesticides poisoning takes place through oral, dermal (skin) and inhalation processes, over prolonged periods of exposure without adequate protective gears. Chronic poisoning is suspected to cause cancer of the lungs, brain, blood, digestive system and liver (UNEP, 1999). It also causes decreased body immune system leading to symptoms similar to those of HIV/AIDS (UNEP, 1999).

## 2.5 Recommended Safe Use of Pesticides Practices

Recommended safe use of pesticides practices entail observance of safety during buying, transport, storage, the preparation of spray solution, the protective clothing to be worn and post spray activities.

### 2.5.1 Buying, Transporting, Storing Pesticides and Disposal of Empty Pesticide Containers

It is recommended that only the required quantity of pesticides should be purchased to avoid being left with surplus at the end of a season. Pesticides should be bought from licensed and accredited distributors/ salesmen. During transportation the person responsible should ensure that the pesticides containers are intact and strictly separated from passengers, driver, livestock and food. According to Wilma (1996) during storing of the pesticides, the following guidelines need to be adhered to:

- Pesticides should not be stored in areas of the house or farm where people or animals live

- Pesticides should be stored in their original containers and never to be transferred to containers meant for food
- Pesticides should be kept out of reach of children and non- users
- Pesticides need to be stored in a dry place away from fire and smoke
- Record of pesticides should be kept with dates of purchase and expiry well entered

Empty pesticides containers should never be re-used to hold water or food, as it is impossible to thoroughly clean them. They should be broken, punctured, crushed and buried 1.5m deep in the soil. Disposal by burning should be done away from people, crops, livestock and houses and nobody should stand in the path of the smoke emitting from such fire.

### 2.5.2 Protective Clothing

It's important to wear waterproof protective cloth when applying pesticides. Protective clothes includes the following, rubber gloves, eye protection, rubber or plastic apron, gas masks and rubber boots (GCPF, 1997). According to Waikwa (1999) farmers wear ordinary working clothes while applying pesticides without changing while moving on to other farm activities like carrying fodder, hence contaminating other areas outside the area of pesticides application. Most farmers do not wear gloves; respirators, safety goggles or boots and if they wear shoes they are worn out hence creating avenue for the pesticides gaining entry into the body through the dermal process.

### 2.5.3 Pesticide Labels

All pesticides must have standard labels (FAO, 2000) providing vital information for safe and effective use of pesticides. Users of pesticides are required to read labels, understand them, and follow the instructions provided thereon. The labels must have information pertaining to the name of the product, class, and Pesticides Control Products Board (PCPB) registration number, date of manufacture and expiring date. In Kenya this information must be both in Kiswahili and English (Mabeya and Kimani, 1998). The language should be clear and specific without creating room for confusion. According to Wainaina (1985), labelling is the single most reason for misuse and mishandling of pesticides.

The minimum label requirements are:

- Be in a language well understood by the user

- Be legible
- Be clear to the point without ambiguities
- Indicate clearly the recommended usage rates and restrictions
- Carry precautionary statement and pictograms
- Conform to existing laws on labelling.

During exploratory survey, spot check on the labels indicated gaps in translation, a good example was the post harvesting waiting period which gives very erroneous information in Kiswahili and it reads "Muda salama wa Kutumia" (meaning safe time to use). The English version refers to the post harvest period but the Kiswahili version gives room for immediate use of the crop products because it does not relate to time after spraying.

A lot of misinformation on pesticide is widely disseminated by the popular media during advertisement (Tomlin, 2000). The efficacy of the pesticide is overstressed with little or no rider on the safe use of pesticides practices. Pesticides advertisements aired in a number of local vernacular/ regional radio stations pay a lot of emphasizes on the efficacy of pesticides without underlining the negative impacts on the total environment. The brand names of the pesticides also give the pesticides a non-lethal impression on the environment example Magic, Atom, Karate, Bulldog, to mention but a few. Most of the users might be psyched to think that the pesticides are harmless. As it is in the case of human drugs companies which use various tactics to appeal to viewers /listeners with limited facts that could oversimplify their decisions, the negative impacts of the pesticides are rarely in black and white in the advertisements by the agro-chemical companies. This oversimplifies the decision making process of the users. According to Carson (1962) we need huge skulls and cross bones suspended above the pesticides stores so that the customers might at least enter them with respect normally accorded death-dealing materials.

## 2.6 Registration of Pesticides in Kenya

The Pest Control Product Board does the registration of pesticides in Kenya (Mabeya and Kimani, 1998). It's an offence for manufacturers to formulate, repack or sell unregistered pesticides in Kenya. This is provided for in the pest control Act Cap 346 of 1982. ($GOK_1$, 1982). The government policy on safe use of pesticides is anchored on this act. The enforcement of the current policy lacks institution capacity within the Ministry of Agriculture hence weak linkages between stakeholders within the pesticides sector.

According to Ministry of Agriculture United Kingdom (1983) and Tomlin (2000), the objective of pesticides registration is to safeguard human beings, domestic animals, beneficial insects, wildlife and the environment against risks, which could arise from the use of pesticides products.

Under cap 346 laws of Kenya the law prohibits the sale and use of smuggled pesticides. In the horticultural industry it is very common for the farmers to be found using smuggled pesticides for example pesticides smuggled from Tanzania. The use of smuggled pesticides can be attributed to the fact that majority of the farmers are poor hence they are willing to go for cheaper options which includes the use of smuggled and repacked chemicals. This is due to the fact that 67 % of Kenya population live in the rural areas, 50% of whom are living below poverty line (MPND, 2004).

According to Scaeffer (1992), pesticide policy in Kenya lack adequate, simple and easy to use procedures that defines pest and crop loss. In Africa, 76% of the countries lack pesticides legislation and where they exist they are not vigorously enforced (FAO, 1990). According to FAO (2001) safe use of pesticides campaigns should be inter- ministerial or at least inter disciplinary in character as they are issues of health, safety, food , environmental protection, agricultural production and economic affairs. In Kenya the role of dissemination of safe use of pesticide practices information is vested with the Ministry of Agriculture.

## 2.7 Adoption

According to Adams (1992) adoption is not a sudden event but a process. Farmers do not accept innovation immediately but they take time to think over it and make decisions. An illustrated scheme for explaining adoption can be classified into following four stages;

i. Knowledge stage; individual learn of the existence of innovation and gain understanding of its function
ii. Persuasion stage; individuals form a favourable or unfavourable opinion of the innovation.
iii. Decision stage; Individuals engage in activities, which lead to choice between adoption and rejection.

iv. Confirmation stage; Individuals make final decision to accept or abandon an innovation.

While the farmers in the horticultural sector are progressively moving through this spiral process there and chances of getting poisoned or polluting the environment.

## 2.8 Knowledge of safe use of pesticides practices and adoption

According to FAO (1990), farmers are ignorant about pesticides use due to lack of information about pests control strategies from extension services providers. This leads to low level of adoption on safe use of pesticides practices by the small scale farmers. According to MPND (2004) the Government requires support from its development partners for analysing options for greater private sector participation in knowledge dissemination and more so from the agrochemical companies.

New technologies and recommendations need to be developed in line with farmer knowledge, skills and experience in order to enhance adoption. This can be done through the use of farmers' field schools and farmer research groups (Sahel and Thabit 2004). According to Mugisha (2004) lack of information about technologies leads to low level of adoption. This is due to the poor coverage of the farmers by the extension services provided by both the government and the private practitioners.

According to Vries (1983), the farmers are the passive learners while the trainers are the active educators. Farmers accept the role of ignorant passive listeners hence exist in an oppressive environment. In most cases, if they reject the messages being passed to them, they are silenced by usage of intimidating references as "Experts", research, modern methods as source of information being delivered to them. These sources are most of the times out of reach of the farmers and they cannot be able to collaborate the information received in training sessions hence non adoption.

According to Thesh (1994) a lot of efforts are done towards developing technologies without disseminating it to the field. This might be happening to research in Kenya where new findings/ Knowledge is just confined to the library shelves of the respective research institutions with little or no impact on the study population. This is because the traditional top down agricultural research has no room for farmer participation (Thesh, 1994).

### 2.9 Education Level and Adoption

Through learning human beings develop attitudes and ways of doing things. Learning often involves checking out old ideas and acceptance of new ones. Only during an active interaction period with ideas and other people will adoption take place.

Education is usually the only means to enhance ability of farmers to acquire, synthesize and respond to innovations (Asfaw and Adnassie 2004), this implies that education enhances adoption of technologies in the field of agriculture. According to Helmut and David (1996) the prevalence of illiteracy in rural areas of many developing countries limits the introduction of technologies through information dissemination. According to Postel (1987), safe use of pesticide is not a common practice due to wide spread illiteracy. This is complicated by lack protective clothing and equipment, lack of training on safety procedures and lack of safe working conditions with the farm. Education level is positively associated with adoption level (Herath and Takeya, 2003), the more educated a farmer is the better he/she is placed to internalise and adopt new technologies. This may apply to safe use of pesticide technologies where the more educated a farmer is, the better he/she is able to understand the negative impacts of pesticides on the environment hence take precaution /protective measures.

In a study on improved practices by potato farmers in Bangladesh, farmer's education was found not to be related to adoption (Hogue, et al 1996). Also education appeared to have had very little if any effect on adoption behaviour in agricultural technologies in Ethiopia (Dadi, et al. 2004).

### 2.10 Gender and Adoption

According to Lubwana (1999), gender refers to the defined roles of each sex as well as relationship between them. Technologies are supposed to be gender neutral but the cultural orientation favour one group of gender while suppressing the other when it comes to adoption.

Many farming technologies, safe use of pesticides included are mostly at the disposal of men, although women contribute 70% in agricultural labour (Lubwana, 1999). According to Sawheny and Gombar (1996), application or handling of hazardous chemicals is done by both men and women. In a large number of cases, women handle pesticides directly while mixing and spraying. Women are often responsible for maintaining and cleaning the spraying equipment hence making them more vulnerable to slow pesticide poisoning. Agricultural operations like sowing, weeding and harvesting are done almost exclusively by women. Women also work in coffee, tea, cashew, spice, cotton, and other plantations, all of which involve heavy usage of pesticides.

According to Morris, et al. (1999), women have less contact with extension agents than men. This implies that most of the extension messages are passed through men, and women get second hand information although it's them who play the major part in farming. This in itself can affect the level of adoption of agricultural technologies, safe use of pesticide included. Men and women have unequal access to complimentary resources. In most cases the women are resource handicapped and where a technology adoption requires resource injection, women level of adoption may be affected negatively (Morris, et al. 1999).

Technologies in the Sub-Saharan Africa were primary introduced by male dominated extension officers to male farmers (Lawrence, et al, 1999). This led to male receiving most of the technologies first hand and later passed it over to the women with high possibility of distortion and dilution. In the case of reuse of empty pesticide containers it is the women who might do it through converting them into devices of storing foodstuffs such as; salt, sugar, tea leaves or even reuse pesticides bottles for repackaging medicine meant for human use.

According to Yusuf (1982), when pesticides enter into the blood system of lactating women they concentrate in the breast milk and are transferred to the baby during breast-feeding. Lactating mothers are advised to handle pesticides with great care and with full compliance to recommended safe use of pesticides practices.

According to Morris, et al. (1999), men and women have different technological preferences. In developing safe use of pesticides technologies the gender aspect need to be brought on board especially the protective clothing which need to be women sensitive. When advocating wearing of protective clothing designed as trouser suits for women, it might be against some cultures. This may lead to low adoption rate of the same.

Impacts of agricultural technologies depend on type of decision making process prevailing at the household (Lawrence, et al 1999). If decision making is jointly undertaken by both spouses there are higher chances of adoption than when undertaken by one member of the family. According to Dadi, et al (2004), gender appears to have had very little if any effect on adoption behaviour of agricultural technologies.

It is common in the rural areas for men to out migrate more than women. This leaves agricultural jobs done by men in the hands of women. The women are over burdened with the extra responsibilities, which affects adoption level of recommended technologies (FAO, 2000).

### 2.11 Agricultural Extension and Adoption

According to Aiston (1998), local extension agent or office is the most preferred source of pest management information. This clearly indicates with the thin spread of the Ministry of Agriculture staff in Kenya at the grass root level the farmers will always experience deficiencies in pests' management messages. Other identified sources for pests' management information are: trained company employees, dealers in agricultural chemicals, electronic media, printed media and fellow farmers.

According to Adam (1992), the communication channels used by farmers to access information can be classified as follows:

- Mass media, such as radio, television, newspaper, leaflets
- Personal contact with extension workers and representatives from agro industries either on individual basis or in small groups
- Personal contacts with other farmers

All the above play a major role in the dissemination of safe use of pesticides information dissemination. According to Scaeffer (1992), there are inadequate curricula on agricultural education and the government pest management policies are not environmentally friendly. This leads to poor extension packages development and onwards transmission to the farmers, resulting to low adoption of safe use of pesticides practices. Farmers' participation in field days, seminars, workshop and contact with extension influence the decision of reducing use of inorganic fertilizers (Makokha, et al 1999) and this holds true for all other agricultural technology innovations adoption. Access to extension services is significantly related to adoption of new technologies (Sseguya, et al 1999).When the farmers have constant and timely access to extension services they are higher chances of adoption of the technologies being disseminated.

### 2.12 Farm Size and Adoption

According to Roling (1990), farm size has been the most important factor affecting innovativeness. He found out that access to land for most innovative farmers was almost three times higher than that of the least innovative. This could be due to the fact that farmers with large farms can be able to experiment with innovation to see their results before adopting on large scale. Morris, et al. (1999) found land size to be an important and significant factor affecting the adoption of agricultural technology. However, Amudavi, (1993) found no significant relationship between land size and adoption of maize related technologies in Western Kenya. In adoption of safe use of pesticides the size of land under horticultural crop production may influence the adoption rate. Hence there is need to study it and document the role it plays in adoption of safe of pesticides.

### 2.13 Conceptual framework

The conceptual framework shows the relationship between the independent, dependent and intermediate variables. Figure2- 1 below shows how the three variables levels interact. The adoption of safe use of pesticides has been identified as dependent variable. Selected independent variables which include; knowledge of safe use of pesticides practices, education level of farmer, household head gender, frequency of extension services delivery, and farm size.

It is the independent variables that are causing the effects on the dependent variable, which is the safe use of pesticide. The intervening variables affect the dependent variable and hence were included in the study, example when the cost of pesticides is high, farmers are tempted to use less expensive repackaged and or smuggled pesticides hence deviating from recommendations of safe use practices.

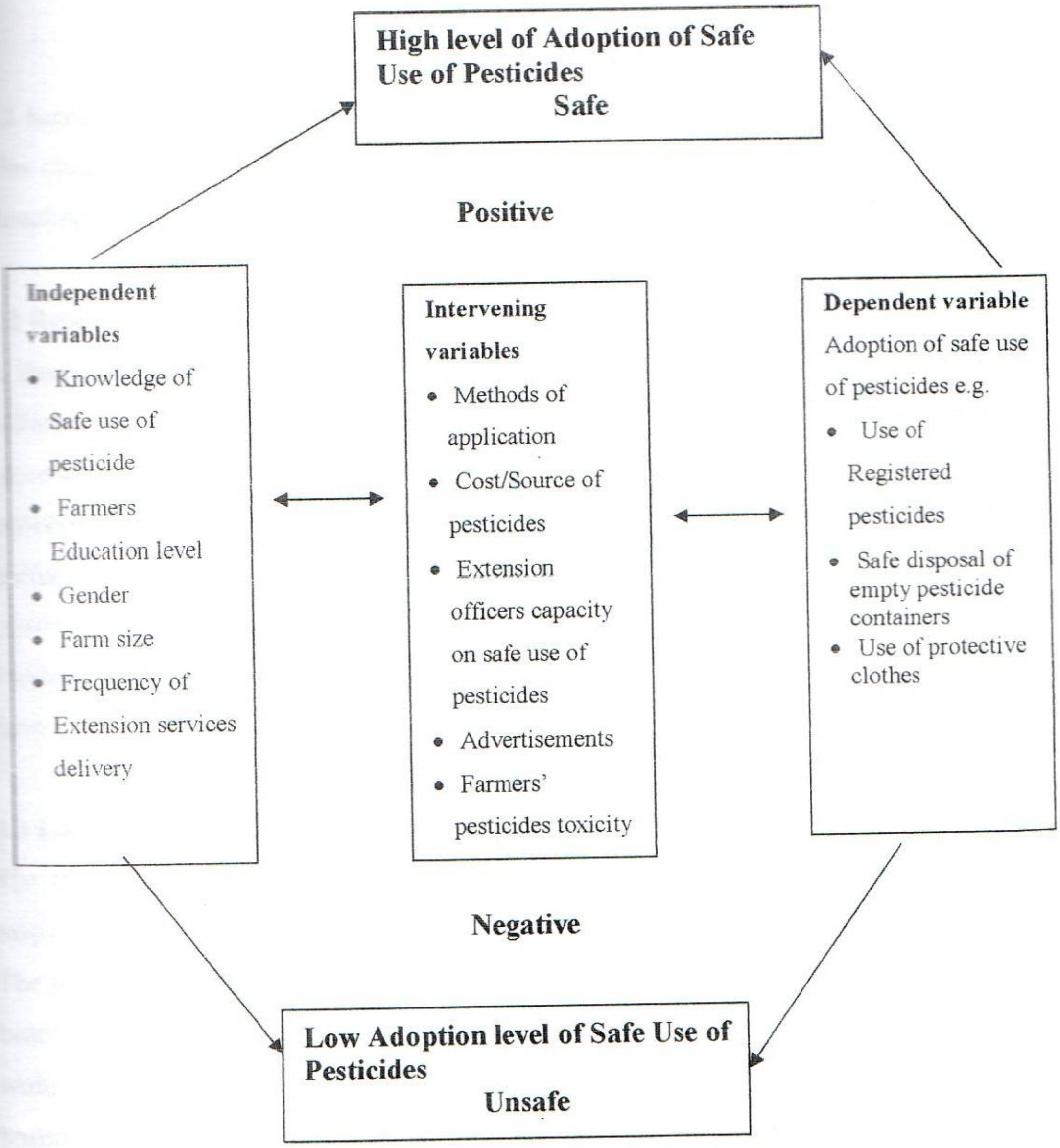


Figure 2-1: Conceptual Framework of Socio-Economic Factors Influencing Adoption of Safe Use of Pesticides in Horticultural Crop Production at Household Level

# CHAPTER THREE

# METHODOLOGY

## 3.1 Introduction

This chapter presents the research design, the location of the study, population, sample size, sampling procedures, instrumentation, data collection and data analysis of the study.

## 3.2 Research Design

A descriptive survey research design was used in this study. This design facilitated the collection of information on attitudes and opinions on events, current practices, conditions, or procedures (Kothari, 2004, Gay, 1992 and Mugenda, 1999). It also dealt with the relationship between non-manipulative Variables in a natural setting. The information collected was useful in describing the relationship of adoption level of safe use of pesticides practices to the existing conditions such as the level of Farmer's knowledge on safe use of pesticides, Farmer's education, household head gender, frequency of extension services and individual farm size.

## 3.3 Location of the Study

The study was carried out in Mbogoini Division of Nakuru North district (Fig 2; location map). The division has high agricultural potential for growing horticultural and food crops. The main crops grown in the division are maize, beans, tomatoes, onions, cabbages, French beans and capsicums. The farm sizes range from 1 acre to 10 acres. A total of 1170 farmers within the division practice irrigated agriculture (MWI, 2006) producing high value horticultural crop outputs. These farmers attach a lot of importance in quality horticultural crop production, which demand high usage of chemical pesticides for pests and disease control.

The total divisional area is 39,200 ha with 35,350ha being classified as agricultural land. The total division population is estimated at 62,340 comprising of 12,499 households. The study area comprises of three locations namely Subukia, Weseges and Maji Tamu. They are 6 sub-locations, two in each location. ($GOK_2$ 2005).

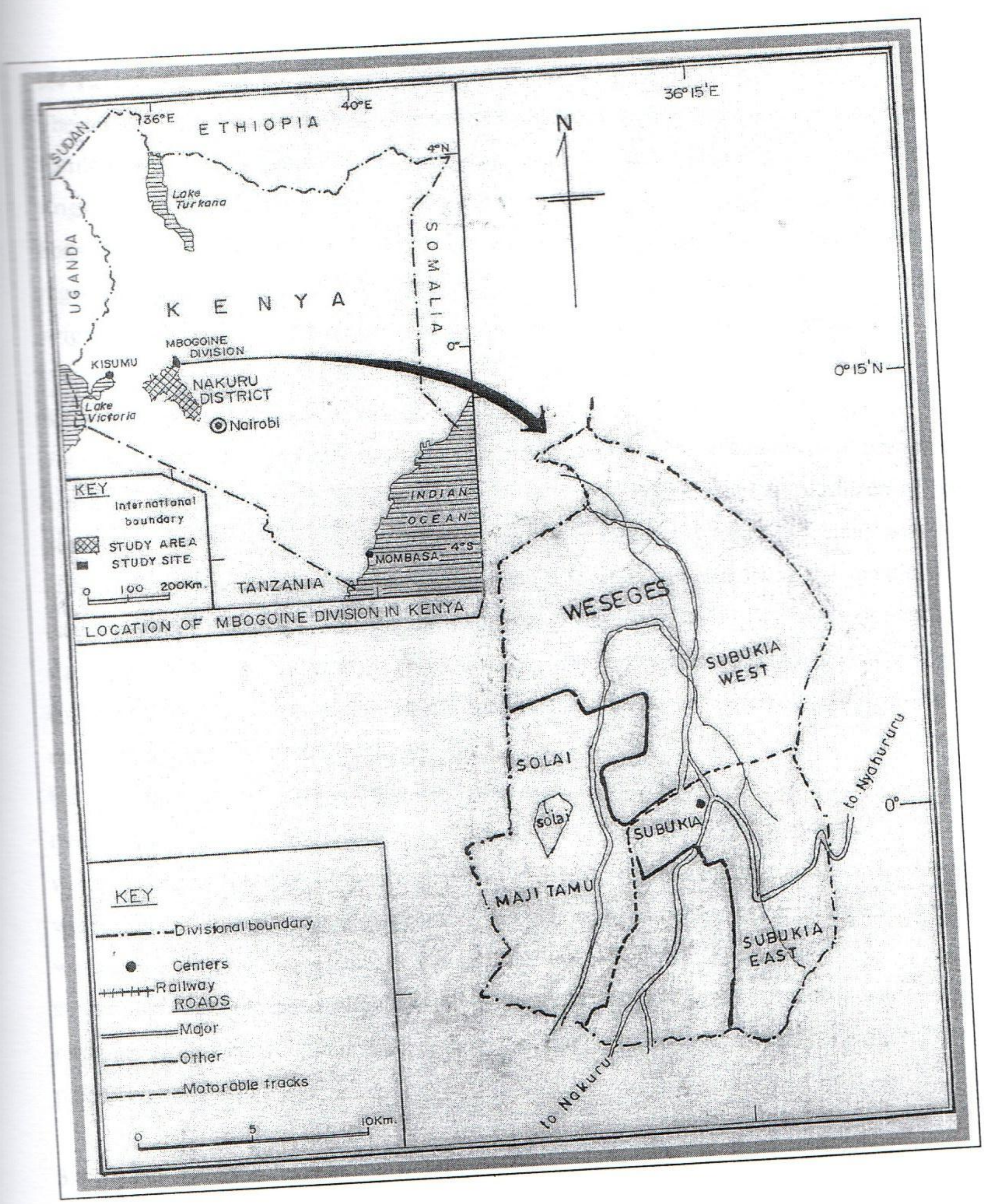


Figure: 3-1 Location Map of Mbogoini Division- the study area

Source: Geography Department-Egerton University

### 3.4 Target Population

The target population comprised of small-scale farmers in Mbogoini Division of Nakuru North district, who undertake horticultural crop production under irrigation. From the District irrigation office inventory report of 2006, the total number of household practising irrigated horticultural crop production was 1170. The inventory comprised of 287 (25%) households registered under women and 883 (75%) registered under men. The households practicing irrigated horticultural crop production in the division were taken as the target population.

### 3.5 Sampling and Sample Procedure

For statistical purpose and analysis, Mugenda and Mugenda (1999) recommend 10 percent of a defined population as an ideal sample size in gathering the required attributes of the population, the sample size using this approach was calculated to 117. Kathuri and Pal (1993), Citing Krejcie and Morgan (1970) offers a formula for calculating the sample size (see appendix 2) using this formula the sample size was calculated to 289. The 289-sample size was preferred in order to increase accuracy and representativeness of the data to be collected. To achieve this sample size, a combination of stratified sampling and Systematic random sampling technique was used. The households were first disaggregated into stratas based on the farmers' gender. Then each stratum was subjected to proportionate systematic random sampling technique. The women strata contributed 25 % of the sample size (72 women) and the men 75% of the sample size (217men). By dividing the total in each stratum with the required proportionate sample size, the interval of sampling was determined. For the women, the interval was 4 and for the men the interval was 7. The starting point in each stratum list was selected randomly using the random numbers table. A number was picked randomly from the random numbers table and its last digit was used to determine the starting point from the stratum list.

### 3.6 Instrumentation

Data was collected using administered questionnaires. Four local enumerators were trained and used to administer the questionnaires. The respondents were guided through the items and the responses recorded down. Both close ended and open-ended questions were used to gather information on safe use of pesticides practices.

### 3.6.1 Measurement of variables

The main dependent variable for the study was the adoption of safe use of pesticides. Adoption was measured using discrete scales where the farmers who practice correct safe use of pesticide practices were considered as high adopters. Responses were measured on a Likert scale with a score of 1 for adoption and 0 for non adoption. Considering the total number of scores in respect to the expected range, adoption index was computed to describe the level of adoption of the respondents. The respondents were grouped into three categories namely low, moderate and high adopters in a range of 0-15. Results obtained during the study gave the actual range as 1-14, from this; the following categories were developed,

0-5 Low adopters

6-10 Moderate adopters

11-15 High adopters

For the independent variable knowledge of safe use of pesticides, a set of 15 questions were asked. Based on respondent answer in respect to expected answers scoring was done on a Likert scale as shown in the Table 1 below.

**Table 1: Scoring Procedure for Level of Knowledge**

| STATEMENT | SCORE |
|---|---|
| Knowledgeable | 2 |
| Uncertain | 1 |
| Un-knowledgeable | 0 |

The expected index range for the respondents was 0-30. But from the data collected, the actual index range was 2-26 where respondents were categorized as indicated below;

0-9 Low Knowledge level

10-18 Moderate Knowledge level

19- 26 High Knowledge level

The index range for each category was arrived at by dividing the actual range by 3 levels. Education level of the farmers was discussed based on the highest level of education. The education level was categorized as follows, no formal education, adult education, primary, secondary, and tertiary.

For extension services delivery, sources which farmers acquired information from were predetermined. The farmers were asked to indicate the frequency of getting information from the identified sources. The discrete variables were measured using a Likert scale as shown in Table 2 below.

**Table 2: Scoring Procedure for Frequency of Extension Service**

| STATEMENT | Number of visits within a four month season | SCORE |
|---|---|---|
| Very often | 4 | 4 |
| often | 3 | 3 |
| Sometimes | 2 | 2 |
| Not often | 1 | 1 |
| Not at all | 0 | 0 |

The expected index range for the respondents was 0-40, but from the data collected the actual index range was 1-24. From the actual index range the respondents were categorized as follows;

| | |
|---|---|
| 0-8 | Low frequency of extension services delivery |
| 9-16 | Moderate frequency extension services delivery |
| 17-24 | High frequency extension services delivery |

These categories were arrived at by dividing the actual range by three hence getting the upper and lower limit for each category.

### 3.6.2 Pre-testing

Selected sample in a similar area to the study area was subjected to the questionnaire. The pre- test sample was taken as 10 % of the intended sample size. This was according to Mugenda and Mugenda (1999), who recommends that the pre-test sample should fall between 1-10%. The pre-test subjects were encouraged to make comment and suggestions concerning instructions, clarity of questions and relevance. The results of the pre-test exercise were used to en-rich the questionnaire and the interview approach. The results from the pre-testing phase were subjected to the data analysis procedures to evaluate whether all the expected outputs were fully addressed. The pre-testing was done in Ndaragwa division of Nyandarua North District, which has farmers undertaking irrigated horticultural crop production. Data from 30 households was collected and analyzed during the pre-testing phase.

### 3.6.3 Validity

Validity is the accuracy and meaningfulness of inferences that are based on the research results: the degree to which the results obtained from analysis of the data actually represents the phenomenon under study (Mugenda and Mugenda 1999). The validity of the instrument was tested by providing selected research measurements experts from Egerton University with copies of questionnaires, before it was taken to the field for data collection. The Experts validated the questionnaire by studying three main types of validity. These are:

- construct validity, which is the measure of the degree to which data obtained from an instrument meaningfully and accurately represents the theoretical concept;
- criterion-related validity, which refers to the use of a measure in assessing subjects behaviour and specific situations and
- content validity which is the measure of the degree to which data collected using a particular instrument represent a specific domain of indicators or content of a particular concept (Mugenda and Mugenda 1999)

### 3.6.4 Reliability

This is the measure of the degree to which research instruments yields consistent results or data after repeated trials (Mugenda and Mugenda, 1999). It reduces random errors, which includes inaccuracy of the instrument, error due to inaccuracy of scoring by the researcher and unexplained error. Reliability of questionnaire was analysed from data collected from the pilot study. The cronbach's coefficient alpha was calculated using the formula shown below, which is general form of the Kunder-Richardson ($KR_{20}$) formula .The computation determined how items correlate among themselves.

$$KR_{20} = \frac{(K)(S^2 - \sum s^2)}{(S^2)(K-1)}$$

$KR_{20}$ = Reliability coefficient of internal consistency

$K$ = Number of items used to measure the concept

$S^2$ = Variance of all scores

$s^2$ = Variance of individual items

A correlation coefficient alpha of over 0.7 in a range of 0-1 is acceptable (Mugenda and Mugenda, 1999). The reliability test indicated that the correlation was 0.7424, hence the questionnaire was reliable.

### 3.7 Data collection procedure

The researcher identified point men in every village that acted as guides and served also as entry points. The questionnaires were administered by making visit to every sampled household and interviewing the registered farmer member. Local language was used in asking the questions to ensure clarity. The no response was dealt with by making sure the questionnaires were administered in as similar circumstances as possible for initially targeted respondent in the sample (Frankel and Wallen, 2000).

### 3.8 Data Analysis

Quantitative and qualitative data was collected from the respondents. Data organization started with the coding of the questionnaire items .The coded data was tabulated in spreadsheets. The coded data was quantitively and qualitatively analysed using computer Program, Statistical Package for Social Science (SPSS) version 11.5. Quantitative data was analysed using descriptive and inferential statistics, which included means, percentage, frequency distribution tables, presentations, correlation analysis, chi test and t-test.

Table 3: Data Analysis Table

| Hypothesis | Independent Variable | Dependent variable | Statistical procedures and data analysis |
|---|---|---|---|
| $Ho_1$ There is no significant relationship between farmers' knowledge of recommended practices on safe use of pesticide and the adoption of safe use of pesticides at household level. | Knowledge level | | Descriptive and inferential statistics , Correlation analysis |
| $Ho_2$ There is no significant relationship between farmers' level of education and the adoption of safe use of pesticides at household level. | Education level | Level of adoption of safe use of pesticides | Descriptive and inferential statistics e.g. Correlation analysis |
| $Ho_3$ There is no significant relationship in adoption of safe use of pesticides between Men and Women at household level | Gender | Level of adoption of safe use of pesticides | Descriptive and inferential statistics , T- test |
| $Ho_4$ There is no significant relationship between frequency of delivery of extension Services and the adoption of safe use of pesticides at household level. | Extension services | Level of adoption of safe use of pesticides | Descriptive and inferential statistics Correlation analysis |
| $Ho_5$ There is no significant relationship between farmers' farm sizes and the adoption of safe use of pesticides at household level | Farm size | Level of adoption of safe use of pesticides | Descriptive and inferential statistics Correlation analysis |

# CHAPTER FOUR
# RESULTS AND DISCUSSIONS

## 4.1 Introduction

In this chapter, research data is presented using both descriptive and inferential statistics. The findings are presented in form of tables and discussions presented for each hypothesis that guided the study.

## 4.2 Response Rate

The response rated at 100% percent implying the questionnaires were administered to all the intended respondents.

## 4.3 Demographic Characteristics of the Respondents

Data on the characteristics of respondents form the core of discussion in this sub-section. This section presents the distribution of respondents by knowledge level, education level, and gender and farm sizes

### 4.3.1 Distribution of farmers by level of knowledge on Safe Use of Pesticides

Table 4 indicates 33.6% of the respondents had low knowledge level of recommended safe use of pesticides practices, 61.9% had moderate knowledge level and 4.5% had high knowledge level. Findings also indicated that 97.5% of the respondents were aware that pesticides were toxic and 68.5 % experienced some form of allergy after spraying pesticides. Examples of allergies experienced are nausea, sneezing, flu, headaches among others. The category of moderate knowledge on safe use of pesticides has the highest number of respondents. This indicates most farmers had been exposed to information on safe use of pesticides and partially practiced it.

**Table 4: Distribution of Respondents by Knowledge Level on Safe Use of Pesticides.**

| Level of Knowledge | Frequency | Percent |
|---|---|---|
| Low | 97 | 33.6 |
| Moderate | 179 | 61.9 |
| High | 13 | 4.5 |
| **Total** | **289** | **100.0** |

### 4.3.2 Distribution of farmers by level of Education

As the data in Table 5 indicates 1.4% of the respondents had no formal education, 0.3% had attained adult education, 58.5% had attained primary level education, and 38.1% had attained secondary level education and 1.7% tertiary level education. From the results the study population was highly literate with the literacy level recorded at 98.6%. From the results it's clear that most of the farmers are able to read the pesticides labels and understand the instructions therein.

**Table 5: Distribution of Respondents by Level of Education**

| Level of education | Frequency | Percent |
|---|---|---|
| No formal education | 4 | 1.4 |
| Adult education | 1 | 0.3 |
| Primary education | 169 | 58.5 |
| Secondary | 110 | 38.1 |
| Tertiary | 5 | 1.7 |
| **Total** | **289** | **100.0** |

### 4.3.4 Distribution of farmers by level of Gender

As the data in Table 6 indicates, majority of the respondents were male (75.1 %) while female respondents comprised 24.9% of the sample. This implies that most of the farms are registered under the male land owners.

**Table 6: Distribution of Respondents by Gender**

| Gender | Frequency | Percent |
|---|---|---|
| Male | 217 | 75.10 |
| Female | 72 | 24.90 |
| Total | 289 | 100.00 |

### 4.3.5 Distribution of farmers by Frequency of Extension Services Delivery

As results in Table 7 Indicates 27% of the respondents experienced low frequency of extension service delivery, 62.3 % moderate frequency of extension services delivery and only 10.7 % experienced high frequency of extension service delivery. This clearly indicates that the frequency of extension services is low. Extension services being the link between the information sources e.g. research, information data bank to name but a few its presences at the farm level is critical. The current scenario in Kenya is wanting, leading to poor transfer of critical information to farmers.

**Table 7: Distribution of Respondents by Frequency of Extension Services Delivery**

| Frequency of extension delivery | Frequency | Percent |
|---|---|---|
| Low | 78 | 27 |
| Moderate | 180 | 62.3 |
| High | 31 | 10.7 |
| Total | 289 | 100.0 |

### 4.3.6 Distribution of farmers by Farm Size

As results in Table 8 indicates respondents farm sizes ranged from 0.25 acres to 5 acres with a mean farm size of 1.22 acres. This implied from the definition of small scale farmers "as farmers owning less than 50 acres, all the respondents were small scale farmers. Majority of the respondents owned land below 1 acre, (67.1% of the sample).

**Table 8: Distribution of Respondents by Farm Size Categories**

| Farm size category | Frequency | Percent |
|---|---|---|
| 0.25-1 acre | 194 | 67.1 |
| 1.2 – 2 acres | 56 | 19.4 |
| 2.2- 3 acres | 29 | 10.0 |
| 3.1 – 5 acres | 10 | 3.5 |
| **Total** | **289** | **100.0** |

## 4.4 Adoption Level of Safe Use of Pesticides

The first specific objective of the study was to measure the level of adoption of safe use of pesticides in horticultural crop production at household level. Table 9 indicates majority of the farmers (62.6%) were categorized as moderate adopters of safe use of pesticides. Low adopters comprised 29.1% and 8.3% respondents were high adopters. This implies that most of the farmers practice some form of safe use of pesticides practices at household level.

**Table 9: Distribution of Respondents by Level of Adoption of Safe use of Pesticides**

| Adoption Level | Frequency | Percent |
|---|---|---|
| Low adopters | 84 | 29.1 |
| Moderate Adopters | 181 | 62.6 |
| High adopters | 24 | 8.3 |
| **Total** | **289** | **100.0** |

One of the key recommended practices of safe use of pesticide, usage of protective clothing, only 27 farmers representing 9.3% had adopted as indicated in Table 10. A huge segment of the respondents totalling 90.7% used a combination of improvised protective clothing, old torn clothes, cotton overalls (plate 1).

**Table 10: Distribution of Respondents by Adoption of Use of Protective Clothing**

| Parameter | Frequency | Percent |
|---|---|---|
| Non adoption | 262 | 90.7 |
| Adoption | 27 | 9.3 |
| Total | 289 | 100.0 |

Plate1: Farmer wearing cotton overall used for as protective clothing.

In regard of disposal of empty pesticides containers 56.2% of the farmers disposed them in toilets (drop pit), 19.8% used burying as a mode of disposal, 11.5% burned while 12.5% of the respondents indicated they left them in the field or putting them under stores (see plate 2 below) this indicates contamination of the environment from pesticides containers is possible because only 31.3% of the respondents used the correct disposal of the pesticides containers, burning or burying.

**Table 11: Methods of Disposal of Empty Pesticides Packages**

| Disposal Method | Frequency | Percent |
|---|---|---|
| Toilets | 162 | 56.2 |
| Burying | 57 | 19.8 |
| Burning | 34 | 11.5 |
| Scattered in field/undesignated places | 36 | 12.5 |
| **Total** | **289** | **100.0** |

Plate 2: Empty pesticides containers Disposed under a general purpose store

As presented in Table 12 on storage of pesticides at house hold level, 33.8% of the respondents stored pesticides in there living rooms, 29.2 % stored in specific pesticides stores, 23.7% in general purpose stores 13.3% buried the pesticides in the field.

**Table 12: Pesticides Storage Area at Household Level**

| Storage | Frequency | Percent |
|---|---|---|
| Living rooms | 98 | 33.8 |
| Pesticides stores | 84 | 29.2 |
| General purpose stores | 69 | 23.7 |
| Buried in the field | 38 | 13.3 |
| Other place | 0 | 0 |
| **Total** | **289** | **100.0** |

**Table 13: Self Reported Types of Allergies**

| Type of allergies | Frequency | Percent |
|---|---|---|
| Itching | 41 | 14.2 |
| Respiratory disorders | 34 | 11.8 |
| Nausea | 57 | 19.7 |
| Dizziness | 37 | 12.8 |
| Stomach discomfort | 29 | 10.0 |
| None | 91 | 31.5 |
| Total | 289 | 100.0 |

Among the allergies reported by the respondents included, itching 14.2%, respiratory disorders 11.8%, Nausea 19.7%, Dizziness 12.8% and Stomach discomfort 10.0%. The respondents reported having felt sick after routine application of pesticides gave a total of 68.5% with only 31.5% having not suffered from the pesticide side effects. Table 13 gives the frequencies of occurrences of the most common allergies of pesticide poisoning.

### 4.5 Relationship between Farmers' Knowledge of Recommended Practices on Safe Use of Pesticides and the Adoption of Safe Use of Pesticides at Household Level

The second specific objective to find out whether adoption of safe use of pesticides at household level is affected by farmer's level of Knowledge of safe use of pesticides practices. For this objective null hypothesis 1 was tested

*Ho1: There is no significant relationship between farmers' knowledge Level on safe use of pesticides and the adoption of the same at household level.*

The mean of level of adoption was 1.43 for low knowledge category; 1.94 for moderate level and 2.46 for high level of knowledge category as shown in Table 14. These means indicate that, as the level of knowledge on the safe use of pesticides increases the level of adoption of safe use practices also increases.

**Table 14: Mean Adoption of Safe Use of Pesticides for Different Levels of Knowledge**

| Level of Knowledge | Mean Adoption |
|---|---|
| Low | 1.43 |
| Moderate | 1.94 |
| High | 2.46 |

From Appendix 3, the $X^2$ critical value at df=4 and at 0.05 is 9.46 while as the calculated $X^2$ Value = 80.077 as indicated in table 15. The calculated chi value falls out of the acceptance region, indicating there is a significant relationship between level of knowledge of safe use of pesticides and the level of adoption of safe use of pesticides in horticultural crop production at household level at 0.05 significant levels.

**Table 15: Cross Tabulation of Level of Knowledge * Level of Adoption of Safe Use of Pesticides**

| Knowledge level | Type of Adopters | | | |
|---|---|---|---|---|
| Level of Knowledge | Low adopters | Moderate adopters | High adopters | Total |
| Low | 55 | 42 | 0 | 97 |
| Moderate | 29 | 132 | 18 | 179 |
| High | 0 | 7 | 6 | 13 |
| **Total** | **84** | **181** | **24** | **289** |

$X^2$ =80.077, df= 4, P value 0.001

The P value =0.001 which is less than threshold value of 0.05 (preset); hence the null hypothesis is rejected and conclude that there is significant relationship between the level of knowledge on safe use of pesticides and adoption of the same. Further in table 16, a correlation analysis comparing the level of knowledge and the level of adoption of safe use of pesticides at 0.01 significance level indicated that there is a significant positive correlation of

0.485 between the variables. Therefore, we reject the null hypothesis and conclude that there is significant relationship between the farmer's level of knowledge on safe use of pesticides and adoption of safe use of pesticides. The results indicate that level of adoption has a positive correlation with level of knowledge on safe use of pesticides.

**Table 16: Nonparametric Correlation between Farmers Knowledge Level on Safe Use of Pesticides and Level of Adoption of Safe Use of Pesticides**

| | Level of Knowledge of Safe Use of pesticides | |
|---|---|---|
| Level of adoption of safe use of pesticides | Spearman's correlation coefficient | +0.485 |
| | N | 289 |

r = +0.485    df = 287    Correlation is significant at the 0.01 level (2-tailed)

## 4.6 Farmers' Level of Education versus Adoption of Safe Use of Pesticides

The third specific objective of the study was to find out whether adoption of safe use of pesticides at household level is affected by the farmer's education level. To address this objective the null hypothesis 2 was tested.

Ho2 *There is no significant relationship between farmers' level of education and the adoption of safe use of pesticides at household level".*

Results as presented in Table 17 indicate that the farmers in non- formal education category were 4 with only 1 rated as a high adopter. In the adult education category, there was only 1 farmer with nil classified as a high adopter. In the primary education category, 169 farmers interviewed with 16 rated as high adopters. In the secondary education category, 110 farmers interviewed with 6 rated as high adopters and in the tertiary education, 5 farmers interviewed and only 1farmer was classified as a high adopter.

The P value calculated is 0.6027 >0.05 (preset threshold value) hence the null hypothesis was accepted and conclude there is no significant relationship between formal education level and level of adoption of safe use of pesticide production in horticultural crop production at household level.

**Table 17: Cross Tabulation of Education * Level of Adoption of Safe Use of Pesticides**

| **Education Level** | **Level of Adoption** | | | |
|---|---|---|---|---|
| Level of Education | Low | Moderate | High adopters | Total |
| No formal education | 1 | 2 | 1 | 4 |
| Adult Education | 1 | 0 | 0 | 1 |
| Primary level | 49 | 104 | 16 | 169 |
| Secondary level | 32 | 72 | 6 | 110 |
| Tertiary | 1 | 3 | 1 | 5 |
| Total | 84 | 181 | 24 | 289 |

$X^2$ =6.402 df = 8, P value= 0.602

From Appendix 3 the $X^2$ critical value at df =8 and at 0.05 is 14.07, the calculated $X^2$ Value = 6.402 (Table 17) which falls under the acceptance region, from this it is concluded that there is no significant relationship between farmers education level and the level of adoption of safe use of pesticides in horticultural crop production at household level at 0.05 significant level. Results presented in Table 18 indicates the Spearman's correlation coefficient as -0.014 which hence that there is a negligible negative correlation between Farmer's education level and level of adoption of safe use of pesticide in horticultural crop production at household level. The null hypothesis is accepted and concluded that there is no significant relationship between farmers' level of education and the adoption of safe use of pesticides at household level at significance level of 0.05.

**Table 18: Nonparametric Correlation between Farmers Education Level and Adoption of Safe Use of Pesticides**

| | Level of Education | |
|---|---|---|
| Level of adoption of Safe use of pesticides | Spearman's correlation coefficient | -0.14 |
| | | 289 |

r = -0.14 df = 287 Correlation is not significant at the 0.01 level (2-tailed) r critical 0.812

## 4.7 Relationship between Farmers Gender and the Adoption of Safe Use of Pesticides at Household Level.

The fourth specific objective was to find out whether adoption of safe use of pesticides at household level is affected by gender of the household head. To address this objective the null hypothesis 3 was tested.

*Ho3 "There is no significant relationship in adoption of safe use of pesticides between Men and Women at household level".*

Results as displayed in table 20 shows that 19 men were rated as high adopters out of 217 male respondents and 5 women rated as high adopters out of 72 female respondents. The means of the male and female respondents were 1.79 and 1.81 respectively as presented in Table 20. This indicates that the female farmers' adoption level is higher than that of male farmers. However, from the means, it is not clear whether there is significant relationship between the gender and adoption of safe use of pesticides in horticultural crop production at household level.

From Appendix 3 the $X^2$ critical value at df=2 and at 0.05 is 5.99, the calculated $X^2$ Value = 0.699 (Table 19) which falls under the acceptance region. From it is concluded that there is no significant relationship between farmers' gender and their level of adoption of safe use of pesticides in horticultural crop production at household level at 0.05 significant level.

**Table 19: Cross tabulation of Gender * Level of Adoption of Safe use of Pesticides**

| | Level of adoption | | | |
|---|---|---|---|---|
| Gender | Low | Moderate | High | Total |
| Male | 65 | 133 | 19 | 217 |
| Female | 19 | 48 | 5 | 72 |
| Total | 84 | 181 | 24 | 289 |

$X^2$ =0.699, df = 2, P value =0.705

**Table 20: Mean of adoption of Safe Use of Pesticides of male and female farmers**

| Sex | Mean – level of adoption |
|---|---|
| Male | 1.79 |
| Female | 1.81 |

As indicated in Table 21, a T-test comparing the above means showed, t calculated =-0.106, the upper and lower limits were: -0.16343 and 1.4679 respectively at 0.05 significance level. The t calculated lies in the acceptance region indicating there is no significant relationship between gender and adoption of safe use of pesticides in horticultural crop production at household level. The P value calculated from the data is 0.705 > 0.05 (preset threshold value) hence the null hypothesis is accepted and conclude there is no significant difference between male and female farmers in adoption of safe use of pesticide production in horticultural crop production at household level.

**Table 21: Non paired t-test for Gender and Adoption of Safe Use of Pesticides**

| Variable | Calculated t-value | Mean difference | df | Significant t | 95%confidence interval | |
|---|---|---|---|---|---|---|
| | | | | | Upper | Lower |
| Gender | -0.106 | 0.780 | 287 | 0.916 | -0.16343 | 1.4679 |

## 4.8 Relationships between Frequency of Extension Services Delivery and the Adoption of Safe Use of Pesticides at Household Level.

The fifth specific objective was to find out whether adoption of safe use of pesticides at household level is affected by frequency of delivery of extension services. This relationship was analysed by testing the null hypothesis 4:

*Ho4: There is no significant relationship between frequency of Extension Services delivery and the adoption of safe use of pesticides at household level.*

From results displayed in Table 22, 64.4% of the respondents' sourced information on safe use of pesticides from other farmers, 21.1% sourced from stockist while 4.8% sourced from extension officers. The study also indicated that the number of extension officers in the area varied from 0 in some pockets of the study area to 3 in others.

**Table 22: Source of Safe Use of Pesticides Information**

| Source of information | Frequency | Percent |
|---|---|---|
| Other farmers | 186 | 64.4 |
| Stockist | 61 | 21.1 |
| Reading | 2 | 0.7 |
| Extension | 14 | 4.8 |
| Radio | 8 | 2.8 |
| Agro chemical companies | 18 | 6.2 |
| **Total** | **289** | **100.0** |

Results indicated only 31.8% of the farmers had at least been visited by extension officers at farm level while 68.2% indicated they had not been visited by extension officers at farm level, as tabulated in Table 23. The trend is below average and demands to be addressed at policy level.

**Table 23: Distribution of Respondents Visited at Farm Level by Extension Officers**

| Parameter | Frequency | Percent |
|---|---|---|
| No | 197 | 68.2 |
| Yes | 92 | 31.8 |
| **Total** | **289** | **100** |

The mean of adoption of safe use of pesticides for low frequency extension services delivery was observed to be 1.76, for moderate frequency of extension services delivery 1.79 and 1.80 for high frequency of extension services delivery as presented in Table 24. From the means, it can be deduced that there is slight influence on level of adoption of safe use of pesticides by increased frequency of extension services delivery.

**Table 24: Mean of adoption of Safe Use of Pesticides for Different Levels of Frequency of Extension Services Delivery**

| Frequency of Extension service delivery | Mean level of adoption |
|---|---|
| Low | 1.76 |
| Moderate | 1.79 |
| **High** | **1.80** |

Table 25 is a cross tabulation between frequency of extension delivery and level of adoption. Cross tabulation indicates: for farmers in the low frequency of extension services delivery only 15 (8.7%) were rated as high adopters, in the moderate category only 7 (7%) were rated as high adopters and in the High category only 2 (10.5%) who were rated as high adopters

The P value =0.24 > 0.05(preset threshold value) hence we accept the null hypothesis and conclude there is no significant relationship between frequency of extension services delivery and level of adoption of safe use of pesticide production in horticultural crop production at household level.

From Appendix 3, the $X^2$ critical value at df=4 and at 0.05 is 9.49, the calculated $X^2$ Value = 7.237(Table 25) which falls under the acceptance region, from it is concluded that there is no significant relationship between frequency of extension delivery and the level of adoption of safe use of pesticides in horticultural crop production at household level at 0.05 significant level.

The correlation analysis indicated a negligible positive correlation of 0.091as presented in Table 26. From the above analysis the Null Hypothesis is accepted and it is concluded that there is no significant relationship between the frequency of extension services delivery and the level of adoption of safe use of pesticides in horticultural crop production at household level at 0.05 significance level.

**Table 25: Cross Tabulation of Frequency of Extension Delivery * Level Adoption of Safe Use of Pesticides**

| | Level of adoption | | | |
|---|---|---|---|---|
| **Frequency of extension service delivery** | **Low** | **Moderate** | **High** | **Total** |
| Low | 28 | 41 | 15 | 78 |
| Moderate | 50 | 118 | 7 | 180 |
| High | 5 | 22 | 2 | 31 |
| **Total** | **83** | **181** | **24** | **289** |

$X^2$ Value = 7.237, df =4, p value = 0.24

**Table 26: Nonparametric Correlation between Frequencies of Extension Services Delivery and Level Adoption of Safe Use of Pesticides**

| | | Frequency of extension service delivery |
|---|---|---|
| Level of adoption of safe use of pesticides | Spearman's correlation coefficient | 0.091 |
| | N | 289 |

r = 0.091 df = 287 Correlation is not significant at the 0.01 level (2-tailed) r critical 0.123

### 4.9 Relationship between Farmers' Farm Sizes and Adoption of Safe Use of Pesticides at Household Level

The sixth objective of the study was to find out whether adoption of safe use of pesticides at household level is affected by the farmer's farm size. This relationship was analysed by testing the null hypothesis 5.

*Ho5: There is no significant relationship between farmers' farm sizes and the adoption of safe use of pesticides at household level*

As presented in table 27 results indicated that there were 194 farmers in the land category 0.25- 1 acre out of whom 17 (8.7%) were rated as high adopters. In the land category 1.2- 2 acres comprised 56 farmers out of whom 1 (1.7%) was rated as a high adopter. In the land category 2.2- 3acres there were 20 farmers out whom 2 (1%) were rated as high adopters and in the land category 3.1- 5 acres there were 19 farmers out of whom 4 (21%) were rated as high adopters,

The p-value was calculated to 0.259 > 0.05 (preset threshold value) hence the null hypothesis is accepted and conclude that there is no significant relationship between farmers farm size and level of adoption of safe use of pesticide production in horticultural crop production at household level.

From Appendix 3, the $X^2$ critical value at df=6 and at 0.05 is 11.07, the calculated X2 Value = 7.729, which falls under the acceptance region. It is concluded that there is no significant relationship between farm size and the level of adoption of safe use of pesticides in horticultural crop production at household level at 0.05 significance level.

Results presented in Table 28 indicate that the correlation coefficient is 0.049, which indicates a negligible positive correlation between land size and the level of adoption of safe use of pesticides in horticultural crop production at household level at 0.05 significant level.

**Table 27: Cross Tabulation of Farm Size Categories * Level of Adoption of Safe Use of Pesticides**

| | Level of Adoption | | | |
|---|---|---|---|---|
| Farm size | **Low** | **Moderate** | **High** | **Total** |
| 0.25-1 acre | 58 | 119 | 17 | 194 |
| 1.2-2 acres | 16 | 39 | 1 | 56 |
| 2.2-3 acres | 5 | 13 | 2 | 21 |
| 3 acres | 5 | 10 | 4 | 19 |
| **Total** | **84** | **181** | **24** | **289** |

$X^2$ Value = 7.729, df =6, p - value = 0.259

**Table 28: Nonparametric Correlation between Farmer's Farm Size and Level of Adoption of Safe use of Pesticides**

| | | Farm Size |
|---|---|---|
| Level of adoption of safe use of pesticides | Spearman's correlation coefficient | 0.049 |
| | N | 289 |

r = 0.049 df = 287 Correlation is not significant at the 0.05 level (2-tailed) r critical 0.409

### 4.10 Discussion

Findings showed that majority of the farmers were categorized as moderate adopters of safe use of pesticides (62.6%). With low adopters being 29.1% and 8.3% being high adopters. It can be concluded that the level of adoption of safe use of pesticides is very low. This agrees with a study done by Otieno (2000) which concluded that the level of adoption of safe use of pesticides is low. This could be as a result of lack of farmers perceiving the pesticides as toxic. From the Kiswahili name of pesticides "Dawa" it does not reflect the lethal nature of pesticides. It should be noted that same term is used to refer to human medicine giving pesticides a comparative non harmful nature. With the low adoption and the association of pesticides to causal agents of cancers, congenital deformities, blurred vision, respiratory diseases, reduced immunity and impotence to mention but a few safe use of pesticides should be enhanced from the National to the grass root level. If the society continues burying its head in the sand and assuming business as usual then, lack of safe use of pesticides is a timed bomb that will adversely affect the humanity.

On adoption of protective clothing only 9.3 % had adopted. Most of the respondents used usual daily wear exposing themselves to dermal entry of pesticides. After the spraying exercise the old clothes are left in the field hence end up being dump due to constant exposure to rains, increasing there are efficiency in pesticides absorption and onwards transmission to the skin. The disposal of empty pesticides containers was done with no due regard of the environmental health. This creates room for non targeted sites getting contamination from the containers and pesticides residues therein. On the pesticides storage only 29.2% of the respondents had adopted the correct method of storage by construction of specific store for pesticides which are required to be under key and lock. From all the other storage methods it is easy for the pesticides to be accessed by non user or children hence chances of poisoning. 33.8% of the farmers stored the pesticides in their living rooms which exposes the occupants to pesticides fumes hence chronic slow poisoning.

On cleaning of the spray equipment, 76.1% of the respondents did it at farm level and disposing of the contaminated water resulting at non designated areas, during heavy downpours the contaminated soils are washed into the water systems and hence chance of contaminated the aquatic system. Results indicated only 9.0% of the respondents had adopted the recommended designated areas with soak away pits for disposing of excess solutions. The rest of the respondents cleaned their equipment near water sources hence spilling the pesticides solutions directly into the aquatic system causing untold suffering to aquatic life.

Majority of the respondents (96.2%) indicated that they took bath after pesticides application activities using lots of water and soap. Most Respondents indicated that some of the pesticides odours are hard to ward of. The researcher was informed by respondents that it is easy to smell chemicals from a farmer even after thorough scrubbing and change of clothes, which may indicate that the chemical smell is coming from within the body.

According to the results 4.5% of the farmers interviewed were rated as highly knowledgeable on safe use of pesticides in horticultural crop production at household level.

From the analysis, the Level of Farmer's Knowledge on safe use of pesticides was identified as a significant factor contributing to high adoption of safe use of pesticide displaying positive correlation.

The results demonstrate that as the level of knowledge on safe use of pesticides increases the level of adoption of safe use of pesticides in horticultural crop production subsequently increases. These results are consistent with a study by Mugisha, et al (2004) which concluded that low knowledge level leads to low level of adoption. This may be attributed to the fact that knowledge which is as a result of expertise and skills acquired through experience and education. High knowledge of safe use of pesticides in horticultural crop production leads to corresponding high expertise and skills acquisition, as farmers acquire the necessary skills and expertise on safe handling of the pesticides, adoption level of the same increases.

Adoption process takes place through four stages namely: knowledge, persuasion, discussion and confirmation stages (Adams, 1992). Knowledge of an innovation is the first and key factor in the adoption process. Through knowledge acquisition an individual learns of the existence of an innovation and gains understanding of its function. Hence when farmers acquire the required knowledge on safe use of pesticides, they are well equipped to adopt the same for the benefit of the total environment. Knowledge is power hence with increase of the same the farmers gets the required spring board for adoption of innovations.

. Farmers' knowledge on safe use of pesticides is a critical factor influencing the adoption of the safe use of pesticides. With the low knowledge level in the study area (4.5%), it clearly indicates that the situation at the household level is grave.

From the study it can be concluded that the literacy level of farmers in the study area was high standing at 98.6%. This high level of literacy clearly indicates that the farmers were not constrained in reading the pesticides labels, hence could read and understand the label contents. The results indicated that there is no significant relationship between farmers' level of education and level of adoption of safe use of pesticides in horticultural crop production at household level. The non significance can be attributed to the fact that the study generally focused to only the education level and not the content of the syllabus.

The study indicates that education has little if any influence on adoption of safe use of pesticides in horticultural crops at household level hence not a crucial social economic factor. These results were consistent with studies done by Hogue, Rashid and Rahma (1996) on adoption of improved practices by potato farmers in Bangladesh and also with Dadi, et al (2004), in their study on adoption of agricultural technologies in Ethiopia which indicated that education appeared to have had very little if any effect on adoption.

From the results both male and female farmers are actively involved in pesticides application in horticultural crop production at household level. Analysis indicated that there is no significant relationship between gender and level of adoption of safe use of pesticides in horticultural crop production at household level. From the findings it is concluded that gender does not have significant influence on adoption of safe use of pesticides. These results agree with some studies done earlier but contradict others. This can be attributed to the farmers acquiring most of their knowledge on safe use of pesticides from their fellow farmers hence creating a scenario where both gender groups are exposed to the same quality of information of safe use of pesticides. Studies on this relationship have always been yielding conflicting results.

According to Dadi, Borton and Ozanna (2004) in their study on adoption of agricultural technologies in Ethiopia which reported that gender appeared to have had very little if any effect on adoption. From the study, it's demonstrated that innovations are gender neutral and the level of adoption for both men and women indicates only a slight dispatch. This can be attributed to the ongoing gender equity awareness at the local levels in both tasks and information sharing. Men and women are collaborating in pesticides application and information sharing on the pesticides use, making it possible for there adoption levels to be the same. Most of the knowledge on safe use in the study area originates from the farmers themselves through experience sharing. This creates a comparative equal knowledge base between male and female farmers hence no significance difference in adoption of safe use of pesticides practices.

It was expected that with application of pesticides being an activity that goes with offensive odours from the pesticides formulations, it would prompt women farmers to adopt the protective clothing's more than men. From the results study, it is only 5.5% of the women adopted protective clothing as compared to 10.1 % of the men. This indicates that the women did not indicate any special orientation towards protecting themselves from offensive odours.

Discussions with male respondents revealed that their wives complained of pesticides odours from their bodies while in bed even after scrubbing their bodies with lots of water and soap. One male respondent confided that the pesticides have started affecting his libido which clearly manifests itself on days he spends applying the pesticides. This has led to strained relationship with his wife due to his low sexual performance.

The study area experiences low frequency of extension services delivery coupled with lean staffing of extension staff. Most of the farmers trusted their fellow farmers for information on safe use of pesticides. This poor level of extension delivery could be a contributing factor to low knowledge level on safe use of pesticides hence low adoption.

Only 0.7 % of the farmers indicated they sourced information on safe use of pesticides from reading a clear reflection of the farmers' poor reading culture. The information shared from farmer to farmer is usually diluted with time and bound to produce defective results. All the known sources should be encouraged so that information on safe use of pesticides is established and sustained.

The results indicates there is no significant relationship between frequency of extension services delivery and the level of adoption of safe use of pesticides in horticultural crop production at household level. These results contradicts a study by Makokha et al (1998) and also a study by Sseguya et al (1999) which reported that frequency of extension services are significantly related to adoption of new technologies.

It was expected by increased frequency of extension services delivery, adoption of safe use of pesticides could also increase. Further analysis of data indicated that 21.8% of the farmers received information on safe use of pesticides during the extension officers' rare visits which explains the lack of significant relationship.

The extension officers could also be lacking capacity in safe use of pesticides related issues hence being ineffective in disseminating this knowledge. The farmers' perception of the current capacity of the extension officers could also be a hindrance to effective reception of messages relating to safe use of pesticides. When the perception is negative, the farmers are unable to take up messages passed to them from the extension officer.

The extension officers are thinly spread at the grass root level hence the coverage of the target groups is limited. This affects the number of exposures of the safe use pesticides messages to the farmers. With limited contact with the extension workers knowledge build on safe use of pesticides gets constrained hence lack of positive contribution towards adoption level.

The land size ranged from 0.5 – 5 acres. The results indicated that there was no significant relationship between the farmer's land size and adoption level of safe use of pesticide in horticultural crop production at household level. The land size has no relationship to adoption of safe use of pesticides. The results were consistent with results of some earlier studies.

The results clearly indicate high resource endowment to farmers with large farm sizes do not translate directly to adoption of a technology.The results were consistent with Amudavi (1993) who found no significant relationship between farmer's land holding and adoption of safe use of pesticides at household level.

Large land parcels are usually associated with resource endowed farmers, hence it was expected they were willing to spare part of their resource to enhance the adoption of safe use of pesticides. But with most agricultural information being cost free, the resource endowment could not have a significant relationship with adoption of safe use of pesticides. Majority of the farmers (67.12%) in the study area own land below 1 acre, these maybe resource poor farmers and could have been expected to be constrained in safe use of pesticides, but without any significant relationship between the farm size and adoption of safe use of pesticides there was no significant difference between small land owners and large land size owners.

# CHAPTER FIVE
# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

This chapter outlines the summary, conclusion, recommendations of the study and the areas for further research are also suggested.

## 5.2 Summary of the findings

This section presents a summary of the major findings. The demographic characteristics of the sample were as follows:

i. A sample of 289 farmers out of 1170 farmers in Mbogoini Division was used. 75% were males while 25% were females

ii. Adoption of safe use is low (8.3%). 62.6% of the respondents were categorized as moderate adopters while 29.1 % were classified as low adopters.

iii. There is significant positive relationship between level of knowledge of safe use practices of pesticides and adoption of the same.

iv. Education level, household head gender, frequency of extension services delivery and farm size have no significant relationship with adoption of safe use of pesticides.

## 5.3 Conclusion of the study

According to the results obtained from the data analysis the following conclusions were made

i. Adoption of safe use is low (8.3%) in the study area. Methods to enhance adoption should been undertaken to influence the farmers in moderate the category(62.6%) to upscale their performance and graduate to full adoption.

ii. Farmer's Knowledge on safe use of pesticides was identified as a significant factor contributing to high adoption of safe use of pesticides in horticultural crop production.

iii. The literacy level of farmers in the study area was high standing at 98.6%. From these results it clearly indicates that the farmers were not constrained in reading the pesticides labels, hence could read and understand the label contents. Farmers' level of education has no significant relationship with level of adoption of safe use of pesticides in horticultural crop production at household level. The non significance can be attributed to the fact that the study generally focused to only the education level and not the content of the syllabus.

iv. The gender of the household head has no significant relationship with the level of adoption of safe use of pesticides in horticultural crop production at household level. Despite the difference in preference in odours between male and female farmers their adoption level of safe use of pesticides tended to agree. The various safe use of pesticides practices were adopted equally by the male and female farmers on safe use of pesticides in horticultural crop production at household level.

v. The area experienced low frequency of extension services delivery coupled with lean staffing of extension staff. Most of the farmers trusted their fellow farmers for information on safe use of pesticides. There was no significant relationship between the frequency of extension services delivery and level of adoption of safe use of pesticides in horticultural crop production at household level.

vi. The land size ranged from 0.5 – 5 acres. The results indicated that there was no significant relationship between the farmer's land size and adoption level of safe use of pesticide in horticultural crop production at household level. The land size has no relationship to adoption of safe use of pesticides. The results were consistent with results of some earlier studies. The results clearly indicate high resource endowment to farmers with large farm sizes do not translate directly to adoption of a technology.

## 5.3 Recommendations

The following recommendations need to be implemented by the key stakeholders namely the farmers, extension officers, agrochemical Industries and the stockists.

### 5.3.1 Recommendations to Farmers

The following are key recommendations that may contribute to increased adoption of safe use of pesticides in horticultural crop production at household level

1. The farmers need to form safe use contact groups at village level to sensitize each other on the importance of safe use of pesticides within there neighbourhood hence exerting peer pressure .
2. Farmer's knowledge base on safe use pesticides need to be increased through the various information pathways at their disposal. This will contribute to increased adoption of safe use of pesticides.
3. Farmers need to adopt use of protective clothing while handling pesticides as a major must.

4. Farmers need to develop a culture of reading and understanding pesticides labels before handling any pesticides

### 5.3.2 Recommendations to Extension Officers

The extension workers should;

1. Make more frequent visits to the farms and disseminate more information related to safe use of pesticides to enhance knowledge which is significant in raising the adoption level of safe use of pesticides
2. Mount more seminars and field days to sensitise farmers on the harmful effects of safe use of pesticides on the health of the total environment.
3. Assist farmers to form Farmers' Field Schools (FSS) in the horticultural growing areas with safe use of pesticides as a key package being disseminated.
4. Mount bill boards and banners with safe use of pesticides messages at strategic points within horticultural crop growing area.
5. Enhance advocacy of safe use of pesticides as an issue of global concern from the village level to National level
6. Need to undertake Annual Environmental Audits in collaboration with the relevant stakeholders in horticultural growing areas and develop Environmental Social Management Plans (ESMP) which can serve as bench mark for the level of safe use of pesticides for continuous monitoring of the trends.
7. Formation of a task force to oversee dissemination of safe use of pesticides information in the various line Ministries.

### 5.3.3 Recommendations to Agro- Chemical Industries and Stockists

The agro chemical companies should;

1. Include a more explicit warning on the harmful effects of the pesticides on the labels in bold, just as the health warning on the cigarette packets.
2. Institutionalize environment issues within the company management structures to disseminate safe use of pesticides information to the users.
3. Increase funding to extension department within the company setup in order to reach out more farmers with safe use of pesticides messages as a Corporate Social Responsibility (CSR).

4. Adhere to ethics while mounting their advertisements, both in the print and electronic media. Always having a rider on the need of safe handling of the pesticides by the users.

## 5.4 Recommendations for Further Research

The following areas need further research:

1. Establish the current pesticides residual level in the study population, their livestock and farm produce.
2. Farmers' perception on pesticides toxicity.
3. Establish the current residue levels in the River Weseges which transverse through the study area.

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## APPENDIX 1 : HOUSEHOLD QUESTIONNAIRE

### General Procedure

Observation: the following were observed:-

- The instrument was administered mainly to persons responsible for making most of the household decisions.
- The respondents were assured of confidentiality of the information they provided closed and open ended questions were given
- Where choices were provided, the respondents were required to tick { } on the choice they felt best for the issue under investigation

### Interviewer's entry notes

Household sample number.......................................................

Date of interview..................................................................

Name of village ...................................................................

### Introduction

Hallo/good day!

I am engaged in a research on socio-economic factors influencing adoption of safe use of pesticides in horticultural crop production at household level in Mbogoini division, Nakuru North district, Kenya

The purpose of this research to investigate and document the socio-economic factors that influence the adoption level of safe use of pesticides in horticultural crop production at household level in Mbogoini Division. I would like you to assist me in answering some questions about use of pesticides in this area. The information you give is important as it will help to identify the problems local farmers face in the usage of pesticides in horticultural crop production. Please be as accurate as possible. Be assured that all that you say will be treated in confidence and will only be used to solve the problems you face in the use of pesticides.

**Part A: Farmer's Bio- Data & Household Characteristics**

1. Name (optional) ..................................................

2. Sex Male { } Female { }

3. Position in the Household ........................................

4. Age

a. Below 20 years { }

b. 20- 29 years { }

c. 30-39 years { }

d. 40-49 years { }

e. 50-59 years { }

f. Above 60 { }

5. Education level

i. Primary

ii .Secondary

iii. Tertiary

iv. Adult education

v. No formal education

6. Land size under horticultural crop production ....................acres

**Part B. Pesticides use and Management**

7. Where do you source your pesticides?

i. Stockist { }

ii. General shops { }

iii. Hawkers { }

8. Are repacked pesticides recommended for use?

Yes { }

No { }

Not sure { }

9. How do you transport pesticides?

i. In original packs and separate from other commodities { }

ii. Together with other commodities { }

iii. Other methods ..............................................................

10. Where do you store your pesticides?

i. Buried in the farm { }

ii. House { }

iii. General store { }

iv. Pesticides Store { }

v. Other Places { }

11. What information is provided for in the pesticide label?

i.........................................................................

ii........................................................................

iii.......................................................................

iv........................................................................

12. Which clothes do you wear while handling pesticides?

a. Recommended protective clothing { }

b. Locally improvised protective clothing { }

c. Old clothes { }

d. Usual wear { }

e. Others { }

13. What is the operational status of your knapsack sprayer?

a. Not Leaking { }

b. Leaking { }

c. Others ..............................................................................................

14. Are pesticides toxic?

Yes { }

No { }

Not sure ( }

15. Do you suffer from any of the conditions listed below during pesticides handing?

a. Itching { }

b. Respiratory disorders { }

c. Nausea { }

d. Dizziness { }

e. Stomach Discomforts { }

f. Others { }

g. None of the above { }

16. After spraying do you take bath?

Yes { }

No { }

Not always { }

17. Where do you clean up the spraying equipment?

a. In natural water source { }
b. At field level { }
c. Designated area with a soak pit { }
d. Others ………………………………………

18. How do you dispose Empty pesticides containers?

a. Burying in designated pit
b. Burning
c. Throwing away in the field
d. Others ………………………

19. How do you clean a blocked nozzle?

a. Blowing using mouth { }
b. By use of wire { }
c. By use of brush { }
d. Other methods { }

20. Out of the spray practices listed below which do you observe?

a. Spraying towards the wind direction
b. Spraying against the wind direction
c. Spraying to and fro in the field
d. Others………………………………………

21. When do you spray?

a. Periodically { }
b. At pest infestation threshold { }
c. Subject to availability of funds { }
d. Others ………………………………………………………………

**Part C: Knowledge On safe use of pesticides**

22. Ask the question below and tick in the brackets alongside. Tick against K if the farmer is knowledgeable on the issue, UN if the farmer is uncertain and NK if the farmer does is not knowledgeable on the issue. The responses should be counter checked with information provided in Part B above.

| Issue | K | UN | NK |
|---|---|---|---|
| 1. Source of Pesticides | | | |
| 2. Use of repacked pesticides | | | |
| 3. Mode of transport of pesticides | | | |
| 4. Pesticide storage at household level | | | |
| 5. Information in Pesticide label | | | |
| 6. Use of protective clothing | | | |
| 7. Knapsack Sprayer Routine maintenance | | | |
| 8. Pesticides Toxicity | | | |
| 9. Pesticides negative impact on human health | | | |
| 10. Post Spray Activities | | | |
| 11. Designated area for cleaning spray equipment | | | |
| 12. Empty pesticides containers disposal | | | |
| 13. Unblocking nozzle | | | |
| 14. Recommended spraying practices | | | |
| 15. Pest/ horticultural crop diseases scouting | | | |

**Part D: Extension Services Delivery**

23. Do you have extension officers in the area Yes { } No { }

24. If yes How many ……………………………

25. Do extension officers Visit your farm Yes { } No { }

26. If yes how often

Very often { } Often { }

Sometimes { } Not often { }

Not at all { }

27. How often were you taught on safe use of pesticides?

Very often { } Often { }

Sometimes { } Not often { }

Not at all { }

28. How often do you attend seminars and field days?

Very often { } Often { }

Sometimes { } Not often { }

Not at all { }

29. How often were you taught on safe use of pesticides?

Very often { } Often { }

Sometimes { } Not often { }

Not at all { }

30. How often do you get your safe use of pesticides information?

Other Farmers { } Extension { }

Stockist { } Radio { }

Reading { } Agro chemical companies { }

31. How often do you get the safe use of pesticide information from the above sources?

| | Other farmers | Extension | Stockist | Radio | Reading | Agro chemical companies |
|---|---|---|---|---|---|---|
| Very often | | | | | | |
| Often | | | | | | |
| Sometimes | | | | | | |
| Not often | | | | | | |
| Not at all | | | | | | |

**Part E: Adoption of safe use of Pesticides Practices**

| 32. Innovation | Adopted | Not adopted |
|---|---|---|
| 1. Correct source of pesticides | | |
| 2. Excellent status of knapsack sprayer | | |
| 3. Correct storage practices | | |
| 4. Dilution rates | | |
| 5. Use of Pesticides in original packs | | |
| 6. Use of crop specific pesticides | | |
| 7. Correct pest scouting | | |
| 8. No smoking/eating during application | | |
| 9. Correct spray practices | | |
| 10. Correct nozzle unblocking procedures | | |
| 11. Use of protective clothing | | |
| 12. Correct disposal of empty pesticides containers | | |
| 13. label instructions | | |
| 14. Taking bath/wash hands after spraying | | |
| 15. Excess spray solution disposal pit | | |

## APPENDIX 2: SAMPLE SIZE FORMULA

Formula for estimating sample size

$$S = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$

S= required sample size

N = the given sample size

P= population construction taken as 0.5 as this magnitude yields maximum possible size required

d= the degree of accuracy as reflected by the amount of error that can be tolerated taken as 0.05

$X^2$ = table value of chi square for 1 degree of freedom relative to the desired level of confidence which is 3.841 for 0.95

Calculations

The population N from the inventory is 1170

P=0.5

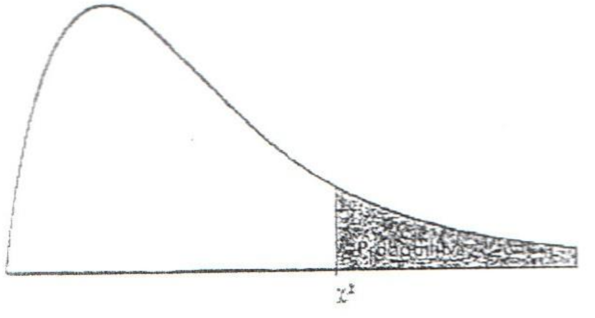
d=0.05

$X^2$ =3.841

Using above equation S = 289

## APPENDIX 3: $X^2$ CRITICAL VALUES






### TABLE C: $\chi^2$ CRITICAL VALUES

| | Tail probability $p$ | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| df | .25 | .20 | .15 | .10 | .05 | .025 | .02 | .01 | .005 | .0025 | .001 |
| 1 | 1.32 | 1.64 | 2.07 | 2.71 | 3.84 | 5.02 | 5.41 | 6.63 | 7.88 | 9.14 | 10.83 |
| 2 | 2.77 | 3.22 | 3.79 | 4.61 | 5.99 | 7.38 | 7.82 | 9.21 | 10.60 | 11.98 | 13.82 |
| 3 | 4.11 | 4.64 | 5.32 | 6.25 | 7.81 | 9.35 | 9.84 | 11.34 | 12.84 | 14.32 | 16.27 |
| 4 | 5.39 | 5.99 | 6.74 | 7.78 | 9.49 | 11.14 | 11.67 | 13.28 | 14.86 | 16.42 | 18.47 |
| 5 | 6.63 | 7.29 | 8.12 | 9.24 | 11.07 | 12.83 | 13.39 | 15.09 | 16.75 | 18.39 | 20.51 |
| 6 | 7.84 | 8.56 | 9.45 | 10.64 | 12.59 | 14.45 | 15.03 | 16.81 | 18.55 | 20.25 | 22.46 |
| 7 | 9.04 | 9.80 | 10.75 | 12.02 | 14.07 | 16.01 | 16.62 | 18.48 | 20.28 | 22.04 | 24.32 |
| 8 | 10.22 | 11.03 | 12.03 | 13.36 | 15.51 | 17.53 | 18.17 | 20.09 | 21.95 | 23.77 | 26.12 |
| 9 | 11.39 | 12.24 | 13.29 | 14.68 | 16.92 | 19.02 | 19.68 | 21.67 | 23.59 | 25.46 | 27.88 |
| 10 | 12.55 | 13.44 | 14.53 | 15.99 | 18.31 | 20.48 | 21.16 | 23.21 | 25.19 | 27.11 | 29.59 |
| 11 | 13.70 | 14.63 | 15.77 | 17.28 | 19.68 | 21.92 | 22.62 | 24.72 | 26.76 | 28.73 | 31.26 |
| 12 | 14.85 | 15.81 | 16.99 | 18.55 | 21.03 | 23.34 | 24.05 | 26.22 | 28.30 | 30.32 | 32.91 |
| 13 | 15.98 | 16.98 | 18.20 | 19.81 | 22.36 | 24.74 | 25.47 | 27.69 | 29.82 | 31.88 | 34.53 |
| 14 | 17.12 | 18.15 | 19.41 | 21.06 | 23.68 | 26.12 | 26.87 | 29.14 | 31.32 | 33.43 | 36.12 |
| 15 | 18.25 | 19.31 | 20.60 | 22.31 | 25.00 | 27.49 | 28.26 | 30.58 | 32.80 | 34.95 | 37.70 |
| 16 | 19.37 | 20.47 | 21.79 | 23.54 | 26.30 | 28.85 | 29.63 | 32.00 | 34.27 | 36.46 | 39.25 |
| 17 | 20.49 | 21.61 | 22.98 | 24.77 | 27.59 | 30.19 | 31.00 | 33.41 | 35.72 | 37.95 | 40.79 |
| 18 | 21.60 | 22.76 | 24.16 | 25.99 | 28.87 | 31.53 | 32.35 | 34.81 | 37.16 | 39.42 | 42.31 |
| 19 | 22.72 | 23.90 | 25.33 | 27.20 | 30.14 | 32.85 | 33.69 | 36.19 | 38.58 | 40.88 | 43.82 |
| 20 | 23.83 | 25.04 | 26.50 | 28.41 | 31.41 | 34.17 | 35.02 | 37.57 | 40.00 | 42.34 | 45.31 |
| 21 | 24.93 | 26.17 | 27.66 | 29.62 | 32.67 | 35.48 | 36.34 | 38.93 | 41.40 | 43.78 | 46.80 |
| 22 | 26.04 | 27.30 | 28.82 | 30.81 | 33.92 | 36.78 | 37.66 | 40.29 | 42.80 | 45.20 | 48.27 |
| 23 | 27.14 | 28.43 | 29.98 | 32.01 | 35.17 | 38.08 | 38.97 | 41.64 | 44.18 | 46.62 | 49.73 |
| 24 | 28.24 | 29.55 | 31.13 | 33.20 | 36.42 | 39.36 | 40.27 | 42.98 | 45.56 | 48.03 | 51.18 |
| 25 | 29.34 | 30.68 | 32.28 | 34.38 | 37.65 | 40.65 | 41.57 | 44.31 | 46.93 | 49.44 | 52.62 |
| 26 | 30.43 | 31.79 | 33.43 | 35.56 | 38.89 | 41.92 | 42.86 | 45.64 | 48.29 | 50.83 | 54.05 |
| 27 | 31.53 | 32.91 | 34.57 | 36.74 | 40.11 | 43.19 | 44.14 | 46.96 | 49.64 | 52.22 | 55.48 |
| 28 | 32.62 | 34.03 | 35.71 | 37.92 | 41.34 | 44.46 | 45.42 | 48.28 | 50.99 | 53.59 | 56.89 |
| 29 | 33.71 | 35.14 | 36.85 | 39.09 | 42.56 | 45.72 | 46.69 | 49.59 | 52.34 | 54.97 | 58.30 |
| 30 | 34.80 | 36.25 | 37.99 | 40.26 | 43.77 | 46.98 | 47.96 | 50.89 | 53.67 | 56.33 | 59.70 |
| 40 | 45.62 | 47.27 | 49.24 | 51.81 | 55.76 | 59.34 | 60.44 | 63.69 | 66.77 | 69.70 | 73.40 |
| 50 | 56.33 | 58.16 | 60.35 | 63.17 | 67.50 | 71.42 | 72.61 | 76.15 | 79.49 | 82.66 | 86.66 |
| 60 | 66.98 | 68.97 | 71.34 | 74.40 | 79.08 | 83.30 | 84.58 | 88.38 | 91.95 | 95.34 | 99.61 |
| 80 | 88.13 | 90.41 | 93.11 | 96.58 | 101.9 | 106.6 | 108.1 | 112.3 | 116.3 | 120.1 | 124.8 |
| 100 | 109.1 | 111.7 | 114.7 | 118.5 | 124.3 | 129.6 | 131.1 | 135.8 | 140.2 | 144.3 | 149.4 |