PESTICIDE USE AND MISUSE BY SMALL SCALE FARMERS IN KIAMBU, KENYA

BY

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A thesis submitted in partial fulfilment of the requirements for the Degree of Master of Education at Kenyatta University

1990

DECLARATION

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

19/6/1992

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DEDICATION

This thesis is dedicated to my family, husband Erick, son Billy and daughter Janice whose continued support, patience and understanding have resulted in its achievement. It is also dedicated to my parents Mr. Samuel Muraya and Mrs. Julieta Njoki Muraya for the foundation they gave me through effort and hardwork in putting me through school.

ACKNOWLEDGEMENT

The completion of this study has been made possible through the assistance and co-operation of many persons both within and outside Kenyatta University. Therefore, it will be ungrateful not to express my gratitude to them.

First, I wish to express my gratitude to my supervisors namely Prof. Ratemo W. Michieka and Dr. Richard K. Kerich who supervised this work with a tremendous sense of duty. To them, I am heavily indebted for constructive criticisms, valuable suggestions and persistent encouragement in writing the thesis. Thanks are also due to Miss Anne Nyamu for her meticulous critique and very useful comments at several stages of this work.

Much appreciation is extended to Kenyatta University for awarding me a scholarship to pursue postgraduate studies in the University leading to the completion of this study.

I am also indebted to a large number of persons, who provided me with information and material assistance during the fieldwork. I am especially grateful to teachers of Kamonjoni Primary School; Mr. Ranja's family, and Mrs. Njenga who spared their time to take me around to the interviewees during my field work.

Sincere thanks are also to my colleagues Rose, Kiugu, Wanjau, Mary, Patricia and Olaly for their concern and moral support throughout the two years of study.

I wish to extend many thanks to Mrs. Mary Kichamu whose industry gave my draft the aesthetic grandeur that it enjoys now.

Lastly, my heartiest thanks go to my husband Erick G. Karembu and children Billy Karembu and Janice Muringo for enduring in a most understanding manner with the conditions at home during the two years of study when it was not possible to fully play the role of a loving wife and mother. Their patience, understanding and persistent encouragement is highly appreciated and to them, I dedicate this work.

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ABSTRACT

This study was set to investigate the use of pesticides by small-scale farmers and its implications on the environment. It further sought to find out whether illiteracy causes misuse of pesticides and if provision of information on pesticides reduces their misuse and mishandling.

Three divisions in Kiambu District were selected using the cluster sample technique for interviews. The interview schedules contained questions aimed at answering the specific research questions.

Data was analysed using descriptive statistics i.e. frequencies, averages and percentages. In some cases, the responses were reported verbatim. The validity of this study relied on the assumption that the interviees were reasonably honest and expressed their true feelings when responding to the interviewer's questions.

It was established that some small scale farmers used a wide range of extremely hazardous pesticides which were either banned or severely restricted for use in developed countries. These included Dichlorodiphenyltrichloroethane

(DDT), dieldrin, heptachlor, cypermethrin and lindane. Factors such as the economic status of the farmers and the prevailing climatic conditions were found to contribute to pesticide misuse and mishandling than illiteracy.

In view of the problems of pesticide use, it was recommended that measures be taken to enforce pesticide regulations and legislation. The introduction of laws and regulations concerning disposal of unused pesticides and their containers should be supported while improved methods of packaging would reduce hazards arising from pesticide use. Further, labelling and advertising of pesticides should be monitored. Environmental education should incorporate pesticide safety education in the whole education system to sensitize and increase public awareness on the risks and potential problems of pesticide use and handling.

CHAPTER ONE

INTRODUCTION

Background of the problem

Pesticide use has increased extensively since the Second World War. Although pesticides enhance agricultural production and control vectors of medical and veterinary importance, their hazardous effects on human health and the environment cannot be ignored. All pesticides have some degree of toxicity which may cause acute or chronic poisoning due to prolonged exposure.

Pesticide poisoning as a result of excessive exposure occurs in various ways. Contact during manufacturing, chemical formulation and application, drinking and eating contaminated food stuffs are common sources. Disposal of surplus and expired pesticides, and of empty pesticide containers are other problems experienced throughout the world especially by the less developed countries. In these countries, pesticides are currently being used extensively to increase output of agricultural production.

The seriousness of the pesticide problem is illustrated by the statistics on pesticide poisoning at the global level. The World Health Organisation, WHO (1981) estimated that one person in the developing countries is poisoned by pesticides every minute and at least 5,000 of them die

annually. The incidence of pesticide poisoning is thirteen times higher in the less developed countries than in the developed ones (Gilles, 1989).

According to the United Nations Environment Programme, UNEP, (1988) there is a low level of awareness and inadequate technology in safe handling of pesticides in less developed countries. This makes pesticide use in these countries hazardous. The situation has been made worse by the fact that developed countries have been exporting banned and severely restricted pesticides to the less developed countries, the Food and Agricultural Organisation, FAO, (1986).

The risk of exposure to pesticides is greater to those with less or no knowledge of safe use. Kenya, and many less developed countries experience a significant level of pesticide poisoning. The Government of Kenya is fully aware of the potential harm that the use of pesticides can cause to human health and the environment. The Pest Control Products Act, which became operational in 1984, is charged with the responsibility of taking specific powers to regulate the distribution and use of pesticides in the country. However, Obel (1985) reported that pesticide poisoning through misuse and mishandling is a serious problem in Kenya. Measures should be taken through environmental education to increase public awareness of the

dangers and risks associated with their use. Environmental education aims at developing a citizenry that is aware of, and concerned about, the total environment, its associated problems and which has the knowledge, attitudes, motivations, commitment, and skills to work individually and collectively toward solutions of current problems and the prevention of new ones.

Statement of the problem

There are several plant and insect pests which infest the main crops grown in Kenya by small scale farmers. Consequently, a considerable amount of pesticides is used for the suppression of crop pests. During application and subsequent use, there is risk that unwanted side effects on the environment and human health could occur. These include the occurrence of pesticide residues in other food products, farm animals and wildlife outside the area designated for the application of the pesticides.

Basic safety rules must be known and understood by all pesticides users, especially when handling the concentrates.

Although it is known that small scale farmers use plenty of pesticides, little is known on how the farmers handle them. No valid statistics on pesticide poisoning are available and little has been done to find out the types of

pesticides used, the methods of application and the major problems associated with their use.

The present study investigated the use of pesticides by small-scale farmers in Kiambu District for the control of various crop pests. The study sought to determine the different pesticides used; assess the farmers knowledge on application techniques; and the use of protective devices. Information concerning formal and non-formal instructions in pesticide use and the channels used were also investigated.

The purpose of the study

The main purpose of the study was to investigate pesticide use by small scale farmers and analyse the major problems associated with their use. The following specific objectives guided the study:

i. to identify the type and class of pesticides used by small scale farmers;

ii. to find out the kind of advice that small scale farmers get on selection and choice of pesticides;

iii. to determine the farmers' knowledge on handling and application of pesticides;

iv. to identify the methods of disposal of unused pesticides and empty pesticide containers;

v. to assess the role of the mass media in providing information regarding pesticide use and management.

The research questions

In carrying out the study, the following research questions were considered:

1. What type and class of pesticides are used in agriculture by small scale farmers?

2. Are farmers informed on how to use pesticides?

3. Are farmers aware of the dangers and hazards that pesticide use can cause?

4. What are some of the environmental implications of pesticide use and handling?

5. Does the mass media play any role in providing information regarding pesticide use and management?

Assumptions of the study

In designing the study, it was assumed that:

i. There is insufficient information on the proper use of pesticides among farmers.

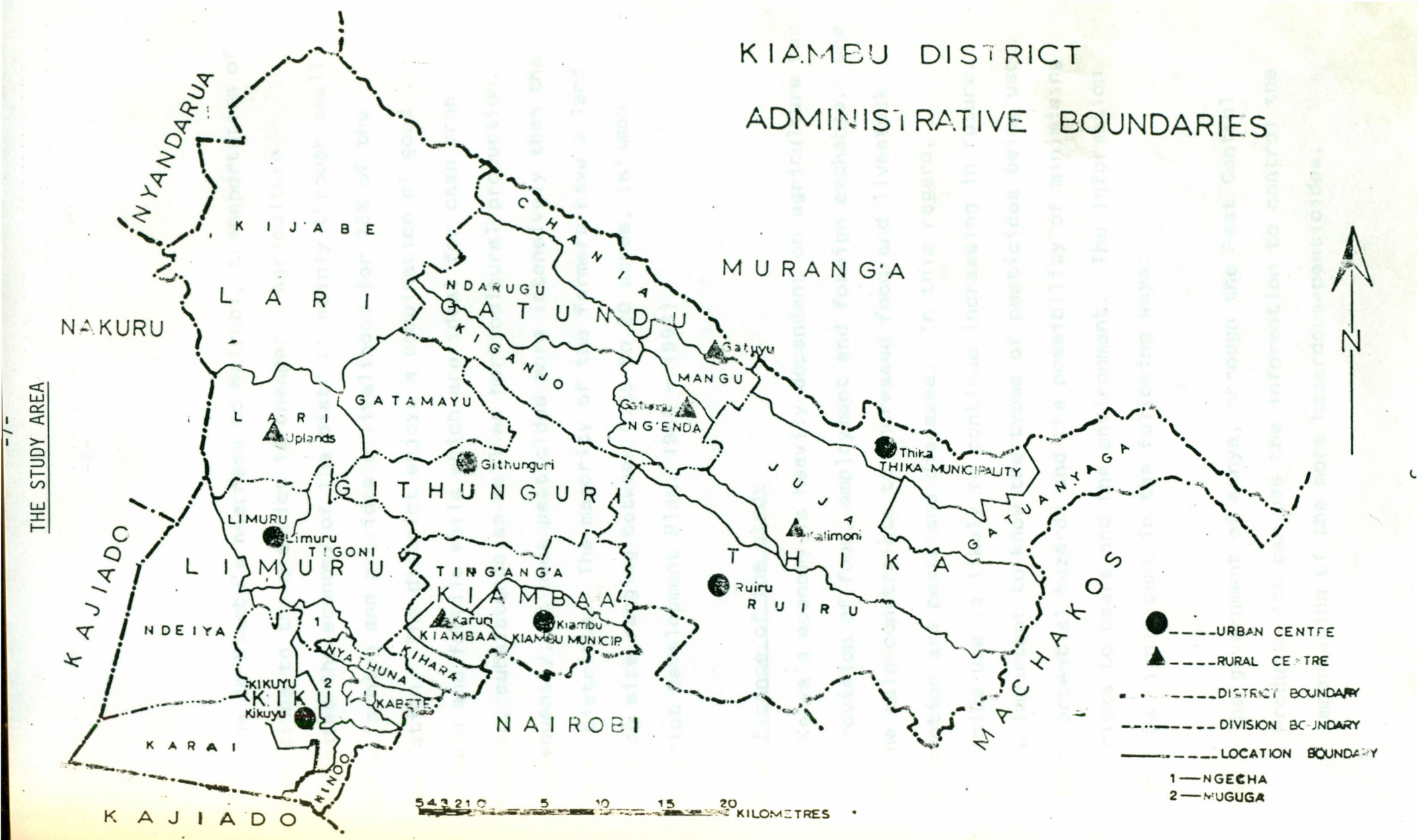
ii. Small scale farmers are ignorant of the dangers pesticides pose to their health and the environment.

iii. Sex is not an important factor in the study, thus male and female farmers were treated alike.

iv. Misuse of pesticides is a common phenomenon among small scale farmers.

The study area

Kiambu District is one of the five districts in the Central Province of Kenya. It is distinguished for its variety of landscapes, climate, resources and land use patterns. The district covers an area of 2,451Km^2 and is divided into seven administrative divisions namely Kikuyu, Limuru, Gatundu, Githunguri, Lari, Thika and Kiambaa as shown in Figure 1.



THE STUDY AREA

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MAP I

SOURCE: KIAMBU DISTRICT DEVELOPMENT PLAN, 1989-1994

Due to Kiambu's nearness to Nairobi, transportation of pesticides to the district is cheaper. Agriculture dominates the economy of the district mainly through small scale farming and provides a livelihood for 75% of the population. The district enjoys a combination of good climate and fertile soils which are ideal for cash crop farming, subsistence as well as horticultural production. Consequently, it uses pesticides more intensively than the other districts. The majority of the farmers have a land holding size ranging between 0.25 to 20 acres, (Kiambu District Development Plan, 1989 - 1993).

Significance of the study

Kenya's economy is heavily dependent on agriculture for the provision of food, employment and foreign exchange. One of the main constraints to increased food and livestock production are pests and diseases. In this regard, pesticide use is likely to continue increasing in future. It is important to know the types of pesticides being used, their potential hazards and the possibility of minimising the risks to users and the environment. The information will be significant in the following ways:

a) The government of Kenya, through the Pest Control Products Act can use the information to control the importation of the more hazardous pesticides.

b) The government can use the information to effectively enforce the legislation for the control of chemical hazards to ensure that toxic pesticides are not available where the necessary safety precautions are unsatisfactory.

c) Training institutions can use the information to advise the Kenya Institute of Education (which is charged with the responsibility of developing curricula) on the need to incorporate pesticide safety education in schools. This will equip the youth of this country with the knowledge and skills needed to ensure safe use of pesticides.

d) From the study, gaps in information to pesticide users will be identified. This will call for the policy makers to ensure that:

- manufacturers label their pesticides properly and do not advertise pesticides with misleading information.

- pesticide retailers are made aware of the hazards of pesticides through non-formal environmental education and that the same information is relayed to farmers when they buy pesticides.

- mass media, (both electronic and print) covers and advertises the benefits as well as risks and side effects of pesticides so that farmers and the general public is aware of them.

e) From the findings of this study, the researcher will provide recommendations on how misuse and mishandling of pesticides can be minimised.

Limitations of the study

1. The study was limited to small-scale farmers of Kiambu District. Kiambu District was chosen because it had adequate representation of small scale farmers, a majority of whom were using pesticides. Due to the time and financial constraints, three divisions, Kikuyu, Gatundu and Limuru were chosen, (See Figure 1). These however could fail to offer an accurate representation of the entire district.

2. Data gathering instruments used were interview schedules and observation record sheets only.

3. Suspicion reigned in some of the interviewees because of the way they viewed the interviewing exercise.

Definition of significant terms and words

The study utilized several concepts and terms, some of which are defined below:

ACUTE EFFECTS

These are the effects caused by pesticides immediately or soon after exposure and are easily linked to specific events. They are the best reported pesticide-related incidents.

ADVERTISING

This means the promotion of the sale and use of pesticides by print and electronic media, signs, displays, gift, demonstration or word of mouth.

BANNED PESTICIDE

A pesticide for which all registered users have been prohibited by government regulatory body or for which all requests for registration or equivalent action for all users have, for health or environmental reasons not been granted.

CHRONIC EFFECTS

These are recurrent effects caused by pesticides months or years after exposure and are more difficult to link to a specific incident than are acute effects. They may cause irreversible damage.

DOSAGE/DOSE RATE

The amount of pesticide recommended to be used on a given area of crop expressed, for example, in litres or kilograms per hectare. Often, the dilution to be employed is also stated, like 1Kg in 100 litres of water per hectare.

ENVIRONMENT

The World Book Dictionary defines environment as all the surrounding things, conditions and influences affecting the growth or development of living things.

ENVIRONMENTAL POLLUTION

This has been defined as the direct or indirect alteration of the physical, thermal, biological or radioactive properties of any part of the environment in such a way as to create a hazard or a potential hazard to the health, safety or welfare of any living species (Allaby 1983).

HAZARD

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

ILLITERACY

For the purpose of this study, the following definition will be used; not knowing how to read or write.

LABEL

The written, printed or graphic matter on or attached to the pesticide; or the immediate container thereof and the outside container or wrapper of the retail package of the pesticide.

LEGISLATION

Any laws or regulations introduced to regulate the manufacture, marketing, storage, labelling, packaging and use of pesticides in their qualitative, quantitative and environmental aspects (FAO, 1986).

PEST

This includes harmful, destructive, or troublesome animals, plants or microorganisms except those found in association with other living animals or man.

PESTICIDE

For the purposes of this study, the FAO definition will be used which defines it as:

> .... any substance or mixture of substances intended for preventing, destroying or controlling any pest. This includes vectors of human or animal diseases, unwanted species of plants or animals causing harm, or otherwise interfering with the production, processing, storage, transportation or marketing of agricultural commodities (FAO, 1986:5).

PROTECTIVE CLOTHING

Any clothes, materials or devices that are designed to provide protection from pesticides when they are handled or applied.

REPACKING

The transfer of pesticides from any commercial package into any other, usually smaller container for subsequent sale.

RISK

The expected frequency of undesirable effects of exposure to the pesticides.

SAFETY

The practical certainty that harm will not occur from a pesticide.

TOXICITY

A physiological or biological property which determines the capacity of a chemical to do harm or produce injury to a living organism by other than mechanical means.

CHAPTER TWO

LITERATURE REVIEW

In his effort to produce adequate supplies of food, man has been opposed to the ravages wrought by insect pests and crop diseases. Theophrastus (300 B.C. cited in Cremyln, 1978) described many plant diseases known today such as scorch, rot, scab and rust. In the Old Testament of the Bible plagues such as in Egypt for which the locust was chiefly responsible are on record.

The idea of combating these pests using chemicals is not new. According to Hassall (1982), the use of inorganic chemicals to control insects dates back to classical Greece and Rome. In 1000 B.C., Homer reported the use of sulphur for fumigation. The Chinese were employing moderate amounts of arsenicals as insecticides by the sixteenth century and not long afterwards, nicotine was used in form of tobacco extracts.

The use of insecticides has been credited with increased crop yields of 2% per year in the United Kingdom (UK). In the United States of America (USA), removing all pesticide use would increase crop losses from 33% to 42%. Experimental programmes in less developed countries for

example Ghana have recorded improved groundnut yields of 179% per year attributed to pesticide use, (Chetley, 1985). In Kenya, it is estimated that pests and diseases of crops are responsible for more than 30% yield loss in the field, while further losses in storage due to stored product pests and fungi are estimated at 18% of the harvested crop yearly (Wapakala, 1985).

The use of pesticides has also saved many lives. An example is the global efforts to eradicate malaria during the Second World War, which utilized DDT. In 1970, WHO estimated that 2 billion cases of malaria had been prevented, with a saving of 15 million lives after a 15-year programme worldwide (Bull, 1982).

Watcher and Staring (1981) summarised the general development pattern of pesticide use. As pesticide markets in developed countries became saturated and more regulatory measures clamped down, agrochemical transnational co-operations refocussed their sights on the less developed countries. In these countries, regulatory measures were lax, weakly enforced or non-existent. This led to a drastic rise in consumption of pesticides in these countries. In the Africa region, big users of pesticides in monetary terms are Sudan, Tanzania, Zimbabwe, Cameroon, Cote d'Ivoire and Kenya (FAO, 1981). The value and quantity of pesticides

imported into Kenya is steadily increasing and is estimated at over KShs. 700 million yearly (Ondieki, 1988).

The use of pesticides in the agricultural sector will continue to increase in the foreseeable future due to the need to produce more food for the expanding world population. Many crop pests are also becoming resistant to some pesticides in use, hence necessitating the application of higher doses and the introduction of new pesticides.

The increased use of various types of pesticides however, has led to greater emphasis on the possibility of serious environmental contamination arising from their use. In her book "The Silent Spring", Carson made people aware of the potential dangers of environmental pollution by pesticides. She proclaimed:

> .... the most alarming of all man's assaults upon the environment is the contamination of air, earth, rivers and sea with dangerous and lethal chemicals (Carson, 1963: 16)

Classification of Pesticides

Pesticides are chemicals designed to combat the attacks of various pests on agricultural and horticultural crops. They can be classified in many different ways, for example, according to the target pest organism; the chemical

structure of the compound or according to the degree or type of health hazards involved. The general classification is in terms of their use, that is the group of pest organism controlled. Insecticides, for example are products designed to control insect pests, fungicides control fungal diseases of crops, stored produce and fabrics while herbicides (weed killers) are products designed to control unwanted vegetation.

The WHO divides pesticides into five classes according to toxicity. Extremely hazardous pesticides are classified under IA class, while those unlikely to cause harm under normal use, class IV. Between the two classes are three more classes IB, II and III. The classification is based on the LD_{50} of the chemical. This is the lethal dose, in milligrams per kilogram of body weight needed to kill 50% of test animals or organisms. The part of this classification relevant to the present study is shown in Table I.

Table 1: The WHO Classification of Pesticides

Hazard Level	Class	Amount that will kill an adult man if swallowed
Extremely hazardous	IA	A few drops
Highly hazardous	IB	One teaspoonful
Moderately hazardous	II	One tablespoonful
Slightly hazardous	III	Unspecified
Unlikely to cause harm in normal use	IV	Half a kilogram or more

Source: Adopted from "Guidelines to the use of the WHO Recommended Classification of Pesticides by Hazard", 1979.

The WHO recommends that only well trained, educated, closely supervised operators should use the pesticides falling into the two most hazardous classes, IA and IB. However, Hartzell (1988) reported that of the ten most popular insecticides used in Thailand in 1985, six fell under these two classes (IA and IB). The sprayers were rural small scale farmers who were neither trained nor supervised.

The most common type of pesticides used by less developed countries are the insecticides. Most insecticides can be divided into four groups depending on their chemical makeup. Organochlorines were the first insecticides to be

manufactured on a commercial scale, (Cremyln, 1978). The best known of this group are DDT, aldrin, endrin, dieldrin, heptachlor, lindane and hexachlorohexane (HCH commonly known as BHC). Once applied, these organochlorines have been thought to persist in the environment for a long time. McEwen (1979) reported that concentrations of the organochlorines have developed in some predatory birds large enough to affect their reproductive and nesting success. However, the persistence of organochlorines residues in the environment is of distinctly shorter duration in tropical than in temperate areas. In countries like USA these pesticides such as DDT have been banned or severely restricted due to their persistence in the environment (Schapiro and Weir, 1981).

Organophosphates are another group of synthetic insecticides. They are often the most toxic, but quickly break down from the environment. Sometimes they break down into more toxic substances than the original pesticide. The best known are malathion, parathion, diazinon, dipterex, gusathion, phosdrin and azodrin.

A closely related group of insecticides are the carbamates first discovered by the Geigy company in Switzerland in 1947. They include such chemical products as baygon, zireb and servin (Hansen, 1987). While not as

persistent in the environment as the other compounds, these products have a higher immediate toxicity with non-target biological effect. This means they sometimes kill off harmless or even beneficial species like bees which may previously have been overlooked. They may cause considerable environmental damage in excessive use (Copplestone, 1977).

Synthetic pyrethroids are the latest group of insecticides to be extensively marketed. Some of the known examples are resmethrin, allithrin, decamethrin and permethrin (Hansen, 1987). They are slightly toxic to man but extremely toxic to fish.

An important class of organic compounds with herbicidal activity are phenoxyacetic acids. The widely used examples of these are 2,4-diclorophenoxyacetic acid (2,4-D) 2,4,5-tricholophenoxyacetic acid (2,4,5-T) and 2-Methyl-4-Chlorophenoxyacetic acid (MCPA). They are valuable for the selective control of broad-leaved weeds in cereal crops. Since some herbicides are non-selective, they can destroy the basis of ecological diversity. McEwen (1972) reported that herbicides have an inhibiting effect on photosynthesis and can be correctly thought of as inhibitors of the energy trapping and storing processes in plants. In his study on the changes in the physical and chemical environment when a herbicide is applied to a pond with dense vegetation,

Hurbert (1969; cited in McEwen, 1972) noted that destruction of the vegetation resulted in a high mass decomposition resulting in low oxygen level.

There are other documented studies on the effects of herbicides on the predator-prey relationships in an ecosystem. It has been shown that when the weeds are cleared in an agro-ecosystem, this reduces the amount of food available to the herbivores. This in turn reduces the amount of food available for the carnivores and omnivores and thus a change in the predator-prey relationships (Edward and Thompson, 1973).

Pesticide Legislation

Pesticide Legislation means:

> any laws or regulations introduced to regulate the manufacture, marketing, storage, labelling, packaging and use of pesticides in their qualitative, quantitative and environmental aspects (FAO, 1986:8).

A number of organisations like the International Organisation of Consumers Union (IOCU) and governments in less developed countries like Kenya, Uganda and Zambia have expressed concern about the propriety of supplying pesticides to countries which do not have infrastructure to register pesticides and thereby ensure their safe use (Bull, 1982).

In 1972, the United Nations Conference on the Human Environment recommended setting up a centralised register of data on potentially hazardous chemicals. As a result, a centre was established in Geneva by UNEP in 1976 called the International Register of Potentially Toxic Chemicals (IRPTC). The main functions of the register are fourfold: To make data on chemicals readily available to those who need it; to locate and publicize major gaps in information and encourage research to fill them; to identify and publicize the potential hazards of using chemicals; lastly to assemble information on national, regional, global policies for regulating the use and production of hazardous chemicals (IRPTC Bulletin, 1985).

The FAO developed an international code of conduct on the distribution and use of pesticides in 1981. One of the objectives of the code relevant to the present study was defined as:

> to set forth responsibilities and establish voluntary standards of conduct for all public and private entities engaged in, or affecting the distribution and use of pesticides, particularly where there is no or an inadequate national law to regulate pesticides (FAO, 1981:5).

The export to less developed countries of pesticides which have been banned or whose use has been severely

restricted in some developed countries has been a subject of public concern. This has led to intensive discussions on whether the exporting country should assume responsibility for the marketing and use of such products in the importing country. At a meeting in UNEP in 1977, one participant urged that:

> .... unless a product has been adequately tested, certified and widely used in the countries of origin, it should not be used for export (Weir and Schapiro, 1981:66).

On the same issue, the Central American Non-Government Conservation Societies Conference in 1978 adopted a resolution calling on the USA President to act on pesticide exports to other countries. They said:

> Seriously alarmed by the abuse and increasing use in our countries of chemical substances which are prohibited by legislation in USA as well as other countries, we request, in the name of human principle that authorisation be denied to the exportation of such products to our countries for use, at the cost of our health and the lives of dozens of thousands of our fellow men ..... (Shuelberg, 1979:366).

A study on problems of pesticide legislation carried out in Uganda in 1984 reported that there is a general lack of specific detail on agricultural pesticides. Within

Uganda, the Pharmacy and Drugs Act of 1970 still in force mentioned little about labels, storage, transportation, buildings, residence and the effects on the general environment. The study noted:

> .... numerous agricultural pesticides of unknown purity, without labels and largely of doubtful effectiveness have found their way to the farms ... Taking advantage of a free market situation in Uganda and ineffective legislation, the pesticide industry has often availed to farmers pesticides that are ineffective (Karamura, 1985:79).

In Kenya, the Pest Control Products Act which became operational in 1984 controls the manufacture, distribution and usage of pesticides in the country. The Act, established the Pest Control Products Board whose mandate is threefold: To register and approve for use all pesticide products; to issue licences for import and export of pesticide products; and to license all premises used for the manufacture, storage, distribution and sale of pesticides after ascertaining that the premises meet the required standards. However, illegal dealings with pesticides has been reported in the mass media. A report in the daily papers reported for example that:

> Illegal dealers move from one rural market to the other selling highly toxic agrochemicals to rural farmers, who may be ignorant of the dangers such pesticides pose to their health (Gachamba, 1989:15).

Smuggling of pesticides to Kenya has also been reported. Mutiso, the current chairman of the Pesticide Chemicals Association of Kenya reported in the same daily that this is a major source of dangerous pesticides in Kenya. He gave an example of a smuggled pesticide which had been used for spraying coffee but was substandard. It was later identified as chalk-dust mixed with a small amount of an unknown chemical.

Adam (1976) stated that 40% of the less developed countries were estimated to have no specific legislation of pesticides and where they did, individual schemes were inadequate. However, recent reports from some of the less developed countries like Sri Lanka, Zimbabwe and Kenya (Stroud, 1985) have enacted some comprehensive legislation. Other reports in Zambia by Goma (1985), Sudan Gezira by Osman and Balla (1985) have shown that it is of utmost importance for the less developed countries to enact laws and to regulate the importation, distribution and use of pesticides. When enforced, this will ensure that they (pesticides) pose no dangers or hazard to man and the environment.

Environmental Pollution by Pesticides

Pesticides have been criticized by environmentalists and those concerned with wildlife conservation for various reasons:

> Pesticides sometimes kill harmless and beneficial organisms which may previously have been overlooked. They have had unwanted and often unexpected harmful side effects, sometimes arising from misuse and because of the chemical and physical properties of the pesticides themselves ..... (Mellanby, 1976:220)

Whenever a pesticide is applied to the foliage or seed of the crop, or to the soil, there is a possibility that some of it will persist and may lead to serious contamination of the environment. This may be depicted as a cycle of pesticide in the environment (Figure 2). There is a unity between all forms of life, so accidental ingestion of pesticides by humans or animals might produce adverse effects. In this case there would be a possibility of health risks to the operatives who are engaged in handling and spraying them. There is the possibility of hazard to children when adults permit them access to such chemicals, and the likelihood of their deliberate use for suicide or murder. Since crop protection chemicals are applied to plants which will produce edible crops and, in some cases, to the crops themselves, there is the possibility that small residues might remain in the crop until it is eaten by the

consumer. If this happens, it will be deleterious to the consumer's health either acutely or chronically.

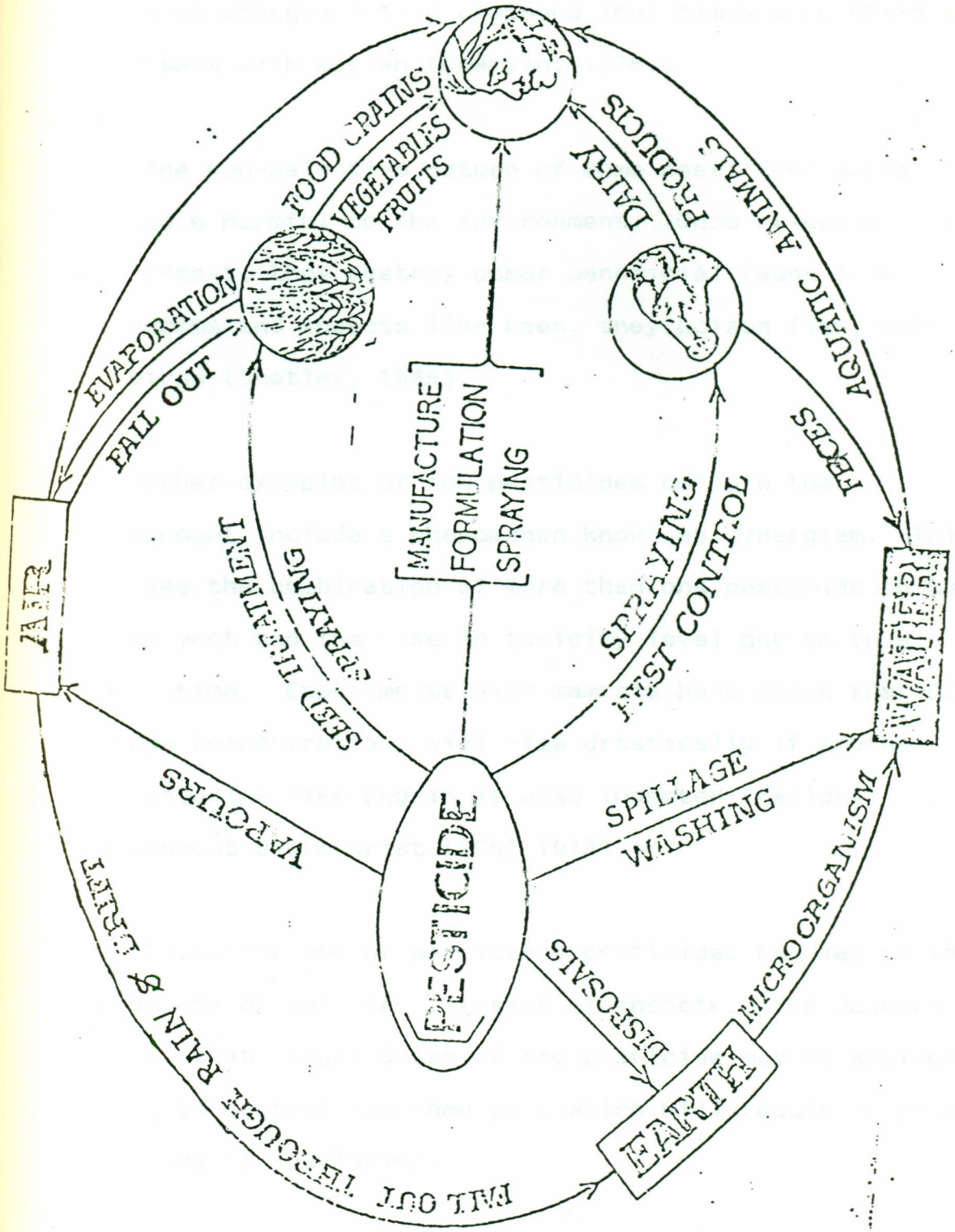
Furthermore, since pesticides are sprayed widely over large areas, there is the possibility that they may drift on the wind and that small concentrations may build up in the atmosphere at large. These would be hazardous to beneficial insects such as bees, to wild animals and birds which feed on the crop, and to creatures which live within the crop or in the soil beneath it, thus indirectly to wildlife which feeds on those creatures. Pesticide which falls down can be washed down into the soil by rain and eventually finds it way into lakes and rivers where it will adversely affect fish and other aquatic life.

One researcher observed that the frightening thing about pesticides is that:

> Pesticides do not stay in one place; they infiltrate the surrounding environment and reach rivers, lakes, ponds and oceans through runoff from soils and plantations treated with pesticides and, through agriculture and industrial waste .. (Dudani, 1988:21)

Pesticides have also been known to cause damage by chemically changing into other different poisons when released in the environment. Heptachlor, an organochlorine

Figure 2: THE PESTICIDE CYCLE IN THE ENVIRONMENT



for example changes to heptachlor epoxide a toxic poison lethal to plants and animals in minute amounts, while parathion changes into a compound four times more toxic when in contact with oxygen (Cremyln, 1978).

The non-selective nature of some pesticides makes them even more harmful to the environment. Once released in the environment, they destroy other beneficial fauna like earthworms and insects like bees, they poison fish, wildlife and birds (Chetley, 1985).

Other examples of how pesticides pollute the environment include a phenomenon known as synergism. This involves the combination of more than one pesticide in the environment and the rise in toxicity level due to this combination. Experiments with mammals have shown that DDT storage concentrations will rise drastically if another hydrochlorine like endrin is also ingested (National Environment Secretariat (NES) 1978).

Extensive use of persistent pesticides has led to the appearance of resistant strains of insects. The dangers of this is that larger doses of the pesticide may be applied in trying to control the same pest which will result in greater environmental pollution.

Nicaragua has documented severe resistance problems. One researcher in the cotton fields of Nicaragua observed:

> With the introduction of pesticides in the 1950s, cotton in Central America boomed with yields reaching a peak in 1965. But in the next five years, production declined at an annual rate of 15.9% and the country came close to bankruptcy. The primary cause of this situation was the failure to achieve control of the pests by the prevalent unilateral reliance on pesticides. Problems of serious and increasing resistance to insecticides were evident .... (Leon, 1976:812).

A serious feature of pesticides and especially organochlorines is their ability to become concentrated along food chains causing death to organisms at the end of the chain, a process often referred to as biomagnification. An example of this type of effect in the environment was reported in California, USA in Clear Lake (Cremyln, 1978). DDT was sprayed in the lake to kill gnats. After a period of ten years, fish eating diving birds were observed dying at a very high rate. The DDT had accumulated in the phytoplanktons and other plants in the lake. These in turn were eaten by the fish which were eaten by the birds. An analysis of the lake's ecosystem showed that the phytoplankton contained approximately 250 times the original concentration of DDT applied to the lake. The fish contained 2,000 times the original concentration while the fish-eating diving birds had a magnification of 80,000 times

the original concentration of the chemical (Cremyln, 1978).

Methods of disposal of unused pesticides and empty pesticide containers have caused environmental pollution in a number of countries. Traditional methods of land fills, storage in surface impoundments and deep well injections have recently been found to be entirely unsatisfactory, reported UNEP (1989). Persistent pesticides have accumulated in these sites for decades showing that environmental aspects of such disposal methods had not been considered. Several cases of groundwater contamination by chemicals leaking from unsatisfactory landfills and surface impoundments have also been reported.

Brown (1979) reported that in USA, more than 200 substances including 175 organic chemicals have been identified in groundwater. At Love Canal in USA, homes were built on a former pesticide dumping site. Rainwater percolating into the ground leached the buried chemicals into a sludge that contaminated the buildings. Researchers assessing the potential health problems in children living near the site found serious learning problems, hyperactivity, eye irritation, skin rashes and stomach pains more prevalent than in a control group (Postel 1987).

In the Africa region, pesticides have also been criticized especially for their non-selective nature and

bioaccumulation. At the Seventh Pan-African Ornithological Congress held in Nairobi, Kenya in 1988, participants protested to FAO against the pesticides used in locust control campaigns in Africa. They said that the pesticides used were killing birds and the pests which they fed on, thus interfering with the ecosystem. They noted that there had been no thorough assessment of the environmental impacts of the methods used to combat locusts in Africa (Kimathi, 1988).

One of the participants of the Nairobi Congress, Crick, reported that evidence from farmers in Senegal and Gambia had indicated that flies, mosquitoes, aphids, beetles, honeybees, parasitic hymenoptera, crabs and weaver birds are killed during locust control operations. Some of these insects helped farmers because they fed on pests which destroyed crops. The chemicals in common use were fenitrothion, diazinon, dieldrin and lindane, the participants noted.

Problems Related to Pesticide Use and Handling

All pesticides are, by definition toxic substances. They are not potentially hazardous but are deliberately released into the environment because they are toxic (UNEP, 1987). However, while some are extremely toxic, others are unlikely to cause harm in normal use, and if safety precautions are observed.

According to O'Brien (1984) no one can say pesticides are safe. Even where safety precautions have been followed, pesticides may poison by method entirely different from those intended. She argued:

> The long term effect of pesticides on humans such as cancer, genetic damage and birth defects are all unintended side effects. Phenoxy-herbicides designed to kill plants by causing them to grow quickly, have been found to poison animals by damaging their liver and are suspected of causing cancer in human beings ... (p.2)

Adams (1976) reported that one of the main problems connected with the use of pesticides in most of the less developed countries is the incidence of intoxication and death. This is as a result of misuse of certain pesticides.

A pesticide may be taken into the body through the mouth (oral), skin (dermal) or through the lungs (inhalation). The uptake orally is minimal during application unless an applicator unwisely eats, drinks or smokes before washing his hands and face after spraying. Oral poisoning has occurred when pesticides have been improperly stored in food containers such as beer or soda bottles and have accidentally been taken resulting in poisoning. Eating fruits and vegetables before pre-harvest

interval time, or people committing suicide have been cited in oral poisoning. Pre-harvest interval time is the period specified in pesticides between the last treatment (pesticide treatment) and harvesting of the crop. Principally, contamination of the body is through the skin.

The first major international scare relating to toxic chemicals occurred in 1959 in Minamata, Japan, where large numbers of people began to contract an unusual disease. It was later revealed by research as mercury poisoning. Mercury wastes had been discharged in waterways and ingested by fish. The fish concentrated the chemical with disastrous consequences when eaten by humans. Four hundred people reportedly died (UNEP, 1987).

Reports on industrial and other accidents involving pesticides have appeared in the media more often since then. One recent and extremely dramatic disaster in Bhopal, India in 1984 involved a leakage at a pesticide plant. More than 2,500 people were reported dead and thousands injured. Another accident in Basel, Switzerland was a fire outbreak in a pesticide plant in 1986. The river Rhine was seriously polluted in this incident (UNEP, 1987).

Various studies and surveys on pesticide use and handling have been done in both the developed and less developed countries. An attempt is made to discuss the

findings of these studies so as to provide a rationale and the general background for the present study.

The WHO estimated that there were some 500,000 cases of pesticide poisoning in the world annually, 9,200 of them fatal (WHO Chronicle, 1973). Bull (1982) extrapolated these WHO figures to project a figure for 1981 of an annual rate of 750,000 with at least 13,800 deaths globally. According to the IOCU (1984) over 50% of the poisoning occur in the less developed countries, yet they use only 20% of the global pesticides. Ninety per cent (90%) of those poisoned in these countries die. While these poisoning could be attributed to lack of proper training, most are caused by poor handling and by safety pre-requisites for use which cannot be met given the local conditions (Bull, 1985).

The effective use of pesticides depends to a great extent on how they are applied. A lot of equipment used in less developed countries is poor and often inadequate. Some makes and designs have proved unsuitable and some require excessive maintenance which often cannot be provided locally (Mathews, 1979).

In a survey on pesticide application methods carried out by Alam (1984) in Bangladesh he found that most of the sprayers were locally manufactured knapsack types that were kept in poor condition. He observed that most farmers used

brooms, leaves and plunger pumps because the sprayers were unusable. Few application safety precautions were observed and no application training courses existed.

Another survey carried out in the Philippines concerning the use of pesticides by small scale rice growers indicated that the toxicity of the pesticides the farmers handled was often poorly appreciated:

> .... One still sees farmers smoking or eating while spraying. Many do not appear to be aware of dermal toxicity and few avoid re-entering freshly sprayed fields or preventing others from doing so ... (Loevinsolhn, 1982 Unpublished Report:2)

Sumagil (1984) surveyed pesticide application methods in Philippines involving 138 farmers. The survey showed that 70% owned knapsack sprayers. Slightly over half of the sprayer owners were trained on sprayer use. Most farmers claimed they followed the recommended practices though only 25% knew the meaning of active ingredient.

Lack of proper training in pesticide use has also been reported in developed countries. A survey by Van den Bosch (1978) in the UK found that 86% of farmers received no training in pesticides' use safety. The study found fewer than 20% using protective clothing; 39% who failed to read general information on pesticides; more than one quarter who

found such information 'hard to understand' and more than half who used the wrong equipment.

A workshop held in Penang, Malaysia in 1982 to assess the global impact of pesticides abuse and misuse for developed and less developed countries established a number of common problems and perceptions, (Chatfield, 1982). The participants of the workshop noted that in the less developed countries, pesticides are routinely imported from developed countries without any regulations. Health hazards warnings are usually taken for granted by the exporting country. Another observation was that pesticide users were widely either underprotected and/or unprotected from the hazardous effects of pesticides. There were also routine large scale abuses of overuse and improper application methods.

Where the use of pesticides is most intense, users should be monitored for evidence of excessive exposure. However, this is usually hampered by lack of money, staff, expertise and ignorance (Gunns, 1976). Irrespective of how a pesticide enters the body, acute poisoning may occur after one dose or exposure. Chronic poisoning is caused by repeated small doses absorbed over a long period of time.

A study done by Cheng (1979) involving 200 farmers in Benguet (Malaysia) indicated that many of them were

suffering from internal and external body disorders due to the toxic effects of pesticides. Most of the ailments included drying of the skin, itchiness of the hands, face and lips; loss of appetite; abdominal pains; body weakness; chest pains; dizziness and nausea. Reddening of the eyes which resulted to blurred vision and blindness were other complications.

Mwanthi and Kimani (1989) conducting a research in Kiambu District, Kenya, have also reported pesticide related ailments among farmers such as skin irritations, asthmatic attacks, hypertension, constant headaches and diarrhoea. Due to long hours of handling chemicals, the coffee sprayers are the most hit with these pesticide ailments.

Sri Lanka has one of the best documented studies of pesticide poisoning (Bull, 1982). Jeyeratnam (1986) gave figures for pesticide poisoning cases between 1975 to 1980 for Sri Lanka. In total, 69,394 cases were reported during this period of which 5,085 were fatal. Many studies related to pesticide use have been done in Sri Lanka and thus this country has a better view of the magnitude of the problem than other less developed countries.

The Sri Lankan health authorities and other government officials work together to fight against indiscriminate use of pesticides. Public lectures and seminars have focussed

on creating an awareness of the dangers of misusing pesticides. Those involved directly or indirectly in the manufacture, sale and distribution of pesticides are now being told firmly to guard against the sale of highly toxic pesticides and to warn the public of the dangers of improper use (Aloysious, 1990).

Another study on pesticide poisoning in humans was carried out in Vietnam, (Pesticide Action Network, 1983). The study was aimed at establishing if any correlation existed between exposure to pesticides like chlorophenals and increased birth defects, psychiatric problems and cancer in the Vietnamese population. The results indicated that male exposure to phenoxyherbicides such as 2,4-D and 2,4,5-T could cause transmission of congenital abnormalities through sperm.

Appropriate protective clothing should be worn whenever a pesticide is being applied to avoid contamination. These include overalls, gloves made of neoprene, closed shoes, eye and face shields, masks, hats and respirators. In most of the less developed countries, farmers spray pesticides without sufficient protective clothing. Surveys done in Philippines, Bangladesh and the Africa region have indicated that most farmers wear long-sleeved shirts as their only protective clothing. Various reasons have been given for this ranging from climatic conditions not being conducive

especially in the tropics to lack of money to buy them. One solution to this problem could be to define a limit for oral or dermal toxicity above which a pesticide should not be recommended for general field work.

Ishikura (1984) reported that in Japan, there has been a trend to use pesticides of lower toxicity as new compounds became available. At the international level, FAO (1986) directed that pesticides whose handling and application require the use of uncomfortable and expensive clothing and equipment should be avoided, especially in the case of small scale users in the tropics.

The extent of the problem of pesticide poisoning in both developed and less developed countries was examined by Muchiri (1988). He identified a variety of ways in which pesticide poisoning could occur. He cited farm workers mixing and applying pesticides or entering freshly sprayed fields as the group most at risk. He further found that children drinking pesticides by mistake, families using pesticide containers for storing food and drinking water, and the contamination of food during transport and storage may also contribute to pesticide poisoning.

Problems and hazards of pesticide use could be prevented if users had easy access to reliable and adequate information through such channels as official extension

services, labels, mass media and company sales promotions. A label which is the final and most direct instruction to the user should give all necessary information for safe and effective use, yet labels are often inadequate or inaccurate.

Bull (1985) reported a series of surveys which were done to examine the status of pesticide labelling. One survey in Mexico revealed that 50% of the labels examined had incorrect information. Another label for Endrin by Shell Chemicals from the Philippines was also examined. Endrin formulations are banned for almost all uses in Europe and the USA, and if used, adequate protective clothing would have to be recommended. In USA, a special warning to female users would have to appear on labels. This Philippine label in English only, contained inadequate precautionary information and had no warning to female operators. The same report noted that Kenya has a better control of the situation than many other developing countries. However, a few pesticides purchased locally for example rentokil, gusathion and dedevap all had labels which did not meet the various standards set up by WHO, International Labour Organisation (ILO) and included in the FAO code.

Hazards from agricultural inputs were examined by Wainaina (1985). He identified labelling as one single major reason for misuse and mishandling of pesticides, and

the resultant hazards as ignorance on the part of the user. This view has been confirmed by the Pesticide Chemicals Association of Kenya. To minimise these problems, the association expects members to meet some minimum label requirements. They should be in the language most understood by the users, and in Kenya, Kiswahili and English have been recommended. However, no statistical data has been collected to analyse the percentage of small-scale farmers who can read and understand the two languages. Other requirements include a statement of precaution users must take while using, and giving disposal instructions.

The problem of pesticide poisoning in Kenya continues to cause grave concern. A look at case report forms of the emergency units of hospitals in Kenya show that pesticide poisoning is a frequent cause of admission in many hospitals. In 1985, it was reported that Kenyatta National Hospital had one to two cases of actual pesticide poisoning daily; Aga Khan Hospital two cases weekly, and Nairobi Hospital, one case weekly, (Obel, 1985). In all above cases, organophosphates were the suspected poisons.

Toxicity hazards can be reduced by improved methods of packaging. Most farmers have a small acreage and need small packets of pesticides to avoid storage of partially opened packets. However, surveys have indicated that in many of the less developed countries, retailers decant pesticides

into unlabelled bottles and sometimes wrap the pesticides in papers similar to those used to wrap foodstuffs. This has led to accidental poisoning and especially so because most farmers store the pesticides in their houses (Sumagil, 1984).

In one of the Kenyan daily newspapers, it was reported that misuse of pesticides is largely as a result of ignorance. Toxic chemicals are unpacked and measured out into smaller quantities as demanded. The paper noted:

> .... no labels are fixed, no protective clothing is worn, water is usually unavailable to wash off any pesticides which accidentally come in contact with their bodies. The pesticides are sold near openly displayed foodstuffs like vegetables, ripe bananas and sugarcane ..... (Gachamba, 1989:15)

Waiyaki and Munene (1987) conducted a study on chemical usage and the environment in Embu District of Kenya. They found that most chemicals were adequately labelled and pesticides formulated locally were labelled in English and Kiswahili. However, they noted that a local language would be a great help. These findings contradicted other studies done earlier by Bull (1982) and Karamura (1985) who made a general conclusion that in less developed countries, pesticides are inadequately labelled and misleading.

In rural communities of less developed countries pesticide containers are used widely for storing foodstuffs like sugar, salt and tea leaves. People save or sell the empty containers for preparing, transporting or storing food and drink. Waiyaki and Munene's study indicated that problems of disposal of chemicals and empty containers was apparent. No arrangements for their disposal by either the Kenya Grain Growers Co-operative Union (KGGCU) or any local co-operative societies existed. They supported this by the following:

> Plastic containers are used by children to carry water, empty pesticide containers and bottles are seen scattered about in shambas long after use, and some farmers use empty pesticide containers for storing honey, sugar, salt or when milking .. (Waiyaki and Munene, 1987:187)

Advertising of pesticides is very widespread in the less developed countries. A wide variety of methods are used including bill boards, ends of houses, street signs, radios, televisions, cinema, cars with loudspeakers and many others. Bull (1982) noted that most of the advertisements are inadequate and in some cases dangerously misleading and irresponsible.

Hartzall (1988) reported that one pesticide manufacturer advertised a woman spraying pesticides dressed in only a 'bikini' (swimming suit). In countries like Sri

Lanka, lobbies against misleading advertisements on pesticides through the mass media have been mounted and television advertisements can no longer show farmers spraying pesticides without wearing adequate protective clothing. All advertisements must show that proper clothing (gloves and masks) is an important requirement in the spraying activities (Aloysius 1990).

A study to assess the extent and role played by the mass media in advertising pesticides in Kenya is necessary to create awareness on the dangers of improper use of pesticides to the general public.

Monitoring of pesticide handling in Zimbabwe and Zambia was seen as one way of correcting the mistakes that farmers repeated frequently. Such monitoring was carried out in 1987 by the Scientific Environmental Monitoring Group (SEMG) of UNEP. At the beginning of the operation, the safe handling techniques and protective clothing of the pesticide users were inadequate. There was careless handling and unnecessary contamination of the farmers. Insufficient washing of the application equipment and pollution of the rivers with the pesticides was observed as there were no arrangements made for where to clean the equipment. After repeated advice given by SEMG representatives over a period of one year, the pesticide handling gradually improved.

Farrington (1977) examined situations where pesticide use recommendations are not followed in developed and less developed countries. He said that these situations can be explained by a complex interaction of economics, risks, management and human nature. Although several researchers have reported that small scale farmers often spray less pesticides than recommended usually due to the lack of funds or inadequate supply of the chemicals, farmers still do not use recommended dosages even where credit and supply are available he argued.

In 1988, the pesticide industry in Kenya led the government in attempts to curb the uncontrolled distribution of pesticides. Kenya, being one of the few countries in Africa that is aware of the hazardous environmental effects of toxic chemicals has banned or severely restricted the following chemicals: DDT, Lindane, Aldrin, Dieldrin, Endrin, Parathion, Chlordane, Heptachlor, Dibromochloropropane, 2,4,5-T, Ethylene Dibromide and Camphaclor Toxaphene, (Kimani pers. com., 1990). However, it is pathetic to note that although the ban is active, there are no measures taken to implement the restrictions as yet.

The current and future use of pesticides in less developed countries was discussed in a series of seminars held between 1971 and 1975. One of the conclusions reached

was that as regards safety and pesticides, priorities differ in solving associated problems. One of the seminar participants observed that:

> In less developed countries, the first priority is in solving problems of intoxication as a result of direct contact, whereas in developed countries they are mainly interested in residues and environmental issues .... In less developed countries, there are no reliable statistics on the incidence of pesticide poisoning or on medical services in rural areas (Adam, 1976:23)

Many of the studies undertaken to investigate pesticide use in the Africa region are very recent. Kenyan studies have been few. The reasons why small scale farmers misuse pesticides have been slightly sought for by case studies. Investigations as to whether certain variables like lack of information and illiteracy influences improper and unsafe use of pesticides have not been extensively explored. Actual statistics on pesticide usage are poorly documented.

It is in view of the foregoing problems that this study was carried out so that there would be an increase in understanding the factors that influence pesticide misuse in Kenya.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

The project adopted a case study approach focussing on three divisions of Kiambu District, Central Province, Kenya. The district was chosen because it is a region of intensive small scale farming, producing vegetables and flowers for the Nairobi market as well as for local consumption. Consequently, a wide range of pesticides was expected to be in use. The farms were an average size of one to two hectares and thus it was possible to get a good representation of small scale farmers relevant to the present study.

Pilot Survey

A pilot survey was carried out in a number of farms in Kikuyu Division of Kiambu District to pre-test the questionnaire. This was necessary to ensure that the items in the questionnaire were clear and reliable.

Twenty farmers completed the questionnaire during the pilot survey. These farmers were not included in the actual sample of the final study. The pilot survey revealed that most farmers misunderstood the questions. Others could not respond to the items unless they were translated into their local language, though they could read the words in the

item. As a result, some major changes were made on the questionnaire. To facilitate data collection, the researcher trained two assistants conversant in both English and the local language to administer the questionnaire and collect data. Data was therefore collected through interviews by using the questionnaire.

Sampling Techniques

The respondents for the study were obtained from three divisions out of the seven that make up Kiambu District. In chosing the divisions, the researcher used the cluster sample technique described by Best (1970). The cluster sample is a variation of the random sample, particularly appropriate when the population is large or where the geographical distribution is widely scattered.

To establish population validity, the researcher gathered data about the sample and the population on characteristics critical to the study as given by Walter (1979). The data was to determine the degree of similarity between the accessible population and the target population. It was found out that the majority of the population was made up of farmers growing similar types of crops within the set geographical locations. The three divisions finally sampled were Kikuyu, Gatundu and Limuru. In Kikuyu, the main crops grown are vegetables, fruits and flowers, while in Gatundu, two main cash crops coffee and tea, and a

variety of subsistence crops like maize, beans and potatoes are grown. Limuru has tea as the major cash crop and a variety of vegetables.

The respondents within a division were chosen using systematic random sampling. This was found to be convenient since the sample was being drawn from a large population. A systematic sample consists of the selection of each n^{th} term from a list (Best 1970). Since a list of all small scale farmers in the district was not available, the starting point for the selection was chosen at random.

The researcher identified the villages in each division. From each village, four farmers were chosen using an interval of ten farms to economise on time and costs. In each division, forty small scale farmers were selected and this made a total of one hundred and twenty respondents. The sample was considered an adequate representation of the district considering the critical features mentioned earlier.

In addition, the researcher visited each division's main open air markets independently and randomly chose six pesticide dealers, two from each division and interviewed them. Three agricultural extension officers, one from each division were also chosen randomly and interviewed.