Evaluation of Pesticides Storage, Transportation Policies, Procedures and Their Hazards and Impact on Handlers and Near-by Residents
"With special emphasis on the importance and need for extension and training interventions"

By
Hala Mohamed El Bakri Elzein
B.Sc. (Agric-economic). Honour.
University of Khartoum -1988
M.Sc. In Environmental Studies
University of Khartoum - 1995

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Supervisor
Prof. Ali Mohayad Bannaga

Co-supervisor
Dr. Azhari Omer Abdelbagi

Department of Agricultural Extension and Rural Development
Faculty of Agriculture
University of Khartoum

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ولا تفسدوا في الأرض بعد إصلاحها وادعوه خوفاً وطمعاً إن رحمت الله قريب من المحسنين

صدق الله العظيم

- آل عمران ٦٥
To the people of Sudan especially those who are exposed to and victimized by the excessive and faulty handling and utilization of the agro-chemicals.

With love and respect

Hala
From the very beginning to the end I thank Allah who provides me with health and strength and through whom a number of relatives and friends and many more than I can mention helped me throughout this study.

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Hala
ABSTRACT

This study was carried out to evaluate the current policies and procedures of pesticides storage, their legal requirements, and the negative impact of current management systems on the working staff and people living and/or working in the neighbourhood of the pesticides stores.

The study utilized primary data obtained from two surveys using questionnaires administered by the researcher herself. The first questionnaire covered 138 randomly selected residents living around Al-Samrab pesticide store. The second questionnaire was covered 87 workers in the Plant Protection Directorate HQs (PPD). Assessment of the working environment in the PPD stores was carried out. Parameters evaluated included heat and light measurements. The regulations governing pesticides storage and transport as cited in the Pesticide Act 1994 and its relevant by-laws and international standards, were reviewed and analyzed. Coordination level between the various organizations involved in pesticides activities in Sudan was assessed.

Frequency distribution and Pearson correlation coefficient tests were used to analyse the data.

The study has revealed the absence of extension services and training in many aspects related to pesticides activities such as storage, handling and transportation as well as the low level of knowledge of pesticides hazards among the personnel engaged in the PPD HQs and people residing near Al-Samrab pesticides store. Also the study has shown the non-enforcement of regulations related to storage, handling and transportation of pesticides as cited in the Pesticide Act 1994. The study
revealed that people working with pesticide are more susceptible to their hazards. Also there is a possibility of hazard to those living or working in the neighbourhood of the pesticides stores.

Those target groups claimed to suffer from many symptoms related to acute and chronic pesticides poisoning. The study has indicated that extension services are not functioning in the establishment of a system of complementary relationship among the concerned institutions and other national stake-holders. Also the study revealed that there is a lack of awareness among governmental officials in the Urban Development and Investment Authority about allocation of sites and zones for chemical factories, stores and hazardous industries.

The study recommends the following:

1. Continuous training of personnel involved in pesticides stores.
2. Relocation of pesticides stores in residential or populated areas to other suitable places.
3. Suggestion of some amendments and/or additions to the regulations regarding storage and transportation of pesticides in the relevant by-laws.
4. Pre-employment and periodical medical examination for the workers, occupationally exposed to pesticides.
5. Environmental monitoring in the areas covered by chemical industries utilization and storage.
7. Encouragement of protective measures and gear for workers occupationally exposed to pesticides.

8. Representation of the Agricultural Extension Department as one of the important departments in the National Pesticides Council.

9. Provision of extension services and training to concerned targets.

10. Environmental awareness raising and training for governmental officials in the Urban Development Department, Investment Corporation and other Relevant Departments.

11. Creation of high level of coordination with various organizations involve in the pesticides activities.
بسم الله الرحمن الرحيم

خلاصة الأطروحة

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CHAPTER ONE

1.1 Introduction

Our planet is inhabited to day by ca 6 billion people. Statistics show that the world population increases by 2% annually, and doubles every 37 years. Nowadays, about one billion people are at undernourished, and more than 1.8 billion have unbalanced or inadequate diet. This growth in world population and the associated increase in demand for food has forced the farmers / producers to move towards the modernization of many agricultural practices in order to attain higher productivity levels. In the field of crop protection, this has been marked by extensive use of chemicals in pest control practices. During the last three decades hundreds of new chemical compounds had been developed as pesticides (Bonsall 1985, Coppleston 1985). The use of insecticides can increase cotton yield by 100%, potato and fodder crops by 15%. The FAO also reported that if pesticides are banned, the yield of crops and animals will be reduced by 30% and the prices will increase by 50 - 70%. Furthermore, the benefits of, pesticides can be measured in terms of millions of lives saved, millions of illnesses prevented and additional food production to alleviate malnutrition and starvation for billion of peoples (Hermann, 1998; Bashir et al., 1999).

It is unfortunate that the toxic action of pesticides is not specific to pest species only but the majority of these compounds affect other forms of life. Furthermore, the side effects of pesticides include; environmental pollution, toxicity to non target organisms including mammals, natural enemies, pollinators … etc., pest resistance and emergence of secondary pests (Elrajhi and Taj Edin, 1998).

Sudan is considered among the main pesticide users in the Middle East and Africa. The annual consumption of pesticides in the Sudan is estimated at 5000 metric ton (MT) which in value term approach 60 million US$ equivalent to 5% and 10% of the total for Africa and the Arab world respectively (Bashir, et al., 1999).

In Sudan several institutions are involved in the importation, distribution and utilization of agricultural pesticides. They include the Plant Protection Directorate (PPD), Sudan Gezira Board and other irrigated agricultural schemes, Ministry of Health and Ministry of Animal Resources. Several institutions and organizations have in various ways given their support to Sudan in its efforts to improve and rationalize pesticide use and these include: FAO, WHO, GTZ, UNIDO, GIFAP and the Sudanese Agrochemical Association (SAGA) (Mukhtar, 1999).
1.2 Problem statement

Pesticides are toxic chemicals used to kill or control pests. They are characterized by a wide spectrum of activity and their effects are not restricted to target pests only, but they affect other members of the ecosystem from microorganisms to higher vertebrates. The Global use of pesticides is expanding and new technologies like genetically modified crops didn’t result in complete rejection of pesticides use irrespective of the wide spread rejection by the public and some decision-makers of relying upon toxic chemicals in food production, health and livestock protection (Hermann, 1998).

In developing countries, three millions people suffer from single short-term exposure including that resulting from suicide or murder with 220,000 deaths (WHO, 1990). Furthermore over 700,000 people per year are thought to suffer from the chronic effects of long-term exposure (WHO, 1990). The magnitude and nature of such effects could be underestimated because the symptoms of pesticide poisoning may be incorrectly ascribed to other causes. It is also difficult to assess the main factors contributing to mortality from pesticide poisoning. Environmental contamination, accidental exposure during work, failure to use protective clothing and errors in mixing, are among the responsible (Cooper, 1990).

Many pesticides are known to be highly hazardous and either banned or severely restricted in industrialized countries such as parathion,
mevinphos, and endrin which are widely available in developing countries and often used without precautions (Wayland, 1975, Edwards 1977, WHO, 1992).

In developed countries health risks are likely to be low when pesticides are used according to proper agricultural practices and when food safety systems ensure that residue limits meet approved standards, such as those adopted by the Codex Alimentarius Commission which is an international body responsible for the execution of the joint FAO/WHO food standard programme. This programme is aimed at protecting the health of consumers and facilitating international trade in food. A major contribution to good practices in the use and distribution of pesticides is the international code of conduct on the distribution and use of pesticides (FAO, 2002).

In most recorded cases where food has been implicated in pesticide poisoning, the chemical was found in the food following accidental contamination through either negligence or ignorance. For example in a number of cases food has been contaminated because of unsafe packing and leakage of pesticides during storage and transport worldwide and in the Sudan (Table 1 and 2).

Table (1): Pesticide-poisoning episodes worldwide.

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Cases</th>
<th>Deaths</th>
<th>Comments</th>
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<tr>
<td>Guyana</td>
<td>1966</td>
<td>88</td>
<td>10</td>
<td>Flour contaminated with parathion during interna-tional transport</td>
</tr>
<tr>
<td>Qatar &amp; Saudi Arabia</td>
<td>1967</td>
<td>874</td>
<td>26</td>
<td>Flour contaminated with endrin during international transport</td>
</tr>
<tr>
<td>Jamaica</td>
<td>1968</td>
<td>NR</td>
<td>18</td>
<td>Flour contaminated with parathion during interna-tional transport</td>
</tr>
<tr>
<td>Iraq</td>
<td>1971-2</td>
<td>6000</td>
<td>500</td>
<td>Treated seed corn consumed as food</td>
</tr>
<tr>
<td>Jamaica</td>
<td>1976</td>
<td>79</td>
<td>17</td>
<td>Flour contaminated with parathion</td>
</tr>
</tbody>
</table>
Pakistan 1976  2810  5  Poor safety practice for malation in malaria control programme

Indonesia 1983  168  96  Eight episodes of poisonings from consumption of food (various pesticides)

Pakistan 1984  194  19  Sugar contaminated with endrin during in-country transport.

Sierra leone 1986  49  14  Flour contaminated with parathion during in-country transport.


Table (2): Pesticide-poisoning episodes in the Sudan.

Pesticides storage sites where leaks and spills are not correctly cleaned up are examples of point source pollution. Some pesticides persist for decades leaving residues in the soil, water and air, causing environmental pollution of many sensitive areas such as, areas where ground water is near the surface or easily accessed, areas near schools, playgrounds, hospitals and other institutions, areas where people live or work, areas where food or feed is processed, prepared, stored or served (Edwards 1973, Haskell, 1985).

There is a possibility of health risks to the workers who are actually engaged in handling and in different operations, concerning pesticides business from manufacturing up to their disposal. Also there is
a risk to those who work or live in the pesticide storage area (Matsumura, 1985).

Water pollution by pesticides is often caused by inadequate storage and distribution of agrochemical. In the United States dieldrin remained the most serious pollutant in USA surface waters (Matsumura, 1985). Accumulation of obsolete pesticides continue to pose a serious threat to health and to the environment. In developing countries, contamination of soils, and water is through seepage and run off. Air pollution is more pronounced around the storage place. Many of the obsolete pesticides which were supplied up to 40 years ago, are classified as Persistent Organic Pollutants (POPs) and therefore contaminating the global environment. Leaking stocks of highly hazardous and obsolete pesticides threaten many community resources in developing countries and the cost of disposal is enormous. Uncounted costs include removing residues from water, health costs of treating affected individuals and poor health affecting capacity to work (Hermann, 1998 and WHO, 1990).

In the Sudan, the revised countrywide survey confirmed the existence of 666 tonnes of obsolete stocks. Most stocks are kept under poor or substandard storage conditions and in leaky containers distributed over more than forty three major and minor sites, many of them were seriously affected. Most of the sites have no proper pesticides stores, even the existing ones were of poor ventilation. A substantial proportion of
stocks are kept close to residential area (FAO, 1999). In 1990 Butrous and Algadi estimated the quantity of contaminated store soils at 309.6m$^3$, also he reported on problems of pesticide empty containers that pose serious environmental hazards particularly in the areas where there is shortage of water.

The illegal pesticides dumping in Sudan had created a real environmental problem. Quarshi Railway station in Hasahisa is a good example, where obsolete pesticides have been buried. Immediate investigations revealed that the DDT concentration in the soil surface samples over the dumping pits exceeded the international limits by 1000 times (Algadi, 1992). Subsequent analysis of soil and water samples over and surrounding the dumping sites revealed lower residues level of DDT as well other organochlorine pesticides moving at various rates vertically and horizontally from the dumping sites (Elmahi, 1996; Babiker, 1998; Abdelbagi et al., 2003).

Also pesticides residues had been found in fish and even in human milk. Elzurgani and Ali (1981) found that all fish tissue samples collected from different areas of Sudan contain DDT residues. Eltom (1997) studied organochlorines insecticide residues in human milk collected from lactating mothers from Fadasi Clinical Centre, near Wad Medani, Sudan, HCH aldrine, heptachlor epoxide were detected. Many poisoning episodes were reported in Sudan among pesticide store workers (Elamin
1972 and Fakhri 1973). Several fatal incidents have also been reported in Sudan. The most famous case occurred in 1987 in the Gezira State and caused 2 deaths, 21 abortions and several cases of allergy in humans. Further 40 sheeps and goats died after drinking from the water pond which was contaminated with spilled pesticides washed into a village pond by rain water (FAO, 1999).

According to Alhindi (1995) a total of 505 people were poisoned by consumption of pesticide contaminated food in Sudan in the only 22 documented cases during the period 1985/1991 as reflected earlier in Table (2). About 13% of the poisoned persons died. As mentioned by the author, these reported cases resemble only a minor fraction of the true picture, which is very difficult to assess due to the lack of complete medical documentation. The misuse or improper handling, transportation and storage of pesticides were behind the cited cases.

Some of the causes of hazards to both agricultural workers and the general public are the non-enforcement of current legislation of Pesticide and Pests Control Act, wide spread ignorance of the hazards involved, absence of extension work, less efficient occupational health measures and lack of well-trained medical staff to deal with pesticides poisoning.

1.3 Objectives of the study

The main objective of the study was to examine the current system of management of pesticides stores and to evaluate its impact on the people living and working in the neighbourhood of pesticide stores as well as other personnel dealing with pesticides.

The specific objectives are:

1. To assess the impact of pesticides stores on the personnel, neighboring residents and workers in their neighborhood.
2. To assess the level of knowledge about pesticides hazards among the personnel involved in the pesticide stores.

3. To examine the level of awareness of the hazards of pesticides among residents in the neighborhood of pesticide stores.

4. To identify the organizations related to pesticides management and examine their relationship and level of coordination in various activities relating to pesticides.

1.4 Hypotheses

1. There is a considerable health risk that threatened workers who are engaged in handling, storage and transportation of pesticides, neighboring residents and workers in the neighbourhood of pesticides stores.

2. There is low level of knowledge about hazards involved among the personnel in pesticide stores.

3. There is low level of awareness about hazards of pesticides among residents in the neighbourhood of pesticides stores.

4. There is low level of coordination between different organizations involved in pesticides management.
CHAPTER TWO

LITERATURE REVIEW

2.1. The concept of agricultural extension

2.1.1. Definitions of extension:

There are many definitions of extension. According to Swanson and Claar (1981) extension is an on-going process of transmitting useful information to people (the communication dimension) and then assisting these people to acquire the necessary knowledge, skills and positive attitudes to utilize this information on technology effectively (the educational dimension).

It may be a system and process of service and education designed to meet the needs of people whether in urban or rural areas. The ultimate goal of the extension process is to teach people to enable them to use skills, knowledge and information to improve their quality of life. However, for the extension work to be effective, it must have people's own actions springing of their knowledge, understanding and conviction (Nagel, 1997; Puncell and Anderson, 1997; Rolling, 1990; Roberts, 1989 and Axinin and Throat, 1972).

Oakely and Garforth (1985) explained the term extension as a process which occurs over a period of time and not a single, one time activity. They also described extension as an educational process which works with rural people, supports them and prepares them to confront their problems more successfully.
Albrecht et al. (1989) defined extension as follows "it is a process whereby the extension worker tries to motivate his extension partner and to give him the capability with the help of encouragement and ideas to act to solve his acute problems".

Extension, or non-formal education, can be used effectively in non-agricultural programmes, such as rural health, family planning or community development (Swansons and Claar, 1981). The term extension has a variety of meanings and its job may vary considerably country by country.

Van Den Ban (1985) stated that in the UK, Germany and Scandinavia, the focus is on advisory work. In the American Society, the term extension education means that they are dealing with an education activity to teach people to solve problems by transmitting information. In France the term "Vulgarisation" indicates that extension is a question of simplifying information so that ordinary people can understand it".

Rolling (1990) gave different names and terms to extension according to the purpose it is expected to achieve depending on the policy tradition with which it functions. The Netherlands uses "Voorlichting" which means keeping a light in front of someone to follow him or her to find the way.

2.1.2. Agricultural extension:
The term agricultural extension has a variety of meanings. Extension might be described as the process of helping farmers to become aware of and adopt improved technology from any source to enhance their production efficiency, income, and welfare (Puncell and Anderson, 1997).

Maunder, 1973 defined agricultural extension as "A service or system which assists farm people, through educational procedures in improving farming methods and techniques, increasing production efficiency and income, bettering their levels of living and lifting the social and educational standards of rural life". UNDP views agricultural extension as a central strategic component in the agricultural development process, including both technology transfer and human resource development in developing countries (UNDP, 1990).

According to Van Den Ban and Hawkins (1996) extension involves the conscious use of communication of information to help people form sound opinions and make good decision. Agricultural extension is not a monolithic structure rather it is an educational process with a goal of communicating of useful information to people, then helping them to learn how to use it to build a better life for themselves, their families and their communities (Adams, 1982).

2.1.3. Historical development of agricultural extension
Extension began at an earlier date following the Second World War (Rivera, 1991). Agricultural extension was organized informally in the 19th century in several industrialized countries, at the end of 19th century and its functions became formalized within ministries or departments of agriculture. The first, modern, agricultural advisory and instructional service was established in Ireland during the great potato famine of the mid-nineteenth century (Jones, 1982, Rivera, 1991). Japan was the first country to establish formal policy mandate to a national agricultural extension system, followed in 1914 by the United States (Axin and Thoart, 1972).

The development of Agricultural Extension (AE) organizations in the third world countries, occurred mainly after the Second World War. The introduction of Agricultural Extension organizations in Africa started in the 1960s and 1970s (Swanson and Rassi, 1981). In most third world countries, the introduction of general agricultural extension organizations was brought about by technical assistance, particularly from the United States.

There are differences in the historical and technological context of agricultural extension in developed and developing countries (Baxter, Slade and Howell, 1989).

2.1.4. Target groups for Agricultural extension:
Rolling (1990) raised the issue of targeting extension offerings, and argued that the introduction and use of target categories in extension automatically implies a concern for adapting the offering to different target groups. Re-targeting extension to reach different target groups specially the poor is a new approach of agricultural extension. In this approach the role of extension is not only to deliver technology but also to develop human resources and to empower people to exercise effective demand for appropriate services. This function includes mobilization, organization, training and system management, in addition to transfer of technical innovation (Roling and Jiggins, 1993, Oakely and Garforth; 1985 Hunter, 1980).

2.1.5. Importance of agricultural extension in agricultural development

Development of agriculture is an integral part of economic development. It also has a direct and beneficial effect on the overall economic development. If development is to take place and become self-sustaining, it will have to start in rural areas in general and the agricultural sector in particular (Todaro, 1977).
Agricultural extension is an essential component in the agricultural development process. Extension enable farmers to, adopt new production technologies successfully and use support services to increase production (Swanson, 1984).

People have a wide range of views about the relative value of agricultural extension. In different situations it has been organized in different ways to pursue different objectives. However agricultural extension has been criticized because it has neglected certain categories of agricultural producers, such as women and small farmers (Swanson and Claar 1981).

Maunder (1973) included an even broader role of inter-institutional relationships. "Agricultural extension services are established for the purpose of changing the knowledge, skills, practices and attitudes of masses of rural people. Schools, health services, regulatory agencies, churches, buyers of agricultural products, suppliers of production requisites and many other institutions and services are also involved in activities affecting rural people. It is the function of extension service organizations not only to establish a system of harmonious internal relationships, but also to establish complementary rather than competitive relationships with all other institutions, services and organizations contributing to progress in the rural community.

2.1.6. The extension services in the Sudan
Extension service started in Sudan in 1958 with an agreement between the government of the Sudan and the United States of America. The Sudan government agreed that the Agency for International Development (AID) sends a mission to the Sudan to help the country with its many and varied agricultural problems. In 1958 a program of U.S. economic and technical assistance to Sudan under the Mutual Security Act was established.

The extension program was among the early efforts of the mission where the Department of Agriculture was provided with technicians who worked in close collaboration with the Sudanese counterparts Noah (unpublished).

The first provisional extension unit was established in the second half of 1958 at Maridi in the Southern part of the country. Operation and the extension activities during those early stages were limited to the district level (Abdel Rahman et al., 1972). It is argued that extension system not being originally a national demand is viewed for a long time as a strange activity and was placed as the bottom of the government agents for a long time. The major consequences of such situation that extension system remained as lower priority ineffective delivery system (Ahmed, 1994).
The Extension Division during those early years was part of the Agricultural Education Department of the Ministry of Agriculture and Forestry.

In 1968, the Education Department separated into two divisions, one for extension and the other for agricultural education.

In 1974, the Agricultural Department changed to Agricultural Extension and Education Department. Later in 1975 it had become Agricultural Education in the Ministry of Higher Education (Barghouti, 1976; Abdelrahman, 1972; Federal Agricultural Extension Administration, 1994). In the early eighties the extension services witnessed the introduction of the extension component oriented projects at different parts of the country, sponsored by international organizations. In 1991 the name of Agricultural Extension Administration was changed to Federal Administration of Agricultural Extension and Information. As a result different roles and responsibilities were declared including:

- The coordination with different organizations and corporations in order to develop suitable extension methods to be implemented in different agricultural areas.

- The provision of technical assistance, training and evaluation.
- Integration with agricultural research corporation in order to
develop the technical packages and follow-up their
implementation.

In 1996, the restructuring of the Federal Ministry of Agriculture and
Forestry resulted in the retention of the Federal Administration of
Agricultural Extension and Information and the expansion of its functions
to include staff training under the name of the Federal Extension and
Training Administration. At present the Federal Extension and Training
Administration is entrusted with technical support and training of
extension workers and other staff members of the Federal and 26 States
Ministries of Agriculture (Mohamed, 2001).

2.1.7. Philosophy of Sudanese extension services

The extension philosophy in Sudan springs from the conviction of
the Sudan government to bring about desirable changes in its rural
population to attain a better standard of living, especially among the
farmers. Its major function is to carry out the application of science in the
fields of agriculture and to provide rural people with scientific knowledge
and research findings. Additionally, it provides a channel through which
practical problems important to rural people are transmitted to research
institutions for solution.

This genuine and very realistic philosophy is, however, incomplete
and is strongly criticized because it has neglected agricultural workers in
non-farming communities such as the personnel in the agrochemical factories and stores. Also it has neglected people residing in the rural areas and who may probably be affected by the agricultural activities. This is because much of the extension activities are directed towards agricultural production and does not pay much attention to the necessary coordination with other people working or living in the areas where production is practiced. Coordination in these situations is very vital as it enables the concerned parties to work together, add to each other's achievements and make their work cost-effective (Bannaga, 1984).

Co-ordination means the synchronization of efforts and the related integration of tasks to achieve unity of efforts. It is also defined as the process of timing activities and re-uniting sub-divideded work, by combining consistent and harmonious action activities (Dugdale, 1964). James et al. (1984) defined co-ordination as the process of linking the activities of the various departments of the organization. Objectives and activities of different organizations change with changing problems and needs and must be restated and redefined from time to time. Governments departments almost always have numerous objectives, usually competing with one another and at times conflicting. However the efforts of workers specializing in various tasks must be effectively interrelated. This is accomplished by defining each job and by
grouping workers doing related tasks under the same boss and groups of workers performing related tasks under a common boss. In coordination there must be clearly established channels of communication. Someone must have authority to give direction to resolve differences among individuals working on related tasks. Communication within the organizations and between organizations is an important means for coordinating the work of separate departments, each of these communicators has a message, an idea, or information to transmit to someone or some group. Communicators in an organizations can be managers, supervisors, subordinates (Carson and Harris, 1963, Donnelly et al., 1990).

2.1.8. Institutional relation and coordination of the agricultural extension and other related services

Although most rural development organizations including agricultural extension, have many related and similar functions very few of them are coordinating their work in practice. In the case of the agricultural extension organizations the relationship with the other organizations is very weak if not lacking altogether. Where such coordination exists, this depends generally on individual and personnel efforts and cooperation (Mohamed 2001). In order to function efficiently, according to Bannaga (1990) "agricultural extension has to cooperate and coordinate with other agricultural and non-agicultural departments such as research, industry,
irrigation, trade, education, health, investment, urban development department, social welfare, local government and youth organizations. Therefore, an urgent need to promote such relationships between Agricultural Extension and the other specialized and technical departments is highly needed. In order to meet this requirement, the name of Agricultural Extension was changed in 1991 to the Federal Administration of Agricultural Extension and Information and was mandated to develop suitable extension methods to be implemented in different agricultural areas in collaboration with other related institutions”.

In spite of the fact that the above decision was taken over 20 years ago, reluctance to coordinate is still persistent because that managers, researchers and extension workers actively resist coordinating their activities. They perceive that coordination limits their autonomy. They are reluctant to spend their time in meetings or to commit their resources for joint activities (Bannaga, 1989).

2.1.9. Agricultural extension and pesticides hazards

Agricultural extension is basically an educational activity. It is mandated to advise and educate in a practical manner (True, 1928; True, 1929; Mander 1973; Farquar, 1962; Oakley and Garforth, 1985). Agricultural workers even those working in the agrochemical industries, pesticide trade, agrochemical stores should be educated in the
knowledge and skills of handling chemicals and their hazards. The education and training related to such area rest with the extension advisors in collaboration with the occupational health supervisors, the primary health workers and the subject matter specialists (SMSs) of the Plant Protection Directorate (PPD).

The agricultural extension officer should therefore cooperate very closely with the occupational health supervisors, the primary health workers, PPD SMSs and teach all workers in the agriculture and related activities specially those with low level of education. His conduct must be clear and honest specially about the hazards of pesticides and the safety precautions. Each worker and/or recipient should be taught and assisted to understand the dangers he is going to face and at the same time, to protect himself and the environment.

The individuals or groups, who handle hazardous chemicals, are at higher risks and they are normally, the first to be affected. This is because they get in contact with very high concentrations of chemicals during loading and off-loading or mixing for spraying or when stacking and retrieving the sacks and containers in stores and shops as well as when inspecting the contents for legal and customs purposes in the sheds and warehouses in the sea ports and the airports.

The implications of all the above will, hopefully, be illustrated and clearly reflected in the results and recommendations of the study. Each
concerned partly could find (including the customs administration, which is sponsoring the Ph.D. student and research programme), lessons, conclusions and recommendations which can be possibly implemented if they are relevant to his mandate and responsibilities.

2.2. Pesticides

2.2.1 General

Pesticides have played a major role in the world's struggle against food shortages and vector-borne diseases. (Cooper, 1990). However, the manner in which these agrochemicals are handled poses significant health risks to manufacturers (production workers) transporters, vendors, farmers and agricultural workers (WHO, 1990, Mawanthi and Kimani, 1993). In addition pesticides are ubiquitous in our bodies and environment as they have been found in the air, river, ground water, fog, soil and in human, animal and plant tissues (Cox, 1993c).

FAO and the United State Environment Protection Agency (U.S.EPA) define a pesticides as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest including vectors of human and animal disease, unwanted species of plants or animals causing harm or otherwise interfering with the production, processing, storage or marketing of food, agricultural commodities, wood and wood products or animals foodstuffs. They may also be administered to animals to control insects or other pests in or on their bodies. (Ecobichon 1993; FAO, 2002).

Most pesticides are chemicals that are used to kill pests. Among these are insecticides, fungicides herbicides, nematicides, rodenticides,
acaricides and molluscicides, which are used to kill, respectively insect pests, fungal diseases, weeds, nematodes, rats and mice, mites and ticks and snail disease vectors. They may also kill other organisms, and most are poisonous to humans (FAO, 1996).

Most active ingredients in pesticides have to be formulated or prepared into the most convenient form for field application. The following inert ingredients are commonly found in formulations, solvent or carrier substances, emulsifier or wetting agent, synergist, antifoaming agents, corrosion inhibitor or stabilizer, and coloring substance. However, these inert ingredients frequently comprise a large part of a commercial pesticide product and their adverse effects are not well known and may exceed those of the active ingredients (WHO, 1990; Meinzingen, 1993).
2.2.2. Pesticide use in the Sudan

The greater bulk of pesticides imported into the Sudan, which is considered as one of the major users in the Middle East and Africa, is utilized for the production of agricultural crops. Such as cotton in the Gezira Scheme which started as early as the 1940s. Beside cotton production, pesticides were used for control of national pests, public health and in the veterinary field (Saad, 1975, Saad, 1991). In Sudan several departments are involved in the importation and utilization of pesticides. They include the Plant Protection Directorate (PPD), Sudan Gezira Board, other agricultural schemes and the Federal Ministry of Health. The annual consumption of pesticides in the Sudan is estimated at 5000 MT which is equivalent to 5% and 10% of the total for Africa and Arab world respectively. Several institutions and organizations had in various ways given their support to Sudan in its efforts to improve and rationalize pesticide use such as FAO, WHO, UNIDO, GTZ, GIFAP .. etc (Kannan et al., 1999).

2.2.3. Pesticides purchasing policy of the PPD

This part highlights pesticides procurement procedures. For many years the PPD imports pesticides separately outside the national tender. However, since 2002 the PPD started to import through the national tender. Before the beginning of each season a meeting in the PPD.HQs. is held chaired by the Director of the PPD and comprises the external stations directors together with the heads of departments including pest control director and operations director. This committee is responsible for
setting up recommendations for the quantities and kinds of pesticides for the next season. The quantities of carry over of pesticides were reviewed also (Dawood, 2003).

Pesticides are usually tendered for by the Sudan Gezira Board (SGB) on behalf of all purchasers. Invited bidders are called to tender for the supply of pesticides for all major corporations and this includes the requirements for Plant Protection Directorate. After the bid deadline the tenders are opened in public and prices are declared (Ministry of Agriculture and SAGA, 1999).

Members of technical committee composed of Agricultural Research Corporation ARC Scientists appointed by the Director General in addition to the heads of the plant protection departments of Sudan Gezira Board (SGB). The committee assesses the bids, and ensures that the products in the tender meet the technical specifications. Samples for analysis are accepted by the Sudanese Standard and Metrology Organization (SSMO). The samples are delivered to the Agricultural Research Corporatiom Laborotary for analysis (Reference samples). The technical recommendations are submitted to the contract sub-committee formed by the SGB which prepares tables of all bids, the term and delivery conditions and their prices (Ibid, 1999).

The results of the analysis of the technical and the contract sub-committees are submitted to the joint committee chaired by the Director of SGB attended by all the corporation managers, the ARC (Technical
committee), PPD and Ministries of Health, Irrigation, Finance and Economic Planning and Bank of Sudan. The meeting submits its recommendations about quantities and values of pesticides to the Ministry of Finance (Ibid, 1999).

The central purchasing committee of the Ministry of Finance normally accepts the decisions and recommendations submitted by the joint committee. Approval of the bid results in the announcement of the award and the confirmation that Bank of Sudan will open the letter of credit following the appropriate procedures of import licenses. The SGB on behalf of the corporations issues a letter of acceptance to the suppliers and sings the contract with them (Ibid, 1999).

The Managing Director Committee is chaired by the Managing Director of SGB and all corporations top management plus, the Director of the ARC and the director of the PPD. This committee reviews and examines the joint committee recommendation and the final approval of quantities and values are submitted by this committee (Ibid, 1999).

Awards are delivered by SGB on behalf of all beneficiaries. Based on this award a contract supported by the letter of guarantee is issued by the Sudan Cotton Company and Farmers' Bank and Bank of Sudan signed by the purchaser and the bidder. Goods are then delivered and transported to the site (Ibid, 1999).
2.2.4. Transportation of PPD pesticides:

The transport of pesticides from Port Sudan to the PPD headquarters and the other areas is usually done by trucks belonging to the Red Sea Corporation. The transportation process of the chemicals is carried like any other good. No training system no provision of awareness about the hazards of transportation of the dangerous chemicals is offered. As well as safety measures were not followed.

PPD Headquarters receives the pesticides stocks of the Western Region to gether with pesticides of Khartoum State and the reserve stock for other sites and later the stocks are moved to Alsamrab pesticide store.

2.2.5. The PPD storage policy

The PPD had several stores most of them were initially built outside urban areas to avoid people being exposed to dangerous pesticides as well as to minimize hazards of environmental contamination. However many storage sites were in poor conditions and were constructed without international standard specifications. This is considered as one of the contributors to the problem of the accumulation of obsolete pesticides in the country. In its efforts to improve pesticides storage facilities (PPD) built 26 stores in different parts of the country utilizing a Dutch donation of approximately 20 million Sudanese pounds and about three million Guilders (Butrus, 1991). In order to build the
store properly each site was made to consist of a pesticide store, pesticide
bait mixing and handling shed, fuel and gas cylinder store, emergency
shower and toilet, security fence, gate and store keeper’s office.

2.2.6. PPD-pesticides stores; historical background:

2.2.6.1. Alwaborat Store:

The first PPD store building which belongs to the Sudan Railway
workshop was located between the River Steamers Department
“Alwaborat” and the old Bahri hospital. Since 1940s, it was devoted to
the storage of the PPD pesticides such as Roger, Sevein, Aldrin, Dieldrin
which are received through the southern gate by train for storage and
distribution for the whole country. This store was surrounded with wire
fence and contained a huge closed room (Gamalon) 30 x 50 m divided
into three parts for the storage of pesticides, wheat for poisons baits and
pesticide equipment and 2 stores 4 offices, water cycle, bathroom and
guardroom. There was a huge water pipe for fire fighting in addition to
the flour for bait mixing. The store’s floor is made of concrete material.
Along the southern border the store was separated from the Blue
Nile by 15 meters strip only. From the western side the store was
surrounded by “Alwaborat” and the houses of the public health workers.
New Khartoum North water station was located at the eastern side of the
store. At the northern side, the store is separated from the residential area
by the waste dumping area. In 1990 the store was abandoned and the
packed pesticides drums were transported to Alsileit store by trucks of the
Army Air Force.
The whole area of the store was given to the general water corporation. No cleaning or decontamination procedures were followed.

2.2.6.2. Alsileit Pesticide Store:

This building belonged to the Mechanical Transport Department (MTD) (the workshop for the trucks maintenance). It was located 12 kilometers away from “Almauna” highway. There is a village one kilometer away on the western side of the store. The store consists of a closed room (Gamalone) 30 x 15 m with an earthy floor, shade and toilet. The storage of pesticides in this store had commenced since 1990. Also large quantities of obsolete pesticides and many poisons baits sacks were kept in it. In 1994 the store was abandoned and the pesticides were moved to Alsamrab store. The closed room was given to the National Service Camp for Training Secondary School students. This decision was faced with the strong objections from the PPD of Khartoum State. No decontamination procedure was done. Two incidents had been reported, namely theft of pesticide stocks which worth 6 million Sudanese pounds and the death of a donkey after eating from the baits sacks.

2.2.6.3. Alkhojalab Store:

This store belonged to the scout camp facing the Nile. It consist of one shack (Kurnuk) for poisons baits preparation for Khartoum State. The
storage of pesticides commenced in 1990. There are large quantities of obsolete pesticides accumulated in the store yard.

2.2.6.4. Alhalfaya Pesticides Store:

This store is located in the northwest part of Alhalfaya town. It is surrounded by productive animal farms along its northern, western and southern borders. The store was rented by the Plant Protection Directorate (PPD) until 1989 and consisted of two rooms. During the flood of 1988 the store was abandoned and the pesticides drums were moved to Alsamrab store. However, leaky drums, torn packages empty containers and contaminated soil were left at the site.

2.2.6.5. Kober Pesticides Store:

This is a one-room store located inside the premises of the PPD of Khartoum State. This house was rented by the PPD Khartoum State since 1991 up to 1998. Small packages for daily uses were kept inside. Also as the case in other stores, no procedures of cleaning or decontamination were followed after removal of the pesticides.

2.2.6.6. Alsamrab Pesticides Store:

Alsamrab pesticides store is located in the Eastern part of Alsamrab residential area. This store which belongs to the PPD it is surrounded by a brick fence and contains a closed ventilated room, 2 rooms used for storage of pesticides belong to Khartoum State latrin,
bath-room and guard's tent. Currently, its completely surrounded by human residence along its Western, Southern and Northern borders and is separated from the houses with a five meters road only. Along the Eastern and Southern Eastern border, there are many forage farms.

Big drums, small pesticides packages plus stocks of obselet pesticides were kept inside the closed room. Quantities of obselet pesticides were left under the bare-sun with numbers of empty containers. Empty pesticides containers which may probably contain obsolete chemicals were corner dumped in a large pit close to the south western fence.
2.2.6.7. Khartoum International Airport Warehouses:

There are two types of stores at Khartoum Airport. Governmental warehouses which include Sudan Airways warehouses, and Customs warehouses and Private warehouses. Pesticides chemicals are kept in the warehouses with other goods before the inspection and clearance process and are transported by the same equipment with food and other goods irrespective of their hazards. The warehouses contents can be classified as fixed contents such as handling equipment, stationaries and others. Temporary contents such as personal effects, chemicals, pharmaceuticals, food-stuffs, seeds and others. The goods are stacked according to the numbers of bills till the clearance agents finish the process of clearance and delivery of the goods to their owners. The staff of the warehouses suffer from heat, noise, dust, unpleasant fumes and contamination of handling equipment. No protective clothes or washing facilities are readily available at the site.

2.2.7. The investment corporation policies:

2.2.7.1. The investment corporation policy for granting stores:

The concerned authority submits the request to the agricultural and services section identified its needs for the storage of certain goods or products. This request is attached to the possession certificate of the needed area. The investment authority according to the investment
regulations grant the customs concession, for the construction of the stores, this customs concession exempt the concerned authority from the customs duties. No special consultation with the National Pesticides Council (NPC) or Health Department is done specially when considering granting permision for storage of dangerous chemicals.

2.2.7.2. The investment corporation policy for granting the license for pesticides stores:

To have a license entails the following steps in sequential basis.

The concerned authority submits the request to the industrial section attached with the feasibility study for establishing a certain industry.

The industrial section transfers the feasibility study to the Ministry of Industry and to the other concerned departments for example the Ministries of Health and Agriculture. According to approvals from these departments, the investment corporation grants the investment license. According to this license the aplicant will be granted the customs and taxes concession.

In the cases of giving license for pesticides factories they claimed that they consult the Ministry of Agriculture but not the (NPC).

2.2.8. The planning of governmental areas:

The general governmental policy in planning urban and semi-urban areas normally calls for separation of industrial, residential and
agricultural areas. The concerned authority organizes the planning of residential areas to comprise the settlement of the coming generations every ten years. However, since the late seventies internal migration resulted in the expansion of urban and semi urban settlements in Khartoum State.

In 1983 an aerial map had been done to demarcate the illegal settlements and the villages in Khartoum State, then the Ministerial committees had been formed and were formalized to deal with the illegal settlement. The Urban Development Directorate was established in 1983 divided into 2 departments. Villages Organization Department and Violate Control Department. The later is responsible for demolishing the illegal buildings. However, the direct responsibility lies in the hands of the local authority. There is poor relationship between the local authority and the planning department in a certain area. Generally the planning department identifies 6 meters between the houses and any other compond such as mosque, hospital, school. The formalization of the villages organization committees in Khartoum North commenced in 1992. No consultation procedure with any concerned department was done during the replanning of any residential area containing dangerous facilities such as pesticides stores. This ignorance of concerned national bodies such as (NPC) resulted in the religalization of the residential area.
of Alsamrab causing it to surround the previously remote and completely well separated modern pesticides store.

2.2.9. Chemical groups of pesticides

Pesticides can be classified by various methods. The most important classification is based on target pest. According to target pest they are classified into insecticides, herbicides, fungicides, rodenticides… etc. Insecticides (insect killers) can be classified into many chemical groups. They include organochlorine (such as DDT cyclodienes @ HCH), organophosphate such as parathion, malathion, Diazmon and others), carbamat (such as Aldicarb, propoxur), pyrethroids (such as allethrin, phenothrin) and many others (Matsumora, 1985; Haskell, 1985 and Fukuto, 1990).

Herbicides such as phenoxy acetic acid, 2-4-D and MCPA were the first selective and safe herbicides. Other herbicides includes Dalapon, Trizines, Atrazine Diquate and Glyphosate (Haskell, 1985).

Fungicides are usually divided into two groups according to the way they are used. Protective fungicides are applied to plants or are incorporated in coatings on surfaces. Examples include Benomyl captan and thiopanatethyl (Matsumura, 1985, Haskell 1985, Fukuto, 1990).

Rodenticides are toxic chemicals used for the control of rats and other pest species of rodents (Cremlyn, 1978).
2.2.10. Toxicity of pesticides

Toxicity is the capacity of pesticide to cause harmful effects and is expressed in numerical terms the most widely accepted index being the LD$_{50}$ which is the median lethal dose needed to kill at least 50% of the test animals. The harmful effects can range from slight symptoms such as headache and nausea to severe ones such as coma, convulsions and even death (Matsumura 1985, Wayland, 1975).

Toxicity is divided into many types, based on the frequency of exposure to a pesticide and the time for toxic symptoms. The most important types of these are the acute and chronic toxicity. The former is due to short-term exposure and symptoms which occurs within a relatively short period of time, the later is due to long-term exposure and its symptoms occur over a longer period. Most toxic effects are reversible and do not cause permanent damage but complete recovery may take long time (Bull 1982, Matsumura 1985).

Various schemes were developed to classify pesticides according to their inherent toxicity e.g. EPA, WHO … etc.

The WHO system classifies pesticides into four categories: class Ia is extremely hazardous, Ib, highly hazardous, II moderately hazardous, and III slightly hazardous (FAO, 1999).
This hazard-based classification enables those handling and using pesticides to take appropriate precautions to minimize exposure. This WHO classification is recommended for use by many countries (Wayland, 1975; Kegley et al., 1997).

### 2.2.11. Factors determining the outcome of pesticides poisoning

Whether or not the absorbed dose will be sufficient to cause death depends on the inherent toxicity of the compound. Extremely toxic pesticides usually pose the smallest LD$_{50}$ values. The LD$_{50}$ should be interpreted cautiously since there is a wide difference in response between different species of organic life (Rather, 1994).

The dosage of the pesticide is another factor which determines to a large extent, the outcome of poisoning. If a large dose has been absorbed, the poisoning would be serious for not only compounds of high toxicity but also to compounds of low toxicity. Another factor determining the outcome of toxicity is the duration of the exposure for many pesticides. The toxic effects observed from a single exposure may be quite different from that of repeated exposure. Many symptoms of repeated exposure are slow to develop and in some instances may mimic symptoms of other chronic disease, making it difficult to differentiate them from symptoms of diseases. The route of exposure is another factor determining the outcome of toxicity. Pesticide exposure may occur through ingestion,
inhalation or through the skin and eyes (GIFAP, 1984, GIFAP, 1988, 1989, Kupchella and Hylan, 1989; Rather 1994).

The dermal route represents the most common way of exposure. The effects seen in the majority of cases are usually confined to the skin with symptoms such as irritation and skin sensitivity. For people dealing with pesticides, care must be taken to avoid pesticide contact with the skin by wearing proper protective clothing (Haskell, 1985; Rather, 1994). Oral route does not present a major occupational hazard but intentional (suicide and homicides) and accidental ingestion happens through this route frequently. If proper personal hygiene is maintained by the workers handling pesticides, the poisoning through oral route can be prevented to a considerable extent. The consumption of contaminated food is indicative of hazards to the general public than pesticide users (Quantic, 1985, Haskell, 1985).

Pesticides can also enter the body through the lung, by breathing (inhilation route). The pesticides volatility and the technique of pesticides application determines the rate and amount entered. The gases or vapours are rapidly absorbed into blood stream. All fumigant are absorbed in this way (Rather, 1994).

2.2.12. Symptom of poisoning
Chlorinated hydrocarbon insecticides are mainly central nervous system poisons, eliciting a variety of Central Nervus System (CNS) symptoms. A number of degenerative alteration are caused by Chlorinated Hydrocarbons insecticides particularly in the liver and the kidney. The number of accidental deaths caused by Chlorinated Hydrocarbons insecticides are far less than that caused by Organophosphates (Matsumura, 1985).

O'Brien (1960) summarized the usual symptoms of Organophosphate poisoning in mammals as defecation, urination, lacrimation, muscular twitching, fibrillation and convulsions. Radeleff (1964) stated that “it is common practice to divide the signs and symptoms of Organophosphate poisoning in both man and animals into muscarinic, nicotinic and central nervous”. Muscarinic effects include nausea and vomiting, abdominal pain, gastrointestinal hypermotility, sweating, increased bronchial secretion, excessive lacrimation and salivation, diarrhea, respiratory difficulty, heart spasms, dyspnea, miosis, bradycardia, and fall in blood pressure. Nicotinic effects include, paralysis of volantry mucles. Twitching or spasms occur in the muscles of the tongue, eyelids, face, followed by weakness diminished or absent tendon reflexes, rise in blood pressure and paralysis.
Central nervous system effects are due to direct action on its elements. Symptoms may include headache, irritability giddiness, tension, restlessness apprehension, foreboding, ataxia, deep general tremor, drowsiness, mental confusion, fever, convulsions, loss of reflexes, flaccid paralysis and heart block and arrest coma (Matsumura, 1985).

Symptoms of poisoning by carbamate insecticides are rather similar to those caused by Organophosphates. The major ones are related to the accumulation of acetylcholine. Symptoms include diarrhea and vomiting, tremors, convulsive seizures of muscles, hyper salivation, excessive sweating and blurred vision (Haskell 1985).

Signs of pyrethroid poisoning include tremor, paraesthesia on areas of exposed skin, especially on the fore-arm face and neck.

In the case of poisoning by antico-agulant rodenticides, the blood will not clot as easy brusing and prolonged bleeding from minor injuries (Haskell, 1985).

2.2.13. Immunotoxicity of pesticides

Clinical and epidemiological studies of humans who are occupationally or accidentally exposed to pesticides provide direct evidence that normal immune system structure and functions are thereby altered.
Experimental evidence based on in vitro and in vivo models suggests that Organochlorines, Organophosphorus, carbamates and metallic pesticides are immunotoxic. Studies in the wild fish, birds and mammals exposed to pesticides through their food provide evidence that these compounds are immunosuppressers (Repetto and Baliga, 1996).

2.2.14. Long term effects of pesticides

2.2.14.1. Effects on reproduction

Exposure to pesticides could induce birth defects if female agricultural workers are exposed to a pesticide that may have deleterious effects on their health fertility and pregnancy outcomes. Also urban women can be exposed to pesticide residues in their drinking water and food. Many pesticides can pass from mother to unborn child through the placenta potentially leading to birth defects and fatal death (Brown and El Hinnawie, 1988; Zhang et al., 1992; Antaniyazovao, 1995; Repetto and Baliga, 1996 and Alli, 1999).

Taha et al. (1994) examined the risk factors for perinatal mortality among a population of women delivering at Wad Medani Hospital in Gezira Province and Sennar Hospital in Blue Nile Province, Central Sudan in 1989 and 1990 and among population using a community midwife for delivery. There were 5098 live births and 230 still births registered in the hospitals during the study period. The still birth rate was
estimated at 43.2/1000 live births. During prior of 4 years the stillbirth rate was estimated as 52/1000. The study attributed the rate of still births in hospitals to pesticide exposure. Among the other factors the study recommended avoidance of contact with pesticides during pregnancy.

Between 1989 and 1990 a doctoral student used hospital-based and community-based cases and controls at Wad Medani and Sennar hospitals and surrounding communities in the Gezira and Blue Nile provinces to examine risk factors of low birth weight and prenatal mortality and to determine the effect of malaria and extensive pesticide use on reproductive outcomes. He reported that exposure to pesticides increased the risk of fetal death among both the hospital - and community - based populations (Taha, 1992).

There have been some human studies which have demonstrated likely associations between exposure to toxic substances such as pesticides and impaired reproduction in men. Pesticides may reduce male fertility by their influence on spermatogenesis (Nieschlage and Schurmeyert, 1984, Rosenberg, 1993, Tageldin and Alrajihi, 1998; Sinclair, 2000).
2.2.14.2. Pesticides and mutagenicity, teratogenicity and carcinogenicity

Groups of male rats were treated with dimethoate, dichlorvos and parathion-methyl. The frequency of cells revealing aberrations as well as numeric and structural aberrations were evaluated. Both dimethoate and dichlorvos demonstrated mutagenic effects but not parathion-methyl at the used insecticide doses (Nehez et al. 1994).

According to Mueller, 1992 studies indicated that Dichlorvos was mutagenic and might be carcinogenic, neurotoxic and teratogenic.

The mutagenic potential of chlorpyrifos (Durmet) was studied in the *Drosophila* wing. Larvae of the 2<sup>nd</sup> and 3<sup>rd</sup> instar carrying suitable recessive genetic markers on chromosome 3 were exposed to different concentrations of the insecticide and the frequency of induction of mutant on the wing was noted. The study showed that chlorpyrifos is genotoxic in somatic cells as well as germ cells of *Drosophila* (Patnaik et al., 1992).

Researchers at the U.S. National Cancer Institute (NCI) have concluded that exposure to pesticides has been associated with cancers of the lymphatic and hematopoietic system and brain (Repetto and Baliga, 1996).

Miral 500cc (an Organophosphorus compound) mutagenic and genotoxic activities were evaluated. The results indicated that Miral is
mutagenic in salmonella and capable of inducing chromosome aberrations at high doses in mice (Sierra et al., 1998).

Soliman et al. (1997) conducted a pilot study to describe serum Organochlorine levels among 31 Egyptian colorectal patients and 17 controls. High levels and large inter-individual variability of P, P-DDE, DDT, beta-HCH and BHC levels were found among most subjects, especially those from rural areas. Farming and aging were each associated positively with high serum Organochlorines level. Colorectal cancer patients had higher serum Organochlorines levels than controls. The high level of Organochlorine reported and their relation to age, residence, occupation and disease status justify further study of possible association between Organochlorines pesticides and colorectal cancer in a large population in Egypt.

An incident was recounted during the current survey in the PPD.HQs.story mentioned by some employees tells that one of the labourers who work for a long time as a pesticide equipment maintenance labourer who didn't follow personal cleaning before urinating had died. The medical investigation revealed that there was a huge tumor around the colon and the rectum (cancer) (see the medical report, Ibn Sina Hospital, Appendix 19).

2.2.15. Environmental fate of pesticides
Environmental fate is concerned with how and where a pesticide enters the environment. How long it lasts and it goes. Two processes normally determine the fate viz; movement and alteration. Alteration may be activation or deactivation or degradation. Pesticides degrade into a variety of other substances as a result of interactions with soil microbes, water, sunlight, oxygen, temperature soil or water pH, and the moisture content of the surrounding medium. Certain pesticides such as Organochlorines, are particularly resistant to degradation and can survive unchanged in sediments and soils for decades. (Alexander, 1965, Kiigemayi et al., 1958, Spencer and Claiath, 1969, Barbash and Resek, 1996).

2.2.15.1. Movement of pesticides in the environment:

Movement occurs for long or short distances by various ways. Once a pesticide is released into the environment it can be transported to different locations in different ways (Kegley et al. 1997).

2.2.15.1.1. Movement by the air

The droplets of pesticide sprays and small particles from pesticide dusts can travel with prevailing wind and sometimes for many miles. A recent review of studies on spray drift from aerial and ground
applications indicates that an average of 80% of the applied pesticide typically does not hit the target application site, and as much as 20% drift away from the site occurs. Additionally, many pesticides evaporate particularly at warmer temperature and these volatilized pesticides move with wind currents into nearby areas (Bennett, 1992). In another study it was reported that only 0.01% of the applied dose hit the target pest while the rest (99.99%) goes as contaminants to the environment. This later figure is even higher in case of aerial spraying frost land (Primental and Levifan, 1986).

Horizontal and vertical movement of some Organochlorines insecticides in Gurashi pesticide store was studied by Babiker (1998). Air-borne pesticides can be deposited back on land as rain washes them out of the air and into surface waters and ground water. For example diazinon, had been found in rain water at concentrations high enough to exceed the toxic dose for sensitive aquatic insects (Connor, 1998).

2.2.15.1.2. Transportation through the food chain:

Fish, marine mammals, and birds carry pesticides long distances where they can be eaten by human or other animals (Connor, 1998). Most Organochlorins insecticides are known to accumulate along the food chain (Wayland, 1975; Haskell, 1985).

2.2.15.1.3. Movement by water
Water is one of the major means of transporting various substances from one place to another in the environment. The amount of pesticide that washes into the receiving water depends on a number of factors including the amount identity and properties of the pesticide, water solubility of the pesticide and other factors. Some pesticide stick tightly to soils and are transported only via sediments. Others dissolve readily in water and travel into streams and rivers (Bergamaschi et al., 1997). In Sudan movement of some Organochlorines insecticides from the Gurashi pesticide store into surface water and soil was studied by Babiker (1998).

2.2.16. Pesticide residues in food and environmental samples

2.2.16.1. Residues in food

Residues monitoring data on human food and environmental samples gained an increased concern in recent years. A lot of work has been done to determine pesticide residues in the environment to minimize the risk from pesticide usage or to eliminate them. Pesticide residues can enter food as a result of illegitimate use as in the case of using pesticides to catch fish. Also food can be contaminated with pesticides during transport or storage (Bull 1982). When pesticides are used excessively illadvisely or close harvest, the residue may exceed the accepted limits and possibly hazardous to health (Bull, 1982; Kegley et al., 1997).
Reis *et al.* (1991) investigated the presence of Dithiocarbamate residues on vegetables and fruit marketed in the state of Reode Janeiro. He found residues in 63% of 466 samples studied with levels exceeding the legal limit in 24% of the samples. Lettuce and parsley had residue level of 50% above the legally allowed followed by carrots (47.4%) and tomatoes (38.2%). Sweet potatoes and turnips showed no residues.

Torres *et al.* (1997) analyzed 200 citrus samples from market of Valencia for 12 Organophosphorus pesticide residues. A total of 32.25% contained pesticide residues and 6.9% exceeded the European Union Maximum Residue Levels (MRLS). Three hundred and fifty five samples of cow milk were collected from the central region of Veracruz State in Mexico and 448 samples of butter brands was analyzed to determine the contamination levels with Organochlorine pesticides. The results obtained indicated the presence of HCH residue at 0.094 and 0.093 mg/kg on fat basis in cow's milk and butter samples respectively. The mean DDT levels were 0.159 and 0.049 mg/kg respectively. In Mexico pesticides are still used for sanitary action. This results indicate the possibility of human exposure through consumption of these products (*Waliszewski et al.* 1997).

A survey was conducted to monitor Organochlorine pesticides and their metabolite residues in milk available in local Hong Kong markets.
Two hundreds and fifty two samples were analyzed, 42 contained Organochlorine residues at levels exceeding the extraneous maximum residue limits of the Codex committee on pesticide residues. DDE and HCH isomer were detected, although Organochlorine pesticides such as DDT and HCH have been banned in China since 1983. Residues of such compound may still persist in the environment and cause contamination through food chain (Wong and Lee, 1997).

Altahir (1979) studied some Organochlorine pesticides residues in vegetables in Wad Medani market. He found that all samples contains pesticides residues. Abdalla (1980) detected Endosulfan residues (1.4 - 1.8 mgkg) on the surface of tomato fruits. Also Abdalla (1980) investigated the residues of Endosulfan in tomato fruits from five commonly cultivated varieties.

Temic (Aldicarb) residues were detected in leaves of the egg plant (16.15ppm)(Butrous and Mohamed, 1986). The residues of Disulfoton were investigated in tomato fruits grown in treated and control soils, in Khartoum province (Dahab, 1988).

Elzorgani (1976) studied the residues of Organochlorines insecticides in some fishes and birds in the Gezira of the Sudan. He reported that all fish muscle samples were found to contain p.p.DDE, p,p-TDE and p,p-DDT with total concentration ranged from 0.27 to 16.0
Abbadi (unpublished) made a survey on cottonseed, cottonseed cakes and crude cottonseed oil. He reported that in all commodities residues had not exceeded 4 ppm. The lowest value in the purified oil was 0.04 - 1.00 ppm. Elzurgani and Ali (1981) reported that all fish tissue samples collected from different areas in Sudan contain DDT residues. The concentration of DDT residues in the muscle and liver of fish ranged between 0.04 to 0.2 ppm. Fat samples contained higher residue levels which ranged from 0.30 to 3.3 ppm.

Abbadi (1974) reported that all cow milk samples collected in different areas in Gezira (Sudan) contain residues of DDT, DDE and DDD. The mean values for total DDT residue was 0.23 ppm which exceeded the acceptable limit for total DDT in cows milk.

Eltom (1997) carried out analysis of 50 samples of cow milk from Fadasi village near Medani town, Sudan. Results showed 0.12 ppm of HCH, 0.01 ppm of Aldrin, 1.28 ppm of heptachlorepoxide and 1.75 of DDE.

2.2.16.2. Residues in soil and water:

Agnihotri (1996) determined Organochlorine residues in soils from agricultural fields in north India. Results indicated the presence of HCH and DDT residues in all samples. Residues of aldrin and endosulfan were detected in a large number of samples. Few heptachlor residues were
detected. Alpha HCH p,p-DDT and alpha endosulfan dominated over the other isomers or metaolites of HCH, DDT and endosulfan respectively. Dorfler et al. (1997) determined the occurrence of pesticides and other chemicals in ground water samples from the United States. Atrazine concentrations reached levels up to 10 micro grams/l. The result showed that the herbicide atrazine is among the pesticides most frequently detected in ground water. Atrazine, ametryn, bromacil, simazine and norflurazion were the most frequently detected pesticides in surface water samples and DDE, DDD and ametryn were the most frequently detected pesticides in sediment. Samples were collected in a monitoring work that includes 27 stations in south Florida canals. The maximum atrazine detection occurred in winter to late spring. Endosulfan residues were occasionally observed in surface water in Homestead area and most of them exceeded those occurred in confined water (Miles and Puffer, 1997).

Abbadi and Elzurgani (1981) reported residues of DDT in Gezira soils as 0.26 mg kg⁻¹ in cotton soil 0.24 mg kg⁻¹ in wheat soil and 0.22 mg kg⁻¹ in follow soil. Endosulfan residues were found as 1.0 mg kg⁻¹ in soil samples three weeks after application(Elzurgani, et al., 1979). Bala (1984) made an assessment of pesticide residues in soil, canal water and the underground water in some villages of the Gezira (Sudan). He
reported the presence of p.p-DDT, p.p-DDE-, p.p-DDD and endosulfan in all samples. Algadi (1992) detected DDT residues in the dumping pit in Hasahisa. The lowest detected amount of DDT residues and its metabolites was 32 ppm of p.p DDE while the highest detected amount was 605 ppm of the metabolite p.p DDE in soil samples. Small levels of DDT were detected in large number of soil samples.

Elmahi (1996) and Abdelbagi et al., (2000, 2003) detected measurable levels of DDT, γ HCH, Aldrin, Dieldrine, Heptachlor epoxide in 100 soil samples collected from different parts of the Sudan representing areas of intensive and limited pesticide use.

Babiker (1998) investigated level and movements of some Organochlorines insecticides in Gurashi pesticide store in Hasahisa town. Thirty two samples were collected from different sites inside and outside the dumping pit. Water samples collected from four drinking water wells and two pools around the area. His results showed the presence of endosulfan (α and β), γ HCH, heptachlor, DDD, nitrofen and 2,4 dichlorophenol residues moving at various rates from the dumping site.

Mohamed (1999) investigated the level of total mercury in pesticide store and some food factories in Hasahisa town. A total of twenty six samples were collected from different suspected contaminated sites with Phenyl Myrcury Acetate (PMA). The results indicated an elevated mercury level
in all samples analysed. The highest level of contamination was found in soil of the pesticide store (51 ppm), followed by the two food factories (24 ppm and 19 ppm), stock of redundant cottonseeds (15 ppm) and cotton field (14 ppm).

2.2.16.3. Residues in human samples

2.2.16.3.1. Residues in human milk

Dwarka et al., (1995) analyzed 193 samples of human milk in UK. They found residues of some Organochlorine insecticides in some of the samples. Burnetto et al (1996) detected residues of DDT in human milk samples from 145 women in Venezuela. The concentrations of DDT ranged from 5.1 to 68.3 g/litre. They found that DDT concentrations increased with maternal age. Organochlorine pesticides and polychlorinated biphenyls (PCBS) were detected in samples of breast milk taken from 92 donors in southern Kazakhstan. (Hooper et al., 1997).

Over 147 samples of human milk were collected from lactating mothers during 1994 in central Sudan, all samples were found to contain DDT residues predominantly in the form of DDE. Levels ranged from 0.008 to 71.83 part per billion (PPb)(Mohamed, 1995).

Eltom (1997) studied Organochlorines. Insecticide residues in human milk collected from 50 lactating mothers from Fadasi clinical
Organochlorines residues were detected in human adipose tissue samples collected from Kyungnam in Korea. No significant difference between sexes was found in the residue levels of polychlorinated dibenzo p. dioxin and dibenzofurans (PCDDS/DDFS) (Kang et al., 1997).

Pauwels et al (2000) performed a study to determine and compare persistent organic pollutant (POP) levels in different matrices in a female population. A total of 96 serum tissue and 46 adipose tissue samples were collected from infertile women. The result showed a strange association between adipose tissue and serum residues.

2.2.16.3.3. Residues in human blood

Elzurgani and Musa (1976) monitored the residues of Organochlorines in human blood of some occupationally exposed personnel of the Gezira Research Farm, Wad Medani, Sudan. They found DDE and p, p-DDT in all samples with concentration range of 0.01 - 0.12 mg/ml for DDE and 0.02 - 1.01 mg/ml for p,p, DDT Dieldrin was less frequent and at concentration not exceeding 0.01 mg/ml in most cases.
One hundred ninety five human blood samples were collected from different locations, representing residents in areas of limited and intensive pesticide use in the Sudan. The collected samples were analyzed for Organochlorines residue. DDT inform of DDE, heptachlorepoxide, HCH and Dieldrin were detected in all locations. Aldrin was not detected in all samples. The results revealed that blood levels of tested Organochlorines pesticides decreases with increasing distance from irrigated cotton schemes where huge amount of these pesticides was used. The highest concentration of DDT, heptachlore poxide, HCH and dildrin were observed in blood samples collected from Medani, Hasahessa and Kenana respectively (Elbashir, 1998).

Exposure to cholinergic pesticides among neighbours and workers of pesticide stores as well as mosquito control workers in Khartoum state was investigated by monitoring the whole blood acetylcholinestrase (Ache) activity. The results revealed that all blood samples of Alsamrab pesticide store neighbours and neighbours of pesticide containers dump pit had a depressed Ache level. Results of blood enzyme activity of pesticide stores and mosquito control workers, indicated that all blood donors had a depressed Ache after loading and unloading and spray operations (Mukhtar, 1999).

2.2.17. Disadvantages of pesticides use:
2.2.17.1. Environmental pollution:
This included residues in food and environmental samples discussed earlier.

2.2.17.2. Side effects of pesticides on beneficial non-target organisms

(Arthropodes + microorganisms):

Many pesticides such as Organophosphorus carbamates and Organochlorine destroy both pest and beneficial organisms, indiscriminately and therefore upsetting the balance between pests and natural enemies (Quarles, 1998). Beneficial organisms include pollinators, natural enemies, earth worm and soil microorganisms.

Many pesticides are acutely toxic to bees for example, exposure of honey bees to as little as 0.00000002 grams of pyrethrin per bee causes death. (Buchmann, Nabban, 1996). Insecticides affects beneficial predators either by killing them directly or by disrupting the food chain and reducing their food supply. Pesticides also deplete populations of earth worms and soil microorganisms (Kegley et al., 1997). The effect of BT (Bacillus thuringiensis var kurstaki) spray, applied in 1997 on the non-target butterfly was investigated in a 32.4 ha. Area in USA. Butterfly diversity, species richness and density all showed similar reduction in numbers in the year following the BT spray (Severns 2002).
Population of onion thrips, *Thrips tabaci*, and its natural enemies was monitored in small field plots of onions to which standard insecticide (methamidophos, endosulfan and chlorpyriphos), selective insecticides, and an organic insecticide were applied. Natural enemies were observed in the unsprayed and organic treatments. None of these natural enemies increased sufficiently to provide effective thrips control. No natural enemies were found in the standard or selective insecticide treated plots. (Workman *et al.*, 2002).

Suganthy *et al.* (2002) conducted a study on soil inhabiting and above ground natural enemy fauna of the grain pod borer, *Helicoverpa armigera*, in a chick pea ecosystem in India during the 1998-99 post rainy season. Treatments included a control, 0.006% neem extracts, *Helicoverpa armigera* nuclear polyhedrosis virus (HANPV), 0.07% endosulfan 35 EC, establishment of bird perches at 1 perch per plot, and a combination of these treatments (integrated pest management, IPM). The treatments were applied 5 times at 15-20 day intervals. The overall effect of the 5 sprays revealed that endosulfan was found to affect ground dwelling natural enemies severely, resulting in 40% reduction in natural enemy population compared to the control followed by neem spray (with 8% reduction) and IPM plots where the observed reduction was 7%. In
general endosulfan resulted in the highest percentage of natural enemy reduction (45%) over control.

2.2.17.3. Toxicity to human and domestic animals:

Pesticides are an important class of toxicants capable of producing adverse effects upon man, animal and the environment (Chichester, 1965). Malathion is one of the safest of the Organophosphorus insecticides, however human poisonings still occur (Namab and Hiraki, 1970). In Japan population (99 millions) there were 63 poisoning cases resulting in ten deaths from occupational or accidental handling and 480 poisonings, including 404 deaths from suicidal during 1957-1961 and 1965-1966 (Anonymous, 1967). In Iraq imported wheat and barley seeds intended for sowing had been treated with methyl mercury fungicide. The warning labels in sacks were in English or Spanish and rural families ate the seeds and fed to their livestock. Officially over 6000 people were poisoned and nearly 500 killed (Bull, 1982; Bakir, 1973). There have also been several cases of poisoning from eating pesticide-contaminated wheat in India at a wedding party where about 150 people died (Bahat, 1981; Sharma, 1990).

2.2.17.4. Resistance of treated pests:

Most major pests and vectors will eventually develop resistance to most insecticides if they continue to be used against them. Such
resistance may be due to the insect not being affected by the insecticide itself, or it is behavioural pattern effectively isolating it from sites which have received the insecticide.

Example of resistance among insects in the USA and in the tropics regions. Codling moth in America, mosquitoes and flies in the tropics the red spider mites on fruit trees and in glass houses in Britain. In 1965 the Food Agriculture Organization of the United Nations listed 195 resistant species of arthropod pests. In 1980 this rose to 392 species. In California resistance of white fly on cotton was noted after repeated sprayings with organophosphorus and pyrethroids insecticides. The result was a 43% increase in the cost of cotton production. Resistance in black aphids on cotton in the central valley resulted in 2000% increase in applied chloropyrifos between 1991 and 1995. On grapes, application of carbaryl led to increased populations of the pacific mite. In citrus, organochlorine and organophosphorus pesticides rise citrus red mite from minor or non-pest status to the most important citrus pest in California (Martin, 1963; Youdeowei and Service, 1983; DeBach and Rosen, 1991).

2.2.17.5. Emergence of secondary pests:

Cotton growing in the Gezira started experimentally in 1911 by pumps, then the area increased significantly in 1925 when Sinnar Dam was completed. All the cotton pests which are treated by chemicals at
present were known since the first start of cotton growing. The species *H. armigera, B. tabaci, E. Lypica* and *A. gossypii* were all recorded since the early thirties. Chemical control however started only at the end of the forties against the cotton jassid (1949-1950), the chemical used was DDT. In the late fifties the white fly due to the use of DDT and later endrin, attained the status of a primary pest and additional spraying was added to control it with jassid and the number of sprays increased to control the two pests. In season 1964/1965 *H. armigra* was very serious and received the first application of pesticides in this season and since this year it has been one of the major pests which necessitate regular spraying every season and the number of sprays in the Gezira reached five sprays. Due also to the continuous chemical spraying in the late sixties, *A. gossypii* became a serious problem affecting also the quality of the lint due to its contamination by honey-due causing the known lint stickness. Additional two sprays were recommended in 1970 to reduce the lint stickness and the number of sprays in the Gezira reached seven sprays. All the above mentioned pests were created by the application of insecticides which promoted these secondary pests to the status of primary pests. The only key pest in the Gezira is the cotton Jassid, all other pest are man-made through the continuous application of chemicals (Abdelrahman, 2003).

2.3. Work environment and health:

*Stores as occupational environment may be risky to health in some way or another. Occupational hazards are classified as chemical, physical and biological. Their possible action on health occurs, when workers are exposed*
to them. Physical hazards arrised when working under noise, heat or cold and light problems (Clayton and Clayton, 1979).

The work environment should not in any way, affect the health of the employees. According to the WHO definition “health is the state of complete physical mental and social well-being and not merely the absence of disease infirmity” (Jeyaratnam, 1991). The ILO/WHO definition of occupational health is “the promotion and maintenance of the highest degree to physical mental and social well-being of workers in all occupations”. The WHO considers occupational health services to be responsible for the total health of the worker and if possible, his or her family (Jeyaratnam, 1991).
CHAPTER THREE

RESEARCH METHODOLOGY

3.1. The study area

3.1.1. Alsamrab residential area

Alsamrab residential area is located 11.5 kilometers north of Khartoum, east of Al Halfaya Town. Administratively, it is part of sharg Elneel commission, it is located seven kilometers east of Khartoum-Atbara highway.

As a result of migration during drought periods since the seventies, Alsamrab population increased and has transformed from a rural society dominated by northern tribes, to a semi-urban society inhabited by the western tribes who occupy 250 faddans which is divided into two parts eastern and western with five distinct quarters.

Alsamrab pesticide store has been located in the eastern part and is completely surrounded by human residents along its western, southern and northern boarders and separated from the houses with a five meter road only. Along the eastern and south eastern border, there are many forage farms (Fig. 1 and plates 1 and 2).
3.1.2. The plant protection directorate:

The Plant Protection Directorate Headquarters (PPD.HQs) is located in the industrial area in Khartoum North. Between 15° 38” 11.7” north Latitude and 32°, 32”, 55.5” east longitude. The PPD.HQs was established in 1963. It is surrounded by Alrobi Accumulator Co. LTD along its northern side and the Desert Locust Control Organization for eastern Africa (DLCO) along the southern side.

The PPD.HQs has been for more than four decades the main depot for long term and temporary storage for pesticides purchased by the PPD.HQs, the PPD HQs contains two pesticides stores (the large store and Alistedama Corporation Stores).

3.1.2.1. The large store:

A large closed room (Gamalon) is located in the western part of the PPD HQs (Fig. 2) devoted for storage of pesticide chemicals and equipment. This storage site was not initially constructed for storing pesticides. PPD staff suffer inside the store from high temperature, unpleasant smells inadequate light and dust. Pesticides sacks and small pesticides packages were stacked on the floor of the store. Normally pesticide stocks are kept within the PPD HQs enclosure before distribution to other sites.
Fig. 2
Plate 1. Alsamrab pesticide store is surrounded by human resident

Plate 2. Obsolete pesticide stored within the enclosure of the store
3.1.2.2. Alistedama stores:

Alistedama corporation store former Sudanese-German integrated services for Vegetable and Fruit Farmers (SVFF) is located in the southern part of the PPD H.Q. within the enclosure of the PPD workshop. It consists of two small-ventilated rooms. The store was established in 1986 surrounded by Alhamamateen Oil & Soap Factories along its southern border. Along the eastern border the store is surrounded by the Arab Oil Corporation. Small pesticides packages were kept in shelves inside the closed room plus big drums were left directly on the store’s floor (Fig. 3) the amount of pesticide stored in this store were summarized in Table (3).

There are many categories of personnel working in the PPD H.Q. including subject matter specialists, agriculturists, store keepers, technicians general labourers and cleaning labourers, guards, workshop workers, safety officers, accountants and drivers.
Table (3): Pesticides currently stored in Alistedama Agricultural Corporation Stores (2002):

<table>
<thead>
<tr>
<th>Pesticides</th>
<th>Quantity</th>
<th>Year (in)</th>
<th>Outgoing quantities</th>
<th>Remainant</th>
<th>Year (out)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kgs</td>
<td>Lts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decies</td>
<td>-</td>
<td>4226</td>
<td>1996</td>
<td>4226</td>
<td>-</td>
</tr>
<tr>
<td>Sevin</td>
<td>3025</td>
<td>-</td>
<td>1997</td>
<td>3025</td>
<td>-</td>
</tr>
<tr>
<td>Folimat</td>
<td>-</td>
<td>3000</td>
<td>1997</td>
<td>3000</td>
<td>-</td>
</tr>
<tr>
<td>Malathion 57%</td>
<td>-</td>
<td>245</td>
<td>1997</td>
<td>245</td>
<td>-</td>
</tr>
<tr>
<td>Bayleton</td>
<td>3000</td>
<td>-</td>
<td>1997</td>
<td>3000</td>
<td>-</td>
</tr>
<tr>
<td>Benlate</td>
<td>1277</td>
<td>-</td>
<td>1999</td>
<td>1277</td>
<td>-</td>
</tr>
<tr>
<td>Folimat E.C</td>
<td>-</td>
<td>4000</td>
<td>1999</td>
<td>1679</td>
<td>2321</td>
</tr>
<tr>
<td>Desies 25%</td>
<td>-</td>
<td>2400</td>
<td>1999</td>
<td>515</td>
<td>1489</td>
</tr>
<tr>
<td>Malathion 57%</td>
<td>2000</td>
<td>-</td>
<td>1999</td>
<td>1200</td>
<td>800</td>
</tr>
<tr>
<td>Bayleton</td>
<td>500</td>
<td>-</td>
<td>2001</td>
<td>500</td>
<td>-</td>
</tr>
<tr>
<td>Sevin</td>
<td>5280</td>
<td>-</td>
<td>2001</td>
<td>2783</td>
<td>2497</td>
</tr>
<tr>
<td>2.4.D</td>
<td>-</td>
<td>27929</td>
<td>2001</td>
<td>27929</td>
<td>-</td>
</tr>
<tr>
<td>Round-up</td>
<td>-</td>
<td>1000</td>
<td>2001</td>
<td>861</td>
<td>139</td>
</tr>
<tr>
<td>Benckal</td>
<td>-</td>
<td>1308</td>
<td>2001</td>
<td>1236</td>
<td>72</td>
</tr>
<tr>
<td>Klash</td>
<td>-</td>
<td>100</td>
<td>2001</td>
<td>25</td>
<td>72</td>
</tr>
<tr>
<td>Calven</td>
<td>-</td>
<td>372</td>
<td>2001</td>
<td>372</td>
<td>-</td>
</tr>
<tr>
<td>Goal</td>
<td>-</td>
<td>1900</td>
<td>2001</td>
<td>1875</td>
<td>25</td>
</tr>
</tbody>
</table>

Fig 3.
3.2. Data collection

Data from various sources have been collected. However, the study depended mainly on primary data. Two surveys were conducted. The first survey was conducted on residents living around Alsamrab store. The second one was conducted on the employees of the PPD.HQs covering the different occupations present viz, the store-keepers, subject matter specialists, technicians loading and off-loading and maintenance labourers, safety officers, guards, cleaning labourers, drivers, clerical staff accountants. A single visit type of questionnaire was used to interview the residents and the PPD employees (Appendix 1 a and b). Also direct observations in the study areas were used for data collection as such observations allow the researcher to observe and record behaviour as it occurs and enable the researcher to gather supplementary data that may qualify or help to interpret the findings obtained by other techniques and enable the researcher to explore new areas of inquiry (Chadwick et al., 1984, Badri 1993).

3.3. Sample design:

The only practical way to learn something about a large population is to obtain data from part of it. This part is called a sample (May, 1993, Badri, 1993, Robert, 1993).

This study has employed simple random sampling for the purpose of obtaining the sample. Simple random sampling refers to the selection
of units from a population or a universe so that every unit has exactly the
same chance or probability of being included in the sample (Chadwick et
al., 1984, Babbie, 1994).

The following steps were conducted to draw a simple random sample:

i) **For Alsambrab residential area:**

   i) The population around the store had been defined.

   ii) A list of family members of households which was prepared by
       the local committee was used as a sampling frame. A sampling
       frame is the list of all sampling elements from which the
       sample is selected (Muller et al. 1961, Lucas, 1970).

   iii) Samples were randomly selected from each direction around
       the store.

ii) **The plant protection directorate (PPD):**

1. A list of employees was obtained from the personnel section and was
   used as a sampling frame (including 98 persons).

2. Samples were selected using a table of random numbers.
The following steps are followed during the use of the table of random numbers to select a random sample:

1. Numbers were assigned to each individual in the sampling frame (from 1 – 98).
2. Starting point in the table of random numbers was selected randomly followed by downward movement in the column.
3. Using two digit numbers 57 out of the 98 employees were selected. Any number between 1 and 57 was selected.
4. The numbers were recorded as they were identified. The list of 57 of employees constituted the sample for the study of the PPD.
5. After the numbers were selected, employees names as represented by these numbers were identified.

3.4. Sample size

Introduction

The size of the required sample is decided on the basis of the nature of the population, the topic, the completeness of the sampling frame, the resources available for the researcher and the degree of accuracy necessary for the project (Chadwick et al., 1984).
3.4.1. Calculation of the sample size for Alsambrab Residential Area

For Alsambrab residential area a list including households and their family members had been obtained from the local committee. This list was used for the calculation of the standard deviation and from that, sample size was determined as explained below:

3.4.1.1. Calculation of the standard deviation

For the calculation of the standard deviation for Alsambrab residents two measures (the mean and the variance) are needed.

3.4.1.2. The calculation of the mean:

The formula for calculating the means is as follows:

\[
\text{Mean} = \frac{\sum x}{n}
\]

Where the symbol (\(\Sigma\)) is the capital Greek letter. Sigma means “the sum of” and tells to add a certain number of scores, \(X\) represents the scores to be added e.g. (the family size). \(N\) stands for the number of scores to be added (112 households).

\[
\frac{740}{112} X = 7
\]
3.4.1.3. The variance

The variance of the distribution is the mean of the squared deviations of scores from the mean of the distribution.

For a population the variance is represented by $\sigma^2$.

**The formula for variance is:**

$$\sigma^2 = \frac{\sum(x - \mu)^2}{N}$$

$$\sigma^2 = \frac{678}{112}$$

3.4.1.4. Standard deviation

Is simply the square root of the variance. The formula of the standard deviation is as follows:

$$\sigma = \sqrt{\frac{\sum(x - \mu)^2}{N}}$$

$$\sigma = \sqrt{6} = 2.4$$

To obtain the sample size, the following formula was used

$$\frac{ZX.\sigma_x}{\sqrt{n}}$$

(Lucas and Harlod, 1970)
Where:

- $D =$ Standard error
- $ZX =$ Confidence interval
- $\sigma_x =$ Standard deviation of mean from total population
- $N =$ Sample size

\[
D = \frac{1.96 \times 2.4}{\sqrt{n}}
\]

\[
N = \frac{(1.96 \times 2.4)^2}{0.4}
\]

<table>
<thead>
<tr>
<th>Sample size</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>2212</td>
<td>0.1</td>
</tr>
<tr>
<td>553</td>
<td>0.2</td>
</tr>
<tr>
<td>246</td>
<td>0.3</td>
</tr>
<tr>
<td>138.28</td>
<td>0.4</td>
</tr>
<tr>
<td>89</td>
<td>0.5</td>
</tr>
</tbody>
</table>
The optimum sample size was 138 households with a standard error 0.4. To get better information direct interviewing by the researcher herself was carried out to increase the level of precision.

3.4.2. Sample size for the PPDHQs:

The standard deviation for the Plant Protection Directorate, a list provided by the personnel section was used as a sampling frame. To calculate the standard deviation similar steps were followed.

Equation (1) was used to calculate the mean:

\[ \sum X = 94.82 \]
\[ N = 98 \]
\[ \bar{X} = \frac{94.82}{98} = 0.967 \]

Equation (2) was used to calculate the variance:

\[ \sum (x - \bar{x})^2 = 15.1 \]
\[ \sigma^2 = \frac{15.1}{98} = 0.15 \]
\[ \sqrt{0.15} = 0.387 \sigma = \]

The sample size was calculated using the formula (4)

\[ 0.1 = \frac{1.95 \times 0.387}{\sqrt{n}} \]
\[ n = (7.5)^2 = 57.53 \]

The total number of the employees: 98
Then a complete coverage was carried out for the rest of the 29 workers added to the sample studied (57) to include loading and maintenance labourers (4), store keepers (6) guards (14) and safety
officers (5). Each of them represent a small population and has a special type of exposure.

3.5. Data analysis:
After the data had been organized, the frequency distribution of answers was created. The frequency distribution describes the distribution of answers to each item or variable in the data and was calculated as follows:

3.5.1. The frequency distribution:
According to Robert (1993) and Cozbcy (1981) a frequency distribution is simply a list of all the possible categories for each variable showing the number of respondents in each category. Frequency distributions as presented in computer output show both the numerical and percentage distribution for each variable. The reasons for studying frequency distributions according to (Chadwick et al., 1984 and May 1993), are as follows:

- Enables the researcher to determine whether the use of certain statistical tests is legitimate.
- Enables the researcher to combine many categories into fewer ones.
- Sometimes examining the frequency distribution for a single variable itself is sufficient to satisfy the research objectives.
- It helps in making comparisons between the obtained distribution and other distributions for the same variable. Such comparison is essential
because without it, there is no way to ascribe meaning to the
distribution revealed.

3.5.2. Pearson correlation coefficient

Person correlation coefficient was used to provide the direction and
quantitative measure of the relationship between different variables such
as educational level, occupation, length of work experience and practices
as independent variables and the appearance of respiratory,
dermatological and some other symptoms as dependant variables among
the employees. Also the same coefficient was used to provide the
direction and quantitative measures of the relationship between the
presence of pesticide stores (direction; location and type of settlement)
and prevalence of some symptoms as hazards of pesticides among the
residents of Alsamrab area.

According to Babbi (1994) descriptive statistics are used to
summarize the distribution of attributes on a single variable. Others
summarize the associations between variables. When the data for
variables being related are given in numbers, the appropriate measure of
association is person’s coefficient of correlation which is represented by
the letter r.

For the calculating the coefficient of correlation r the following
formula was used:
\[
 r = \frac{N \sum (Xy) - \sum X \sum (y)}{[N(\sum x)^2 - (\sum x)^2][N(\sum y)^2 - (\sum y)^2]}
\]

(Balolock, 1984, Badri, 1993)

Where:

\[N\] = is the number of respondents
\[X\] = the score, (the independent variable) 
\[Y\] = represents the dependent variable 
\[X\] = represents the independent variable

Seven items (\( \sum x \), \( \sum x^2 \), \( (\sum x)^2 \), \( \sum y \), \( \sum y^2 \) \( (\sum y)^2 \) and \( \sum xy \) had been calculated, three of them were calculated, these are \( \sum X \), \( \sum X^2 \) & \( (\sum X)^2 \), which had been found for calculating the means and variance for a variable. The same items had been calculated for the second variable (y) and then Ey, Ey^2 and \( (\sum y)^2 \). Then the sum of the products of each X value times its associated y value were added. These products which are referred to as cross-products (XY) are then summed, represented by E(XY), the sum of the cross products.

3.5.3. Interpreting the coefficient of correlation

The (r) approaches either – 1.00 or + 1.00, indicates a strong relationship, either negative or positive, respectively. As (r) becomes smaller it indicates a weaker relationship, with zero indicating no relationship at all between the variables under examination, (Seltiz 1976; Chadwick et al., 1984; and Badri 1993).
3.5.4. Significance of coefficient of correlation:

To determine the significance, we need to calculate the degrees of freedom (df) for the analysis was calculated. For a univariate distribution the (df) equals the number of cells minus one read down the left hand column and then looked across on the same line to find the critical value to correlation for a given level of significance. Generally researchers consider relationship that is not likely to happen due to sampling error and it is more than 5 times in 100 samples as .05 level of significance. Results at the .05 level are considered significant. The other levels commonly used are .01% which is called very significant and at the .001 level are described as highly significant (Badri 1993, Rabbi 1973). The greater the significance of the coefficient value, the less likely have make type 1 error (Badri, 1993 and Babbi 1973).

3.5.5. Test of significant

To illustrate the steps involved in conducting a test of significance of correlation, first the null and alternative hypothesis were formulated. In general the null hypothesis is that X & Y are not associated. The alternative hypothesis is that X & Y are related in the population. Second the level of confidence was suggested as 0.05 level. Third (r) was calculated.
Fourth the critical value of r was determined from the table. The critical value is found at the intersection of 0.05 level of significance and the number of (N) for the number of pairs of Xs & Ys used in calculation. Critical values for (r) are listed in table of (r) for the person correlation coefficient.

Using the results of the comparison between the proper critical value and the calculated value for (r) it was decided whether to accept or reject the null hypothesis. Where the calculated value exceeded the critical value the null hypothesis is rejected and the alternative hypothesis is accept which means that there is a relationship between variables under examination.

3.6. Quality of work environment:

For assessing the quality of work environment light, heat, measurements were conducted at the stores of the PPD HQs.

3.6.1. Light measurements:

The lights were measured by direct reading instrument: MERIS Authorization n° BA 79.

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France

The light expressed in lux, having two scales the upper range 0-500 lux, the lower range 0-5000 lux.

3.6.2. Heat measurements:
Measurements were taken for the main parameters used in the calculation and the evaluation of the thermal environment.

1. **Air temperature:**

   Was measured by mercury (liquid in glass) thermometer from capsule LTD of range 0-65°C.

2. **Dry and wet bulb temperatures:**

   Were measured by Sling or Whirling Psychrometer which consists basically of two thermometers:

   - **Dry bulb thermometer:** Liquid in glass mercury thermometer of range 0-65°C. which measure the dry bulb temperature.

   - **Wet bulb thermometer:** Is thermometer having its bulb covered by cotton wick which is wetted with distilled water, measured the wet bulb temperature.

* **Kata thermometer:**

   Is an alcohol liquid in glass thermometer with large bulb and an upper reservoir, with two marks on the stem, with a range 125-130°C, and silver bulb. Kata factor was 517. Stopwatch was used to determine the cooling time by means of Kata thermometer.

3. **Air velocity:**

   The air velocity measured through the cooling power of the moving air which measured by the kata thermometer.
* The globe temperature:

Was measured by globe thermometer: This instrument consist of a hollow metal sphere with diameter of 15cm (or 6 inch) painted in matte black to absorb as much as possible the radiant heat.

* Radiant temperature:

The mean radiant temperature of the surrounding is then calculated using the parameters: air temperature, globe temperature and air velocity.

* Natural wet bulb thermometer:

This instrument consists of mercury in glass thermometer, whose bulb is covered by highly absorbent fabric wick, woolen cotton being the most suitable, the wick is extended over the stem of the thermometer and its long enough so that:

a) Its other end can be immersed in distilled water, which is kept in container underneath.

b) About 2.5cm of wetted wick remains exposed to the air (between the top of the container and the bottom of the bulb).

Wet bulb globe temperature (WBGT) index was using to calculate the allowable exposure time.

This was calculated according to:

\[ WBGT = 0.7T_{nwb} + 0.3T_g \]

3.7. Pesticides Act 1994:
The regulations related to storage and transportation of pesticides as cited in pesticides Act 1994 and its relevant by-laws were analyzed according to local situations and international standards and suitable amendments to close gaps in the regulation were suggested.

3.8. Correlation between various organizations involved in pesticides management in the Sudan:

Interviews were conducted with officials in relevant organizations and their ideas and assessment of the existing level of coordination between these sectors were analysed with the objective of suggesting suitable means of promoting such interaction and cooperation.

CHAPTER FOUR

RESULTS AND DISCUSSION

In this chapter the impact of pesticide on the personnel and people living and/or working in the neighborhood of a pesticide stores, their attitudes and practices of the work’s as well as storage environment and the coordination levels between different organizations involved in pesticides activities were assessed.

The obtained results are summarized as follows:

4.1. Pesticide store neighbours:

4.1.1. Social characteristics of Alsamrab residents:

4.1.1.1 Sex
Appendix (2) shows that about 57% of the residents were males and 43% were females.

### 4.1.1.2 Age

Appendix (2) shows that the highest percentage of the respondent fell in the age category 20-40 years who represent about 71% about 22% fell in the age category 41-60 years, and only about 6% above 60 years old.

### 4.1.1.3 Marital status:

About 85% of the residents were married while 8% of them were single (Appendix 2).

### 4.1.1.4 Family size

Appendix (2) shows that about 74% of the residents had small family size (1-5 members) while about 24% of them had medium family size (6-10 members).

### 4.1.1.5 Educational level

The result in Appendix (2) shows that, the majority of the respondents either received preschool education or were illiterate, who represent about 43 and 32%, respectively. While about 23% had 11 years of formal schooling and only 0.7% were highly educated.

### 4.1.1.6 Occupation

About 37 and 21% of the respondents were labourers in private and governmental sectors respectively and 12.3% were employees while 29% were housewives (Appendix 2).

### 4.1.1.7 Length of residence:

A high percentage of the respondents representing about 68% settled from 1-10 years and 31% settled from 11-20 years at this area (Table 4).
(Table 4)
4.1.1.8 Direction of residence from the store

Table (4) shows that about 40, 24, and 19% of the residents reside north, west and south of the store, while 13 and 10%, reside southwest and north east of the store.

This result indicates that the majority of the respondents settled in the northern side of the store which represent to the legal settlement. However those people could be more exposed to pesticide hazards specially during the summer season where the south west wind prevails. Exposure can be through skin contact or by inhalation of pesticides vapour or wind blown contaminated dust.

4.1.1.9 Distance of residence from the store

Table (4) shows about 60% of the respondents settled in distance less than 25 meters from the store., about 19 % were settled 250-500 meters, and few respondents (about 11.6 %) reside in a distance more than 500 meter from the store plates 1 and 2.

This result indicates that there is lack of enforcement of 1994 Pesticide Act specifying the location of pesticide stores the Act states that pesticide store should not be close to populated areas.

This store was initially constructed in a remot area from any human residence. However, the drought period which prevails during the eighties of last century had forced many people specially from west Sudan to move and migrate to the capital Khartoum. Therefore, a huge masses of people had illegally settle around the store. The ignorance of the official in the replanning of villages and illigal settlement about the hazards of living very closed to a pesticide stores result in legalization of these settlement and now the store is completely surrounded by human settelment and only separated from them by less than 5-meters road in some cases.

This may indicate the lack of awareness among government officials responsible for replanning of villages or illigal settelment in relation to any hazardous chemical or pesticide store. The location of the neighborhood of any housing or settlement should provide enough protection against health innjuries and environmental pollution, a criteria which was not followed at all.

This may indicate that the extension staff and subject matter specialist in the concerned department are not coordinating closely with the physical planners who need technical advice for the proper and safe allocations of sites for building pesticide stores.

4.1.2 Location of the source of water

All of the residents claimed that the water for domestic consumption is obtained from the artesian well established in Alsamrab not more than 300 meters from the pesticides store and from the dumping pit of pesticides containers.

4.1.3. Population awareness

According to the general rating of knowledge 17-47% of the respondents claimed to lack any knowledge of pesticides types, handling toxicity and precautionary measures, while 17-30%, 23-27%, 3-27% claimed to have little,
moderate and good knowledge of the above elements, respectively (Figures 4-7, Appendix 3a).

From what was presented it is clear that small portion of the respondents claim to have knowledge of pesticide hazards which the majority lacks such knowledge.

4.1.3.1 Source of Knowledge

As fig (8) and appendix (3b) show a high proportion (87%) of the respondents got their knowledge by contact with nonofficial people, small percentage (6.6) got information from some extension departments, and only 6.6% got their knowledge through the mass media such as TV, radio and newspapers.

It is obvious that the respondents got most of their knowledge from nonofficial source and what they got may not be of good quality.
Fig. 4. Frequency distribution of respondents according to their level of knowledge of types of Pesticides.

Fig. 5: Frequency distribution of respondents according to their knowledge on handling Pesticides.
Fig. 6: Frequency distribution of respondents according to their knowledge of toxicity of Pesticides

Fig. 7: Frequency distribution of respondents according to their knowledge of precautionary measures of Pesticides
According to their opinions as Appendix (4) high percentage (about 85%) of the respondents thought that pesticides adversely affect the human beings in the study area. While 66 and 26% of the respondents thought that pesticides affect animal and plant respectively (figure 9-11).
The people in the study area are very poor. They live in an over crowded houses which lack the basic services such as piped water, sanitation and health care. The majority of residential buildings fall outside any health and safety regulations and their sitting and constructions were never subject to any building or planning codes and regulation. As the result many of these pollutants many concentrate in these houses which had poor ventilation and causing negative impact on their health.

According to our observation, children and women appeared to be more effected. This may be attributed to the fact that, women and children spend more time within the settlement and its contaminated environment. Children appeared to be thin, weak and physically retarded as they spend more time playing very close to the contaminated soil than adults. Also they have greater hand – to – mouth activity which increases the opportunities for direct ingestion of pesticides carried by the wind or in the dust. The physiological immaturity of children makes them more susceptible to the toxic effect of pesticides (Matsumora, 1985).

Fig. 10: Frequency distribution of respondents according to their opinion about hazards (side effects) of pesticides to animals
Fig. 11: Frequency distribution of respondents according to their opinion about hazards (side effects) of pesticides to plant
5.1

Fig. 12: Frequency distribution of respondents according to smelling strange odors.

In addition to these factors the poor education, extension and health-care, services, exacerbate the risk of exposure to pesticides as well as it predispose them to infection by endemic diseases.

Furthermore, many respondents claim that death of domestic animals such as poultry, goats, donkeys as well as wild birds is occasionally observed near the vicinity of the store yard specially when these animals graze in/or drink contaminated water.

4.1.4 Environmental problems

4.1.4.1 Presence of strange smells at the store site

Approximately all of the respondents reported that they felt discomfort from bad and unpleasant smells, particularly during windy days (figure 12 and Appendix 5). Air and dust are mobile and represent transference media for pesticides (Hurtig et al, 1972, Matsumura 1985, Elmahi 1996). Wind blown dust can carry pesticide contaminants for surprisingly long distance (Cohen and Pinkerton, 1966).

Considerable amount of pesticides have been stocked for years in this place as indicated in table (5) and therefore may present a real source
of contamination and hazards to the residents bearing in mind the extreme

closeness of this store to their residence. Health hazards among

neighbours of the store, as measured by the depressed activity of

cholinesterase, were reported by Mukhtar (1999).

Table (5) Pesticide Stocked in AlSamrab pesticide store during period

1992-2001
4.1.4.2 Effect of season on strength of smell:

About 48 and 28% of the respondents reported that smells were strong during summer and autumn seasons few fraction (less than 10%) of the respondents claimed that they suffered more during winter, summer and winter or all over the year (figure 13 Appendix 5).

The majority of the respondents suffered from smells during hot seasons because the high temperature causes chemicals to volatilize and therefore become available for short distance transport or redistribution within the site. Pesticides that are more volatile have the greatest potential to go into the atmosphere (Way Land, 1975; Matsumora, 1985).

4.1.4.3. Changes in stagnant water around the store:

Appendix (6) shows that about 51% age of the respondents observed clear changes in the stagnant water around the store. The majority of them observed different types or mixtures of colours (Figure 14).

For many years the soil of the store enclosure had been contaminated with the pesticide spills and leakage from defective containers due to improper handling or stacking or explosion or corrosion, of containers due to unfavorable environmental conditions.
Fig. 13: Frequency distribution of respondents according to their seasonal perception of strange

Fig. 14: Frequency distribution of respondents according to their observation of a change
In additional some obsolete pesticides were stored within the enclosure (plate 3, 4 and table 6) of the store. Empty pesticide containers were also dumped there close to the southern west fence of the store. This highly contaminated soils within this site can be eroded with the run off rain water into the temporary pools resulting in the observed change in the colour of the water. Physical transport of contaminated soil with run off water into stream and pools and the surface water was reported by several authors (Way Land, 1975; Matsumora, 1985). In Sudan some organochlorine insecticides were detected in surface run off water desending from the highly polluted soil of Gurashi Dump pit in Hasahessa (Babiker, 1992).

4.1.5 Pesticides health problems.

The survey results revealed the prevalence of many symptoms of diseases among the residents. However only certain types are discussed because of their possible correlations to exposures to pesticides.

Figures (15) and appendix (7) shows that headache was the main symptom, prevailing among various respondent and about 91 % suffers from it, followed by Flue and Sneezing (77%) chest tightness (54%), and runny nose (53%)(Fig. 16).

Plate 3. Obsolete pesticide stored under the bare-sun
Plate 4. Pesticide empty containers stored outside the storage vome

Fig. 15: Frequency distribution of respondents according to their complain of headache

Fig. 16: Frequency distribution of respondents according to their complain of respiratory effects
People residing along the northern side of the store complained more of headache, flue and sneezing and chest tightness (dyspnea) as table (7) illustrates. This may be attributed to the south west wind, that prevail during the summer, the longest season of the year, which may carry contaminated dust or vapour to this direction. Wind blown dust or vapour were reported by many authors as the major methods of environmental transport of contaminants as mentioned earlier (Cohen and Pinckerton, 1966; Matsumora, 1985).

About 45 and 53 % of the residents complained of skin irritation and blurred vision with those who live nearer to the store suffering more than the others (Fig. 17 and table 7). Most of the mentioned symptoms (headache, runny nose, blurred vision)(Fig. 15, 16 and 18), are relevant to cholinesterase inhibition and this may indicated a possible exposure to cholinesterase inhibitors i.e. organophosphorus and carbamate insecticides (matsumora, 1985; Fukuto, 1990).

Table (6) indicated the presents of some organophosphorus insecticides among the store products, further the store soil may be heavily contaminated with such a products, an assumption which can be further supported by the finding of Mukhtar (1999) who reported a depressed cholinesterase activity among residents around Alsamrab store.

Table (6)
Fig. 17: Frequency distribution of respondents according to their complain of skin irritation

Fig. 18: Frequency distribution of respondents according to their Complain of blurred vision
According to correlation analysis, people residing in legal settlements complained more of skin irritation, than the others residing in the illegal area. This may be due to the fact that the majority of legal houses are located in the northern side of the store, which is exposed more to the south west wind blowing during the summer season (table 7). This again support the earlier finding of poor knowledge and coordination among officials in housing and urban development departments who chose to legalize housing in hazardous area.

4.1.6 Utilization of pesticide empty containers:

Fortunately no empty pesticide containers had been utilized by the residents in this area. This because the store is well secured and surrounded by a brick fence.
4.2. The plant protection directorate Headquarter

PPD workers were classified into three groups according to their possible frequency of exposure to pesticides, these groups are; Group I represents those who are frequently exposed; Group II, represents those who are less frequently exposed and Group III, represents those who work in storage environment.

4.2.1. Social characteristics of the workers in the plant protection directorate (PPD) headquarter

4.2.1.1. Sex

Results indicated that males represents 81%, 85% and 42% of group I, group II and group III respectively (Appendix 8).

4.2.1.2. Age

The results shows that the majority of the workers in group I, II and III fell in the age categories (41-60) years, who represent about 78 %, 71 % and 62 % of the studied population, respectively (Appendix 8).

4.2.1.3. Marital status

The results also shows that the majority of the respondents were married with the respective percentage of 87, 83 and 74 % in group I, II and III (Appendix 8).
4.2.1.4. Educational level

About 59% of the workers in group I had received 11 years of formal schooling with a small proportion received high level of education and very small percent received preliminary level of education. Most of the workers in group II either, received preschool education (43%) or were illiterate (37%). Fifty percent of the workers in group III had attended 11 years of formal schooling, about 38% attended high education and very small percentage either received preschool education or were illiterate (Appendix 8).

4.2.1.5. Family size

The results also show that 59% of group I had small family size 1-5 members), 11% of them had medium family size and only 7.4% had no children.

The medium family size in group II represent about 52% while 38% and 3% of the respondent in this group had small and large family size respectively. About 58% of respondents in group III had small family size and one third of them (33%) had no children. Female workers represent about 58% of this group. Interviewed female workers attributed the lack of children to the exposure to poisonous chemicals (pesticides) (Appendix 8).
Generally, the result indicated that group I had small family size compared to group II and III (Appendix 8).

4.2.1.6. Number of shifts per day

All the workers in group III, 70% of group I and 46% of group II worked for one shift per day. About 37% of group II worked for two shifts/day while 30% and 17% of group I and II worked sometimes for one or two shift per day in (Appendix 9).

4.2.1.7. Experience

About 52% of the respondents in group I worked for 11-20 years, 30% worked for 21-30 years, 11% worked for less than 10 years and 7% worked for more than 30 years. On the other hand, 51% of group II and 37% of group III had an experience of less than 10 years respectively. While 26% of group II and 54% of group III worked for 11-20 years, 17% of group II worked for 21-30 years and only 5% worked for more than 30 years. Similarly only 8.3% of group III worked for more than 30 years (Appendix 9).

4.2.2. Knowledge of pesticides

Results (Fig. 19, appendix 10) show that about 44% of the respondents in group I (The highest percentage) had good knowledge of pesticides. The highest percentage of the workers who had little knowledge (91%) was found in group II. Fifty percent of the respondents in group III and 15% in group I had little knowledge of pesticides as well.
The other half of group III plus 37% of group I and 6% of group II claimed that they had moderate level of knowledge about pesticides hazards. Among group II and I, 8.6 and 3.7% claimed that they lack any knowledge about pesticides.

The results revealed great variability in the level of knowledge among workers. Those who frequently exposed (G.I) appear to have good level of knowledge about pesticide hazards and this is a great advantage from occupational point of view. However, other groups (II, III) who also share to some degree the same working environment must have a similar or close level of awareness, contrary to the current situation. The major source of information to various respondents appears to be from colleagues, with extension services contributing with < 9% in various groups. This indicated the poor contribution of extension services, which should be the leading services, in disseminating such information.
Fig. 19: Respondent knowledge about pesticides hazards
4.2.3. Training programmes

Small proportion of group I (24%) attended training course, 60% of them attended irregular courses for more than one week. The majority of the respondents, about 56% attributed the lack of training to the scarcity of chances. All of the respondents in group II claimed to have no training programme and attributed that to the absence of such programme (Appendix 11).

It is obvious that no considerable progress had been made along this line. Workers who are not qualified and trained can not cope with the consequences of pesticide misuse and abuse. The lack of adequate training can result in serious consequences to worker’s health and the environment. The lack of training and poor knowledge available to respondents (mentioned earlier) caused for quick action to improve the current situation. Specialization and training are essential and important to avoid hazards and risks which may occur and threaten the workers and the environment. Ware housing or storage operations can be conducted safely if they are operated by well trained and qualified staff. Training should include knowledge of product hazards, general safety procedures procedure to follow incase of emergency (GIFAP, 1989, 1998; Way Land, 1975; WHO, IPCS, 1994).
4.2.4. Attitudes and practices of the respondents:

4.2.4.1. Using protective clothes:

About 63% of the respondents in group I and 97% in group II work without using any type of protective clothes. All of them claimed that there were no protective clothes available (Fig. 20, Appendix 12). The above result is an indicator of the poor enforcement of pesticide Act 1994, which obligates the employers to provide appropriate protective clothes to their staff and inform the workers about the importance of using suitable protective clothes and equipment to prevent or reduce exposure of pesticides.

The standard protective clothing and equipment must be used. Specially in the case of spilage of pesticides. Therefore protective equipment must be available in the premises at all times. It is the responsibility of the employer to provide the staff with the appropriate protective clothes and equipment, instruct the workers, in its proper use and see that it is maintained and replaced if faulty (GIFAP guidelines, 1997; IPCS, 1994; Way Land, 1975).
Fig. 20: Respondent usage of protective clothes against pesticides hazards.

![Bar chart showing respondent usage of protective clothes against pesticides hazards.](chart.png)
4.2.4.2. Personal decontamination

- **Methods of washing after handling pesticides:**

Fig. 21 and appendix (13), show that 78, 60% of groups I and II respectively claimed that they are used to wash themselves with soap and water after handling pesticides. This results reflected that most of the respondents in group I knew that personal cleaning plays an important role in reducing chances of poisoning by pesticides. Those workers provide their own soap as PPD store did not usually provide any soaps, and this is against general guidelines and regulations (including pesticide Act, 1994) which compel the authorities on managing pesticides stores to provide decontamination facilities (Pesticide Act, 1994; The by-Law in pesticide storage and transportation; WHO/IPCS, 1994; Way Land, 1975; GIFAP guidelines, 1997).

- **Washing after spillages of pesticide on the body:**

In the case of spillages of pesticides on the body about 74 and 63% of respondent in groups I and II respectively, claimed that they used to wash themselves and change their clothes at the end of the work. However, only 26 and 29% of respondents in group I and II wash themselves immediately, and 9% in group II never care about washing (Fig. 22 and Appendix 13).

Fig. 21: Methods of washing after dealing with pesticides
Fig. 22: Respondent careness of personal washing after spillages of pesticides
The majority of the workers regardless of their education were not following the instructions for successful decontamination of the body surface after spillage. Such an event requires prompt striping off clothing and rapid application of soap and water (Way Land, 1975; FAO, 1987). This negative attitude reflects the lack of effective supervision and absence of extension services and appropriate training.

### 4.2.4.3. Decontamination of spillages on store floors

Fig. (23) and Appendix 14a, show that half of the store keepers reported that in the case of spillages on the store's floor, they did nothing while about 17% of them said that they used to remove and burny the contaminated soil, add water to the contaminated soil and repacks the spilled chemicals. This means that the majority of store keepers did nothing following spill and even not report the cases to a responsible person to deal with it and follow the procedures of cleaning pesticide spills. Interviews showed that in many cases store keepers instruct one of the cleaning labourers to remove the spills, without any protective equipment. This may indicate their carelessness and ignorance about hazards of exposure to contaminated sites and also reflect the lack of effective supervision on store keepers from higher staff. The store keeper is responsible of decontamination of the floor of the store. Spills must be cleaned up immediately. Always have two people working on handling
Sever spills, untreated spills may corrode other containers and may contaminate store environment (FAO, 1996).

4.2.4.4. Disposal of pesticides

Results in Appendix (14b) show that 50% of the store keepers burry unwanted pesticides away from the store. Thirty three percent stored it in the yard and only 17% used to keep it inside storage rooms. Disposal of pesticides should be refere to the relevant national authority. Disposal of pesticides required specialist skills. However, the end product in most cases is still toxic. In the Sudan in several occasions obsolete pesticide stocks were dumped in pits within the store house enclosure in the main store belong to the Sudan Gezira Board in Gurashi side near Hasahessa. This adversely threatened the environment including human, animals and underground water (Abdalatif, 1993; Abdelbagi, et al., 2003).

4.2.4.5. Disposal of pesticides empty containers

The majority of the store-keepers (50%) interviewed said that empty containers are stored for a time before disposal, about 33% said that they are burred away and 16% said that empty containers are stored inside the storage room until saled (Appendix 14b, Fig. 24).

Fig. 23: Decontamination of spillages on store floors
Results indicated that there is no clear policy for disposal of empty containers. Empty containers are highly contaminated and must be disposed in a safe manner (Way Land, 1975; IPCS, 1994).

4.2.5. Pesticides health problems

The health problems among the workers in the plant protection directorate headquarters as a result of their exposure to pesticides was
assessed. The results revealed prevalence of many symptoms among the workers. Symptoms were grouped into various categories as shown below.

4.2.5.1. Respiratory symptoms

Among the short-term effects the following respiratory symptoms were reported.

- **Flue and sneezing**

Fig. (25) and appendix (15) show that among the three groups the highest percentage of affected workers was among group II of whom about 60% complained of flue and sneezing followed by group I and III where about 59 and 50% of them respectively suffered from flue and sneezing. This is probably due to the fact group I and II were directly exposed to pesticides while group III was indirectly exposed. Also, group II claimed to have received some sort of knowledge about pesticide hazards from colleagues but since the majority of them were either less educated or were illiterate. They could not even make use of such low quality of knowledge. Therefore they work with low level of safety measures which increases the risk of exposure to toxic chemicals. The lack of extension services is major cause behind such a situation. On the other hand correlation analysis among group I (Table 8) shows that loading, unloading and maintenance labourers were more affected by flue and sneezing followed by the specialists, technicians and the store
keepers. This could be attributed to their direct contact with pesticides during work and also because of the work without protective clothes.

- **Runny nose:**

Results showed that similar ratio of respondents among the three groups suffer from runny nose (37, 34 and 42% in G. I, II and III respectively)( Fig 26, Appendix 15).

Table (8) shows that among group I the less-educated workers complained more of runny nose as well as workers who have long experience among group II. The less-educated workers among group I were not aware of the possible dangers when handling pesticides.
Table (8)
Fig. 25: Respondents complain of flue and sneezing

Fig. 26: Respondents complain of Runny nose
Workers employed for prolonged periods can become very careless in following precautions when handling pesticides and the situation will exacerbate in the absence of extension and health education.

- Chest tightness

About 37% of respondents in group III and II and 33% in group I reported that they suffered from chest tightness (Fig. 27, Appendix 15). In spite of the fact that group III was indirectly exposed to pesticides the respondents complained relatively more of this symptom.

The respiratory symptom claimed by various respondents are of the cholinergic type which are known to be occurred as a result of exposure to organophosphorus or carbamate insecticides (Matsumora, 1985). The list of chemicals present in the store contains chemicals of this group. Depression of cholinesterase activity was reported among workers of pesticides store specially following loading and unloading operations (Mukhtar, 1999).

Other causes of chest tightness and other respiratory symptoms can not be excluded as the PPD HQs. is located in the industrial area close to many factories such as Alrobi Batteries, Alhamamatain Soap factories with their vapours and fumes, which may cause chest tightness and feeling of discomfort (Clayton and Clayton, 1979).

4.2.5.2. Neurological symptoms:

- Headache:
Headache was the most common symptom among the three groups. About 85, 77 and 70% among group II, III and I respectively complained of headaches (Fig. 28, Appendix 16). Headache is reported among the cholinergic symptoms caused by exposure to organophosphorus and carbamates (Matsumora, 1985).

Among group I female workers complained more of headache than male workers Table (8). This could be attributed to the fact that women are physiologically more sensitive to poisons specially pesticides than men (Cincinnati, 1991; Klaasen et al., 1986).
Fig. 27: Respondents complain of chest tightness

Fig. 28: Respondents complain of headache
4.2.5.3. Gastro intestinal symptoms

- **Abdominal cramps:**
  
  About 43% of group II and 33 and 22% of group III and I respectively claimed to have suffered from abdominal cramps (Fig. 29; Appendix 16). This result revealed that the highest percentage of affected workers, was among group II who are less educated, illiterate and ignorant of pestcids hazard. According to correlation analysis workers with long past duration of work among group II complained more of abdominal cramps (Table 8), although the correlation is poor (0.43). Abdominal cramps were among the reported symptoms of cholinergic poisoning resulting from exposure to organophosphorus and carbamates insecticides (O’Brien, 1969, Matsumora, 1985).

4.2.5.4. Dermatological symptoms

- **Skin irritation**
  
  About 33%, 28% and 25% of group I, II and III respectively suffered from skin irritation (Fig. 30, Appendix 16). The result also indicated that workers who belonged to group I were more affected as they were directly and frequently exposed to pesticides. As many workers had poor education, not trained, worked without protective clothes and other negative attitudes therefore, the chances of skin contamination are expected to be high. Exposure of skin to pesticides is known to cause skin irritation (Way Land, 1975; WHO, IPC, 1994).
Fig. 29: Respondents complain of abdominal cramps

Fig. 30: Respondents complain of skin irritation
4.2.6. Medical examination:

The workers were interviewed about the medical examination, all of them reported that there was no any type of medical examination (pre-employment or periodical). For jobs in which there is probably regular or prolonged exposure to pesticides, medical examination before employment as well as during the work is highly desirable. This will protect the worker, make sure that he/she will come to no harm if the correct safety precautions are followed. Also the medical examiner must consider whether any existing disease (Asthma, Nervus disease, Liver disorder) might be exacerbated by exposure to pesticides. This implies a far greater cooperation between health agricultural extension services (Bull, 1982; WHO, IPCS, 1994; Way Land, 1975).

4.2.7. Practices and attitudes of drivers

(Table 9) shows that all the drivers claimed that they didn't carry food or other goods with the chemicals. They used to give complete safety checks for their vehicles and make sure that there are no broken or leaky containers as well as they wash their cars after the un-loading operations. On the other hand, the drivers reported that there was no provision of protective clothes, symbols of danger, first aid kits and they did not used to cover dusty powdered products.

Table (9): Attitude of drivers
<table>
<thead>
<tr>
<th>Activities</th>
<th>No</th>
<th>Rarely</th>
<th>Some times</th>
<th>Usually</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrying pesticides with other goods</td>
<td>6</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Washing out the vehicle after unloading operation</td>
<td>6</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Give complete safety check to the vehicles before transportation</td>
<td>6</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Provide the car with protective clothes and first aid kits and symbols of danger and cover for dusty products</td>
<td>6</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Make sure that there is no Leakey containers to be transported</td>
<td>6</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

There is no system of training programmes, for pesticides transportation, knowledge of product hazards, general safety procedures emergency measures in the cases of mishaps.

The results indicated that there is a lack of enforcement of existing legislation regarding pesticide transportation (pesticide Act 1994; by-Low of pesticides storage and transportations, 2002) which calls for minimizing risk and hazards to the workers including drivers and the environment by following strict safety measure as also outline in the technical monograph of safety (FAO, 1997)
4.2.8. Environmental problems

4.2.8.1. Presence of pesticide smells

Group III (working in the neighborhood of a pesticide store) were interviewed about the presence of unpleasant vapours and smells. The majority of them (79%) reported that they felt discomfort from bad smells. About 53% said that smells become stronger during summer and autumn and 37% said the smells become stronger during the summer season. Approximately all of the respondents claimed that the smell become stronger during windy days (Table 10).

Many pesticides volatilized may evaporate at hot conditions. Pesticides vapours can move with the wind current into near-by areas to cause bad smells (Kegly et al., 1997). This termed short range transport or redistributions within the site (Haskell, 1985). Redistributions may occur also by moving water specifically for pesticides of high water solubility. As the result bad smell and discomfort can be detected by nearby residents or by passers. The hot temperature, water solubility enhances movement into mobile forces of the environment such as moving air and/or water (Cohen and Pinkerton, 1966; Bennet, 1992 Barabash and Resek, 1996). This may explain the observed acuteness of the smell during hot or humid or windy days as claimed by the respondents.
4.2.8.2. Changes of stagnant water during rainy season

About 79% of the respondents declared that, they observed many changes in stagnant water around the store. Fifty eight percent complained of unpleasant smells and 32% observed change of the colour of water into oily, yellow or red (Table 10).

PPDHQs. had been for more than four decades the main storage depot for imported pesticides and pesticide donations provided by aid agencies in large quantities before distribution to different regions, in the country. In addition some obsolete stocks were stored in containers in the same area (Table 11). The soil in PPDHQs yard may be contaminated as a result of leakage from defective containers due to improper stacking or damage from rough handling or during transportation or through long period of exposure to direct sunlight which affect both the container and its contents (Burton, 1981; ILO, 1991). In rainy seasons, dissolve pesticides appear at the surface, hence people can observe different colours and bad smell. Even pesticides of low water solubility can be physically carried by run off water (Bennet, 1992; Barbash and Resek, 1996). Therefore respondents could observed such a change.

Table 10
4.3. Physical conditions of the store:

Stores as occupational environment is risky to health in some way or another. Occupational hazards are classified as chemical, physical and biological. Their possible action on health occurs, when workers are exposed to them. Physical hazards arise on working under noise, heat or cold and light problems (Clayton and Clayton, 1979). Therefore it is very critical to highlight the physical conditions of the store and to comment on their satisfaction to local and international specifications.
4.3.1. Measurements:

4.3.1.1. Light:

According to the measurements in some positions, the level of illumination was found far below the recommended level being 10 lux at positions 1, 2, 3 in store A, 110, 70 in store B₁ and B₂ 75 in store B₃ (Fig. 2-3; Table 12). The recommended illumination levels for medium and fine stores is 200 to 500 lux. From the point of view of safety at work, visual capacity and visual comfort are extraordinarily important. This is because many accidents occur due to illumination deficiencies and therefore increase the hazards of falls and contact with pesticides containers. Workers can find it harder to identify labeling in containers to apply the system of first in, first out, as well as to avoid hazards from handling dangerous chemicals (Perez and Calleja, 1998).

At these positions there is a need for additional light sources. The luminance of an object, of its surroundings, and of the work area influence the ease with which an object is seen, which affect the productivity and the psycho-physiological well-being of the worker (Perez and Calleja, 1998).

Table 12: Light measurement.

<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Light in lux</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Perez and Calleja, 1998).
Table (13) shows the heat measurements in two stores (the larger store and Alestidama corporation stores).

The wet bulb globe temperature (WBGT) was taken to identify the allowable exposure time for workers to work inside the store. The (WBGT) index depends on its calculation mainly on natural wet bulb temperature (t_{nwb}) and to some extent to the globe temperature (t_g). From (WGBT) the permissible heat exposure time can be calculated. The permissible heat exposure (TLVs)(^\circ C)(WGBT) is given in table (14).

### Table (13): Wet bulb globe temperature (WBGT)(^\circ C) of PPD pesticides store and Alestidama corporation stores (Feb. 2002):

<table>
<thead>
<tr>
<th>Location</th>
<th>Dry bulb ((^\circ C))</th>
<th>Natural wet bulb F° ((^\circ C))</th>
<th>Globe temperature F° ((^\circ C))</th>
<th>Relative humidity RH%</th>
<th>WBGT F° ((^\circ C))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stor A The large store</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position I</td>
<td>37(^{89.6})</td>
<td>22.5(^{72.5})</td>
<td>38(^{100.4})</td>
<td>41</td>
<td>27.15</td>
</tr>
<tr>
<td>1. Large store</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store A</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Alestidama corporation stores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store B(_1)</td>
<td>70</td>
<td>110</td>
<td>250</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Store B(_2)</td>
<td>75</td>
<td>210</td>
<td>210</td>
<td>350</td>
<td></td>
</tr>
</tbody>
</table>
According to table (13) for a person performing continuous light work all the WBGT values are within the permissible limit. However for a person performing medium work the WBGT are within the permissible level except in store A, at position I where the worker should have a work-rest cycle according to calculations below:

\[
\begin{align*}
25\% & \quad 26.7 \\
X & \quad 27.2
\end{align*}
\]
Therefore, the worker at position I should have 18.26 minutes rest each work hours for performing medium work.

For a person performing heavy work, in store A at position I, the calculation of rest-cycle is as follows:

\[
x - \frac{25}{50} - 25 = \frac{27.2 - 25.0}{29.4 - 25.0}
\]

\[
x = 37 \%
\]

\[
x = 37 \times \frac{60}{100} = 22.5 \text{ minutes}
\]

Therefore at position one the person should not do the heavy work continuously and should have a work-rest cycle of 22.5 minutes rest each hour.

At position II, a person performing heavy work should have a work rest cycle according to calculation bellow:

\[
x - \frac{25}{50} - 25 = \frac{26.7 - 25.0}{29.4 - 25.0}
\]

\[
x = \frac{2.2}{4.4}
\]

\[
x = 37 \%
\]

\[
x = 37 \times \frac{60}{100} = 22.5 \text{ minutes}
\]
\[ x - \frac{25}{50} - 25 = 26.7 - 25 / 29.4 - 25 = 1.7/4.4 \]

\[ x = 34.66 \% \]

the rest cycle = 34.66 X 60/100 = 20.79 minutes

Therefore the worker should have 20.79 minutes rest cycle each hour.

In store B₁ and B₂ (Alestitama stores) all the WBGT values are within the permissible limit for the different types of work load (light, moderate and heavy).

Table (15) Allowable exposure time of workers in the concerned stores (Feb. 2002)

<table>
<thead>
<tr>
<th>Location</th>
<th>WBGT</th>
<th>AET (minutes) each 60 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Store A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position I</td>
<td>27.15</td>
<td>60</td>
</tr>
<tr>
<td>Position II</td>
<td>26.65</td>
<td>60</td>
</tr>
<tr>
<td>Store B₁</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position I</td>
<td>24.05</td>
<td>60</td>
</tr>
<tr>
<td>Position II</td>
<td>23</td>
<td>60</td>
</tr>
<tr>
<td>Store B₂</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position I</td>
<td>23.35</td>
<td>60</td>
</tr>
<tr>
<td>------------</td>
<td>-------</td>
<td>----</td>
</tr>
<tr>
<td>Position II</td>
<td>23.65</td>
<td>60</td>
</tr>
</tbody>
</table>

WBGT: Wet bulb globe temperature.

AET: Allowable exposure time.

For light work (L): The metabolic heat: 600 BTU/hr.
For moderate work (M): The metabolic heat: 1000 BTU/hr.
For heavy work (H): The metabolic heat: 1800 BTU/hr.

Heat represent one of the classical physical stresses in the occupational environment. Humans can tolerate internal temperatures below 35°C or above 41°C for only very brief periods of time. If the core temperature of the body falls below 35°C hypothermia results and death is likely to occur. On the other hand Hyperthermia results when core temperature exceeds 40.6°C in the absence of sweating (Mulchiler, 1978; Kenny, 1998).

Clinical disorders can result from excess heat:
High temperature can result in inhibition of sweating because malfunctioning of sweat glands, shivering, heat exhaustion from depletion of body water and/or salt, state of collapse as the result of
insufficient blood supply to the cerebral cortex. Heat stroke can result from failure of the thermoregulatory centre. While heat cramps occurs from salt loss and dilution of tissue fluid. All these can cause the lack of efficiency in performing heavy tasks, accelerates the onset of fatigue, increased body temperature and discomfort, increase irritation, anger, and other emotional states, in addition heat exposure increase the respiratory rate which increase the probability of more inhalation of toxic vapours and fumes (Mulchiler, 1978; Kenny, 1998).
4.3.1.3. Washing facilities:
The workers were interviewed about the presents of washing facilities. About 67 and 77% among group I and II claimed that they have washing facilities, the majority of them (78%) among the two groups reported that they used basins for washing, few percentage of them claimed that sometimes they used bath rooms for washing (Appendix 17). Washing facilities should be included in any pesticides store and provided with alternative arrangements if there is no pipe water supply. The process of washing and bathing should not be left for the workers to be done at home. Washing facilities should be equiped with soap and detergent materials (Way Land, 1975; ILO, 1991, FAO, 1996).

4.3.1.4. First aid kits:
The PPD stores are not provided with first aid kits. Adequate first aid facilities should be available to treat minor injuries and contamination of eyes and skin, and should be provided with anti-dotes (ILO, 1991).

4.3.1.5. Fire fighting equipment:
The PPD stores are not provided with suitable fire fighting equipments. A suitable fire extinguisher in good working order should be at hand, in case of emergencies (ILO, 1991).

4.4. Analysis of the pesticides and pest control material Act, 1994:
The use of pesticides in the Sudan is governed by strict, rigid rules and regulation regarding registration, importation, distribution (storage
and transportation) and application procedures. The main objective of Pesticides and Pest Control Act, 1994 were to co-operate efforts to protect humans and the environment, organize pesticides registration, ensure the quality of imported pesticides, proper and safe use and licencing of local trade in pesticides. The National Pesticides Council (NPC) is a multi disciplinary inter ministerial committee which is composed of members from various relevant departments - (Plant Protection Directory, Agricultural Research Corporation, the National Health Laboratory, the Occupational Health, the Institute of Environmental Studies, relevant departments in universities, the Veterinary Research Corporation, Medical Entomology Department, Customs authority and other relevant departments)-is responsible body for controlling all activities related to pesticides in the Sudan.

From the pesticides and pest control Act, 1994 several by-laws and bills were drawn and put into action. They include by-laws for storage, transport, retail marketing, pesticides inspection, handling and trading and formulation industry (Appendix 18).

The issue of bills on all matters related to pesticides drives its powers from the Act, 1994. Regulation for storage and transportation of pesticides and retail marketing were reviewed analyzed and criticized.

**Regulation for storage and transportation of pesticides:**

**Article II, paragraph (4): selection of sites for stores:**
I) Distances of large pesticides stores from agricultural and range
land areas as well as the topography of the land and levels of
ground water were not considered.

II) In the case of small stores or retail shops the sites should be
established out sites residential and populated areas or food
markets

III) In the case of pesticides stores in sea ports and air ports the
supervision of the National Pesticides Council was not
considered.

Paragraphe (6) Storage conditions:

XI) The storage of pesticides in sea ports and air ports if not
claimed within three months should be transferred to stores for
unidentified pesticides under custom supervision. The three
months period is quite long for such dangerous chemicals it
may suitable to reduce it to one month only. Unclaim products
after this period must go to pesticides stores (not to stores for
unidentified pesticides as indicated in the by-laws).

Paragraph (5): Specifications of the stores and emergency exit and
separate ventilated accommodation for protective and personal clothes,
provision of the stores with exhaust fans were not included in the
positions.
4.5. Level of coordination between various organizations involved in pesticides management in Sudan:

As table (16) shows there is high level of coordination between the plant protection directorate (PPD), the National Pesticides Council (NPC), the Agricultural Research Corporation (ARC) and the Sudan Agrochemicals Association (SAGA). The registrar of the NPC is the director of the PPD. The ARC work closely with NPC as it is represented in the NPC and its Technical Committee also ARC is responsible for organization of the national meeting of pest and disease committee which passes its recommendations about new registrations of pesticides to the NPC.

SAGA have played significant role in collaboration with the various governmental institutions and Agricultural Productions Schemes in all aspects related to proper and safe use of pesticides such as provision of safety materials, training facilities and organization of specialized workshop on issues of mutual concern.

The extent of the relationship was strong between the PPD and the Agricultural Extension (AE). The AE organized joint training courses for the extension officers with other sectors but they are below the desired level. Some universities such as University of Khartoum have good level of coordination with NPC either as active members in NPC or its
technical committees or as researchers and discussant in recommending and approval of new registrations.

The extent of the relationship was moderate between the PPD and Ministry of Health (occupational health), although it was strong with NPC. Also the results indicate that no relationship between the PPD and the other organization including the environmental health (Ministry of Health, Higher Counsil for Environment and Natural Resources (HCENR), Sudanese Environment Conservation Society (SECS), Ocupational Safety (Ministry of Labour), Ministry of Interior Affaries (The Trafic Administration, Civil Defence). The Trafic Administration is responsible for the determination of specifications or trucks including those involoves in transport of chemicals. The civil defence administrations is responsible for the protection of building against natural disastors (flood) and fire accidents.

Table 16.
There was no relationship between the Investment Corporation, Urban Development Department and NPC or PPD. There is a need for establishing consultation procedure with concern department when considering granting permission for storage of dangerous chemicals, as well as during the replanning of any residential area containing dangerous facilities such as pesticides stores.

The evaluation of inter-institutional relationships indicate the presents of inadequate communication and understanding between NPC and some relevant organizations. Such week coordination can affect proper planning, performance and management of pesticides in the country. Therefore, it is very important to strengthen such interaction between all relevant organizations involved in pesticide activities in the country. The extend of the relationship between universities, Urban Development Department and Investment Corporation and the other relevant departments were not determined for some logistic reasons.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary:

This study evaluated the impact of the current system of management in local pesticides stores on the people living and working in
the neighborhood of pesticide stores and the personnel dealing with pesticides.

The study also evaluated the impact of pesticides exposure, personal attitude and available facilities and provisional workers involved in handling pesticides.

The simple random procedure was followed in the selection of one hundred and thirty eight inhabitants of Alsamrab residential area. The same procedure was followed in the selection of fifty seven of the workers and employees belonging to the PPD Headquarters. Two questionnaires were employed for data collection and interviews were conducted with the managers of organizations involved in pesticides activities.

Assessment of the work environment and physical conditions of the PPD.HQs stores was conducted. Regulations governing pesticides storage and handling were analyzed and criticized. The techniques used for data analysis were the frequency distribution and the pearson coefficient of correlation.

The study arrived at the following findings:

A) Alsamrab residential area:

1. The majority of the residents of Alsambrab either received preliminary education or were illiterate.
2. A high percentage of the respondents settled from 1 to 10 years, the majority of them reside in the north side of the store which represent the legal settlement. However those people are more exposed to the hazards of pesticides contamination during the summer season where the south wind prevails.

3. Most of the residents settled in a distance less than 250 meters from the store, and a few of them reside in a distance more than 500 meter from the store. This indicated that there is a lack of enforcement of the 1994 pesticide Act. The Act states that the minimum distance should be not less than 5 km. It also indicates that planners in the villages planning department have poor knowledge of the adverse health and environmental consequences of the presence of such stores in the populated area.

4. The water for domestic consumption is obtained from artesian wells located not more than 300 meters from the pesticides store and from the dumping pit of pesticide empty containers.

5. A small proportion of the residents had knowledge of pesticide hazards from non-official sources, which may not be of good quality.

6. Approximately all of the residents reported that they felt discomfort from bad and unpleasant smell, particularly during windy
days. The majority of them reported that smells were strong during summer and autumn seasons.

7. Large proportion of the residents observed many changes in the stagnant water around the store during the rainy months, because storms push water with contaminated soils to the ponds around the store causing change in colours and bad smell.

8. The majority of the residents thought that the pesticides adversely affect the human beings in this area, where people are poor and live in over-crowded houses or squatter settlements of poor ventilation and often have no access to the basic services. As a result many of these pollutants may concentrate in the houses and cause adverse consequences on their health. A large number of the people who owned animals observed many incidents of deaths among poultry and goats near the store.

9. The results showed that headache was the main symptom, prevailing among the residents followed by flue and sneezing, chest tightness and nose flowing. These symptoms indicate a possible exposure to cholinergic pesticides such as organophosphorus and carbamates.

10. The result of correlation analysis revealed that people residing in the northern side of the store complained more of headaches, flue and sneezing and chest tightness. This may be due to the blowing of the southwest wind that prevails during the summer which is
represents the longest season of the year. The wind could blow more pesticide contaminants into this direction.

11. Large proportions of the residents complained of blurred vision and skin irritation. The correlation analysis revealed that those who live nearer to the store suffer more than the others. Also people residing in the legal settlements complained more of skin irritation than the others who reside in the illegal areas. This may be due to the fact that the majority of legal houses are located in the northern side of the store, which is exposed more to the southwest wind blowing during the summer season. Blurred vision is one of the major signs of cholinergic type of intoxication caused by exposure to organophosphorus and carbamates.

(B) Respondents in the PPD headquarters:

1. The majority of the employees had received moderate education, while the majority of the workers either received primary education or were illiterate.

2. The result indicated that group I (highly exposed) had small family size compared to group II (less frequently exposed) and III (worker in the neighbourhood of pesticide stores). One third of group III had no children and female workers represent about 58% of them. These female workers attributed their sterility to the presence of the poisonous chemicals (pesticides).
3. The majority of the workers work for one shift/day. However, among group II all the guards work for 2 shifts/day.

4. The majority of the workers in the three groups worked between 11 to 20 years.

5. Large proportion of respondents in group I had good knowledge of pesticides hazards while the majority of respondents in group II had little knowledge of it. On the other hand fifty percent of group III had little knowledge of pesticides and the rest had good knowledge. This result is attributed to the fact that the large number of highly educated workers are among group I and III, while the low educated workers belong to group II. This may indicate the complete absence of extension service available to respondent. Also respondents clearly indicated the absence of training programmes and therefore workers were not aware of the hazards of these poisons and general safety rules to reduce hazards and risks which may threaten their health and the environment.

6. The majority of workers and employees work without using protective clothes. This is an indicator of non-enforcement of the pesticide Act 1994 which obligates the employers to provide protective clothes and devices to their staff and compells applicators to use them.
7. In the case of personal decontamination when dealing with pesticides most of the employees among group I reported that they knew that personal cleanliness plays an important role in protecting against pesticides poisoning, and they can provide themselves with soap compared with workers among group II.

8. In the case of spillage’s of pesticides on the body, the majority of respondents in group I and II reported that they used to wash and change their clothes after the end of the work. This indicated that the workers regardless of their education were not following the instruction of successful decontamination due to the lack of effective supervision and absence of extension services and training programmes.

9. The store keepers reported that they did not report the cases of spillages of pesticides on store floors, to a responsible person to deal with it. However, the removal of the spills was conducted by the cleaning labourers with their bare hands and without using any protective measures. This indicates carelessness and ignorance of the hazards of contamination and lack of effective supervision.

10. There were differences in the attitudes of the store-keepers towards the disposal of pesticides and their containers in spite of the facts that the result indicated that there was no clear policy regarding this process.

11. The most observed symptoms, among various respondents were, flue and seezing, runy nose, chest tightness, headache, abdominal crambs, and skin irritation. Groups which are directly engaged with pesticides and those of low educational level suffers more. The majority of these symptoms (headache, runny nose,
abdominal crambs …etc) were cholinergic type of symptoms caused by possible exposure to organophosphorus and carbamate insecticides. Female respondents claimed to have suffered more of some of these symptoms and females are reported to be more sensitive to pesticides than men. It is also worth to mention that PPD HQs is located within the industrial area and close to Alrobi Batari and Alhamamatain Soap Factories with their various types of fumes which may also contribute to the respiratory symptoms reported.

12. Concerning the pesticide transportation the drivers reported that they did not carry food with chemicals and follow complete safety checks of their vehicles before departure. On the other hand they reported that there was no provision of protective devices and clothes, first aid kits and there is no system of training programmes about transportation of dangerous chemicals, general safety procedures, and emergency measures in the cases of mishaps. This indicated the lack of enforcement of the existing legislation regarding pesticide transportation.

13. Concerning the environmental problems

- Group III were interviewed about the presence of unpleasant smell, the majority of them reported that they felt discomfort from bad smell particularly during summer and autumn and during windy days.

- The majority of group III declared that they observed changes in stagnant water during the rainy seasons. The PPD HQs had been the main storage depot for imported pesticides, for more than four
decades, in addition some of the obsolete stocks were stored in the site. Therefore, the soil may become highly contaminated as a result of leakage from defective containers caused by improper stacking or damage through rough handling during transportation. The contaminated soil may be eroded by run off water causing the change in colour and bad smell.

14) Physical conditions of the stores:

- According to the light measurements the level of illumination was found far below the recommended level in three positions in store A and two positions in store B₁ and one position in store B₂.

- According to the heat measurements for a person performing continuous light work all the WBGT values are within the permissible limit. However, for a person performing medium work the WBGT values are within the permissible limit except in store A and position 1, were the worker should have 18.26 minutes rest-cycle each work hour. For a person performing heavy work in store A at position 1 the worker should not do the work continuously and should have a work – rest cycle of 22.5 minutes rest each hour. At position 2 a person performing heavy work should have 20.79 minutes rest cycle each hour. In store B₁ and B₂ (Alistidama stores) all the WBGT are within the permissible unit for all types of work.

15) The results of institutional relationships revealed that the level of coordination is very high between the PPD the National Pesticide
Council and Agricultural Research Corporation and the Sudan Agro-chemicals Association (SAGA), and also the relationship is high between the PPD and the agricultural extension. Some universities such as University of Khartoum have a good relationship with the NPC. In general, the institutional relationships indicate that there is low level of coordination among the various organizations concerning pesticide activities such as (Ministry of Health, Higher Council for Environment and Natural Resources, Ministry of Labour "Occupational Safety", Ministry of Interior "Civil defence and Traffic Administration". There was no relationship between the Investment Corporation, Urban Development and NPC or PPD. The evaluation of inter-institutional relationships indicate the presence of inadequate communication between the NPC and relevant organizations.

However, there is a distinct relationship between SAGA and the occupational health. However, this relationship (between SAGA and occupational health is found to be very strong in the Gezira scheme but, it seemed to be more informal or personal relationship than a formal one.

This is attributed to the fact that SAGA have continued to perform its role in collaboration with the various governmental institutions in all aspects related to the safe use of pesticides.
5.2. Conclusions

The following conclusions can be drawn from the study:

1. The study has explained the absence of extension work in many aspects regarding pesticide activities such as storage, handling and transportation. Furthermore it reflects low level of knowledge of pesticide hazards among the personnel engaged in the PPD HQs as well as people residing near the pesticide store in Alsambrab area.

2. The study has explored the non-enforcement of pesticide Act, 1994 regarding, pesticide, storage, handing, transportation, training and education, protection of the workers and allocation of stores.

3. People working with pesticides (handling, loading mixing .. etc) have a potential to come in contact with concentrated formulations and are at great risk for harm. The way to reduce this risk is to reduce exposure to the pesticides through the use of proper protective clothes and the following of all safety rules. Also the result revealed that there is a possibility of hazard to those living in the neighbourhood of pesticide stores which represent a source of environmental contamination.

4. There are no comprehensive epidemiological studies identifying adverse health effects of exposure to pesticides in
the PPD HQs, and there is lack of reference value and pre-exposure clinical information.

5. Legislation on the control of pesticides are the responsibility of the NPC which is an intersectorial council composed of most concerned parties, yet other related authorities (e.g. Ministry of labour and others) which are responsible about related issues such as transportation of pesticides are not represented. Further the authorities in national ports may be asked to advise the authorities or to perform certain duties in the field of pesticide control without the consent of the NPC.

6. The study revealed that the presence of pesticide stores, in Alsambrab area and in the PPD HQs had made many individuals to think that, they had been made ill by the exposure to pesticides.

7. The working environment is not comfortable for the manpower working at the stores in the PPD HQs because of the inadequate facilities e.g. washing basins and bathrooms, soap and detergent materials. Moreover there is a risk of injuries from poor lighting, inadequate ventilation, heat and lack of occupational health services like first aid facilities, clinical check up … etc.
8. The study has explored that there is a lack of environmental awareness among governmental officials in Housing and Urban Development Departments and Investment corporation on allocation of chemical factories, stores of hazardous industry.

9. In addition to regulations, appropriate practices such as protective devices, education and extension and cooperative relationship between those who engaged in pesticide storage handling and transportation and other related departments can also promote the welfare of all in the community.

10. The extension services are not functioning to establish a system of harmonize and complementary relationships among all concerned institutions to make progress in pesticide activities.
5.3. Recommendations

The need for the development of pesticide stores management system and pesticides handling that guarantee workers general safety and environment conservation, is becoming increasingly urgent. In order to achieve that end the following approaches are recommended. These recommendations are addressed to the National Pesticides Council.

1. The continuous training of personnel is of great importance as it through new information and techniques to those who needed it. Moreover, it will also remind those who tend to forget or neglect it. The agricultural extension officers should cooperate with the occupational health supervisors, PPD Subject Matter Specialists (SMSs), the occupational safety authorities to teach all workers specially those with low level of education about the hazards of pesticides and to promote safety and hygiene and increases environmental awareness as well.

2. Regarding the storage, By-laws and bills that were drawn and put into action deriving their powers from the 1994 Pesticides Act, several points needed to be added or amended:

**Sites and distances of the stores**

These points should be added to paragraph (A)

- Large stores should be far away from rangeland and agricultural areas. Soil nature and properties and topography of
the land should be considered. The site should not be in an area with high ground water levels nor should it be adjacent to seasonal flood course.

**Paragraph (B)**

- In the case of small stores or retail shops the site should be established in remote area outside residential, populated areas and food marketing.

**Paragraph (C)**

- In the case of temporary storage such as what happens in ports and airports for customs procedures (inspection clearance purposes) the construction and the establishment of the pesticide stores should be under the supervision of the NPC.

**Specifications of the stores**

The following points should be added to the storage and transportation pesticides By-law:

- There should be an emergency exist in addition to the entrance doors.
- Separate ventilated accommodation must be provided for protective and personal clothes.
- Exhaust fans should be fitted to large stores.

**Storage specifications**

**Paragraph (k) should be amended as follows:**
In the case of temporary storage of imports the unclaimed and/or neglected pesticides should not be stored for more than one month. The NPC should be informed immediately to move the pesticide stocks to another store of suitable specifications. In this case there should be a contact person to coordinate with customs and the NPC and report any stocks every month.

The NPC should carry out its responsibility to the enforcement of the legislation, concerning the location of pesticides stores, protection of the worker engaged in pesticide activities and conservation of the environment. Empowering, functioning and strong support of the inspection committee will do much in these issues. This recommendations are addressed to the NPC, PPD, Higher Environmental Council and Ministry of Health.

3. An urgent action should be taken to relocate pesticide stores in residential or populated area.

4. Provision of protective clothes for the staff in permanent and temporary stores including ports and airport personnel.

5. Reconstruction and/or rehabilitation of the stores is important to maintain proper storage and suitable working conditions.

6. Provision of important facilities (drinking water, first aid kits, washing facilities, soap and detergent materials) in pesticide stores.
7. For protecting the health of employees the employer shall ensure that the exposure of employees to hazardous substances is monitored in accordance with a suitable procedure. Monitoring should be at least once every year and records must be kept for 20 years at least. For the female workers in the PPD, pregnancy and lactating periods should be considered.

8. Pre-employment and periodical medical examination is important.

9. Epidemiological studies and environmental monitoring should be carried out to investigate the negative impact on humans and environment in the areas covered.

The following are addressed to the agricultural extension.

10. There is a vital need for extension services, awareness raising and training for governmental officials in urban development department, investment authority, Ministry of Trade and Industry to enable them to consider developing future plans for a location of chemical factories and stores away from populated and residential areas.

These are addressed to the NPC.

11. Agricultural extension administration should be represented as one of the relevant departments in the NPC.

12. Hard work and intensive efforts should be done with the various concerned governmental and non-governmental institutions to
activate initiated Sudan pesticide safe use project proposed by Sudan Agrochemicals Association (SAGA) since 1999.

13. Extension service should be studied and evaluated with the view of creating communication with various organizations involved in pesticide activities in order to perform high level of coordination so as to:

- Provide accurate information about the exposure to many hazardous pesticides.
- To ensure that pesticide exposure incidents enter the official records.
- Accumulate evidence to inform regulators, researchers, decision-makers to deal more effectively with problems of pesticides exposure.
- Support victims and/or their families to the extent possible in their efforts to gain compensation for their injuries.
- Provide training facilities and organization of specialized workshops on issues of mutual concern.
- Set up an information and document centre to provide reliable information on the health and environmental hazards of pesticides.
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المراجع العربية

۱. عبد الله بن ﷲ وضيفة الدين تاج ﷲ فتح الدين تاج علی

۲. عثمان محسن محمد متكول (١٩٠٢).

۳. الفتي عبيد محمد عيسى (٢٩٩١).
Appendix (1a)
Questionnaire (1)
Effects of pesticide on human residents around pesticides store

Date:
1. Serial No. (  )

2. Name: ..............................................................

    Female (  )    Male (  )  3. Gender:

4. Tribe: .....................................................................

5. Marital status:

    (  ) Single    (  ) Married
    (  ) Widow    (  ) Divorced

6. Age: ......................................................................

7. Qualification:

    (  ) Khalwah (Quarnic scholl) (  ) Illiterate
    (  ) Intermediate (  ) Primary
    (  ) University (  ) Secondary
    (  ) Postgraduate

8. Number of children within the family:

    Females (  ) Males (  )

9. Occupation:

    (  ) Employee    (  ) Labour
    (  ) Housewife    (  ) Free business

10. Length of residence

    ...........................................................................

11. Distance and direction of your house from the pesticides store

    ...........................................................................

12. What are the source of potable water
( ) Artesian well    Well ( )
( ) Main water-network

Other sources (specify) .................................................................

13. Sources of water for other purposes:
Different (specify) ( ) Same as the potable water ( )

14. Do you have knowledge of pesticide?
No ( ) Yes ( )

15. If yes, fill in the following table:

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxic effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precaution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16. Where did you get this knowledge?
Newspapers ( ) TV. ( ) Radio ( )
Environmental conservation Society of the area ( )
Other (specify) .................................................................

17. If No, why?
( ) Lack of information
( ) I am not interested to know

18. Are there strange smells around the warehouse?
No ( ) Yes ( )

19. If yes, in which season the smells are stronger?
Autumn ( ) Winter ( ) Summer ( )

20. Do these smells get stronger during strong winds?
No ( ) Yes ( )

21. Is there any change in colour or smell of the stagnated waters around the store?
22. If yes, describe these change.

23. To what extend are man, animal and plant affected by the pesticides in the area?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal</td>
<td></td>
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<td></td>
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<tr>
<td>Plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24. Do you feel any of the following symptoms, either after living at the area, or while you are at this site?

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Headache</td>
<td></td>
</tr>
<tr>
<td>Abdominal cramps</td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
</tr>
<tr>
<td>Inappetence</td>
<td></td>
</tr>
<tr>
<td>Runny – nose</td>
<td></td>
</tr>
<tr>
<td>Sneezing and flu</td>
<td></td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
</tr>
<tr>
<td>Over-sweating</td>
<td></td>
</tr>
<tr>
<td>Dyspnea</td>
<td></td>
</tr>
<tr>
<td>Shaking</td>
<td></td>
</tr>
<tr>
<td>Spasm conv.</td>
<td></td>
</tr>
<tr>
<td>Inability to move</td>
<td></td>
</tr>
<tr>
<td>Paralyze</td>
<td></td>
</tr>
<tr>
<td>Miscarriage</td>
<td></td>
</tr>
<tr>
<td>Respiratory disorder</td>
<td></td>
</tr>
<tr>
<td>Allergy</td>
<td></td>
</tr>
<tr>
<td>Tumour or abnormal physical bruises</td>
<td></td>
</tr>
</tbody>
</table>

25. When did you feel these symptoms?

After living at the area (   ) Before living at the area (   )

26. If yes, in which season do you feel these symptoms?
( ) Autumn ( ) summer
( ) All over the year ( ) winter

27. Have you ever made medical check-ups to treat the symptoms?

No ( ) Yes ( )

28. Are there any empty pesticides containers being utilized at the area?

No ( ) Yes ( )

29. If yes, in what way?
Appendix (1b)

Questionnaire (2)

Effects of pesticide on human residents around pesticides store

Date:

1. Serial No. (     )

2. Name: ............................................................................................................

3. Gender:
   - Female (     )
   - Male (     )

4. Age: ............................................................................................................

5. Marital staus:
   - Single (     )
   - Married (     )
   - Widow (     )
   - Divorced (     )

6. Number of children within the family:
   - Females (     )
   - Males (     )

7. Education level:
   - Illiterate (     )
   - Khalwah (     )
   - Primary (     )
   - Intermediate (     )
   - Secondary (     )
   - University (     )
   - Postgraduate (     )

8. Experience (year of work)
   - 11 – 20 years (     )
   - 1 – 10 years (     )
   - > 30 years (     )
   - 21 – 30 years (     )

9. Number of shifts per day:
   ............................................................................................................
   ............................................................................................................

10. Do you know that pesticides are hazardous products:
    - No (     )
    - Yes (     )

11. The source of your knowledge ?
12. Have you ever had training on pesticide (storage, handling, transportation, … etc)

No ( ) Yes ( )

13. If yes, specify the type of training, its duration and the organizer.

A regular course less than a week ( )
A regular course more than a week ( )
A regular course for a week ( )
A regular course for more than a week ( )

14. Do you use protective clothing while dealing with pesticide?

No ( ) Yes ( )

15. If yes, why?

Not important ( ) Not available ( )
Others ( ) Inconvenient does not suit the climate ( )

16. After being exposed to pesticides you wash your self using:

Soap and water ( ) Water only ( )
Others ( )

17. If no, why?

Water and soap not available ( )
Because you are not a ware of the hazard of contamination ( )

18. If part of the pesticide spilled over your body, what would you do?

You immediately wash your self and change your clothes ( )
You wash your self and change your clothes after work ( )
Never care ( )

19. Are there washing facilities at the work site?

No ( ) Yes ( )

20. If yes, what type:

Booth ( ) Bath-rooms ( ) Basins ( )
21. If there is a spillages of pesticides on stores floor, what would you do?

( ) Nothing  
( ) Remove the contaminated soil and bury  
( ) Add water to the contaminated soil  
( ) Repacked the pesticide

22. In what way the empty containers are disposed?

( ) Burried away  
( ) Stored for a time  
( ) Store inside the storage room waiting sale

23. In the case of sale, are they washed first

No ( )  
Yes ( )

24. Have you ever felt any of the following symptoms after dealing with pesticide? and to what extent

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td></td>
</tr>
<tr>
<td>Abdominal cramps</td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
</tr>
<tr>
<td>Blurred vision</td>
<td></td>
</tr>
<tr>
<td>Lack of appetite</td>
<td></td>
</tr>
<tr>
<td>Runny nose</td>
<td></td>
</tr>
<tr>
<td>Flue &amp; sneezing</td>
<td></td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
</tr>
<tr>
<td>Over sweating</td>
<td></td>
</tr>
<tr>
<td>Chest tightness</td>
<td></td>
</tr>
<tr>
<td>Shivering</td>
<td></td>
</tr>
<tr>
<td>Convulsions</td>
<td></td>
</tr>
<tr>
<td>In ability to move</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>Paralysis</td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td></td>
</tr>
<tr>
<td>Skin irrigation</td>
<td></td>
</tr>
<tr>
<td>Tumours</td>
<td></td>
</tr>
</tbody>
</table>

25. Are there any periodical medical examination?

No (  )    Yes (  )

26. Attitude of drivers

<table>
<thead>
<tr>
<th>Activities</th>
<th>No</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Usually</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrying pesticide with other goods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washing out the vehicle after unloading operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Give completely safety check to vehicles before transportation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide the car with protective cloths, first aid kit and symbols of danger and cover for dusty products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make sure that there is no leaky containers to be transported</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix (2)

Frequency distribution of the residents according to personal characteristics.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td>Male</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>59</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>20-40</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>41-60</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>&gt;60</td>
<td>9</td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td>Single</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Married</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>Divorce</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Widow</td>
<td>5</td>
</tr>
<tr>
<td><strong>Educational level</strong></td>
<td>Illiterat</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Molderate</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Higher</td>
<td>1</td>
</tr>
<tr>
<td><strong>Family size</strong></td>
<td>1-5</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>6-10</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>&gt;10</td>
<td>1</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td>Governmental labour</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Private labour</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Employee</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>House wife</td>
<td>40</td>
</tr>
</tbody>
</table>
**Appendix (12)**

Use of protective clothes

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>(not available)</th>
<th>Uncomfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>27</td>
<td>10</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>%</td>
<td>100</td>
<td>37.0</td>
<td>63.0</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Group II</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>35</td>
<td>1</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>%</td>
<td>100</td>
<td>2.9</td>
<td>97.1</td>
<td>100%</td>
</tr>
</tbody>
</table>

Group I: frequently exposed to pesticides
Group II less frequently exposed to pesticides
Appendix (17)

Frequency distribution of the respondents according to presents of washing facilities

<table>
<thead>
<tr>
<th>Group</th>
<th>Yes</th>
<th>No</th>
<th>Basins</th>
<th>Bath rooms</th>
<th>Basins + bath rooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I (27)</td>
<td>18</td>
<td>9</td>
<td>14</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>100</td>
<td>66.7</td>
<td>33.3</td>
<td>77.8</td>
<td>11.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Group II (35)</td>
<td>27</td>
<td>8</td>
<td>21</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>100</td>
<td>77.1</td>
<td>22.9</td>
<td>77.8</td>
<td>18.5</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Group I: frequently exposed to pesticides
Group II less frequently exposed to pesticides