ESTABLISHMENT OF A COMPREHENSIVE SURVEILLANCE SYSTEM FOR ACUTE PESTICIDE POISONING IN TANZANIA

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DECLARATION

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LIST OF ABBREVIATIONS

AchE:	Acetylcholinesterase Enzyme
APP:	Acute pesticide poisoning
CDC:	Centers for Disease Control and Prevention
CFR:	Case Fatality Rate
CNS:	Central nervous system
DDT:	Diphenyl Dichloro Trichloroethene
DNA:	Designated National Authority
DALDO:	District Agriculture and Livestock Development Officer
US EPA:	Environmental Protection Agency
FAO:	Food and Agriculture Organization
GCLA:	Government Chemistry Laboratory Agency
GHS:	Globally Harmonized System of Classification and Labeling of Chemicals
HCF:	Health Care Facility
HCP:	Health Care Provider
HEED:	Health and Economic Consequences of Pesticides
HMIS:	Health Management Information System
IDRC:	International Development Research Center
ILO:	International Labour Organization
IR:	Incidence Rate
IPCS:	International Program on Chemical Safety
KCMC:	Kilimanjaro Christian Medical Center
MR:	Mortality Rate
MTUHA:	A Swahili acronomy for HMIS (see above) and it is abbreavated as "Mfumo wa Taarifa za Uendeshaji wa Huduma za Afya".
NIOSH:	National Institute for Occupational Safety and Health
NSGRP:	National Strategy for Growth and Reduction of Poverty
OP:	Organophosphates
OC:	Organochlorines
OPD:	Out Patient Department
OSHA:	Ocupational Safety And Health Authority
PAHO:	Pan American Health Organization
PIC:	Prior Informeed Consent
PCC:	Poisoning Control Center
PNS:	Peripheral nervous system
PPA:	Plant Protection Act
PPE:	Personal Protective Equipment
PRR:	Prevalence Risk Ratio

PY: Pyrethroids

SMS: Subject Matter Specialist

SENSOR: Sentinel Event Notification System for Occupational Risk

TPRI: Tropical Pesticides Research Institute

UCT: University of Cape Town

UNEP: United Nations Environmental Program

WAHSA: Work and Health in Southern Africa

WHO: World Health Organization

GLOSSARY OF TERMS

Pesticide and different types of pesticides

Pesticide: Any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or animal diseases, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products, or animal feed, or which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant, or agent for thinning fruit or preventing the premature fall of fruit, and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport (FAO, 2003).

Different types of pesticides include:

Acaricides: Pesticides used for controlling ticks and mites.

Avicides: Pesticides used for controlling bird pests.

Fungicides: Pesticides used for controlling fungal diseases.

Herbicides: Pesticides used for controlling weeds.

Insecticides: Pesticides used for controlling insect pests.

Molluscicides: Pesticides used for controlling snails and slugs.

Plant growth regulators: Pesticides used for controlling plant growth.

Rodenticides: Pesticides used for controlling rodents.

Other terms:

Acute pesticide poisoning: Any pesticide related injury or health effect, including systemic and non-systemic effects, resulting from suspected or confirmed exposure to a pesticide within 48 hours (WHO, 2008).

Accidental Poisoning: Unintentional poisoning that is unexpected or unforeseen. For the purpose of this thesis, this definition is distinguished from those cases which result from work practices, defined below as "occupational poisoning."

Active ingredient: The biologically active agent present in a pesticide formulation.

Adjuvant: Any adhesive, deposit builder, emulsifying agent, spreading agent, synergist or wetting agent intended to be used as an aid to the application of a pesticide.

Banned product: A pesticide for which all registered uses have been prohibited by final government regulatory action or, for which all requests for registration or equivalent action for all uses have, for health and environmental reasons, not been granted.

Common name: The name assigned to a pesticide active ingredient by the International Standards Organization or adopted by national standards authorities to be used as a generic or non-proprietary name for that particular active ingredient only.

Defoliant: Any chemical sprayed or dusted on plants to cause its leaves to fall off.

Desiccant: A substance with a great affinity for water, used as a drying agent.

Exposure: Human contact with the agent (pesticide) at the boundary between the individual and the environment

Formulation: The combination of various ingredients designed to render the product useful and effective for the purpose claimed. This is the form of the pesticide as purchased by users.

Homicide: Situation where one kills another person deliberately.

Intentional Poisoning: Poisoning resulting from an intention to cause self-harm or to harm others deliberately.

Label: The written printed or graphic matter on, or attached to, the pesticide container or packaging.

Manufacture: Means the production, by a corporation or other entity in the public or private sector or any individual engaged in the business or function (whether directly or through an agent or through an entity controlled by or under contract with it) of the active ingredient of the pesticide or preparation of its formulation or product.

Designated National authority (DNA): The government agency or agencies responsible for regulating the manufacture, distribution or use of pesticides and more generally for implementing pesticide legislation.

Occupational Poisoning: Poisoning occurring during work or away from work as a result of an occupational exposure where a pesticide was being used in the context of work process.

Pictogram: A symbol displayed on a pesticide label which conveys a message visually regarding pesticides handling or storage without the use of words.

Registration: Means the process whereby the responsible national government authority approves the sale and use of a pesticide following the evaluation of comprehensive scientific data demonstrating that the product is effective for the purposes intended and not unduly hazardous to human or animal health or the environment.

Severely restricted pesticides: Pesticides for which virtually all registered uses have been prohibited by final government regulatory action but certain specific registered use/s remain authorized.

Sign of poisoning: An indication of an illness or condition experienced by a person which is physically detectable through a physical (medical) examination.

Symptom of poisoning: An indication of an illness or condition experienced by a person which they feel or are able to report but which is not dependent on a physical examination. Symptoms can only be elicited in response to asking a person affected. Symptoms may or may not be associated with physical signs.

Thinning: The selective removal of flowers, fruits, shoots, and seedlings or young plants to allow adequate space for the remaining organs/plants to grow efficiently.

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ABSTRACT (350 words)

Widespread under-reporting of acute pesticide poisoning (APP) in developing countries, such as Tanzania, leads to under-estimation of the burden from APP. This thesis aimed to characterize the health consequences of APP in rural agricultural areas in Tanzania with a view to developing an effective surveillance system for APP.

Several sub-studies comprise this thesis: A household survey of farmers; A hospital data review for APP, both retrospective, covering a 6-year period, and prospective for 12 months; Health care providers' knowledge and practices relating to APP and notification; Pesticide retailers' knowledge, distribution and handling practices; Stakeholder views regarding APP, notification and risk reduction strategies; and an assessment of APP data from sources other than the hospital system.

The study found that major agents responsible for poisoning included Organophosphates and highly or moderately hazardous products and the age group 20 – 30 years was most affected. The majority of health care providers lacked skills for diagnosis of APP. The most problematic circumstances of poisoning in hospital data review was suicide but was occupational with pesticide stakeholders and in household surveys. Prospective data collection in the hospital review reduced the amount of missing data, suggesting that with proper training and support, hospital-based reporting can provide better surveillance data. Many farmers and pesticide retailers had unsafe practices likely to result in exposure and risk for poisoning. Modelling suggested that the Incidence Rate for occupational poisoning ranged from 11.3 to 279.8 cases per million people with a medium estimate of 32.4 cases per million people.

The study identified a high burden from APP in Tanzania, largely unreported, particularly from occupational poisonings, and proposes an APP surveillance system for Tanzania aimed at addressing both workplace and non-workplace settings. The system is expected to identify poisoning outbreaks, circumstances and outcomes, agents, poisoning patterns by gender, age, population and geographical areas most affected. Data sources for the system will include health care facilities and other government Institutions, media and community members through community self-monitoring. The system is expected to generate rate estimates and trends for pesticide poisoning, identify opportunities for prevention, further research needs and, ultimately, assist in reducing health risks arising from pesticide exposure.

EXTENDED SUMMARY

Background and aim

Pesticides are extensively used in Tanzania for control of various pests in agriculture, public health and livestock production. The huge amount of pesticides used coupled with unsafe handling practices in Tanzania suggest a high potential for human exposure, health injuries and illness. Reliable data on the burden caused by acute pesticide poisoning in Tanzania are not available due to the lack of a surveillance system for acute pesticide poisoning. The aim of this study was to determine the extent of acute pesticide related illness and injury among farmers and their families in Tanzania and the extent of under-reporting across different sources of data in order to propose a surveillance system.

Methodology

The study included six sub studies namely (i) a farmers' household survey which involved evaluation of the profile of pesticides handled, and farmers' knowledge, practices and poisoning associated with pesticides in 7 rural farming areas of Arumeru district in North Tanzania; (ii) Hospital-based surveys for APP, both prospectively and retrospectively, in selected regions of Tanzania which aimed at characterising APP documented, describing agents responsible for poisoning and estimation of poisoning rates; (iii) Characterization of health care providers' knowledge, diagnosis and management of APP in selected regions of Tanzania; (iv) Evaluation of Tanzanian pesticide stakeholder views regarding awareness of APP, notification and risk reduction strategies for APP; (v) Characterization of pesticide retailers' knowledge, products distributed and pesticides handling practices in selected regions of Tanzania and (vi) Characterization of APP in selected regions in Tanzania reported to the Ministry of Home Affairs (Police department), the Government Chemistry Laboratory Agency (GCLA), the Tanzanian Occupational Safety and Health Authority (OSHA) and articles in local newspapers. The study designs in these sub-studies were largely descriptive but include some cross sectional analysis of risk factors. Data was collected in 2005 using standard data collection sheets for each study.

Data analysis involved univariate descriptive statistics for frequencies and percentages of all categorical or count variables. Chi square testing was used to compare distributions of dichotomous variables and multivariate logistic regression was used to measure associations of variables. Estimation of the burden of underreporting of APP was conducted by modelling the true rates for occupational APP in Tanzania and adjusting reported rates for the burden of missing cases. The statistical software used to analyze the data was SPSS version 16 and Stata Version 10.0. The study protocol was approved by Tropical Pesticides Research Institute ethical committee and the National Institute of Medical Research in Tanzania (REF NIMR/HQ/Vol XI/371) and also by the University of Cape Town Health Science Faculty Research Ethics Committee in South Africa (328/2004).

Findings

Firstly, this study has characterised the pattern of APP cases in selected health care facilities in Tanzania. The major agents responsible for poisoning including OP's and WHO I and II products. Persons in the productive age of 20 – 30 years are most affected by APP. Suicide appears to be the major circumstance for poisoning seen at health facilities. Secondly, the majority of occupational poisoning cases affecting farmers are rarely reported to hospitals and, as a result, they are likely to be omitted in surveillance data

and hence contribute to underreporting. Thirdly, the data collected in this study demonstrated large volumes of missing information, which is largely due to the absence of a sound surveillance system for APP. However, the improvement in data quality in the prospective hospital-based study and reduction in the extent of unknown data is a clear indication that with proper training and awareness creation, surveillance systems can better capture the majority of the APP cases. Fourthly, this study has also shown that majority of the farmers in the study site had good knowledge on routes of exposure but had unsafe practices likely to result in exposure and risk for poisoning. Common poisoning symptoms encountered by farmers were documented and the patterns of symptoms were consistent with both the pattern of products commonly used by the farmers (OPs and WHO class II agents) and with agents they linked with poisoning. This suggests that surveillance of usage and distribution of pesticides might be an important strategy for public health prevention. Fifthly, the study found that majority of health care providers (HCPs) in Tanzania lack skills for the diagnosis and management of APP. The APP cases handled by the HCPs are reported in the national Health Management Information System (HMIS) without adequate details needed for surveillance purposes.

Sixth, the study also confirmed that pesticide stakeholders perceive APP as a serious problem in the Tanzanian community and recognise that occupational circumstances are an important risk. This suggests that successful interventions may be possible because most of these stakeholders are decision-makers and can therefore influence decisions on APP reduction interventions.

Seventh, the study further found that pesticide distribution in Tanzania by pesticide retailers is accompanied by many unsafe handling practices likely to contribute to the burden from APP affecting both the retailers as well as the farmers. The study found consistency between the pattern of products sold by pesticide retailers and those found to be associated with APP, which suggests that surveillance should not only be for APP but also should keep track of retailer sales.

Eight, this study has developed the first APP rate estimates for Tanzania in terms of mortality and incidence. Modelling suggests that the Incidence Rate for occupational poisoning is likely to range from 11.3 to 279.8 cases per million people with a medium estimate of 32.4 cases per million people. Despite underreporting of APP cases, establishment of these rates is a tremendous achievement, being a first for Tanzania and perhaps for the SADC region. However, further studies are necessary to improve the accuracy of these estimates.

Ninth, this study showed that only 50% - 67% of data needed for PIC notification of severely hazardous pesticides under the Prior Informed Consent convention could be located in existing surveillance data. This is due to the absence of a surveillance system for APP in Tanzania and the fact that PIC system demands many parameters in the data collection. This means that chemicals that should be listed for review under the PIC provisions avoid inclusion even when they pose serious hazards under normal conditions of use in developing countries.

Tenth, factors confirming the need of surveillance in Tanzania were demonstrated in this study – these include the high usage of pesticides, high morbidity and mortality, diversity of the agents used, poor safety knowledge and practice among users, poor capacity of health care providers to identify and notify cases and inadequate information systems.

Conclusion

To address the burden of injuries arising from APP , a system is proposed for APP surveillance in

Tanzania aimed at addressing poisoning arising from pesticides in both workplace and non-workplace settings. The proposed surveillance system is expected to identify outbreaks of APP, circumstances and outcomes of pesticide poisoning, agents responsible for poisoning, poisoning patterns by gender, age, population groups and geographical areas most affected. Data sources for the system will include health care facilities and other sources (such as media, cases from the Government Chemistry Laboratory Agency, police records, and OSHA records), so as to capture both severe and less severe APP cases, which are usually not reported to health care facilities. Community surveillance involving data collection by community members will be used as complementary to facility-based surveillance. The system is expected to generate rate estimates and trends for pesticide poisoning, identify opportunities for prevention, further research needs and, ultimately, assist in reducing health risks arising from pesticide poisoning.

CHAPTER 1.0: INTRODUCTION

1.1 Pesticide use in Tanzania

Pesticides are extensively used in Tanzania to the control various pests and diseases in agriculture as well as livestock production and to combat human vector-borne disease. The demand for food self-sufficiency and food security has led to increasing use of pesticides. Cotton, horticultural crops and coffee are crops which consume large quantities and varieties of pesticides, mostly fungicides, followed by insecticides and herbicides (United Republic of Tanzania, 2006). Among the insecticides used in Tanzania, organophosphates (OP) are most commonly used followed by carbamates and pyrethroids. Organochlorinesas a class are the least used products in Tanzania since most have been deregistered due to health and environmental concerns (Mbakaya et al, 1994; United Republic of Tanzania, 2006).

Most of Tanzania's population of 35 million people (United Republic of Tanzania, 2002) live in rural areas and 85% of the country's workforce is engaged in agriculture, which is the core of the national economy (Akhabuhaya, 2005). Cultivation of horticultural crops in Tanzania normally generates high earnings per unit area and is often an alternative for farmers where acreages are too small to provide adequate income from field crops (Mwasha, 1998). With the liberalization of agricultural markets in developing countries, the number of small scale farmers growing vegetables for both domestic and export markets is increasing (Dinham, 2003). Vegetable cultivation attracts high rates of application of pesticides and farmers in many developing countries use many acutely toxic insecticides on these crops (Dinham, 2003; Williamsom et al, 2003). Apart from application of pesticides, exposure can also occur for farmers involved in the harvesting process or who enter the sprayed field too soon after spraying.

Active ingredients registered for use in vegetable and coffee production in Tanzania are listed in Annex 1 & 2 (United Republic of Tanzania, 2006). Of the active ingredients registered for use on vegetables, the largest single group (20%) is organophosphates and 60% are classified by the World Health Organisation (WHO) as either highly (Class I) or moderately (Class II) hazardous (United Republic of Tanzania, 2006). Coffee in Tanzania has been a cash crop for many years contributing substantially to the country's Gross Domestic Product (GDP) (United Republic of Tanzania, 2002) and its cultivation consumes huge quantities of pesticides (Ngowi et al, 2001a; Lekei et al, 2006). Of the active ingredients used in coffee production, organophosphates account for 14% and they rank second after triazoles. Excluding experimental products, about 42% of all active ingredients registered for coffee include products classified as extremely, highly or moderately harzadous by WHO (Annex 2).

Tanzania's economy is similar to economies of many developing countries, where agriculture plays a critically important role (Forasteri, 1999; Stringer et al, 2004). Over 60% of the economically active population in the Third World depend on agriculture (WHO/UNEP, 1990). In Latin America, for example, agricultural production provides economic support to 112 million people (Stellman, 1998) and in Central America it supports 4.3 million people (Wesseling, 2000).

There is a general belief that pesticides are essential for development and to meet the need to increase food production (FAO, 1990). This has led to the use of pesticides as the most common solution to pest problems in agriculture. As a result, farmers in India are often highly exposed to pesticides (Gupta, 2004). The benefits of these pesticides, however, have to be balanced against the risk posed to farmers and other agricultural workers (Litchfield, 2005). For this reason, it is important to consider the potential adverse effects of pesticides on human health.

1.2 Pesticide exposure and health effects: Overview

Health is recognized as one of the most important components of human and resource capital of rural populations in developing countries. Of the 8 Millennium Development Goals intended to relieve global poverty, 4 are related directly to health. Agricultural work, particularly in developing countries, carries a significant risk for injury and illness related to pesticide handling (Jeyaratnam, 1990; Kishi, 1995; Senanayake et al, 1995; Wesseling et al, 1997; Eddleston, 2000). Over 2.5 million tons of pesticides, worth US$ 30 billion, are applied to crops worldwide annually (Gannage, 2000; McKenzie, 2001). Direct exposure to pesticides can occur at all stages of pesticides handling, while indirect exposure may occur with ingestion of contaminated foodstuffs, contamination of water for washing and drinking, and through drift into domestic environments. Improper use, lack of awareness and poor knowledge on safe handling of pesticides contribute to the risk of both acute and chronic health effects from pesticide exposure (Galden, 1998; Sodav et al, 2000; Konradsen et al, 2003).

The effects of pesticides on human health may be due to direct organ toxicity or due to allergic mechanisms. Allergic effects involve the development of a reaction after pesticide exposure through a process known as sensitization. Such effects may include respiratory sensitization manifesting as asthma, skin sensitization manifesting as dermatoses, and ocular and nasal sensitization manifesting in allergic conditions.

Direct toxicity may manifest as either acute or chronic effects. Acute effects typically appear immediately, usually within 24 to 48 hours of exposure (IPCS/WHO, 1999). These effects are more easily and accurately diagnosed than delayed (chronic) effects because they tend to be more obvious and can be more easily linked in time and place to exposure. Often, they may be reversible or cured if appropriate medical care is given promptly, but may be fatal, particularly if not properly treated. Health effects resulting from acute exposure depend upon the nature of the chemical substance, the dose and the route of exposure and individual susceptibility.

Generally, there are local and systemic acute effects. Local acute effects involve only those parts of the body with which the pesticides come into contact. Local acute effects can be irritant effects such as burning, redness and itching of the eyes, nose, throat or skin; watering of the eyes, irritation of the mucous membrane of the respiratory system causing cough. Systemic effects of pesticide poisoning occur when the pesticide is absorbed into the body and affects one or more organ systems.

Acute pesticide poisoning (APP), manifested as local and systemic poisoning, is a particularly important occupational and public health problem in developing countries (Jeyaratnam et al, 1985; Jeyaratnam, 1990; WHO/UNEP 1990; He et al, 1999). More than 50 % of all acute pesticide poisonings and 99% of pesticide-related fatalities occur in less industrialized countries (Schlosser, 1999). This illustrates the impact of deficient hygiene and safety conditions under which these products are used (Henao et al 2002; Gunnell et al, 2003). Due to poverty, small scale farmers in developing countries are often the most vulnerable to pesticides exposure and poisoning (Schlosser, 1999).

Reliable data on the incidence of pesticide poisoning are rare in most countries (Kishi, 2001; Murphy et al, 2002). However, most countries recognize that the magnitude of pesticide poisoning is not well known and that available figures represent only a small fraction of pesticide poisoning. Only a small proportion of poisonings are reported to the health care system and these are usually severe cases of ingestion from suicide attempts (London et al, 2005). The bulk of cases which are mild to moderate poisonings, from occupational circumstances and accidents, are not necessarily reported to the health care system due to costs, inaccessibility of services and fear of losing employment (Murphy et al, 2002). Therefore, the magnitude of occupational pesticide poisoning may be so underestimated that it cannot effectively inform policy (London and Bailie, 2001; Corriols et al, 2008).

As a result, different initiatives to address the under-recognition of APP have been implemented at national and international levels. For example, the United States redesigned its national surveillance system to improve capability of capturing of APP cases (Murphy, 2002). The WHO's International Program on Chemical Safety (IPCS) piloted a pesticide poisoning surveillance system for developing countries (WHO, 2000; Murphy et al, 2002; Thundiyil et al, 2008), the main objective of which was to assess the extent of human pesticide poisoning with a view to planning prevention, treatment and educational activities in cooperation with other partners.

The acute effects of pesticide exposure are relatively well understood. By contrast, much more uncertainty surrounds long-term or chronic effects, especially those believed to arise from low-level exposures to pesticides, for example through residues in food or water. Chronic effects are illnesses or injuries that persist over long periods and may not appear until several years after exposure to a pesticide. Chronic effects include production of tumours, malignancy or cancer and changes in the genes or chromosomes. Developmental and reproductive effects occur in the foetus by exposure to the reproductive system in men as well as women. These effects include birth defects, miscarriage or stillbirth, infertility or sterility. A delayed systemic effect is an illness or injury that does not appear within 24 hours of exposure. Such effects include blood disorders such as anaemia or an inability to coagulate; nerve or brain disorders such as paralysis, tremors, behavioural changes and brain damage; skin disorders such as porphyria; lung and respiratory disorders such as emphysema and asthma; and liver and kidney disorders such as liver and kidney failure.

Several studies have shown that many people who experience acute pesticide poisoning from organophosphates later suffer long-term neurological damage such as muscle weakness or paralysis, sensory disturbances and reduced memory and attentiveness (Ruijten et al, 1994; Ames et al, 1995; London, 1997; Delgado et al, 2004). Since organophosphates may account for as much as 70% of occupational pesticide poisonings (WHO, 1990), the number of people suffering such neurological damage could be substantial.

Chronic dermatitis, which includes rashes and enhanced sun sensitivity, is one of the most common effects of pesticide exposure seen in farm workers (WHO, 1990). For example, the fungicides chlorothalonil and maneb have been identified as risks factor for dermatitis among banana plantation workers in Panama (Penagos et al, 1996) and potato growers in Equador (Cole et al, 1997).

Pesticide exposure may also cause reproductive damage. Male sterility has been conclusively linked to heavy exposure to dibromochloropropane (DBCP), once commonly used to control nematodes (Garry et al, 1996). Several epidemiological studies suggest that exposure to certain pesticides, particularly the herbicide 2,4-D, which is widely used on crops, pastureland, rights-of-way, and lawns heightens the risk of birth defects, although the evidence is not conclusive (WHO, 1990; Garry et al, 1996). A study conducted in California suggests that maternal organophosphorus (OP) pesticide exposure is associated with poorer fetal growth, although the findings are inconsistent (Harley et al, 2011).Pesticide exposure has also been implicated in cases of immune system suppression (Reppeto et al, 1996; Nordby et al, 2005). A compromised immune system makes it more difficult to fight off infectious diseases, parasites, or tumors, and could increase the toll of these threats on human health. This combination could be particularly significant in developing countries, where the population's exposures to both pesticides and infectious agents such as human immunodeficiency virus (HIV) infection may be high and their immune systems already be compromised by other factors (Naidoo et al, 2011).

Epidemiological studies suggest a link between some pesticides and cancer. Recent studies conducted in US link cancer risk and methyl bromide (Barry et al, 2012), terbofos (Bonner et al, 2010), pendimethalin (Andreotti et al, 2009). Others studies have shown an association between exposure to organochlorines and various cancers, including lymphoma and leukemia, as well as lung, pancreatic, and breast cancer (Zahm et al, 1995). Such findings are significant because organochlorines such as DDT, aldrin, and chlordane are widely dispersed in the environment and can easily accumulate in human tissues. Epidemiological evidence links exposure to several common herbicides with cancer. Several studies have found an association between 2,4-D and non-Hodgkin's lymphoma (Zahm et al, 1992; Blair et al, 1993). In one study, farmers exposed to the herbicide for more than 20 days per year had a six fold higher risk of non-Hodgkin's lymphoma, and those who mixed or applied the herbicide themselves had an eightfold greater risk (Hoar et al, 1986).

Occupational factors may therefore make an important contribution to the global burden of disease (Hamalainen et al, 2009) which has long term implications for economic development (Driscoll et al, 2005; WHO, 2005; Fingerhut et al, 2006; Rantanen, 2007; Hamalainen et al, 2009). Work related morbidity and mortality not only result in suffering and hardships for the workers, farmers and their families but also adds to the overall cost to society through lost productivity and increased use of medical and welfare services. This cost has been estimated at between 2 and 14% of the GDP in different studies in different countries (Mikheev, 1994). Absence from work due to illness and both temporary and permanent disability, as may arise due to exposure to hazardous pesticides, may therefore have a direct impact on economic development. The report of the WHO Commission on Social Determinants of Health highlighted the link between health and economic development and emphasized that the poorest populations are disproportionately affected by preventable and curable diseases and bear the financial burden of illness (WHO, 2005).

Given that there are high levels of exposure to pesticides in developing countries, and that many studies have revealed a high burden from pesticide poisoning, reduction of health hazards arising from APP may contribute to increasing capacity for production and thereby promote economic development.

1.3 Occupational health risks associated with pesticide use in Tanzania

Many small scale farmers in Tanzania are at high risk of adverse pesticide health effects because of extensive use on local farms and chances of exposure from other non-work related sources, such as domestic contamination and accidental spills or discharges. Farming is unlike other occupations in that the workplace is often the same setting as the home (Figure 1.1) and family members may assist in farm activities as a family enteprise. Thus, families of small scale farmers may have additional opportunities for indirect exposure to occupational hazards regardless of whether they themselves engage in farming.

Figure 1.1: A residential house within a coffee farm intercropped with banana.

A previous study in Tanzania identified pesticide poisoning as a major problem in the community, reported by 63% of all health care providers interviewed (Ngowi et al, 2001b). In coffee growing areas of Tanzania, an average of 62 poisoning cases were recorded in local hospitals per year over the period 1980 – 1990 and most of these cases were due to attempted suicide (Ngowi et al, 1992). The study also revealed that there was poor recordkeeping regarding the agents responsible for poisoning. In another study conducted in Dar es Salaam, Tanzania, among the 42 poisoning cases recorded, 29.2% were caused by pesticides and 70% were caused by unknown chemical products (Ndosi et al, 2004) possibly including pesticides.

Apart from agricultural activities, occupational pesticide exposure in Tanzania may also arise from activities in pesticide stores, retail shops, formulation plants and transportation. Most pesticides used in Tanzania are imported from industrialized countries by licensed pesticide importers and a total of 47 licensed importers were registered with TPRI at the end of 2005 (TPRI, 2005). Despite this, a small quantity is sourced locally from the 12 formulation plants licensed under the Plant Protection Act, 1997 (United republic of Tanzania, 1997; Lekei et al, 2007). These local formulators produce a range of pesticides including Permethrin, D Allethrin, Copper Oxychloride, Atrazine, Pyrethrins, Bromodiolone, Endosulfan, Alpha Cypermethrin, Mancozeb, Chlorothalonil, 2,4-D, Carbaryl, Cyhalothrin (Lekei et al, 2007). Notably, no OP products are locally produced - all OPs used in the country are directly imported (Lekei et al, 2007). Ensuring safe pesticide handling and use, especially in rural areas through national legislation, is difficult in Tanzania, a situation similar in many developing countries (London et al, 2000; London, 2003; Ngowi et al, 2006; London et al, 2008).

1.4 The need for surveillance of Acute Pesticide Poisoning (APP).

Rates of pesticide poisoning in some regions of the world surpass those of many of the acute infectious health problems traditionally considered to be among the most frequent and severe in developing countries (Choi et al, 2001; London et al, 2001; Osorio, 2002). While APP is thought to affect as many as 39 million people around the world, there is no reliable global mechanism to track poisoning or diseases related to pesticide use (Besbelli, 2000; Henao et al, 2002; CDC, 2005). This situation highlights the need for effective pesticide poisoning surveillance systems.

Surveillance in public health is defined as the systematic and continuous collection, analysis, and interpretation of data on health events for the purpose of planning, execution and evaluation of health interventions (Ballard et al, 2001). Generally, illness surveillance is essential for the efficient and timely delivery of health services (Murray et al, 2002) and provides valuable guidance for health policy reform. Information provided by surveillance systems allows for the rapid mobilization of public health responses in the control of potentially contagious conditions but may also assist in the public health control of non-communicable diseases such as pesticide poisoning. A surveillance system requires developing the functional ability to compile, analyze, and disseminate data in a timely fashion to those able to undertake effective prevention and control actions (PAHO, 2001).

Operational evaluation of the effectiveness of a surveillance system should specify the purpose, goal and impact and examine the roles of surveillance programme staff, information flows, protocols for data collection and management, dissemination of findings and the effectiveness of interventions (CDC, 2001). Attributes of the surveillance system include:

Simplicity: The simplicity of a public health surveillance system refers to both its structure and ease of operation. Surveillance systems should be as simple as possible while still meeting their objectives.

Flexibility: A flexible public health surveillance system can adapt to changing information needs or operating conditions with little additional time, personnel, or allocated funds. Flexible systems can accommodate, for example, new health-related events, changes in case definitions or technology, and variations in funding or reporting sources. In addition, systems that use standard data formats (e.g. in electronic data interchange) can be easily integrated with other systems and thus might be considered flexible.

Data quality: Data quality reflects the completeness and validity of the data recorded in the public health surveillance system. Most surveillance systems rely on more than simple case counts. Data commonly collected include the demographic characteristics of affected persons, details about the health-related event, information on factors contributing to exposure, and the presence or absence of potential risk factors. The quality of these data depends on their completeness and validity.

Acceptability: Acceptability reflects the willingness of persons and organizations to participate in the surveillance system. Acceptability is a largely subjective attribute that encompasses the willingness of persons on whom the public health surveillance system depends to provide accurate, consistent, complete, and timely data.

Sensitivity: The sensitivity of a surveillance system can be considered in two levels. First, at the level of case reporting, sensitivity refers to the proportion of cases of a disease (or other health-related event) detected by the surveillance system (Weinstein et al, 1980). Second, sensitivity can refer to the ability to detect outbreaks, including the ability to monitor changes in the number of cases over time.

Representativeness: A public health surveillance system that is representative accurately describes the occurrence of a health-related event over time and its distribution in the population by place and person.

Timeliness: Timeliness reflects the speed between steps in a public health surveillance system. This attribute refers to the entire cycle of information flow from collection to dissemination. The need for timeliness depends on the public health urgency of the problem and the type of interventions available.

Predictive value positive: This describes the proportion of reported cases that actually have the disease under surveillance. This can be estimated by looking at how many of the reported cases meet the case definition or how many are eventually classified as confirmed.

Stability: This refers to how reliable is the system. This can be evaluated by checking whether the system can be operational when it is needed.

Other attributes: Reliable data implies authentic data in that similar results are produced in successive trials or studies. The data can be trusted, and depended on with a high degree of certainty. Valid data means data that is close to the truth or reality as much as possible. For effective surveillance, it is important to use standardised variables and standard case definitions. By applying a standardized format for data collection, it makes aggregation of data from different regions feasible and increases the reliability of the data. While public health surveillance is normally for infectious conditions, it can also be used for non-communicable conditions such as APP.

Surveillance for APP therefore implies the establishment of a system for capturing illness and injury data arising from pesticide handling and use in either work or non-work settings (Wesseling et al, 1997). The system encompasses illness and injury caused by single or mixed exposures to pesticide products as well as the identification of any outbreaks of pesticide related illness. Data typically collected would include population demographics, types of agents responsible, circumstances leading to poisoning, information on factors contributing to exposure, dates of exposure, severity of illness and outcomes of pesticide poisoning (fatalities, referrals). It also involves evaluation of environmental conditions that create the risk situation and detection of potential exposures, alerting authorities to the need for effective and timely intervention.

The design of a surveillance system should be based on the main objectives of the system and resources available. Establishing and promoting better methods for collecting data related to APP assist in identifying health problems caused by pesticides. The information collected can be utilized in prevention and control activities leading to a reduction in morbidity and mortality.

Surveillance for pesticide illness has increased over the past decades (Jeyaratnam, 1982; WHO/ILO/UNEP, 2000; London et al, 2001; Osorio, 2002) but the use of surveillance data for problem solving in the developing world remains quite limited (Murray et al, 2002). Problems with pesticides poisoning surveillance systems include inadequate data capturing, lack of coordination in different information systems, poor data quality and under-notification (London et al, 2001).

A limitation of surveillance systems in many developing countries is failure to provide feedback to the client communities. Commonly, the data collected is seen as the domain of the health care system and upper level policy makers (FAO, 2001). Rather than being analyzed and used at local level the data migrates only up to central Government institutions (FAO 2001). As a result, communities from which the data is derived are not aware of the magnitude of pesticide poisoning as a public health problem nor are they given the opportunity to take preventive actions or develop community solutions (FAO, 2001).

1.5 Routine data from the Health Information Management System in Tanzania

Poisoning surveillance activities in Tanzania, as in other developing countries, are poorly developed and are affected by multiple problems (Kaija, 1995). Many short-term poisonings are not reported unless they are life threatening. The few cases that do seek care at health facilities may be unrecognized because they resemble other health conditions. Furthermore, some health care providers may fail to recognize, diagnose and manage poisoning cases due to inadequate training in toxicology and occupational health (Ngowi et al, 2001b). Low income farmers, who are most exposed to pesticides, often do not have the means to seek medical care.

Tanzania has a well-established Health Management Information System (HMIS), which is a routine reporting system operating in all health facilities in Tanzania through the Ministry of Health and Social Welfare. The role of this system is to provide solutions to management questions and generate data for selected indicators. The HMIS came into operation in all regions of Tanzania in 1997. Under the HMIS, tools used for data collection include Out Patient Department (OPD) and admission registers. The OPD register records the patient's name, address, age, sex and data on type of OPD visit (new attendance or return visit), diagnosis, treatment and referrals. The admission register is used at health facilities that admit patients and includes Inpatient Number, ward, name, address, next-of-kin, age, diagnosis, date discharged and final outcome (death, recovery or referral). The districts receive raw data from health facility reports and transfer the data immediately to a district file, which is then transmitted to the regions and finally to the Ministry of Health and Social Welfare. The HMIS covers a range of health care levels, including community health at the village level, health care centers, district hospitals, regional and referral hospitals (Kaija, 1995). Information flows through the health care system to and fro including notifications for notifiable diseases such as cholera and meningitis.

Among the weaknesses of the HMIS are incomplete data collection, weak data presentation, poor data accessibility, high workload of health staff and poor availability of processed information when needed (Rubona, 2001). According to HMIS, APP falls into a category known as "Poisoning". This category covers all types of poisoning incidents and includes all poisoning cases arising from pesticides, kerosene, drugs, snakebites, insect bites plants and other agents. The system is not specific for pesticide poisoning monitoring.

Even if the network were to include pesticide poisoning, a further difficulty is inadequate expertise in the diagnosis of pesticide poisoning amongst health care providers. For example, a survey of Tanzanian health care providers in agricultural areas conducted from 1991 – 1994 indicated that 80% of health care providers had never managed a pesticide poisoning case and over 30% were not conversant with the diagnosis and treatment of pesticide poisoning cases (Ngowi et al, 2001b).

In Tanzania the National Pesticide Designated Authority in terms of the Plant Protection Act is responsible for the surveillance of pesticide distribution and use, but it does not accommodate surveillance of APP or its health effects in humans believing that it is the mandate of the Ministry of Health and Social Welfare. General poisoning cases are reported through the HMIS in the Ministry of Health and Social Welfare, which as pointed out above, lacks specificity for pesticide poisoning and any information on causal circumstances. This means the current health system in Tanzania lacks a pesticide poisoning surveillance system for planning and prevention. A previous study in Tanzania identified this problem and recommended the need for research to establish a national pesticide poisoning surveillance system (Ngowi, 2002a).

1.6 Statement of the Problem

Pesticide usage in Tanzania is high. In common with experience from other developing countries, it is anticipated that different types of pesticides used in agriculture in Tanzania may cause adverse acute health effects in farmers and their families. However, the magnitude of this problem is not known due to the lack of precise and reliable poisoning data because of the absence of a proper surveillance system for APP in Tanzania.

1.7 Significance

Policies for the prevention of poisoning and promotion of health, particularly of rural populations exposed to pesticides should be informed by good surveillance data. Comprehensive data collection and an effective surveillance system will facilitate quantifying the burden of disease from APP resulting from pesticide use and handling and identification of opportunities for control and prevention. An accurate APP database will provide justification for investing resources in the planning of appropriate intervention measures to reduce both pesticide exposure and acute poisoning. This will serve the purpose both of improving human health as well as increasing capacity for production and thereby promote economic development.

CHAPTER 2.0 LITERATURE REVIEW

This chapter reviews the literature on pesticides with particular reference to Acute Pesticide Poisoning (APP). It starts by outlining the definition of a pesticide according to the Food and Agricultural Organization of the United Nations (FAO), followed by a review of approaches to the classification of pesticides by different chemical groups, WHO hazard classes, target pests, formulation and by Globally Harmonized System of Classification and Labeling of Chemicals (GHS) systems. The chapter also describes pesticide registration categories in Tanzania and outlines the profile of pesticides handled by farmers in Tanzania and other countries to reflect health risks posed by pesticides. The review then goes on to focus on the problem of APP and surveillance systems for APP. Examples of surveillance systems in different countries are described. Finally, this chapter highlights different sources of APP data and provides an overview of the general challenges for APP surveillance systems.

2.1. Pesticide definitions, classification and categorization

2.1.1. Pesticide definitions and classification

The FAO defines a 'pesticide' as any substance or mixture of substances intended for preventing, destroying or controlling a pest, whether in the context of vector control, agriculture, wood preservation or veterinary treatments. The pests may be insects, fungi or weeds. Pesticides also include agents that regulate plant growth (FAO, 2003).

A pesticide formulation is composed of active and inert ingredients. The active ingredients are responsible for the product's efficacy are clearly indicated on pesticide labels but inert ingredients are generally not displayed on product labels although they may cause adverse environmental and health effects. Pesticide manufacturers often claim the information on inerts to be a commercial secret (Lekei et al, 2004). Pesticides can be classified by chemical group, target pest, formulation type, WHO hazard classes and GHS system.

2.1.2. Pesticide Classification by Chemical Group

One approach to pesticide classification is according to chemical composition or groups. This system defines groups such as organochlorines, organophosphates, carbamates and pyrethroids within the insecticide category, and inorganics and dithiocarbamates among the fungicide category, and phenoxyacetic acids, triazines and bipyridyls within the herbicide category (See Annex 3 for poisoning symptoms of these chemical groups).

(i) Organochlorine pesticides

Organochlorines or chlorinated hydrocarbons are organic compounds containing chlorine in a hydrocarbon structure usually applied as insecticides. DDT is an example of an organochlorine that was used successfully in the past to control diseases such as typhus and malaria. Organochlorines were banned or restricted after 1960s in many countries because of their adverse effects on the ecosphere (He et al, 1999). Organochlorines are persistent and lipid soluble agents that accumulate in the environment as well as in food chain. In Tanzania, a number of organochlorine products were used on coffee, cotton and other crops until the 1990s. These included DDT, Aldrin, Chlordane, Toxaphene and Dieldrin. Generally most of the organochlorine products have been deregistered in Tanzania with the exception of Endosulfan 4% Dust, which is registered for use on maize and tobacco against stalk borers and chewing pests and Endosulfan 35EC, which is registered for various crops against chewing and sucking pests (United Republic of Tanzania, 2006). DDT in Tanzania is under consideration for use in Indoor residual spray (IRS) for mosquito control by the ministry of health.

(ii) Organophosphates

Organophosphates (OP) are organic derivatives of phosphoric or similar acids. They are highly toxic compounds readily absorbed through the skin, mucous membrane, gastro-intestinal tract and respiratory airways. Among the insecticides registered in Tanzania, OPs account for about 20% and are second only to pyrethroids (54%) in number of agents registered (Annex 4).

OPs were first developed as insecticides but some were of interest to the Nazis as possible nerve gas weapons (Davies, 1987). The acute toxic effects of OPs are caused by an inhibition of acetylcholinesterase, an enzyme that inactivates the neurotransmitter, acetylcholine. Acetylcholine then accumulates at the cholinergic synapses resulting in Peripheral and Central Nervous System (PNS and CNS) overstimulation. Depression of red blood cell and plasma levels of cholinesterase are indicators of biological effects of exposure to OPs (WHO/UNEP, 1990; He et al, 1999; Stallones, 2002). While the former is more closely related to CNS effects of OP, the latter is a better marker of exposure to OP compounds (Stallones, 2002). In addition, different OPs may have stronger effects on either Plasma or RBC cholinesterase, as a result of which, these cholinesterase enzyme may be a better marker for some OPs than others. Indirect cholinesterase inhibition can also occur and it is caused by metabolism of sulphur attached to phosphorus (for phosphothiates compounds).

OPs are responsible for acute poisoning in many developing countries (He et al, 1999). Acute OP poisoning has also been associated with long term CNS and PNS defects. Low dose cumulative exposure to OP is also suspected of causing long term CNS defects, though the mechanism is unknown and the evidence other than for neurobehavioural symptom outcomes is equivocal (Kamel et al, 2004; London et al, 2005; London et al, 2009).

Organophosphate pesticides have relatively short half-lives and are quickly metabolized and excreted from the body (Wessels et al, 2003). Organophosphate metabolites, including dialkyl phosphates, in urine have been used as biomarkers of organophosphate pesticide exposure in many studies (Bouchard et al., 2010; Eskenazi et al., 2004; Fenske et al., 2002; Grandjean et al., 2006; Lacasana et al., 2010; Ye et al., 2009). Also, analysis of organophosphate pesticide levels in blood allows for direct measurement of parent compounds rather than metabolites and may more accurately represent the dose that reaches the target tissue (Bradman and Whyatt, 2005).

Organophosphate poisoning results in both specific and non-specific symptoms. The specific symptoms include miosis (pupillary constriction), excessive salivation and bradycardia while non-specific symptoms include nausea, vomiting, skin irritation and diarrhoea, weakness, dizziness. More details on symptoms of pesticide poisoning are outlined in annex 3

(iii) Carbamates

Carbamates are salts or esters of carbamic acids and are mainly used as insecticides. Carbamates are also cholinesterase inhibitors and produce clinical features of cholinergic excess similar to that of OP toxicity. However, because of spontaneous hydrolysis of the carbamylated AchE enzyme, the symptoms are generally reversible and of shorter duration. The carbamates penetrate the blood brain barrier poorly and, compared to OPs, generally have less effect on brain AchE activity and produce fewer CNS symptoms (Goel et al, 2007). While this is generally the pattern, there are significant exceptions. For example, aldicarb and carbofuran are WHO Class Ia (extremely hazardous) and Class II (highly hazardous) pesticides, respectively.

(iv) Pyrethroids

Pyrethroids are synthetic derivatives of natural pyrethrins and are mainly used as insecticides. Natural pyrethrins are extracted from flowers of the pyrethrum (chrysanthemum) plant and were identified as a result of efforts made to find synthetic products that are relatively less toxic to non target organisms. Pyrethrin represents 6 compounds namely cinerin I & II, Jasmillin I & II and Pyrethrin I & II. Synthetic analogues called pyrethroids have since been synthesized from these compounds and are used as contact non-systemic insecticides. These insecticides are reported to exhibit very low acute toxicity for mammalian species including humans, low dermal absorption capacity, but have high toxicity for fish and non-target insects. They break down rapidly in the environment. During formulation pyrethroids are usually combined with piperonyl butoxide, which is a known inhibitor of key microsomal oxidases enzymes. This prevents the insect's enzymes from clearing the pyrethroid and ensure that the pyrethroid will be lethal and not merely a paralyzing agent.

2.1.3. WHO Classification by Toxicity

The classification by toxicity developed by WHO estimates the degree of hazard for human health based on the LD50 (Lethal Dose 50) for each pesticide. The LD50 in mg of pesticides per kg body weight is the threshold dose (either oral or dermal), which causes the death of 50% of a group of test animals, usually rats or rabbits. The LD50 reflects the acute toxicity of a material. The lower the LD50, the more toxic is the product (WHO, 1990). Based on these criteria, the WHO defines four categories of toxicity namely Class Ia (Extremely hazardous pesticides with LD50 ranging from <50 mg/kg for oral and < 50 mg/kg for dermal exposure)); Class Ib (Highly hazardous pesticides with LD50 ranging from 5-50 mg/kg for oral and 50 – 200 mg/kg for dermal exposure); Class II (Moderately hazardous pesticides with LD50 ranging from 50 – 2000 mg/kg for oral and 200 – 2000 mg/kg for dermal exposure); Class III (Slightly hazardous pesticides with LD50 of over 2000mg/kg for oral and oral) and Class IV (Pesticides unlikely to present acute hazard in normal use with LD50 of 5000 or higher for both oral and dermal exposure). WHO classification does not bear a direct relationship to the GHS classification discussed below (see section 2.1.4), since the former is based on primarily acute toxicity, while GHS takes chronic and other effects into account (WHO, 2010).

2.1.4. Classification by Globally Harmonized System for Chemical Hazard and Labeling

The Globally Harmonized System for Chemical Hazard and Labeling (GHS) has also provided guidelines for chemical hazard classification. The GHS was developed out of an international mandate in 1992 at the United Nations Conference on Environment and Development (UNCED) for hazard communication (Silk, 2003). The GHS was endorsed by the 2002 World Summit on Sustainable Development (WSSD) and the Intergovernmental Forum on Chemical Safety (IFCS). The GHS was designed to provide a common and coherent approach to defining and classifying hazards and communicating hazard information on labels and safety data sheets. The anticipated benefits of harmonization include enhanced protection of human health and the environment, sound management of chemicals worldwide and trade facilitation.

The GHS was formally adopted by the United Nations Economic and Social Council (UN ECOSOC) in July 2003.

Under this GHS system chemicals are grouped according to physical hazards (categories of flammables, explosives and oxidizing reactive products) and heath hazards (categories of acute toxins, carcinogenic products, mutagenic products, products with reproductive toxicities, skin irritants and products with skin sensitization, serious eye damage/eye irritation, sensitization, systemic toxicity like neurotoxicity, immunotoxicity and, liver damage) (United Nations, 2004).

2.1.5. Classification by other approaches

There are other pesticides classification approaches which include classifying pesticides by the agent that the pesticide aims to control and by the type of formulation (see Table 2.1).

Table 2.1: Other pesticides classification approaches.

No	Classification method	Categories	Definition
1	Classification by target pests	Insecticides	Pesticides used for controlling insect pests
		Fungicides	Pesticides used for controlling fungal diseases.
		Rodenticides	Pesticides used for controlling rodents.
		Acaricides	Pesticides used for controlling ticks and mites
		Herbicides	Pesticides used for controlling weeds
		Avicides	Pesticides used for controlling bird pests
		Moluscicides	Pesticides used for controlling snails and slugs
		Plant growth regulators	Pesticide used for controlling plant growth.
2	Classification by formulations	Emulsifiable Concentrates	These are liquid formulations in which the active ingredient has been dissolved in oil or other solvents and an emulsifier has been added so that the formulation can be mixed with water or oil for spraying. The EC formulations form white emulsions when mixed with water
		ULV (Ultra Low Volume)	These are formulations composed of active ingredient which is mixed in oil based solvent carrier. The formulations are homogenous liquid ready for use through ULV equipment
		Flowable Concentrates	Are formulations made of active ingredients that do not dissolve well in water or oil. The active ingredient is very finely ground and suspended in a liquid along with suspending agents, adjuvants, and other ingredients
		Wettable powders	These are dry powdered pesticide formulations. They look like dusts but, unlike dusts, they contain wetting and dispersing agents.Wettable powders usually form suspension when mixed with water and hence agitation is required during application
		Aqueous Concentrates,	These are formulation in which the active ingredient is mixed with water carrier. They are not composed of organic solvents
		Water dispersible granules	A preparation granule consisting of granules to be applied afterdisintegration and dispersion in water.
		Emulsions in Water	A fluid, heterogeneous preparation consisting of a dispersion of fine globules of pesticide in an organic liquid in a continuous water phase.
		Granules	These are dry particles made up of porous materials, such as corn cobs or walnut shells, to which the active ingredient has been applied. Granular pesticide formulations are most often used as soil treatments. They can be applied directly to the soil since they usually do not cling to plant foliage.
		Pellets.	These are very similar to granules, but their active ingredient is combined with inert materials to form a slurry (a thick liquid mixture). This slurry is then extruded under pressure and cut at desired lengths to produce a particle that is relatively uniform in size and shape. Just like granules pellets are applied in the soil.
		Fumigants	Fumigants are formulations that form gases or vapors toxic to the target pest. Some fumigants are formulated as gases while others are are liquids packaged under high pressure and change to gases when they are released. Other active

			ingredients are volatile liquids enclosed in an ordinary container and therefore are not formulated under pressure. Others are solids that release gases when applied under conditions of high humidity or in the presence of water vapor.
		Dusts	These are formulations containing very finely ground mixture of the active ingredient combined with dust carrier like talc, clay, chalk or other such materials. They are applied dry and are never mixed with water.

2.2. Pesticide Registration Categories in Tanzania

Pesticides in Tanzania are registered under the Plant Protection Act (United Republic of Tanzania, 1997). By the end of 2006, there was a total of 792 pesticide products registered in Tanzania under 4 registration categories namely Experimental, Provisional, Full and Restricted (United Republic of Tanzania, June 2008).

Experimental category: This category accommodates products which are essentially used for scientific investigation and efficacy trials. These products are not authorized for commercial purposes. In 2008, there were 309 experimental products, including 170 insecticides, 57 fungicides, 53 herbicides, 14 acaricides, 4 nematicides, 7 rodenticides and 4 Plant growth regulators.

Restricted category: This category accommodates products which are highly toxic and biologically persistent in the environment and the food chain, which have no specific antidotes or are thought to cause pest resistance. These products are strictly controlled in that they may only be handled by trained personnel and cannot be handled by untrained farmers. These products are only available from selected pesticide suppliers. In 2008, there were a total of 42 restricted products including 18 insecticides, 5 herbicides, 5 fungicides, 13 acaricides and 1 nematicide.

Provisional and Full Category: These two categories accommodate products which have already successfully passed through experimental registration. These categories are for general use and farmers are authorized to handle them. In 2008, there were a total of 215 provisional products including 114 insecticides, 44 fungicides, 40 herbicides, 11 acaricides, 3 nematicides, 2 rodenticides and 2 avicides. Products approved for provisional registration have dossiers requiring minor amendments such as corrections to labels, proper filling of application forms and other procedural actions.

In 2008, there were 226 products in the Full registration category. These are the products which have fulfilled all requirements for registration and have dossiers requiring no further amendments or actions. The category has products which include 104 insecticides, 48 fungicides, 54 herbicides, 2 plant growth regulators, 2 rodenticides ,1 avicide and 15 acaricides (United Republic of Tanzania, 2008).

The list of all pesticides registered in Tanzania can directly accessed at the URL:
www.kilimo.go.tz/regulations

2.3. Pesticide Use in Developing Countries

The pesticide industry is highly profitable with global sales of pesticides amounting to US$ 31 billion in

2005 (Croplife International; 2006). About three quarters of pesticides are used in developed countries, mostly in North America, Western Europe, and Japan, where high pesticide application rates are common. In these regions, the pesticide market is dominated by herbicides, which tend to have lower acute toxicity than insecticides. In most developing countries, the situation is reversed, and insecticide use predominates, with a correspondingly higher level of acute risk (Williamson et al, 2003).

Insecticides of choice in the developing world are often older, broad-spectrum compounds belonging to OP and carbamate groups noted for their acute toxicity. These products are popular, partly because they are no longer under patent protection and thus are considerably cheaper than the newer, still-proprietary pesticides increasingly used in developed countries. Organochlorine insecticides such as DDT, lindane, and toxaphene are still widely used in the developing world, although their danger to humans and animals and persistence in the environment is well known.

Concerns about food security have determined pesticide usage in most developing countries. For example, Bangladesh has promoted the use of pesticides to expand agricultural land and increase output per acre (Rasul et al, 2003). As a consequence of this expansive policy, pesticide use in Bangladesh has more than doubled since 1992, rising from 7,350 metric tons to 16,200 metric tons in 2001 (Rasul et al, 2003). Many pesticides used in Bangladesh are also banned or restricted under international agreements (Meisner, 2004). Pesticide suppliers in Bangladesh also continue to sell the 12 particularly controversial pesticides known worldwide as the “dirty-dozen” (Meisner, 2004). In addition, studies have shown that inadequate product labelling and users’ lack of information have led to widespread overuse and misuse of dangerous pesticides. Vietnam has also promoted the use of pesticides to expand agriculture land and increase output per acre (Chung et al, 2002). This has resulted in a widespread use of hazardous chemicals (Dasgupta, 2005b).

One factor in this overuse is that many policy makers and some donors regard pesticides as indispensable for agriculture and continue to promote their use. Direct and indirect subsidies on pesticides encourage their application at unsustainable rates and discourage safer and more sustainable forms of pest management. In Costa Rica, for example, the government has exempted pesticides from all taxes and duties. Government revenue foregone approximated US$6 million based on 1996 figures, constituting a substantial incentive for pesticides imported that year, valued at US$102 million (Agne et al, 2000).

Another factor encouraging the irrational use of pesticides is the over-emphasis on minimizing crop losses by crop protection departments and agricultural policy makers. Generalizations of 30% and above crop losses are frequently employed to justify the use of pesticides for food security and poverty alleviation, without any attempt at needs assessments. Focusing on preventing potential yield loss without considering the economics of pest control methods or the external costs is a frequent mistake in crop protection programmes (Fleischer et al, 1999).

Lastly, the pesticide industry has an inconsistent record in taking appropriate initiatives for the safety of their products (Williamson, 2003). Although, over the years, the industry has responded to safety concerns with a number of initiatives to reduce the global death toll from pesticide poisoning, there are clear conflicts of interest where such initiatives may compromise profits. Industry-led initiatives are to be welcomed, but national and international health policy makers should recognize that they may not focus on those aspects of the problem most likely to reduce mortality (Konradsen et al, 2007).

2.4. Pesticides in Africa

Pesticide usage data in Africa is poor with many African national pesticide regulators possessing only sketchy figures for quantities or values imported, which bear scant relation to usage at field level (Williamson, 2003). The little data available often show large fluctuations from year to year, reflecting changes in government or donor programme purchase ability, production policies, private sector import capacity and, to some extent, fluctuations in seasonal demand in different cropping systems. Pesticide donations are frequently missing from government import data and, not surprisingly, official data do not include informal trade or unregulated cross border supply (Williamson, 2003). For Tanzania, it is estimated that 18% of pesticides are used in the public health sector while 81% are used in livestock and agricultural sectors and 1% is used in other areas including protecting buildings from damage caused by insect pests (Agenda, 2006).

In the past, smallholders in many African countries were provided with pesticides by the state, either through commodity boards or via the extension services. Pesticides were subsidized or sometimes even provided free of charge to farmers growing cash crops of importance to national economies, such as coffee, cotton and cocoa. In Côte d'Ivoire, for example, insecticides were given to cotton farmers free of charge from 1966 to 1994 (Ajayi 2000). Pesticides were sometimes provided for use on food cereal or legume staples for local markets or for control of outbreak pests such as locusts, armyworm and quelea birds. Government subsidies for pesticides to farmers in many developing countries were later removed and pesticide distribution remained under private sector working directly with farmers.

For example, following Government restructuring in African countries, pesticide subsidies were removed in Benin in 1991 (Williamson, 2003), Ethiopia in 1995 (Alemayehu, 2001), Ghana in 1996 (Gerken et al, 2000) and Tanzania in 1990s (Lekei at al, 1999; Agenda, 2006). Once the practice was established, the governments stopped subsidizing pesticides because the market for pesticides had been created.

The launching of the economic recovery programmes and liberalization of trade in Tanzania in 1990's resulted in a rise in the amount of pesticides imported into the country from 500 tons/year in 2000 to 2,500 tons/year in 2003 (Agenda, 2006). Tanzania has also launched the Strategy for Growth and Reduction of Poverty (NSGRP) which places the poverty reduction issue high on the country's development agenda. In order to achieve the intended goals under NSGRP, pesticides and fertilizers are expected to be used in order to increase food production. Unsafe handling and use of pesticides is therefore a big potential problem because of likely adverse effects on human health and the environment which may indirectly erode the gains that could be achieved through the NSGRP.

2.5. Acute Pesticide Poisoning

The use of pesticides is increasing in developing countries often under poor and unsafe handling practices. In the last three decades, developing countries' share of global pesticide use increased from 20% to 40% (PAHO, 2001). This huge increase in sales signals probable increased risks of adverse health effects arising from occupational, intentional and accidental pesticide exposure.

The growth in use of pesticides in developing countries has, over the last two decades been accompanied by a growing concern about the acute health effects of pesticide poisoning among small scale farmers (Murphy et al, 1999). About 90% of all APP are believed to occur in less industrialized countries although the quantity of pesticides used there is far less than in industrialized countries (Murphy et al, 1999). Approximately 99% of all deaths due to pesticide poisoning occur in developing countries (WHO/UNEP, 1990). The magnitude of health damage caused by pesticide exposure varies according to the types of pesticides used, mode of application, the extent of exposure, individual susceptibility and climatic conditions (Forasteri, 1999). While both acute and chronic pesticide poisoning seriously impact community health and livelihoods, acute cases are easier to identify, document and quantify (Reeves et al, 2006).

The yearly worldwide prevalence of APP has been estimated at about 1,000,000 unintentional and 2,000,000 intentional cases, with approximately 220,000 deaths per year (Henao et al, 1993; Vergara et al, 1998). This reflects deficient hygiene and safety conditions under which these products are used. These worldwide poisoning statistics do not reflect the real burden caused by pesticides (Jeyaratnam, 1990). There is a good reason to believe that these figures underestimate the true number of adversely affected individuals. A study conducted in Nicaragua in 1996 to estimate the rate of underreporting of poisoning cases to a poisoning registry, found that 65% of the poisoning cases were not reported (Keifer et al, 1996). Underreporting of pesticide poisoning data has also been reported in South Africa to be of the order of 90 %(London et al, 2001).

The above estimates include only the most obvious poisonings which are hospitalized and this means that the real health toll from pesticides, including milder and non-hospitalised cases, is likely to be greater and much more difficult to measure. Some symptoms due to pesticides may not be considered important or may not be recognized by health care providers and farmers. Therefore, despite the apparent magnitude of this problem, much necessary public health information about pesticide health effects is lacking. What is evident is that problems of illness and death following occupational and accidental exposure to pesticides have not been well documented in developing countries (Keifer et al, 1996).

In an epidemiological survey conducted in 7 countries of Central America from 1992 – 2000, it was found that 7000 cases of pesticide poisoning were reported per year (Henao, 1993). The Incidence Rate of APP in Central America in the same study was found to be 20 cases per 100,000 in economically active populations dedicated to agriculture, with a progressive increase occurring in the rate (6.3 per 100 000) since 1992. This increase may be related to an increase in surveillance efforts meaning that there is progressively less under-reporting (Henao, 2002). The data obtained in the same study indicated that 12 pesticides were responsible for the bulk of acute poisoning (Henao, 2002).

Other studies conducted in developing countries report an estimated APP Incidence rate (IR) of 2.3 per 100 in Nicaragua (Corriols et al, 2009) and 180 per 100,000 in Sri Lanka (Eddleston et al, 2006). In a study conducted in Bolivia the estimated IR rose from 38 to 107 cases per 100,000 persons during 2001 (Jors, 2004). The latter studies (Sri Lanka and Bolivia) were based on hospitals survey whereas the Nicaraguan study was active surveillance in the community, based on self-reported APP data, which may account for the sizably higher rate in the Nicaraguan study.

In the Asian region, a survey of APP among agricultural workers revealed that occupational pesticide poisoning accounted for 1.9% of the cases in Indonesia and 31.9% in Sri Lanka while suicides accounted for 62.6% in Indonesia, 67% in Malaysia, 36.2 % in Sri Lanka and 61.4% in Thailand (Vergara et al, 1998). A study in South Africa found an annual rate of notification for APP per 100,000 population from 1987 – 1991 in the study area of 4.2 but the rate with intensified notification was found to be 40.5 suggesting an approximate 10-fold underreporting problem (London et al, 2001).

Suicide using pesticides and other means is a major problem in developing world and thought to be responsible for 593,000 deaths in 1990 (Murray et al, 1997). There are many studies confirming this problem and the role of pesticides in high rates of suicide. A study in Bangladesh demonstrated that 14

% of all deaths among women between the ages of 10 and 50 were due to poisoning, the majority following suicidal ingestion of pesticides (Yusuf et al, 2000). Pesticide poisoning is reported to be the commonest form of fatal self-harm in rural Asia accounting for over 60% of all deaths (Somasundaram et al, 1995; Phillips et al, 2002; Joseph et al, 2003). Further, in a case study of coffee growing areas of Tanzania from 1980 to 1990, an average of 62 pesticide poisoning cases were recorded in hospitals per year, most of which were suicide cases (Ngowi et al, 1992). WHO estimates based on 2002 data indicate that there were 873,000 suicide cases globally (WHO, 2004a) but there is uncertaintly how many of these cases were the result of poisoning with pesticides (Konradsen, 2003). However, what is known is that mortality from self-harm is far greater in tropics than in industrialized world and pesticides in some parts are the most practiced method of self-harm (Eddleston, 2000). In many countries, the widespread availability of acutely toxic pesticides and use in agriculture has made selection of pesticides as the agent of choice for self-harm (Konradsen et al, 2003).

Studies conducted in Africa evaluating the burden of APP in the continent are summarized in Annex 5.

2.6. Surveillance of Acute Pesticide Poisoning.

Studies of acute pesticide related illness have increased over the past 2 decades (Choi et al, 2001; London et al, 2001; Osorio, 2002) although some countries have no surveillance systems for APP. Due to this lack of surveillance in many developing countries, the use of surveillance-derived data for problem-solving remains limited (Murray et al, 2002). The following sections summarize surveillance systems for pesticide poisoning in different countries, outlining the categories of APP used in different surveillance systems (Table 2.2).

2.6.1. Surveillance of pesticide poisoning in Central America

Central America is one of the regions of the developing world where considerable attention has been paid to pesticide related injuries due to the high use of pesticides (Murray et al, 2002). There have been several endeavours to accurately portray the nature and scope of pesticide illness in Central America with the intention of generating pesticide problem-solving measures (Keifer et al, 1996; Vergara et al, 1998; Corriols et al, 2001; Wesseling et al, 2001).

During the 1980s, surveillance for APP in Central America was usually undertaken through the traditional infectious disease surveillance systems under the Ministry of Health. These approaches were relatively ineffective as they captured only cases reported by hospitals. Data collected were incomplete and frequently not consolidated or analysed. In the mid 1980s, two programs, one under the Non-Governmental Organisation, Cooperative for Assistance and Relief Everywhere (CARE) International in Nicaragua and Pesticide Program of the Universidad Nacional of Costa Rica (PPUNA) in Central America (Castillo et al, 1989; Wesseling et al, 1992), demonstrated that the incidence of pesticide related illness was dramatically higher than suggested by data from official sources. At the same time, the Pan America Health Organization (PAHO) initiated a regional project called PLAGSALUD (Spanish for “Occupational and Environmental Aspects of Pesticides in the Central American Isthmus”) to address occupational and environmental health problems associated with pesticide use in a seven-country study in the region. The project began in 1994 with funding from the Danish Agency for International Development (DANIDA) in Nicaragua and Costa Rica and expanded in 1997 to Panama, El Salvador, Honduras, Guatemala, and Belize. PLAGSALUD aimed to strengthen the illness surveillance and response capacities of the ministries of health throughout the region so as to reduce health problems related to pesticides. Among other actions, technical assistance was provided in epidemiological surveillance and research. Data were collected from death certificates, hospital or emergency mortality records, vital statistics and community medical and legal records. Other data sources included reports of occupational injuries and labor absenteeism; registries of companies and of the Ministry of Labor; press reports and results of special research, for example on evaluation of underreporting. Minimum data recommended included socio-demographic variables such as such as age, sex and occupation as well as location of the poisoning, date of poisoning and circumstances of poisoning, and route of exposure, clinical manifestations such as symptoms and severity, agents responsible and outcome of the poisoning. This study found that most APP cases were due to occupational circumstances followed by intentional and accidental. The study demonstrated a rising trend in APP cases and mortality, reflecting either better registration of cases or poor management of pesticides (Wesseling et al, 1992).

2.6.2. Surveillance of pesticide poisoning in the United States

Surveillance for APP in the US happens across a number of state and national systems. In the United States there are numerous state-based and national surveillance systems that collect data on acute pesticide-related illnesses and injuries. On the state level, Arizona, California, Florida, Louisiana, New York, Oregon, Texas and Washington routinely collect illness data due to pesticide exposure and conduct comprehensive case investigations. The most well-known US surveillance system is in California, which mandates biological monitoring of exposed workers and which publishes these data regularly (Ballard et al, 2001).

All eight state-based surveillance systems mentioned above include physician-reporting of pesticide related illness and injury cases. Other sources of case reports vary from state to state, and include Poison Control Centers, Emergency Medical Services, other health care professionals, medical laboratories, hospitals, clinics, migrant legal aid, state agencies with jurisdiction over pesticide use (e.g. state agricultural departments, state structural pest control boards) (Calvert et al, 2004). The state programs also routinely review other data sources such as workers' compensation claims, hospital discharge data and death certificates, to identify additional potential cases and to evaluate the completeness of reporting.

Poison Control Centers in US are mainly responsible for providing advice on the treatment of acute poisonings or to provide general information on poisoning events in response to telephone calls from the public. At national level, the Toxic Exposure Surveillance System (TESS) is maintained by the American Association of Poison Control Centers and collects poisoning reports submitted by approximately 85% of the poison control centres (PCC) in the United States (Calvert et al, 2004). It contains information on all phone calls made to a vast majority of US poison control centers. The advantage of TESS is that it is the only system that provides national data, and identifies a large number of pesticide poisoning cases (Watson et al, 2004). TESS is an important source of information on acute pesticide -related illness arising from non-occupational pesticide exposures.

Lastly, the Bureau of Labour Statistics (BLS) in the US provides annual estimates of the number of occupational pesticide-related illnesses and injuries that result in days away from work which are recorded by employers as required under the Occupational Safety and Health Act of 1970. This system captures only cases that result in lost work time for workers who are legally employed and it is likely to report more severe cases than those being reported to other surveillance systems (Calvert et al, 2004). Data recorded include date of poisoning, age, gender, signs and symptoms, the agent, circumstances of poisoning, route of exposure and outcome (Calvert et al, 2004).

SENSOR PESTICIDES PROGRAM:

Sentinel Event Notification System for Occupational Risks (SENSOR)-Pesticides is a U.S. state-based surveillance program that monitors pesticide-related illness and injury. SENSOR – pesticides is administered by the National Institute for Occupational Safety and Health (NIOSH) which is responsible to provides technical support to all participating states. It also provides funding to some states, in conjunction with the US Environmental Protection Agency (US EPA). The mission of **SENSOR** program is to build and maintain occupational illness and injury surveillance capacity within state health departments.

A total of 11 states participate in the SENSOR-Pesticides program and these include California, Iowa, Michigan, New York, Washington, New Mexico, Oregon, and Texas, New Mexico, Oregon, and Texas. Health departments in five states (California, Iowa, Michigan, New York, and Washington) receive NIOSH funding and technical support to bolster pesticide-related illness and injury surveillance. Six additional states receive technical support from NIOSH: three (Florida, Louisiana, and North Carolina) are funded by the US Environmental Protection Agency (EPA) and three (New Mexico, Oregon, and Texas) are federally unfunded SENSOR-Pesticides partners. Funding support for the SENSOR-Pesticides program is also provided to NIOSH by EPA.

Besides tabulating the number of acute occupational pesticide-related cases, these SENSOR-supported surveillance systems perform in-depth investigations for case confirmation, and develop preventive interventions aimed at particular industries or pesticide hazards. The SENSOR-Pesticides program is most useful for timely identification of outbreaks and emerging pesticide problems. However, a national aggregated database is also available. It consists of acute occupational pesticide-related illness and injury cases submitted by the SENSOR-pesticides states. This database is useful to assess the magnitude and trend of acute occupational pesticide-related illness and injury.

California

There are two pesticide poisoning surveillance programs in California. One is maintained by the California Department of Pesticides Regulation (CDPR) and the other is maintained by the California Department of Public Health (CDPH). The surveillance system maintained by the CDPH participates in SENSOR and is similar to other state systems but is mainly used to track occupational pesticide-related illness and injuries.
Under this system California has mandated physician- reporting of pesticide-related illness since 1971. Physicians are required to report pesticide poisoning events to the local health officers by telephone within 24 hours after examining the patient. Data sources in this system include the pesticide illness report filled out by the health officers receiving the doctor's case report, occupational illness and injury report, poison control center (California Environmental Protection Agency, 2001). The California agricultural commissioner is responsible for the investigation of all pesticide exposure incidents in his or her area. Specialized state-based laboratories provide analytical assistance for the pesticide exposure investigations (California Environmental Protection Agency, 2001). High priority poisoning incidents are categorized according to human health effects (mass poisoning, fatal events, hospitalized cases),

environmental effects (air, water, animal and land contamination) and special incidents involving neighboring states (Osorio, 2002).

2.6.3. Surveillance of pesticide poisoning in China

Pesticide poisoning data in China are often reported as incidence data from hospitals or injury centers. The majority are attempted suicides, but also included are unintentional pesticide poisoning among children (Chen et al, 2005). In China there are 3 major sources of human data on chemical exposure. These include a national occupational disease reporting system under the Ministry of Health, a Poison Control Centre and research studies, including epidemiological studies (Zheng, 2000).

Occupational Poisoning

The national occupational disease reporting system was established by the Ministry of Health in 1986 and relies on a national occupational medical services network. It includes 7 regional occupational health centers located in Beijing, Shangai, Liaoning, Gansu, Sichuan, Hunan and Guangdong as well as the Institute of Occupational Health. The Institutes have responsibility for environmental and biological monitoring of occupational hazards, diagnosis and treatment of occupational diseases and work related diseases, medical assessment of occupational diseases and health education and health promotion for workers. In addition to this, there are 1,789 health and epidemic prevention stations at the country level providing monitoring of work environment and health screening of workers (Zheng, 2000).

Poison Control Centre

The National Poison Control Center (PCC) was established at the National Institute for Occupational Health in 1998. The center collects and distributes poison control information and provides technical support in the management of poisoning including providing advice on diagnosis, treatment and prevention of poisoning, training and education. The poison control network exchanges information by means of e-mails, faxes, mails and internet communications (Zheng, 2000).

Published and epidemiological studies

Epidemiological studies and scientific publications contain information on industrial poisoning, pesticides poisoning and occupational tumours. The research findings are published in more than 20 Chinese Journals in toxicology, emergency medicine, occupational health, environmental health and epidemiology. The available data have provided a scientific basis for the prevention and control of chemical induced effects (Zheng, 2000).

2.6.4. Surveillance of pesticide poisoning in Malaysia

The Malaysia Pestinfo system is the first to be made available in Asia and operates via TELITA, the Malaysian National Videotex system. The system is operated by the Malaysian Telecommunication Company. TELITA can be accessed through a television set and computer equipment with modem connected to telephone network (Razak et al, 1998). The system is economical and each dial up costs US$ 0.05 (Razak et al, 1998). The online poisoning reporting system is an outstanding feature incorporated in Pestinfo. It enables reporting to be done electronically by the end user on a computer through a specially designed format. The system allows documentation of cases reported and acts as an instant referral system which enables systematic follow up. Through the reporting system, initiation of the appropriate immediate response can be undertaken to assist the user in the management of the poisoning case (Razak et al, 1998).

2.6.5. Surveillance of pesticide poisoning in South Africa

In South Africa, surveillance of pesticide poisoning is undertaken across a number of different information systems involving 3 government departments. The major sources of surveillance data lie in the health sector and this relies on statutory notification by medical practitioners in terms of Health Act (London et al, 2001). Follow up investigation and remediation is the responsibility of environmental health officers at the level of local authority. (London et al, 2001). Other important sources of data include departments of Labour and Home Affairs for occupational illness and injury and death registration, respectively. Government control activities are integrated at national level in an inter-departmental committee responsible for pesticide safety. However, despite the existence of these structures, in practice, the different data sources are poorly integrated (London et al, 2001).

2.6.6. Surveillance of pesticide poisoning in Italy

In Italy, the Italian National Institute of Health is required by law to promote and coordinate investigation into possible harmful health effects from exposure to pesticides. The Institute is also responsible for preventive measures for identified problem areas. In keeping with this mandate, a research project was initiated in 1999 that included the surveillance of populations exposed to pesticides and related products. Part of the project was focused on acute pesticide related illness and the development of a national surveillance system was proposed (Settimi et al, 2002). This system is based on close collaboration between the National Health Institute, poison control centers and Departments of Prevention in local health units.

2.6.7. Surveillance of pesticide poisoning by the International Program on Chemical Safety (IPCS)

The IPCS, in collaboration with WHO, developed a protocol to measure APP occurrence in developing countries. The program aimed to prepare and maintain a database on pesticide poisoning cases including information on the agents responsible for poisoning, circumstances of poisoning, outcome of poisoning and main population groups affected (Besbelli et al, 2007). The overall objective of the program was to estimate the extent of human exposure to pesticides and the burden of disease from pesticide poisoning in selected regions with a view to implementing preventive strategies to reduce morbidity and mortality from pesticide poisoning. A specific objective of the program was to establish survey methods for cases of pesticide poisoning which used a common set of tools including a pesticide exposure record (PER), standard case definition, and a simplified severity score.

The IPCS programme intended to assist developing countries establish their own surveillance systems, given their high burden of APP and the difficulty for each individual country to establish its own system. The major strength of the IPCS surveillance project was to harmonize data collection tools for data capturing across various countries. The tool has been successfully used in South East Asia Region countries (India, Thailand, Indonesia, Nepal & Myanmar Bangladesh, Sri Lanka) as well as China and Italy.

The minimum data recorded in this IPCS system include exposure time and duration, location of exposure and activity during exposure, the identity of the health facility and health care providers, patient demographics, circumstances of poisoning, the main activity during exposure, the route of exposure, the identity of the agent responsible for poisoning, treatment options, time spent in hospital, nature of exposure and severity grading and outcome of poisoning (Besbelli and Pronczuk, 2007)

2.6.8. Surveillance of pesticide poisoning in terms of the Rotterdam Convention Reporting System

In response to the recognition that improper and unsafe handling and poor management of toxic pesticides and other hazardous chemicals have the potential to cause serious harm to humans, animals and the environment, governments established in the 1980s a voluntary procedure called Prior Informed Consent (PIC). PIC requires exporters trading in a recognized list of hazardous substances to obtain the prior informed consent of importing countries before proceeding with the trade. PIC was formalized as an international convention through the United Nations Environment Program (UNEP) and the Food and Agriculture Organization of the United Nations (FAO) when the Conference of Plenipotentiaries in Rotterdam adopted the Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals in International Trade on the 10th September 1998 (FAO/UNEP, 2000). The Convention, now known as the Rotterdam Convention, created legally binding obligations for implementing the PIC procedure and entered into force on 24 February 2004. The PIC procedure helps participating countries learn more about the characteristics of potentially hazardous chemicals, initiates a decision-making process on the future import of these chemicals by country authorities and facilitates the dissemination of this decision to other countries. The ultimate aim of the convention is to reduce health and environmental risks from uncontrolled export and import of hazardous chemicals.

The Convention initially included 22 pesticides (including 5 severely hazardous pesticide formulations) and 5 industrial chemicals in the PIC procedure because they had been banned or severely restricted for health and environmental reasons. Since then, more hazardous chemicals have been identified and added under the Convention. Currently, the Convention covers 39 hazardous chemicals including 24 pesticides, 11 industrial chemicals and 4 severely hazardous pesticide formulations (FAO/UNEP, 2000).

The Convention contains an important reporting function for poisoning by pesticides in developing countries under conditions of normal use. The responsibility to notify the Secretariat of a severely hazardous pesticide formulation lies with the Designated National Authority (DNA) who are the persons or agencies responsible for pesticide legislation in the country. In Tanzania, for example, there are two DNAs, one is responsible for pesticides and the other for industrial chemicals.

The report forms for severely hazardous pesticide formulations under the PIC Convention completed by DNAs require a large volume of information on the formulation and the poisoning, including product name, active ingredient, proportion of ingredients, formulation type, a copy of the product label, date and location of exposure, gender and age of exposed persons, circumstances of poisoning, use of Personal Protective Equipment (PPE), product usage and any treatment given. The reporting is important because of a provision in the PIC Convention which allows the addition of new chemicals to the PIC list of hazardous chemicals. Based on Article 6, any developing country experiencing problems caused by a chemical under normal conditions of use in that country, may report the poisoning and the secretariat may then propose inclusion of the pesticide in the PIC list as a hazardous chemical. The reporting of incidents involving severely hazardous pesticide formulations is therefore critical to the proper functioning of the Convention to protect populations of developing countries exposed to that pesticide.

The process whereby a pesticide involved in a poisoning is included under the Convention is as follows: The report on is forwarded to the chemical review committee, which reviews the information and makes a recommendation to the Conference of the Parties (COP). The COP makes the final decision on whether the formulation is to be included in the list of PIC products. The PIC secretariat finally informs the parties responsible of the final decision. The need for good surveillance systems in developing countries is therefore critical for the proper functioning of the PIC system, particularly regarding reporting of severely hazardous pesticide formulations. In the absence of good surveillance, pesticides may continue to cause health and environmental problems in developing countries, but avoid the control mechanisms intended by the PIC Convention.

Table 2.2: Categories of APP cases used in different surveillance systems.

System	Case Categorization
US – SENSOR system	Definite, probable, possible or suspicious
Florida system	Definite, probable, possible or suspecious unlikely, insufficient information, and not a case.
WHO	Suspected and Confirmed by laboratory investigation, Confirmed by history
California system	Definite, Probable, Possible, Unlikely, Unrelated, Asymptomatic and Indirect.
PAHO	Suspected and Confirmed by epidemiological assessment, Confirmed by history
CDC	Definite, probable, possible, suspicious, unlikely, insufficient information, and not a case (symptomatic, not treated).

*No categorization data was provided for other systems

2.7. Implications of health worker practice on APP surveillance

Health care worker practice has a major role to play regarding surveillance because implementation of surveillance systems in many settings is dependent on health care workers, in different ways. Firstly, the correct diagnosis of APP is the action that prompts surveillance activities. Incorrect diagnoses may lead to over- or underreporting.

Secondly, effective treatment and management of APP cases presenting to health facilities is likely to encourage patients to seek health care and go to hospital following APP. This means that treatment and management facilities at the relevant health facilities must be of adequate standard. If patients choose to present to a health facility, this will assist in reducing the extent of under-estimation of the APP.

Thirdly, once diagnosed, health workers are key to completing relevant reporting forms in their health system such as patient registers. Accurate records in patient folders will also assist surveillance where data are drawn from patient records. Further, documents must be securely stored to avoid damage and to be readily available for data compilation when needed in the surveillance system.

2.8. Sources of data on poisoning information

Several possible sources for pesticide poisoning reports exist. Ideally, all of these sources should be used for timely identification of cases. However, if resources are limited, a single type of case ascertainment method may be chosen, supplemented by a periodic survey to review data from other sources.The most common surveillance system is one based on hospital reporting (Barnet et al, 2005). Sources of data on APP that contribute to surveillance are important to evaluate critically because they are instrumental in deriving realistic APP estimates. The quality of the data source is likely to be reflected in the reliability and validity of data extracted. Systems which are well constructed and organized are likely to reflect the true burden of APP in their respective areas. Data sources are also important because of the importance of giving feedback to the source population from which the data originate.

The different sources of data for APP surveillance are reviewed below. This is followed by a summary of data sources available for APP surveillance in different national and regional surveillance systems (Table 2.3).

2.8.1. Poison control Centers

A Poison Control Center (PCC) is a specialized unit providing information on the prevention, early diagnosis and treatment of pesticide poisoning and hazard management. A PCC often follows up a poisoning case until there is a final outcome especially when there is a possibility that a person is at risk of more than minor adverse health effects. The follow-up information is used to determine the severity of the poisoning. A PCC typically collects information such as demographic data, the route of exposure, whether exposure was intentional or unintentional, the site of exposure, case management, clinical effects, therapy received and medical outcome. PCCs are an important source of case reports especially for non-occupational pesticide poisoning. Prompt reporting of cases by the PCC allows the surveillance program to act quickly to prevent additional exposure and illness (Barnett et al, 2005). Many PCCs, especially in developed countries, have pesticide information services, patient management facilities and analytical laboratories. The need for PCCs is well recognized in Africa and African governments have been encouraged to support the establishment of PCCs equipped with appropriate facilities for prevention and management of poisoning (Arovko, 2002). In Africa there are 16 poison control centers located in Algeria, Kenya , South Africa , Zimbabwe, Egypt, Moroco, Tunisia, Senegal (WHO, 2012) and Ghand (Clark, 2004; WHO, 2012).

Countries that have incorporated PCCs in their surveillance systems include US (Ballard et al, 2001; Settimi et al, 2002; Calvert et al, 2004), Costa Rica (Wesseling et al, 1997), and Scotland (Waring et al, 2007). Notably, no African country uses PCCs to support APP surveillance.

Among the major constraints of PCC's in developing countries is lack of funds for establishing and maintaining these centers. Laboratory requirements for this system include sophisticated equipment which is often unaffordable. While this is a problem for developed countries, this is particularly acute for developing countries. Other constraints include the lack appropriate communication facilities, inadequate human resources including toxicologists, clinical and regulatory experts to run and manage the PCC's and weak reporting systems which lead to poor management and follow-up.

2.8.2. Workers' compensation claims

Workers' compensation claims can be a valuable source of information about occupational pesticide poisoning cases where there is good coverage of workers. Access to submitted claims allowed the surveillance program to identify a large proportion of the cases. This is practical for countries that keep such records, as is the case in the US (Ballard et al, 2001; Calvert et al, 2004) and Costa Rica (Wesseling et al, 1997).

For some employers, compensation for employees who are injured by pesticides is a production loss. If a worker is injured in a workplace, employers may refuse to report the case to escape liability for compensation. Underreporting of pesticide poisoning cases, in particular occupational cases, is sometimes directly linked to resistance to compensation claims. In the presence of a good surveillance system, such employers are likely to be legally obliged to report; further, compensation of affected workers would be possible.

Table 2.3: Data sources available for APP surveillance in different national and regional surveillance systems.

Country	Data source	Reference
Nicaragua	(i) Regional pesticide poisoning registry (ii) Ministry of Health surveillance (passive and active) (iii) Population survey of medically treated cases and untreated cases	Keifer et al, 1998 Corriols et al, 2001
US	(i) Poison Control Centers (ii) Bureau of labour statistics (iii) Work absenteeism records (Occupational) (iv) Hospital system (v) Emergency medical services (vi) Medical laboratories (vii)Migrant legal aid (viii) State agencies with jurisdiction over pesticide use (e.g. state agricultural departments, state structural pest control boards) (ix)Workers' compensation claims	Ballard et al, 2001; Calvert et al, 2004
Costa Rica	(i) Ministry of health (hospital reporting system) (ii) Poison control centre (iii) Telephone inquires (iv) Workers compensation records (for salaried workers only)	Wesseling et al, 1997
Equador	(i) Hospital system – government and private (ii) Ministry of health centres (iii)Three Ecuadorian Institute for Social Security (EISS) health centres.	Cole et al, 2000
Central American countries (Nicaragua, Costa Rica, Panama, El Salvador, Hondurus, Guatemala and Belize)	(i)Ministry of health (hospital system) (ii)Vital statistics (iii)Community medical records (iv)Legal records (v)Occupational injuries and labour absenteeism data (vi) Registries of companies (vii) Registries of Ministry of Labour (viii) Press reports (ix) Results of special research	Murray et al, 2002 Corriols et al, 2001
Ethiopia	(i) Ministry of health (hospital system)	Bekry, 1999
South Africa	(i) Health care practitioners (mandatory notification), (ii) the department of labour (occupational cases) (iii) the department of home affairs (death certificates information).	London et al, 2001

2.8.3. Health care professionals

Physician reporting is the most common source of cases mentioned in reporting rules or statutes. While this method has been the mainstay of many communicable diseases and notifiable conditions reporting systems, it is not necessarily the most effective surveillance method for pesticide poisoning. The non-specific nature of symptoms arising from pesticide exposure, difficulties of diagnosis, rare occurrences within individual practices, lack of timely laboratory testing, selection of inappropriate tests and reluctance to report cases makes HCP reporting less reliable (Barnett et al, 2005). HCPs in some situations may be reluctant to report cases for various reasons including discomfort with reporting of clinically non-confirmed cases, concern that an affected worker may experience job loss, perception that pesticides exposures are unlikely to cause illness, ignorance about the reporting requirements and concern that reporting a case might disrupt relationships with employers (Barnett et al, 2005). Nonetheless, many poisoning estimates are based on the data collected by health professionals in health care facilities (Barnett et al, 2005). Examples of countries with reporting systems based on HCP or hospitals include US (Ballard et al, 2001; Calvert et al, 2004), Equador (Cole et al, 2000), Italy (Settimi et al, 2002), Central America (Murray et al, 2002), Ethiopia (Berkry, 1999), South Africa (London et al, 2001), Japan (Nagami, 2005), India (Unnikrishnan et al, 2005), and Portugal (Teixeira et al, 2004)

2.8.4. Affected person or relatives

Over 50% of the existing Pesticides Poisoning Surveillance Programs (PPSP's) in the US accept initial reports from affected persons or relatives but these reports are further investigated and confirmed (Barnett et al, 2005). Other countries accepting self-reporting include Malaysia, which provided for electronic reporting (Razok et al, 1998). Due to poor and unreliable facilities or lack of diagnostic tools and laboratories, information from victims taken on history may be useful in the diagnosis of pesticide poisoning and could therefore play a role in surveillance. The US pesticide poisoning surveillance program (PPSP's) often encourages these persons to seek medical attention. The proposed IPCS categorization system for APPs categorizes all cases reported on history and symptoms alone as "possible cases" (The IPCS surveillance system is fully discussed in section 2.5.7 above).

2.8.5. Laboratories

Medical laboratories may collect specimens and conduct analysis for pesticide and metabolites in a variety of human or animal biological media. The most common laboratory tests for pesticide exposure are measurement of plasma pseudo-cholinesterase or red blood cell acetyl cholinesterase levels, which measure cholinesterase inhibition and can indicate poisoning with OP or carbamate pesticides. Other methods measure pesticides and/or their metabolites in blood or urine. Having laboratories report to a central authority is a potential source for surveillance for pesticide poisoning. The US is an example of a country which has included laboratories as one of its surveillance data sources (Ballard et al, 2001; Calvert et al, 2004). States of California and Washington both require ChE monitoring of applicators who frequently handle cholinesterase inhibitors. The state of Washington has more detailed reporting of monitoring information because results of testing are centralized and reported by the state.

However, there are very few laboratories in developing countries able to perform this function. For example, a survey of laboratories in Southern Africa found a paucity of laboratories able to support surveillance activities (WHASA, 2008).

There are other limitations to laboratory-based surveillance. For example, there are many complexities in the interpretation of cholinesterase inhibition, which may affect their usefulness for surveillance, such as its wide normal range and high inter-individual variability. Someone with a high normal baseline may have substantial cholinesterase inhibition and still have a level within normal range, as a result of which their poisoning will be missed (Barnett et al, 2005).

2.9. Challenges for surveillance systems

Surveillance systems are affected by a number of challenges. First, classification strategies for APP must take into account the level of certainty of exposure, diversity of health effects, and plausibility that there is a causal link. Although laboratory, biological or environmental sampling may provide high specificity in detection of APP cases, sole reliance on these methods may result in a large proportion of missed cases. Further, while inpatient hospital records, suicide registries, forensic evidence and personal interviews may provide reliable data on the cause of APP, these modes may, individually, fail to provide adequate surveillance. Integration of different data sources is the only solution to achieve reliable data.

Second, a case definition which is too broad may lack specificity and overestimate the incidence of APP. Thirdly, due to the wide range of pesticides and their toxicities, clinical presentations can vary significantly. It may be difficult to attribute nonspecific symptoms to the pesticide exposure or other common environmental factors such as heat-related illness.

Fourth, poor diagnosis of APP cases, as a result of inexperienced health care providers or lack of equipment may be a serious challenge to surveillance systems. This can also result from the fact that many poisoning symptoms mimic common conditions resulting in incorrect and/or missed diagnoses and reduced estimates of APP cases.

Fifth, failure to report less severe cases of poisoning, which is common for occupational poisoning cases, is another challenge to surveillance systems. As a result, surveillance systems underreport occupational cases.

Sixth, the lack of a common case definition in a system soliciting data from different departments can be another constraint leading to under-or over-reporting and unrealistic data estimates. Finally, low awareness of pesticides and health effects among the HCPs and the farming community can lead to the failure to report pesticides injuries and hence affect the performance of the surveillance system.

2.10. Conclusion

In conclusion, pesticides exposure may cause serious injuries to farmers and the community. However, the magnitude of the problem is uncertain across different countries. In order to reduce the level of uncertainty regarding the extent of injuries arising from pesticides, effective surveillance systems, based on reliable data sources and a well-defined case definition, are necessary. The combination of different data sources with a common case definition is likely to result in a more realistic picture of APP in the community

CHAPTER 3.0: OVERVIEW : RATIONALE, OBJECTIVES, STUDY SITE AND DESIGN.

3.1. Rationale of the Study

Pesticides poisoning is a serious problem in developing countries and is a potentially serious problem in Tanzania. There is, however, a critical lack of reliable data on the extent of the problem. The existing data on pesticide poisoning worldwide are crude estimates and do not reflect the real burden of disease posed by these chemicals.

Tanzania lacks a surveillance system for pesticide poisoning. The scant data available on APP in Tanzania are documented within the health care system through the Health Management Information System (HMIS). These APP data are likely to represent only a small fraction of the APP problem. This is due to the fact that only a small number of severe poisonings cases are reported to health care facilities and even those presenting may not be reported through the HMIS. Reasons for cases not presenting to health care systems include costs of medical treatment, lack of facilities, especially in rural areas, and fear of reporting (Sivayoganathan et al, 1995; Damalas et al, 2006). Furthermore, the few cases reported to the health care system may be misdiagnosed. This suggests that the magnitude of APP is so underestimated that it cannot effectively inform policy.

This study was therefore designed to address the persistent problem of the lack of valid and reliable data on APP. The aim of this study was to determine the extent of acute pesticide related illness and injury among farmers and their families in Tanzania and to explore how best to estabalish a surveillance system. The study elicited pesticide poisoning data from various sources, developed national incidence rate estimates, recommends appropriate interventions and proposes a national surveillance system for APP. Although the current study addresses the problem of APP, it is anticipated that, in future, the surveillance system may also accommodate data on chronic pesticide poisoning.

3.2. Main aim

To characterize the circumstances and health consequences of APP among farmers and their families from agricultural areas in Tanzania with a view to implementing an effective surveillance system for APP.

3.3. Specific Objectives

3.3.1 To characterize APP in selected regions in Tanzania with regard to the agents responsible for poisoning, demographic risk factors, the circumstances and outcomes of poisoning and population groups affected and to estimate incidence rates of both fatal (mortality) and non-fatal (morbidity) poisonings with pesticides in selected rural districts of Tanzania

3.3.2 To describe the profile of pesticides handled by farmers, poisoning signs and symptoms experienced, past poisonings experienced, pesticide handling practices and farmers' knowledge of pesticide hazards in selected districts of Tanzania.

3.3.3 To describe practices of health professionals regarding the diagnosis and management of pesticide poisoning, their knowledge about pesticides and their hazards, perceptions regarding products mostly linked with poisoning, and their views regarding factors that enhance surveillance for APP.

3.3.4 To describe pesticide stakeholders' views on the gravity of APP in the community, the most common circumstances of poisoning, products linked with poisoning and the strategies for improving notification and reducing poisoning incidents.

3.3.5 To characterize the pesticide products distributed in selected districts in Tanzania by pesticide retailers and their academic qualifications and safety practices.

3.3.6 To estimate the true incidence of fatal and non-fatal APP among farmers in Tanzania as a contribution to the national burden of illness.

3.3.7 To describe the extent to which APP data obtained through surveillance meets the requirement of the PIC notification system.

3.3.8 To compare the completeness and usefulness of different data sources for monitoring APP in Tanzania.

Process Objectives

(i) To prepare and maintain a database on APP cases

(ii) To make recommendations for planning of appropriate interventions in both preventive and monitoring measures including influencing the relevant National policies.

(iii) To propose a national surveillance system for APP in Tanzania

3.4 Study Design and Study Sites

The study included six sub-studies involving both retrospective and prospective data collection. Each sub-study is presented in turn, complete with study design, data collection methods and analyses, results and discussion, in chapters 4 to 9. The study designs in these sub-studies were largely descriptive but included cross sectional analysis of risk factors. Table 3.1 below outlines the sub-studies, including their study sites (Figure 3.1) and design:

Table 3.1: Overview of Sub-studies.

Sub-study Number and chapter	Topic	Sub-study Site (areas/regions)	Study Period	Study Design
1 **(Chapter 4)**	Farmers' knowledge, practices and injuries associated with pesticides in 7 rural farming areas of Tanzania	Arumeru district within Arusha region	January - December 2005	Evaluation of farmer's knowledge, practices and poisoning associated with pesticides

2 **(Chapter 5)**	Hospital-based surveillance for APP : results of prospective and retrospective studies in selected regions of Tanzania, 2000 – 2006	Kilimanjaro and Arusha regions (North Tanzania), Iringa region (Southern Tanzania) and Mwanza region (Lake region)	2000 – 2005 (Retrospective study) 2006 Prospective study	Retrospective and prospective review of hospital APP data.
3 **(Chapter 6)**	Characterization of knowledge, diagnosis and management of APP among HCPs in selected regions of Tanzania	Kilimanjaro and Arusha	January - December 2005	Characterization of health care providers' knowledge, diagnosis and management of APP
4 **(Chapter 7)**	Tanzanian decision-makers' awareness of APP and views on a notification system and risk reduction strategies for APP	Arusha, Kilimanjaro and Dar es Salaam	January – December 2005	Evaluation of awareness on APP, notification and risk reduction
5 **(Chapter 8)**	Pesticide retailers' knowledge and handling practices in selected regions of Tanzania	Kagera, Mwanza, Iringa, Mbeya, Arusha and Kilimanjaro	January – December 2005	Evaluation of their knowledge and handling practices
6 **(Chapter 9)**	Sources of data on APP other than hospital records in Tanzania: Findings from local newspapers and ministry of home affairs records.	All regions of Tanzania (n=21)	January – December 2005	Review of police

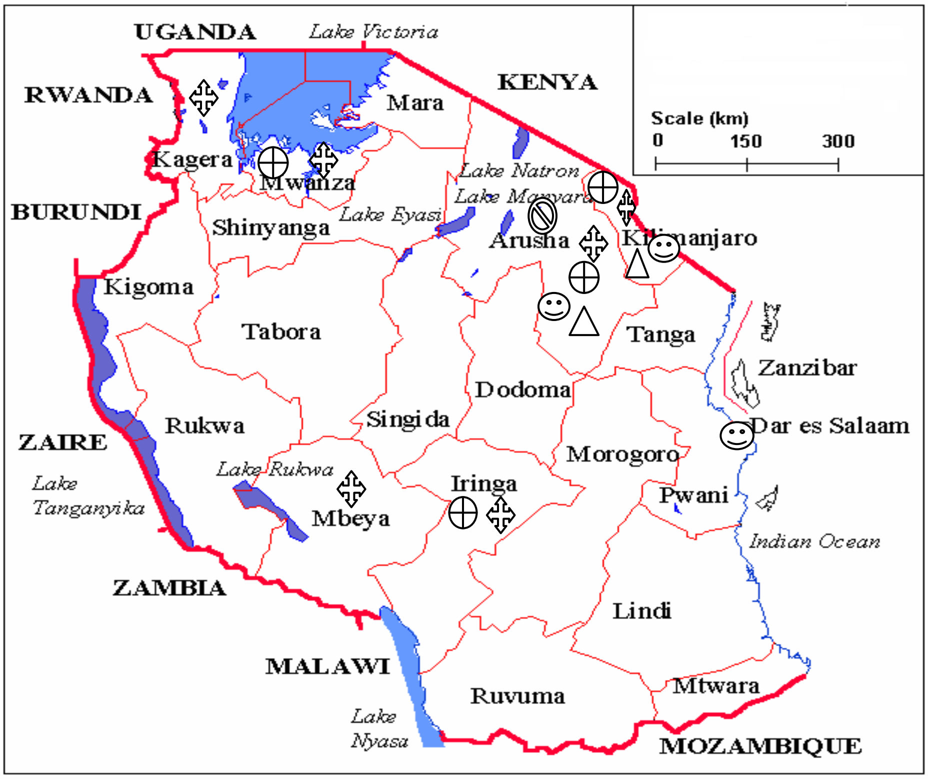


Figure 3.1: A map of Tanzania showing study sites

Key:

⃠	Farmers household survey (Arusha)
⊕	Hospital survey (Arusha, Iringa, Mwanza, Kilimanjaro)
△	Health care providers survey (Kilimanjaro and Arusha)
☺	Decision makers survey (Kilimanjaro, Arusha, DSM)
✣	Pesticide retailers (Kagera, Mwanza, Iringa, Mbeya, Arusha and Kilimanjaro)

Chapter 10 integrates the findings from the different sub-studies in a discussion on surveillance for pesticide poisoning in Tanzania.

3.5. Ethical considerations

In general, sensitization seminars were used to educate target groups, such as farmers about the study. These took the form of open meetings to explain the objectives, purpose and methods of the study. Individual informed consent was also obtained from all participants.

3.5.1. Data confidentiality

The data obtained were kept confidential and individuals involved were not identified in any way in the results or data analysis. The completed questionnaires were kept under lock and key at the Tropical Pesticides Research Institute for the duration of the study.

3.5.2. Potential harms of the study

The possible harm from the study was minimal and was mainly related to the time devoted by the respondents to complete the questionnaire or be interviewed. There may have been psychological stress experienced by a few participants during recalling of the past traumatic poisoning events, particularly for victims who experienced severe poisoning in the past. These rare situations were handled by leaving sensitive questions for last or suspending the interviews until the respondents felt comfortable to continue. Stigmatization of individuals or groups was avoided by ensuring anonymity of the study results, whereby no individuals or groups could be identified in the results or analysis.

Another aspect which may have caused disquiet among the respondents is that pesticide retailers may have been operating illegally and fear of arrest may have influenced their answers. Also, health care workers may have been embarrassed to admit poor knowledge about APP, fearing loss of their jobs. These situations were handled by study sensitization campaigns which emphasised confidentiality of data and preventing harm arising from participating in the study. Furthermore, the letter of introduction regarding the study, signed by the Director of Prevention Services in the Ministry of Health and Social Welfare, assured respondents of no potential harm.

3.5.3. Potential benefits from the study

Benefits from the study included identification of risk factors for APP amenable to intervention; improved understanding of the difficulties faced by farmers in developing countries like Tanzania; and contribution to the empirical evidence base for improved surveillance methods in developing countries. Other benefits included providing evidence for the impact of APP in the community so as to prompt initiation of a system for tracking APP data and for pesticides hazards reduction in collaboration with the Ministry of Health and Social Welfare in Tanzania. It is encouraging that the Ministry has already shown concern by authorizing the study, sponsoring HCPs in the preliminary surveillance training held at Arusha in January 2006 and provisionally designating facilities for future data collection.

It is anticipated that through the surveillance system, the Ministry of Health and Social Welfare will obtain reliable data on APP and undertake appropriate interventions. . Apart from having reliable poisoning data, which will assist in making reliable estimates of national and international poisoning statistics, it is expected that the affected victims would be identified, compensated and assisted in terms of treatment and advice.

Another potential benefit from this study is generating reliable and accurate data for the Prior Informed Consent (PIC) database managed by the National Designated Authority (DNA). The PIC evaluation of pesticide hazards under normal usage depends mainly on the hazard information collected regarding various pesticide formulations. The study will support the role of the DNA to identify the most problematic pesticide products and take appropriate actions in terms of the PIC protocol to reduce human health risks.

3.5.4 Study Protocol Approval

The study protocol and data collection procedures were reviewed and approved by the Tropical

Pesticides Research Institute in Tanzania, University of Cape Town (UCT) Health Sciences Faculty Research Ethics Committee in South Africa (REF:328/2004) and the Ministry of Health and Social Welfare in Tanzania through the National Institute of Medical Research (REF NIMR/HQ/Vol XI/371).

Chapters 4 to 9 each report on the different sub-studies conducted in more detail.

CHAPTER 4.0: FARMERS' KNOWLEDGE, PRACTICES AND INJURIES ASSOCIATED WITH PESTICIDE EXPOSURE IN 7 RURAL FARMING VILLAGES IN TANZANIA

ABSTRACT

Background and aim

Agricultural production in Tanzania is dependent on pesticides as the main strategy for pest control. The pesticides most commonly used in Tanzania include OPs followed by carbamates and pyrethroids. The huge amount of pesticides used for pest control coupled with farmers' unsafe handling practices, suggests a high potential for human exposure, health injuries and illness. Farmers and community members in Tanzania are therefore at high risk for adverse pesticide health effects because of many opportunities for exposures during handling. The aim of this study was to describe the pesticide exposure profile among farmers, including their knowledge about pesticide hazards, previous poisoning signs and symptoms, and farmers' practices in relation to APP in selected agricultural areas.

Methodology

The population included all households in the selected study sites in Arumeru district in the Arusha region. A sample of 121 household consented to participate in the study. Data collection involved both administration of a standard questionnaire to farmers and observation of pesticide handling practices in the households visited. Data were collected on past APP use and the types of pesticide products commonly stored and used, practices related to equipment calibration, means of storage and disposal and knowledge on exposure.

Results

The study found that 93% of the farmers reported being poisoned by pesticides in their lifetime but the majority did not present to hospitals. Unsafe pesticide handling practices were reported by farmers during pesticide storage, use of PPE, disposal of obsolete pesticides, equipment calibration. The agents found to be involved in poisoning included OP (42%) and WHO Class I and II agents (77.6%). The poisoning symptoms most frequently reported included a runny nose, skin irritation, dizziness, throat irritation and lacrimation. The study found significant association between storing pesticides in the home and respondents' education level. Respondents with higher education were less likely to store pesticides in the home (PRR High/Low = 0.3; 95%CI = 0.1-0.7). There was also a significant association between respondent's knowledge (High knowledge versus low knowledge) and reporting practice of equipment calibration (PRR High/Low = 4.0; 95%CI = 1.3-12.8). Similarly, there was significant association between farmers education (High education versus low education) and reported practice of equipment calibration (PRR High/Low = 1.2; 95%CI = 1.03-1.4).

Conclusion

This study found potential opportunities for human and environmental exposure to pesticides in a selected community in rural Tanzania. These findings can be used to make an active contribution to advocacy for sound interventions especially with decision-makers in Tanzania who are currently considering amendments to the Plant Protection Act of 1997. The findings can also contribute to the

establishment of a national surveillance system for APP. Interventions are needed to improve pesticide handling practices to reduce poisoning. Farmers' training and improvement of instructions on labels are highly recommended to achieve these goals.

4.1. Introduction

Tanzania has a population of 35 million people, the majority live in rural areas (United Republic of Tanzania, 2002). About 85% of the workforce in Tanzania is engaged in agriculture, which is the core of the national economy (WHO, 1999). Cotton, horticulture and coffee in Tanzania consume large quantities and varieties of pesticides and the major products in use are fungicides (United republic of Tanzania, 2008). Among insecticides, OPs are used most commonly followed by carbamates and pyrethroids.

As is the case in other developing countries (Konradsen, 2007), the use of pesticides is intensive and is perceived by local farmers as a necessity for crop production. Most pesticides used in Tanzania are imported by licensed pesticide importers (TPRI, 2006). Few pesticides are formulated locally and formulation is conducted by 12 licensed pesticide formulation plants producing mainly pyrethroids (Lekei et al, 2007). Distribution of pesticides to farmers in Tanzania is undertaken by licensed pesticide retailers (Lekei et al, 2007). Over 13,000 metric tons (MT) of pesticides were imported and distributed in Tanzania during 2003 and 2004 alone (Akhabuhaya, 2005). The huge quantity of pesticides distributed, coupled with unsafe handling practices, suggest a high potential for human exposure, health injuries and illness. Many farmers in Tanzania, in particular small-scale farmers, are therefore at high risk for adverse pesticide health effects because of the many opportunities for exposure during handling.

In many developing countries, farmers handle highly toxic pesticides including some banned agents (Sodavy et al, 2000). Studies indicate that farmers in some areas have no information about the products they handle. For example, in Asia, some products distributed to farmers have labels written in a foreign language, not understood by the majority of farmers (Sodavy et al, 2000). In Tanzania pesticide information is unavailable to farmers using unlabelled products resulting from product repackaging before distribution to farmers (Lekei et al, 2004). Another concern is that some studies in developing countries indicate that farmers' source of information or knowledge of pesticides come from biased or untrained informants such as pesticide vendors or neighbouring farmers (Sodavy et al, 2000).

A previous Tanzanian study identified pesticide poisoning as a major problem in the farming community and reported an average of 62 poisoning cases recorded in hospitals per year, most being attempted suicide (Ngowi, 2002a). This problem is not unique to Tanzania. It is estimated that hundreds of thousands of people die globally each year from the effects of the use, or misuse, of pesticides (Konradsen et al, 2003; Sekiyama et al, 2007). Studies in developing countries regarding farmer's knowledge and practices have reported moderate to low levels of knowledge about pesticides (Ibatayo, 2006; Nalwanga et al, 2011), non-usage of personal protective equipment (PPE) during handling of pesticides (Sivayoganathan et al 1995; Yassin et al 2002; Ajayi et al, 2007), unsafe pesticide storage at home (Ngowi, 2002a; Ajayi et al, 2007), poor disposal of empty pesticide containers (Ibatayo, 2006), misuse of pesticides and relatively low knowledge about pesticide safety labels (Ajayi, 2007). A study on safety practices of farmers in Ethiopia reported that the majority of farmers did not use PPE or used worn-out PPE (Mekonnen et al, 2002).

Studies to assess injuries through self-reported poisoning symptoms have been conducted in many developing countries. A study of fern and flowers workers in Costa Rica found that over 50% of respondents experienced at least one symptom of pesticide poisoning (PANNA, 2002). In another study in Cambodia (Sodavy et al, 2000), 88% of vegetable farmers reported poisoning by pesticides with symptoms occurring after spraying (Sodavy et al, 2000). In the same study, 25% of respondents reported experiencing up to 4 symptoms at once and 45% between 5-10 symptoms (Sodavy et al, 2000).

In Tanzania, a previous study in 2007 found that 68% of farmers reported feeling sick after routine application of pesticides and their pesticide-related health symptoms included skin problems and neurological system symptoms (Ngowi et al, 2007). The aim of this study was therefore to describe the pesticide exposure profile among farmers, including their knowledge about pesticide hazards, previous poisoning signs and symptoms experienced, and farmers' practices in selected agricultural areas in relation to APP. This study was important to supplement gaps left by a previous Tanzanian study (Ngowi et al, 2001a) for several reasons. Firstly, this study takes into account newer products which have different health effects. Also, this study considered farmers' risk factors in more detail and estimated the proportion of APP cases reported to health care facilities, information needed for establishing the burden of APP in Tanzania.

4.2. Specific Objectives

(i) To describe the profile of pesticides handled by the farmers in selected agricultural areas in Tanzania.
(ii) To describe farmers' knowledge regarding pesticides and pesticide handling practices.
(iii) To describe farmers' history of pesticide poisoning, actions taken after poisoning and self-reported poisoning signs and symptoms experienced.
(iii) To determine the association between farmers' knowledge and their safety practices.
(iv) To determine the association between past poisoning and both farmers' knowledge and safety practices.
(v) To determine the association between farmers' educational level and safety practices.
(vi) To determine the proportion of self-reported APP cases seen at the public hospitals and clinics.
(vii) To determine the agreement between self-reported symptoms and self-reported poisonings.

4.3. Methodology

4.3.1. Population and sampling

The areas included in this household survey were agricultural areas cultivating coffee and vegetables in the Arumeru district in Arusha region (See figure 3.1 in chapter 3). Arumeru district has a total of 6 divisions and 147 villages (ILO, 2001). The villages selected included Uwiro, Olkungwado, Nguruma, Moivaro, Makisoro, Ambureni and Singis. The sites were selected because, firstly, they were typical of small farmer activity in Northern Tanzania and secondly, TPRI had an existing project running in the six villages, which made survey logistics easier. A further reason was accessibility as the site locations were a few hours' travel from Arusha city. The selected villages comprised of about 5% of all villages in Arumeru district (n=147).

The target population was the heads of families (including either males or females of 18 years or older) dealing with cultivation of coffee or vegetables in the study villages. The sample size estimate of 130 was calculated using an a priori estimation derived from a previous Tanzanian study which found 68%

of farmers reporting APP (Ngowi et al, 2007) and a margin of error of 8% with 95% Confidence.

4.3.2. Data collection

Data collection involved two methods:
i) administration of a questionnaire to farmers, and
ii) observation of pesticide storage areas in the households visited.

The questionnaire had both closed-ended and open ended questions (Annex 6). In cases where the head of family was absent, the spouse or another family member was interviewed. Data were collected on past APP (over a lifetime and frequency of poisoning), signs and symptoms experienced from APP, as well as the types of pesticide products commonly stored and used, practices related to equipment calibration, means of storage and disposal and knowledge on exposure. The data were collected by the PI, assisted in each area by local agricultural extension officers (Figure 4.1 a & b). The officers were trained in advance by the PI in administration of the consent forms and questionnaires, with emphasis on standardizing delivery of the questions.

a

b

Figure 4.1: (a) Inspection of one the household in progress ; (b) Recording of product in storage during the visit.

The officers were also trained to conduct inspections to record pesticide storage locations (inside the house, outside the house or in special storage facilities), whether the pesticides were secured when stored, the condition of the product, evidence of spillage, the identity (labelling) of the products and the presence, condition and types of PPE used, pesticide products found during the inspection process (Figure 4.1).

Inspection also verified what farmers reported in the questionnaires on pesticide storage and PPE (See annex 6 – questions 6.1 and 10.3). Not all farmers had products on site at the time of the survey, hence only a convenience sample of households reporting pesticides present were inspected for storage and spillage. For the rest of the households, data on storage location was therefore based on what farmers reported. The data from farmers, who self-reported storage location, were compared with data from households whose storage locations were physically inspected.

The questionnaire was pre-tested among the farming community living near the TPRI offices in Arusha in January 2005 and found to perform as anticipated. The presence of agriculture extension officers enhanced farmers' willingness to participate because of existing relationships for technical support and other research projects.

4.3.3. Data analysis and data validity

Univariate descriptive statistics were estimated for frequencies and percentages of all categorical variables. For the purpose of data analysis, variables were categorized as outlined in Table 4.1 below. Most cut-offs were chosen as medians or close to medians in the distributions of respective variables. In the case of product storage areas, the use of PPE and container and pesticide disposal, categorization was based on determining whether the practice was safe or unsafe.

Cross-tabulations were conducted as follows:

(a) Poisoning frequency was compared by respondents' education level, poisoning symptoms reported, the use of PPE, age, gender, reported practice of calibration, steps taken after poisoning, reported disposal practice and reported equipment wash area.
(b) Education level was compared by respondents' practice including reported practice of calibration, reported storage location and reported equipment wash area (close to water source or in the farm).
(c) Knowledge of routes of exposure was compared by disposal, use of PPE, calibration, equipment washing and education level.
(d) Lastly, Poisoning status was compared by knowledge, education, use of PPE, calibration, equipment washing, storage and disposal.

Wilcoxon comparison of medians was used to test differences in medians for numeric data and Chi square (χ^2) testing was used to compare the distribution of dichotomous variables. To measure the strength of association between categorical independent and dependent variables, Prevalence Risk Ratios (PRR) were estimated with 95% CIs. SPSS version 16 (SPSS, 2007) and Stata Version 10.0 (STATA, 2007) were used to analyse the data.

To assess validity of responses, farmers were asked to show the interviewer PPE and pesticide storage locations reported in the questionnaire. The reported responses were compared to inspection data for those farmers who reported having pesticides under storage at the time of survey (n=57), and agreement estimated as a kappa statistic. For validity of reporting of poisoning medical records for all respondents, who reported pesticide poisoning in the past year, and 10% of those who did not report, were traced in local health facilities in order to compare to their interview response. Validity was assessed as percentage of agreement.

The association between poisoning symptoms and poisoning frequency was tested for trend by calculating a Chi squared Mantel-Haenszel statistic.

Table 4.1: Categorization of the data collected in household survey.

Data variable	Category
Storage area	In house (defined as any of the following areas: bedroom, bathroom, toilet, kitchen, chicken-shed, above ceiling boards) or general store (store containing pesticides, fertilizers, food crops, farm implements and others) Other locations (defined as storage in pesticide stores or elsewhere on the farm)
Education level	High education (defined as $\geq$ form IV) Low education (defined as < form IV)
Age	Old (defined as >30 years Young (defined as $\leq$30 years)
Poisoning status	Ever poisoned (defined as a situation where the respondent reported being poisoned by pesticides in their lifetime) Never poisoned (defined as a situation where the respondent reported never being poisoned by pesticides in their lifetime)
Poisoning frequency	Highly poisoned (defined as reporting poisoning frequency > 2) Not highly poisoned (defined as reporting poisoning frequency of $\leq$ 2)
Poisoning symptoms	High symptoms (defined as reporting > 10 symptoms) Low symptoms (defined as reporting $\leq$10 symptoms)
Product disposal	Safe disposal (defined as burning, burying, dumping in a hole, re-spraying on field, donating to others or using up the pesticide). Unsafe disposal (defined as dumping in public disposal sites, on the farm, in the toilet or in the bush/ground).
The use of PPE	Users (defined as reporting current use of at least one form of PPE) Non-users (defined as reporting no current use of PPE).
Pesticide container disposal	Safe disposal (defined as burning or burying). Unsafe disposal (defined as re-use for household activities or dumping on the farm, in the toilet or in public sites).
Poisoning symptoms	OP symptoms (defined as symptoms such as breathing problems, excessive sweating, diarrhoea, vomiting, excessive salivation and others). Non-OP symptoms (defined as symptoms not typically associated with exposure to OPs).
Gender	Male (defined as male respondent). Female (defined as female respondent).
Equipment calibration	Yes (defined as situation where farmers reported practicing calibration) No (defined as situation where farmers reported not practicing calibration)
Equipment washing area	Close (defined as directly in the water source or within 10 meters from the water source) Other (defined as more than 10 meters away from the water source)
Knowledge on routes of exposure	High knowledge (defined as reporting over 2 exposure routes) Low knowledge (defined as reporting $\leq$ 2 exposure routes).
Steps taken after poisoning	Hospital (defined as respondents who attend hospital after poisoning) Other (defined as respondents who did not attend hospital afeter poisoning)

4.3.4. Case definition

A case of previous pesticide poisoning was defined as any short term illness or health effects arising from pesticide exposure reported by the respondent (self-report) and confirmed by the researcher as consistent with the respondent's description of pesticide exposure. This approach has been used in other studies in developing countries (Yassin et al, 2002; Atkin et al, 2000; Sivayoganathan et al, 1995; Caffiero et al, 1990).

In this study, further verification of OP poisoning was done by comparing self-reported symptoms and agents reported to be associated with poisoning. The nature of poisoning symptoms reported were categorized into potentially OP-related (including skin irritation, chest tightness, headache, feeling weak, eye irritation, excessive sweating, trembling hands, coughing, difficulty in breathing, forgetfulness, dizziness, loss of consciousness, itching/prickling, wheezing, throat irritation, excessive salivation, diarrhoea, stomachache, convulsions, lacrimation and sleepless nights) and non-OP symptoms (including flu, high fever, vomiting, painful urination, nose bleeds, loss of appetite and others). Bearing in mind that many OP-related symptoms are non-specific and may have other causes, the term "OP symptoms" is used to denote symptoms that are potentially OP-related rather than definitive of a diagnosis. Cross-tabulation of poisoning agent (OP versus non-OP) by reported symptoms (at least one OP symptom versus reporting non-OP symptoms) was conducted using Chi-squared (χ^2) testing to identify any association between the presence of an OP exposure and an OP-related symptom.

4.3.5. Ethical considerations

The participants completed a consent form (Annex 7) before participation in the study and were free to decline participation without any fine or penalty. To ensure confidentiality, their names were replaced by special codes for data analysis. The participants found to use no any form of PPE during pesticides handling were advised to do so. The study protocol was approved by TPRI ethical committee and the National Institute of Medical Research (NIMR) in Tanzania (REF NIMR/HQ/Vol XI/371) as well as Univerisity of Cape Town (UCT) Health Science Faculty Research Ethics Committee (REF:328/2004).

4.4. Results

The response rate was 93.0% (121/130 households). The farmers interviewed were mainly involved in cultivation of vegetables and coffee (Figure 4.2).

Figure 4.2. Vegetable farm containing tomatoes and eggplants in one of the households visited.

Most farmers (88.4%) were male. Their age ranged from 18 - 66 years with average age of 37.5 years (SD 1.18). Education ranged from adult education (education level less than 7 years schooling) to graduate level (4 years at the University). The modal level of education was 7 years (Primary school) of schooling (88%) (Table 4.2).

Table 4.2: Income, land ownership, pesticides mixing, equipment calibration and poisoning events among coffee and vegetable farmers in Arumeru district.

Characteristic	Response	n (Percentage)
Main source of Income	Agriculture + Livestock	74 (61.2 %)
	Agriculture only	27 (22.3 %)
	Livestock only	8 (6.6 %)
	Employment	8 (6.6 %)
	Business	4 (3.3 %)
Land ownership	Own Land	58 (47.9 %)
	Family Land	55 (45.4 %)
	Rented Land	8 (6.6 %)
Ever poisoned by pesticides	Yes	112 (92.5 %)
Poisoning Frequency	Never	9 (7.4 %)
	Once	19 (15.7 %)
	Twice	16 (13.2%)
	Three times	3 (2.4 %)
	Four times and more	74 (61.1%)
Container used for mixing pesticides	Sprayer tank	7 (5.8%)
	Tractor mounted equipment	11(9.1 %)
	Containers also used for keeping water	6 (4.9 %)
	Special containers for pesticides mixing	97 (80.1 %)
Is equipment calibration done	No	97 (80.2 %)
Education Level	Std VII	106(87.6%)
	Form IV	13(10.7%)
	Graduate	1(0.8%)
	Adult education	1(0.8%)

* Responses not mutually exclusive

Over 90% of farmers' main source of income was from either agriculture, livestock or both. Land was predominantly owned individually (47.9%) or within the family (45.4%) (Table 4.2). Twelve respondents reported small-scale farming at their homes whilst holding administrative jobs in floriculture and coffee estates (n=8), or in business (n=4).

Approximately 93% of respondents reported previous poisoning by pesticides in their lifetimes and the frequency of self-reported lifetime poisonings ranged from 1 to a maximum of 7 times with 76.4% of the poisoned respondents reporting two or more poisoning events and 63.5 % reporting 3 or more at some point in the past. The 112 farmers reporting past APP, reported a total of approximately 432 poisonings in the past. About 80 % of the farmers reported that they did not calibrate their spraying equipment (Table 4.2). Actions taken after poisoning (n = 112 respondents) included drinking milk (25%), attending hospital (21%), consulting the pharmacist (13%), applying cream to the affected area (6%), and washing the affected part of body (3%), actions were not mutually exclusive.

Most respondents (60%) reported taking no action following the poisoning. Of 23 farmers who reported attending hospital for poisoning, in 18 cases there was no record of their case in hospital records. There was no evidence of poisoning among those who reported no poisoning.

The active ingredients reported by farmers as associated with poisoning symptoms are listed in Table 4.3.

Table 4.3: Agents reported to cause poisoning among coffee and vegetable farmers in Arumeru district.

Active ingredient	Frequency
Profenofos	34
Chlorpyrifos	20
Lambda Cyhalothrin	18
Mancozeb	14
Cypermethrin	13
Endosulfan	9
Triadimenol	5
Chlorothalonil	5
Others**	21
Total	**139**

*Farmers could have reported poisoning with more than one agent so adds up to more than 121 (products associated with poisoning only).

** Abamectin (n=3), Malathion (n=3), Dieldrin (n=2), Deltamethrin (n=2), Copper (n=2), Amitraz (n=1), Pirmiphos methyl (n=1), Prochloraz manganese complex (n=1), Metalaxyl (n=1), 2,4-D (n=1), Dimethoate (n=1), Propineb (n=1) and Sulphur (n=1)

Of the agents involved in reported poisonings, 42.4% were OP and 77.6% were moderately toxic products (Class II in WHO classification) (Table 4.4).

Table 4.4: Categories of products reported as cause of APP among coffee and vegetable farmers in Arumeru district.

Chemical group	Total products	Percentage
Organophosphate	59	42.4%
Pyrethroids	34	24.4%
Others	31	22.3%
Organochlorines	11	7.9%
Carbamates	1	0.7%
Total	139	100%
WHO Hazard classes		
II	108	77.6%
III	6	4.3%
Unclassified	25	17.9%
Total	139	100%
NB: Unknown active ingredients including bed bug pesticide were omitted		

Table 4.5 lists products commonly handled and Table 4.6 lists poisoning signs and symptoms reported as experienced by the farmers. Among the products reported (n=494) as handled by the farmers, 26 % were OP pesticides, none were WHO Class I products and 49% were WHO class II products (Table 4.5).

Table 4.5: Products reported as used by coffee and vegetable farmers in Arumeru district.

Active ingredient	Chemical group	WHO Class	Frequency (n= 121)	Percentage (%)
Copper	Inorganic	III	68	56.2
Endosulfan	Organochlorine	II	66	54.5
Mancozeb	Dithiocarbamate	U	65	53.7
Profenofos	Organophosphate	II	60	49.6
Chlorpyrifos	Organophosphate	II	50	41.3
Lambda	Pyrethroids	II	25	20.7

Cyhalothrin				
Abamectin	Ivamectins	IV (EPA)*	23	19.0
Others (Unclassified)	-	-	21	17.4
Cypermethrin	Pyrethroids	II	16	13.2
Unknown	-	-	14	11.6
Triadimefon	Triazole	III	13	10.7
Propineb	Dithiocarbamate	U	13	10.7
Metalaxyl	Phenylamide	III	11	9.1
Chlorothalonil	Chloronitrile	U	10	8.3
Dimethoate	Organophosphate	II	10	8.3
Deltamethrin	Pyrethroids	II	9	7.4
Fenitrothion	Organophosphate	II	6	5.0
Dip	-	-	5	4.1
Others**			9	7.4

WHO Class Ia: Extremely hazardous, Ib: Highly hazardous,
II: Moderately hazardous, III: Slightly hazardous,
IV: Unlikely to present acute hazard under normal use condition

*EPA – Environmental Protection Agency

**Pirimiphos methyl (n=3), Sulphur (n=2), Novaluron (n=2) and Amitraz (n=2)

The poisoning symptoms most frequently reported included a runny nose, skin irritation, dizziness, throat irritation, lacrimation, excessive salivation, nausea, excessive sweating, coughing and chest pain (Table 4.6).

Table 4.6: Poisoning signs and symptoms experienced by coffee and vegetable farmers in Arumeru district (n=875).

	Sign/Symptom	OP-related	Frequency (Farmers)
1	Skin irritation	Y	66
2	Chest pain	Y	35
3	Coughing	Y	34
4	Flu	N	65
5	Wheezing	Y	14
6	Breathing with difficulty	Y	40

7	Throat irritation	Y	54
8	High fever	N	29
9	Excessive sweating	Y	44
10	Nausea	Y	34
11	Vomiting	N	6
12	Excessive salivation	Y	43
13	Diarrhoea	Y	10
14	Pain during urination	N	15
15	Stomachache	Y	24
16	Tiredness	Y	9
17	Nose bleeding	N	16
18	Blurred vision	Y	42
19	Lacrimation	Y	40
20	Eye irritation	Y	61
21	Loss of appetite	N	21
22	Headache	Y	66
23	Dizziness	Y	49
24	Unconsciousness	N	10
25	Hands trembling	Y	10
26	Sleepless nights	Y	38
	Total		**875**

Of the past poisonings (n=432) reported by the 112 farmers, they reported 875 symptoms in total; 703 (80.3%) were symptoms consistent with OP poisoning.

Although the median number of OP-specific symptoms (7) was slightly higher among farmers who reported an exposure to an OP than among farmers who reported exposure to non-OP pesticides (5.5), this difference was not statistically significant ($p > 0.05$). Also, the proportion of farmers reporting an OP as a poisoning agent was higher among farmers reporting at least 1 OP-specific symptom than in those who reported no OP symptoms (70.9% versus 50.0%, respectively) but the association was not significant ($p > 0.05$) (Table 4.7)

Table 4.7: Association between OP poisoning symptoms and OP agents among coffee and vegetable farmers in Arumeru district.

	Farmers reporting Non OP or Unknown agent	**Farmers reporting at least 1 OP agent**	**Total**
Farmers reporting Non OP symptoms	1 (50%)	1 (50%)	2
Farmers reporting at least 1 OP symptom	32 (29.1%)	78 (70.9%)	110
Total	**33**	**79**	**112**

Pesticides and spraying equipment were commonly stored in different locations inside the household, including the bedroom, sitting room, bathroom, toilet, kitchen and above the ceiling boards as well as general storage areas in the house used for storing harvested food crops, drinks and other household items. Only 9% of respondents reported storing their pesticides in a storeroom specifically designated for pesticides (Table 4.8).

Table 4.8: Reported storage locations, disposal methods, knowledge of routes of exposure and sources of pesticide information reported by coffee and vegetable farmers in Arumeru district.

Characteristic	**Options**	**Percentage (%)**
Storage of pesticides:	General storage within the house	57.2
	Dedicated pesticide store	9.2
	Elsewhere on farm	9.2
	Toilet	5.9
	Kitchen	5.2
	Ceiling board	5.1
	Bedroom	3.0
	Bathroom	3.0
	Chicken shed	1.8
Storage of spraying equipment:	General store	39 .0
	Equipment store	26.0
	Ceiling board	16.0

	Bedroom	13.0
	Elsewhere on the farm	6.4
Knowledge of pesticide absorption routes:*	Dermal	75.2
	Inhalation	72.7
	Ingestion	9.9
	Other (eyes, wound)	2.4
	Unknown	12.3
Farmers Source of Information on pesticides *	Label	70.8
	Extension officers	38.6
	Pesticides retailers	48.2
	TPRI	6.4
	Unknown	9.6
Disposal of unwanted pesticides *	Burn	3.3
	Bury	5.0
	Donate	4.1
	Dump in a hole	1.6
	Dump in general public sites including town disposal sites.	1.6
	Dump in the farm	28.9
	Dump on the ground	5.7
	Re spray remaining spray solution	34.7
	Dumping in the bush	1.6
	Dumping in the toilet	0.8
	Use all	9.0
	Do not Know	7.4
* Categories not mutually exclusive		

In total, 78 % of the respondents kept pesticides within their residential homes, often in rooms used by a number of family members (Figure 4.3).

Figure 4.3: Products stored within a residential house

Storage of pesticides inside homes featured commonly both when self-reported and on inspection of storage locations in the households visited (Table 4.8 and 4.9).

Table 4.9: Agreement between reported and inspected storage of pesticides among coffee and vegetable farmers in Arumeru district (n=57).

Storage reported	Storage on inspection		
	In house/general storage	**In other site / outside house**	**Total**
In house /general storage	41	10	51
In other site / outside house	3	3	6
Total	**44**	**13**	**57**

The proportion of farmers self-reporting storage inside the home was 89.5% (95% CI = 77.8%- 95.6%) in inspected households and 68.8% (95% CI = 55.8%-79.4%) in households not inspected. There was high agreement (44 /57, or 77%) between storage locations on self-report and inspection on whether storage was indoors or outdoors.

Of the 13 discrepancies between self-report and inspection, most cases involved respondents reporting indoor storage; 10 farmers were found to have outdoor storage on inspection while only 3 of the 13 were respondents reporting outdoor storage were found to have indoor storage on inspection. The predictive value of a positive self-report for storage inside the house was 41 out of 51 or 80% (Table 4.9).

The main products found stored in the households at different locations were Mancozeb (n=24), Chlorpyrifos (n=19), Endosulfan (n=13), Profenofos (n=11), Chlorothalonil (n=10), lambda-Cyhalothrin (n=9), Cypermethrin (n=7) and Dimethoate (n=6). Among the products found in the households (n= 99), 34.3% were WHO class II products. Table 4.10 indicates the top 10 active pesticide ingredients most commonly reported as used, stored and involved in poisoning by the farmers. Products which appear in all categories included endosulfan, lambda cyhalothrin, chlorpyrifos, mancozeb, cypermethrin, profenofos and abamectin.

Table 4.10: Ten most frequent active ingredients reported as used, stored and involved in poisoning among coffee and vegetable farmers in Arumeru district.

Used	Stored	Involved in poisoning
Endosulfan	Endosulfan	Endosulfan
Lambda Cyhalothrin	Lambda cyhalothrin	Lambda Cyhalothrin
Chlorpyrifos	Chlorpyrifos	Chlorpyrifos

Mancozeb	Mancozeb	Mancozeb
Cypermethrin	Cypermethrin	Cypermethrin
Profenofos	Profenofos	Profenofos
Abamectin	Abamectin	Abamectin
Copper fungicides	Copper	Malathion
Triadimefon	Amitraz	Triadimenol
Propineb	Chlorothalonil	Chlorothalonil

*The products are not in order of descending frequency .

Containers used for mixing pesticides included a special container for this purpose (80.2%), tractor mounted equipment (9.1%), spraying equipment (i.e. the farmer mixed the pesticide directly into the backpack of spray device) (5.8%) and containers also used for keeping drinking water (4.9%) (Figure 4.4).

Figure 4.4: Example of a domestic container ready for making a spray solution.

There was a wide variety of types of PPE reported as used among the farmers. The PPE most often used were gumboots (n=25). Other reported PPE included long coats (n=8), hats/helmets (n=8), hand gloves (n=6), overalls (n=6), respirators (n=6) and facemasks (n=3). A total of 81 farmers (66.9%) reported no PPE use at all (Figure 4.5).

Figure 4.5: A farmer spraying without any form of PPE.

Among the 40 farmers (33.1%) reporting PPE use, the number of different PPE items used ranged from 1 to 6. However, the quality and condition of the PPE were poor. Over 60% of the total of 117 PPE types reported among the 40 users were damaged or extremely contaminated when inspected. Most (4 / 6) respirators reportedly used by the farmers were actually disposable dust masks unsuitable as PPE to prevent inhalation of pesticide fumes.

Methods of disposal of unwanted pesticides were reported as spraying on the crop (n=42) and dumping out on the farm (n=35) (Table 4.8; Figure 4.6).

Figure 4.6: Dumping of pesticides in the farm demonstrating one of the unsafe disposal methods.

Methods reported for disposal of empty pesticide containers include burying in the soil (n=38), burning (n=33), dumping on the farm (n=25), selling back to pesticide retailers (n=7) and reuse for household purposes (n=8). Other disposal options (n=8) were less common and included dumping on the ground/bush, burying in a special hole, throwing down the toilet and dumping in public disposal sites. Thirteen farmers could not report a disposal method.

Farmers' reported knowledge on the ways in which pesticides enter the human body showed that the majority knew of dermal (75.2%) and inhalational (72.7%) routes of absorption. Knowledge of other routes of absorption (via the eyes and through open wounds) was less common (Table 4.8). About 10% indicated lack of knowledge of any route of absorption (Table 4.8).

Regarding sources of pesticide handling instructions, most farmers reported that they obtained instructions from pesticide labels (70.8%), pesticide retailers (48.2 %) or agricultural extension officers (38.6%). A very small proportion (6.4%) reported receiving such information from the Tropical Pesticides Research Institute (TPRI) (Table 4.8).

Among the 144 products found at 121 households, 36 products (25%) were found to have been repackaged into a secondary container. Of the 36 repackaged products, 42% were OP and 45% were WHO class 1 or II pesticides. The secondary containers were either paper or plastic bags, glass or plastic bottles some of which were originally containers for drinking water or soft drinks (Figure 4.7).

Figure 4.7: A pesticide (Endosulfan Dust) which is repackaged into a secondary container.

Some of the products showed signs of spillage into surrounding surfaces. These agents included Copper Oxychloride, Copper Hydroxide, Chloropyrifos, Pirimiphos Methyl and Profenofos. None of the repackaged containers had a proper label.

Associations with frequency of past poisoning and with high symptom reporting

There were no significant associations of poisoning frequency with age, gender, education, use of PPE, calibration, container disposal, pesticide disposal or knowledge on routes of exposure (Table 4.11).

Table 4.11: Associations with past poisoning frequency and with the number of poisoning symptoms, age, gender, education level, safety practices and knowledge.

Variable	Categories	Poisoning frequency	Prevalent Rate Ratio

		>2	≤ 2	
Poisoning symptoms	High (> 10)	29(82.9%)	6(17,1%)	High/Low = 2.2; 95% CI = 1.0 - 4.8
	Low (≤ 10)	48(62.3%	29 (37.7%)	
Age	Young (≤ 30)	23(74.2%)	8(25.8%)	Young/Old = 1.3; 95% CI = 0.7 - 2.6
	Old (> 30)	54(66.7%)	27(33.3%)	
Gender	Female	12(92.3%)	1(7.7%)	Female/Male = 5.5; 95% CI = 0.7 - 40.3
	Male	65(65.7%	34(34.3%)	
Education Level	High (≥ Form IV)	10(71.4%)	4(28.6%)	High/Low = 1.1; 95% CI = 0.4 - 3.4
	Low (< Form IV)	67(68.4%)	31(31.6%)	
Use of PPE	No use of PPE	53(67.9%)	25(32.1%)	Non Use/Use = 0.9; 95% CI = 0.7 -1.3
	Use PPE	24(70.6%)	10(29.4%)	
Steps taken after poisoning	Hospital	15(71.4%)	6(28.6%)	Hospital/Other = 1.1; 95% CI = 0.5 - 2.7
	Other	62(68.1%)	29(31,9%)	
Calibration	Yes	16(84.2%)	3(15.8%)	Yes/No = 2.8; 95% CI = 0.8 - 10.3
	No	61(65.6%)	32(34.4%)	
Equipment wash area	Close to water source	57(77.2%)	22(27.8%)	Close/Other = 1.2; 95% CI = 0.9, 1.6
	In the farm	20(60.6%)	13(39.4%)	
Container disposal	Unsafe	44(66.7%)	22(33.3%)	Unsafe/Safe = 0.9; 95% CI = 0.7 - 1.3
	Safe	33(71.7%)	13(28.3%)	
Pesticide disposal;	Unsafe	38(76.0%)	12(24.0%)	Unsafe/Safe = 1.4; 95% CI= 0.9 - 2.4
	Safe	39(62.9%)	23(37.1%)	
Product storage	Living house	53(61.6%)	33(38.4%)	Living house & General store/Other = 0.7; 95% CI= 0.6 - 0.9
	Other	24(92.3%)	2(7.7%)	
Knowledge of routes of exposure	High (3 routes)	5(62.5%)	3(37.5%)	High/Low = 0.7; 95% CI= 0.2 – 3.0
	Low (≤ 2 routes)	72(69.2%)	32(30.8%)	

There was a marginally significant association between high poisoning (reporting > 2 poisoning frequency) and (i) reporting of high symptoms (>10 symptoms) (PRR = 2.2; 95%CI = 1.0- 4.8); (ii) washing spraying equipment close to water sources (PRR Close/Other = 1.2; 95% CI = 0.9, 1.6); and (iii) unsafe pesticide disposal practices (PRR Unsafe/Safe = 1.4; 95% CI= 0.9 - 2.4).

The frequency of poisoning symptoms increased with increasing poisoning frequency recorded ($\chi 2$ Mantel-Hantzel for trend = 5.1, $p < 0.05$).There was also a significant inverse association between high poisoning with storage of pesticides in living house (PRR Living house & Gen store/other: = 0.7; 95% CI = 0.6 – 0.9).

There were marginally significant associations between reporting high symptoms (over 10 poisoning symptoms) and a number of behaviours: (i) a failure to use PPE (PRR Non-use/Use = 1.2; 95% CI = 0.9 - 1.6); (ii) failure to practice equipment calibration (PRR No/Yes = 1.2; 95% CI = 1.0 - 1.3); (iii) equipment wash area (PRR Close to water source/Other = 1.1; 95% CI = 0.9 - 1.5); (iv) equipment storage area (PRR Living house & general store/Other = 1.1; 95% CI = 0.9 - 1.3); (v) pesticide storage area (PRR Living house & general store/Other = 1.2; 95% CI = 0.9 - 1.4); and (vi) age (PRR Old/young = 1.1; 95% CI= 0.9 - 1.4) (Table 4.12).

Table 4.12: Associations of poisoning symptoms with age, gender, education level, steps taken after poisoning, safety practices and knowledge.

Variable	Categories	Poisoning symptoms		Prevalent Rate Ratio
		Over 10	10 or less	
Age	Old (> 30)	27 (33.3%)	54 (66.7%)	Old/young = 1.1; 95% CI= 0.9 - 1.4
	Young (≤ 30)	8 (25.8%)	23 (74.2%)	
Gender	Female	4(30.8%)	9 (69.2%)	Female/male= 0.98 ; 95% CI = 0.3 - 2.9
	Male	31(31.3%)	68(68.7%)	
Education level	Low	30(30.6%)	68(69.4%)	Low/High = 0.9; 95% CI = 0.8 - 1.1
	High	5(35.7%)	9(64.3%)	
Steps taken	Hospital	7(33.3%)	14(66.7%)	Hospital/Other = 1.1; 95% CI = 0.5 - 2.3
	Other	28(30.8%)	63(69.2%)	
Products storage area	Living house and general store	30(34.9%)	56(65.1%)	Living house & general store/Other = 1.2; 95% CI = 0.9 - 1.4
	Other	5(19.2%)	21(80.8%)	
Use of PPE	Not use	28(35.9%)	50(64.1%)	Non use/Use = 1.2; 95% CI = 0.9 - 1.6
	Use	7(20.6%)	27(79.4%)	
Calibration	No	32(34.4%)	61(65.6%)	No/Yes = 1.2; 95% CI = 1.0- 1.3
	Yes	3(15.8%)	16(84.2%)	
Equipment	Close to water source	27(34.2%)	52(65.8%)	Close to water

wash area	Other (In the farm)	8(24.2%)	25(75.8%)	source/Other = 1.1; 95% CI = 0.9 - 1.5
Equipment storage area	Living house	31(33.0%)	63(67.0%)	Living house & general store/Other = 1.1; 95% CI = 0.9 - 1.3
	Other	4(22.2%)	14(77.8%)	
Container disposal	Unsafe	19(28.8%)	47(71.2%)	Unsafe/Safe = 0.9; 95% CI 0.6 - 1.3
	Safe	16(34.8%)	30(65.2%)	
Pesticide disposal	Unsafe	17(34.0%)	33(66.0%)	Unsafe/Safe = 1.1; 95% CI = 0.7 - 1.7
	Safe	18(29.0%)	44(71.0%)	
Knowledge of routes of exposure	High (3 symptoms)	2(25.0%)	6(75.0%)	High/Low = 0.7; 95% CI = 0.2 - 3.5
	Low (≤ 2 symptoms)	33(31.7%)	71(68.3%)	

Reporting of poisoning symptoms showed no significant associations with gender, education level, steps taken after poisoning, knowledge on routes of exposure, container disposal and pesticide disposal (Table 4.12).

There was significant association between storing pesticides in the house and respondents' level of education. Respondents with high education were less likely to store pesticides in the home (PRR High/Low = 0.3; 95%CI = 0.1-0.7) (Table 4.13). There were no significant associations between respondents' education and pesticide disposal, equipment washing area, PPE usage and container disposal (Table 4.13).

Table 4.13: Associations of high education with safety behaviours.

Safety Behaviour	Category	Prevalence Rate Ratio (95% Confidence Interval)	
		High Education	**High Knowledge**
Calibration	No (n = 97)	1.2 (1.03 – 1.4)	4.0 (CI = 1.3-12.8)
	Yes = (n =24)		
Equipment wash area	Close to water source (n= 85)	1.6(0.6-4.1)	1.7 (0.4-7.6)
	Other (n= 36)		
Product storage area	In Living house & General store (n = 95)	0.3(0.1-0.7)	0.4 (0.1-1.4)
	Other (n = 26)		
Pesticide	Unsafe (n = 54)	1.2(0.5-3.2)	0.5 (0.1-1.8)

disposal	Safe (n = 67)		
Container disposal	Unsafe (n = 68)	0.9 (0.3-2.3)	1.9 (0.6-6.3)
	Safe (n= 53)		
PPE use	Use = 40	1.0(0.4-2.8)	2.0 (0.6-6.6)
	Do not use = 81		

There was a significant association between respondents' knowledge and reporting practice of equipment calibration (PRR High/Low = 4.0; 95%CI = 1.3-12.8). Similarly, there was a significant association between respondents' education (High education versus low education) and reported practice of equipment calibration (PRR High/Low = 1.2; 95%CI = 1.03-1.4). However, there were no significant associations between respondents' knowledge and container disposal, equipment wash area, pesticide disposal, pesticide storage and PPE usage (Table 4.13) Regarding knowledge and education, there was no association between high levels of formal education (≥ Form 4) and Knowledge of routes of exposure (PRR High/Low = 1.7; 95%CI = 0.4-7.6).

4.5. Discussion

Various sources of potential domestic and occupational pesticide exposure were noted during the survey. Firstly, the frequent storage of pesticides in homes indicated a high potential for exposure of farmers and family members due to storage of chemicals in highly accessible places. In fact, households were more likely to keep pesticides in an unguarded room in their houses than they were to have a special pesticide store. Moreover, some of the products found stored within homes in this study included hazardous (WHO Class II) products such as OP and Endosulfan, an organochlorine pesticide banned in many countries due to health and environmental concerns. Storage of pesticides in unguarded sites in residences is typical in many developing countries (Kimani et al, 1995; Clark et al, 1997; Ngowi et al, 2001a; Murphy et al, 2002). The prevalence of unguarded domestic storage was higher in this study (68%) compared to a previous Tanzanian study (43%) (Ngowi et al, 2001a), probably because respondents in this study were not informed in advance on the exact visiting day by the PI, as a result of which, they had no time to rearrange the stored products before the visit.

The true prevalence of pesticide storage within the home may have been slightly higher than reported given that the prevalence of household storage was higher (89.4%) in inspected households compared to households where no inspection was conducted (68.7%) and that a small proportion (8%) of respondents had underreported their household storage when inspected (Table 4.10). However, agreement between inspection and self-report in inspected houses was generally high (77%) and the positive predictive value of self-reported indoor storage was 80% (Table 4.9), suggesting that underreporting of household storage was not substantial and there was probably good validity of the self-report measure.

Secondly, failure to use PPE is another problem generating potential for significant pesticide exposure. This is supported by the finding of a significant association between high poisoning symptoms and non-usage of PPE (Table 4.12; PRR Non usage / Usage = 1.3, 95%CI =1.0-1.6). Non-use of PPE might be caused by unavailability or inability to afford PPE. However, even when PPE was used, their protective role was limited. For example, the most commonly reported PPE were gumboots, which are completely inadequate as sole protection for typical use. Most farmers, who reported use of respirators as protection were, on inspection, actually using disposable dust masks, which were not effective for protection when spraying toxic liquid pesticides, and may paradoxically increase risk because the users mistakenly believe they are protected and so may not follow other safety precautions. Farmers who reported using respirators were not able to distinguish between a respirator and dust mask, which may suggest that farmers are influenced in their choices of PPE by considerations of minimizing costs. Had PPE use been more appropriate, the association between failure to use PPE and symptoms may have been even stronger than that found in the study.

In good occupational health and safety practice, PPE has an important place but too often it becomes a substitute for more important and sustainable safety measures (Melvin, 2006). For example, Integrated Pest Management (IPM), safer application methods (enclosed cabins, avoidance of spray in windy conditions) or substitution (use of less toxic agents or mechanical barriers to pests) are important ways to reduce reliance on, and exposure to pesticides in agriculture. There is a hierarchy of controls in occupational health (Schoeman et al, 1994) in terms of which PPE should never be the first and only strategy. Rather, PPE should be part of a hierarchy of controls starting with engineering controls, control at source and administrative controls.

Poor use of PPE is widely reported in other developing countries (Clark et al, 1997; Murphy et al, 2002; Yasin et al, 2002; Soares et al, 2003; Salameh et al, 2004). Clark and colleagues (1997) reported that in the tropics, use of PPE is poorly tolerated because of discomfort associated with hot and humid conditions and prohibitive costs. A recent study in northern Greece (Damalas et al, 2006) show that about half of farmers interviewed (46%) did not use any special protective equipment when spraying pesticides. Similar results have also been reported among pesticide applicators in India (Mancini et al, 2005). What also emerges from this study is the high levels of inappropriate use (dust masks instead of respirators, gumboots as sole protection) among those reporting PPE use. Thus, the literature may over-report use of PPE by not examining the appropriateness of PPE used.

Calibration of spraying equipment is important to prevent both over-application, which results in human exposures, excessive residues and threats to both, local and export produce, as well as under-application, which may result in insect resistance. However, 80% of the farmers in this study did not calibrate their spraying equipment and appeared not to be conversant with the concept of calibration. The high poisoning symptoms reported by the farmers who did not calibrate their equipment (Table 4.12) supports the argument that poor application practices can result in higher exposure through increased emission rates.

Thirdly, unsafe disposal of unwanted pesticides and empty pesticide containers may be an important source of pesticide exposure. Farmers commonly dumped products and containers in unsafe ways, either on the farm, in rural areas, or in the general city disposal facility. These practices could easily lead to environmental contamination by runoff, leaching or distribution in dust particles through wind to other areas and are typical of many developing countries (Gerken et al, 2001). About 5% of farmers indicated that they wash and re-use the empty pesticide containers for other household activities. A similar prevalence of re-use of containers has been reported in other studies in developing countries (Gerken et al, 2001; Heeren et al, 2003). This is a serious and direct path for non-occupational human exposure.

Prevalence of self-reported past poisoning among farmers was high (92.5%), higher than reported farmers in Kenya (Ohayo-Mitoko et al, 2000), as was the frequency of poisoning episodes (61.1% of farmers report 4 or more previous poisonings). These figures mostly likely reflect non-severe cases which go unrecorded in the absence of an APP surveillance system because they do not present to hospital. Such APP cases might be captured in community-based self-reporting systems. The majority of the symptoms reported (79.2%) were consistent with the acute effects of OP insecticides, of which Profenofos and Chlorpyrifos were agents commonly used by the farmers. The association of OP-relatedness of symptoms with OP as poisoning agent (Table 4.7) suggest plausibility of the argument that OPs are the main contributor to pesticide-related symptoms among the farmers. Moreover, the symptoms of dizziness and headaches, which were prominent among the farmers in this study (Table 4.6), have been reported in both a Tanzanian study (Ngowi et al, 2001c) and a South Africa study of OP-exposed farm workers (London et al, 1997) and symptoms consistent with OP poisoning have been reported commonly among farmers in United Arab Emirates, (Beshwari et al, 1994), Ghana (Clark et al, 1997) and Kenya (Kimani et al, 1995).

A number of findings showing the importance for surveillance emerge in this study. Firstly, 60% of poisoned respondents did nothing about their symptoms, and 81% did not go to a health care facility. There are a number of reasons why poisoned farmers may not report their injuries to a health care facility. Many farmers are too poor to afford payment for their medical bills, as a result of which they may choose not to report their injuries to health care facilities. Also, the fact that many cases are of mild severity means that most of them will recover naturally, so farmers may be less motivated to seek health care. Moreover, there may also be problems in the diagnosis of pesticide poisoning since the injuries are sometimes confused with other health problems and this may further discourage farmers from reporting.

There may also be problems with access to health services. Families may live too far from health facilities. Even if available, the facilities may have no appropriate drugs or medical services available, so poisoned victims may not see the value of attending these health facilities. Farmers who have been poisoned may also be unaware of the long term adverse health effects of pesticides, further contributing to a lack of motivation to attend health facilities. This means that facility-based surveillance is likely to miss poisoning cases among farmers who do not attend services. On the other hand, some cases may arrive at the health facility but still not be recorded in the database due to a poor recording system. In this study, for 18 of the 23 farmers who reported attending a health facility in the past for pesticide poisoning, there were no records of these poisonings at the facilities. This suggests a large proportion of cases presenting to hospitals are unreported in hospital information systems (78.2%; 95%CI = 55.79% - 91.71%).

The finding of low reporting of APP in this study is consistent with other community-based studies with farmers in both developing (Ohayo-Mitoko et al, 2000) and developed (Martin et al, 2002) countries, which have found that a minority of farmers suffering pesticide poisoning (between 8% and 25%) seek health care. This has important implications for surveillance, which are key to prioritizing and evaluating interventions to control the problem. Previous research in South Africa suggested that between 80% and 95% of poisonings due to pesticides were not reported (London et al, 2001) and research in Nicaragua found that approximately two thirds of APP cases are not reported (McConnell,1993; Corriols et al, 2008). Methods to ensure that the full spectrum of cases of pesticide poisoning is captured by surveillance are therefore urgently needed, particularly in developing countries where the exposures and risks are highest.

Of the 10 pesticides most commonly reported as causes of poisoning (Table 4.10), the majority (70%) were also listed as most commonly used or stored in households, although not necessarily in the same order of frequency. Endosulfan, Chlorpyrifos, Lambda-cyhalothrin, Mancozeb, Cypermethrin, Abamectin and Pofenofos were consistently present in all lists. This suggests a consistent link between distribution of these products and subsequent human exposure, and also points to the value of data on distribution of pesticide ingredients as a potentially useful form of surveillance as a proxy for exposure. Also of note, is that at least 5 agents commonly responsible for poisoning in this study (Lambda-cyhalothrin, Chloropyrifos, Cypermethrin, Endosulfan and Profenofos) were previously reported in Tanzania (Ngowi et al, 2001a) as causes of pesticide poisoning. In contrast, in this study, DDT was no longer found to be listed as a cause of poisoning, whereas Mancozeb was present but not previously reported, reflecting a change in registration of products over time in Tanzania. Similarly, WHO class I products were not reported as major causes of poisoning in this study, most likely because they are now registered for "restricted use" in Tanzania and are therefore unlikely to be used by small scale farmers.

One reason for the lack of strict consistency between different lists is that the farmers might have been out of stock during the survey and hence some products would not be found at home. Secondly, some of the farmers may not be conversant with the products they handle and, as a result, they may fail to report correctly all pesticides in use. In this study, 12.3% of farmers failed to report all the products they handle. On the other hand, underreporting may be the result of poor recordkeeping by some farmers.

Endosulfan, which was widely reported in this study, and found stored in homes of the farmers, belongs to the group of persistent organic pollutants (POPs). It has already been banned in 56 countries because of its high toxicity and environmental contamination (PANNA, 2008; PANAP, 2008). In terms of acute toxicity, Endosulfan is highly toxic to aquatic life (Sutherland et al, 2004; Silva et al, 2009) and there have been a number of deaths among humans associated with Endosulfan exposure, particularly in Africa and India (Sutherland et al, 2004; Silva et al, 2009). A study in Benin reported 277 cases of acute poisoning and 61 fatalities among farm families between 1999 and 2001, with Endosulfan responsible for 88% of fatalities in the 2000–2001 seasons (Tovignan et al, 2001). An intervention study in Sri Lanka showed that after Endosulfan was banned in 1998, deaths due to APP fell from 50 to 3 in the selected district hospitals over the following 3 years (Roberts et al, 2003). In terms of chronic toxicity, Endosulfan is an endocrine-disruptor, mimicking oestrogen at very low levels of exposure and is implicated in breast cancer. It is also a neurotoxin and has been linked to Parkinson's disease, birth defects and immunotoxicity (Sutherland et al, 2004; Silva et al, 2009). Endosulfan has been associated with developmental and reproductive effects in children environmentally exposed on cashew nut plantations in India (Saiyed et al, 2003).

Based on this accumulating evidence base, in October 2008, the Review Committee of the PIC met and concluded that Endosulfan met the criteria for inclusion in the PIC (Rotterdam) treaty. Despite this, several countries exporting the pesticide, including India, blocked its addition to the prior informed consent (PIC) schedule (BiPRO GmbH, 2010). This study, therefore, adds to evidence for including Endosulfan on the PIC list.

The frequency of use of OP and WHO Class I & II pesticides in this study (28% and 49%, respectively) is lower than previously reported (64% and 76% respectively) by Tanzanian farmers (Ngowi et al, 2001a). The previous study was conducted during 1991 – 1993, and the differences observed may be due to changing trends in Tanzanian agricultural practices with the introduction of newer products, particularly pyrethroids. This trend is mirrored by similar shifts in the pattern of agents most commonly reported as causing poisoning. Also, some farmers may have been using alternative pest control methods such as Integrated Pest Management (IPM) that reduce reliance on chemical pesticides. IPM measures introduced in Tanzania include the use of airtight drums for storage of harvested maize (Saidi et al, 1998), the use of botanicals and inert materials such as dust, cow dung and ashes to protect harvested maize and neem seed powder, pyrethrum dusts and synergized pyrethrum for storage pests (Saidi et al, 1998) and the use of pheromones (Dendy et al, 1991). Other alternative pest control strategies used in Tanzania included the use of *Nucleo-polyhydrus virus* (NPV) for the control of *Spodoptera exempta*; *Metarrhizium anisopliae var acridium* for control of *Nomadacris septemfaciata*; Diatomaceous Earth (DE) for control of various storage pests. There are also several neem (*Azadirachta indica*) products being tested in experimental pest control activities (Agenda, 2006).

In general, the protective effect of higher levels of formal education or even of knowledge of pesticides among the farmers was modest. High educated farmers and farmers with high knowledge were more likely to report practicing equipment calibration (OR = 1.2; 95% CI 1.03-1.4, and OR=4.0; 95% CI 1.3-12.8, respectively) and high-educated farmers were less likely (OR 0.3 (95% CI 0.1-0.7) to report storing pesticides in their homes (Table 4.13). Farmers with low education and low knowledge would be expected to have less awareness of the health and environmental implications associated with pesticides and more prone to store pesticides in their homesteads.

It is possible that farmers may have acquired their knowledge after being poisoned, in that increased symptoms led to both increased awareness and less willingness to store pesticides in the home. This may explain the counterintuitive finding that storing pesticides in the home was inversely associated with high poisoning since the data collected on storage was for current practice while poisoning was for past events. Neither PPE usage nor knowledge was associated with the frequency of past poisoning (Table 4.11). There may also be some underreporting due to reporting bias with reported hygiene practices not reflecting the real situation, and there may be other routes of exposure which were not measured in this study. Despite this, the findings suggest that there may be benefits for the prevention of poisoning with better education and awareness.

Nonetheless, it is still clear that for many safety practices, education and knowledge appeared to play no role (Table 4.13). In particular, there was no association in the use of PPE with either education or knowledge. Yet, the study also demonstrated that farmers were not ignorant of the potential health effects or routes of absorption of pesticide, with over three-quarters of farmers reporting awareness of the main routes of absorption. Similar findings of good knowledge have been reported by Clark, et al (1997) in Ghana. This suggests that even though farmers may know very well the hazards of the chemicals they work with, there may be other social and economic factors beyond their control that increase their risk of poisoning. For example, farmers may be well aware of the hazards but adopt risky practices like unsafe storage and omission of PPE use because of economic pressures to increase production or disincentives related to the costs of PPE and safe storage.

Interventions that provide farmers with information should therefore be coupled with other economic and social strategies to make hygiene practices economically and practically feasible. Of concern, though, is the misconception reported by 25% of farmers that milk could serve as an antidote following poisoning. This was the single most commonly reported action taken after a pesticide poisoning. This myth appears to be widespread among farmers and workers in diverse settings in developing countries (Rees, 2002; Goring, 2003) and particularly persistent, despite the lack of any evidence for its validity. In a study conducted in Tanzania, 64.7% of agriculture extension officers reported that milk is a recommended first aid in pesticides poisoning (Ngowi et al, 2002b).

Farmers in this study appeared to rely heavily on the labels (69%) as their main source of information and to lesser extent on extension officers and pesticide retailers. This reliance of labels as a major source of information is similar to findings of a study in Vietnam where 65% of farmers reported relying on pesticide labels as a source of information (Dung et al 1999**).** However, this source of information is of limited quality since many labels are damaged to the extent that they could not be easily read or understood by the users. The situation was more serious for the products distributed in non-original containers like soft drink containers which bear no relevant information. Further, some pesticides may have the correct labels but the information may not be understandable to the users. Extension officers are expected to fill this gap but there are too few to meet demands for the farming community. Also, some of the available extension officers, as reported in a previous Tanzanian study (Ngowi et al, 2002b), are not adequately trained on pesticide health aspects. Training of the extension officers is therefore strongly recommended.

Pesticide retailers who supply the products to the farmers are also a potential source of information for farmers on pesticide handling, given the inadequate number of agriculture extension officers in many areas. The limitation here is that many retailers are not well trained in safe handling of pesticides and suppliers are likely to be biased in promoting the sale of their products at the expense of empowering farmers to make independent decisions about pest control methods. They may encourage farmers to use their products over products from other companies or non-chemicals methods, which may create confusion among the farmers.

Farmers' reliance on labels for information on pesticides may reflect the fact that the proliferation of pesticide suppliers under trade liberalization policies in Tanzania (Lekei and Mununa, 2004) has led to insufficient technical support for small farmers. It is particularly worrying, given evidence of poor comprehensibility of labels for working populations in developing countries (Berhanu, 1993; Baloyi, 1997) and the reliance on labelling contained in the new system for Global Harmonization of Chemical Hazard Classification and Labelling (GHS) being introduced by the United Nations (United Nations, 2004; Rother, 2008; Rother et al, 2008).

This study found that few farmers disposed of their empty pesticide containers through returning them to manufacturers. Returning of empty containers to manufacturers could be a useful method for safe and economic disposal, but there is no direct link between a farmer and the manufacturer. Communication happens almost exclusively through product distributors or retailers who have no incentive to recyle containers. Another limitation is that some retailers may misuse the empty containers for decanting or repacking of adulterated products instead of returning them to manufacturers. The manufacturers have no policy for the collection of empty pesticide containers from the farmers. Moreover, if farmers were to sell the empty containers back to pesticide retailers as a means of disposal this could be detrimental for safety, particularly with unscrupulous retailers, because it could create a market for empty containers and hence encourage product adulteration through repacking and decanting. This, in turn, may lead to the distribution of substandard products to the farmers in more hazardous containers.

The use of containers for refilling pesticides is another potentially unsafe approach for disposal, due to the fact that it can encourage product adulteration and movement of products with misleading instructions or with no instructions at all leading to poor handling and application. Although only a few cases of reuse of empty containers for domestic purposes (4.9%) were noted among this sample of farmers, the situation is prevalent in many developing countries. Studies in Madhya Pradesh, India (Choudhary et al, 2001; Walter-Echols, 2006), Tanzania (Ngowi et al, 2001a) and South Africa (Heeren et al, 2003) found that rural populations made use of empty pesticide containers for domestic purposes, such as for keeping domestic water. Reuse of empty containers for household purposes is associated with high health risks (Scorziello et al, 1993) due to the fact that simply washing the container does not render it safe.

Handling of repackaged, decanted as well as spilling products, observed in this study, are highly hazardous practices, and probably the result of distribution of pesticides in large containers, which are unaffordable for small scale farmers. Instead, small-scale farmers who have modest needs for pesticides on their small size farms will purchase small amounts decanted into secondary containers including soft drink bottles, which are particularly hazardous.

Among the specific active ingredients associated with poisoning in this study, OP (42.4%) and class I&II (77.6%) agents accounted for the highest proportion (Table 4.4). The proportion contributed by OPs, may be underestimated because some unknown agents may have been OPs. Based on the toxicity of products reported with high frequency and the fact that majority of symptoms reported (79.3%) were consistent with OP poisoning, the study suggests that the diagnosis defined by history and self-reporting is probably a valid measure of products associated with poisoning. Regardless of low knowledge on pesticides' adverse health effects, the respondents were able to identify and link the pesticidess likely to result in illness or injury encountered in the community. This point is discussed in more detail in chapter 10 which integrates the findings from different studies in this thesis.

Among the 23 cases which were reported to health care facilities over the past two years, 5 cases were traced from records at the local health facilities. This number represents 4.1% (95% CI 1.5 to 9.9%) of all respondents reporting a past poisoning and 21.7% (95% CI 8.3-44.2%) of those claiming to have attended a health care facility for their poisoning. The rest might have attended minor dispensaries which were not visited or the records may have been lost or diagnosis missed at the facility.

The converse statistic, the number of pesticide poisoning cases that claimed to have attended a health facility but for whom no record was found, was 78.3% (95% CI 55.8-91.7%). Overall, there was no record in the hospital information systems for 95.9% (95% CI 90.1-98.5%) of farmers who claimed to have experienced a previous poisoning, a figure almost exactly the same as that found in a South African study (95%) of APP cases unreported in the Western Cape Province in 1994 - 1995(London and Bailie, 1999) . This study also found that there were no farmers who said they were not poisoned but presented to hospital, only missed notifications. This implies that there were no false negatives and supports the validity of the measure. These figures are important because they can provide a basis for extrapolating estimates of the true number of APP cases to population levels. Chapter 10 explores this modelling of the true burden of disease from APP in more detail.

4.6. Study limitations

The main limitation in this study was the limited generalisability arising from non-random sampling and potential bias introduced during the selection of the sample. It is possible the 7 villages from which participants were drawn are systematically different from villages in other parts of Tanzania; certainly, the crop production differs to other parts of the country and the villages' previous relationship to the TPRI may make them more sensitive to pesticide safety issues. However, if farmers were to underreport their hazardous practices, this would tend to underestimate the extent of the problem. A different study conducted in Tanzania (Ngowi et al, 2007) found similar age and educational levels among farmers in a different part of northern Tanzania, suggesting that the sample was unlikely to differ very much from similar types of farmers in Tanzania.

Secondly, there was a problem of non-participation of potential respondents. The original sample intended was 130 but only 121 respondents were successfully recruited. Consent may have been an obstacle to participation. Respondents had to sign informed consent before participating in the study and may have been uneasy about this practice, which may therefore have discouraged participation. However, non-participation of farmers with poorer safety practices, low awareness of pesticide hazards and fear of legal liability would most likely introduce bias in the form of underestimating the true extent of the problems.

Another problem was expectation of incentives (financial or other) for research participants, based on farmers' previous experience of large foreign-funded research projects, and the absence of any compensation may have discouraged some of the farmers from participating. Conversely, farmers with past histories of pesticide poisoning may have been more likely to participate. Nonetheless, the extent of non-participation was low (less than 20%) so was unlikely to make a big difference to the findings.

Thirdly, there were also potential information biases. Social interaction among respondents who belong to a common social group was experienced in a few situations such that they responded by providing similar answers. Once detected, participants were interviewed separately to avoid cross-communication. Further, poor knowledge about pesticides among the respondents, such as the failure to identify a pesticide product by its trade name or common name and classification, might have contributed to misreporting of poisoning agents or increased the number of poisonings due to unknown agents (42.8%). The problems due to OP and due to WHO Class I and II pesticides may therefore be substantially underreported.

Farmers' responses about poisoning symptoms, especially past poisoning events and past products handled, may have been subject to poor recall if details were forgotten. Despite having some awareness of hazards and routes of exposure, farmers may have been unable to link all symptoms to particular exposure. This might have led to underestimation of the reported association of OP-related poisoning symptoms and OP products handled. Misclassification of both exposure and outcome described above may have contributed to the absence of a statistical association between the number of OP-related symptoms and a history of OP exposure. Nonetheless, the frequency of poisoning symptoms was found to increase significantly with increasing poisoning frequency (both $\chi 2$ Mantel-Hantzel for trend = 5.1, $p < 0.05$; and PRR of Highly poisoned/Not highly poisoned for high symptoms = 2.8; 95% CI = 1.2-6.1) and the specificity of symptom reporting was supported by its association with a history of OP-exposure (39.4% of farmers with OP-related symptoms reported a specific OP exposure versus 9.1%, of farmers with non-specific symptoms; Fishers exact test, p=0.043). These findings suggest a reasonable degree of validity in the farmer reports.

Finally, the low farmer awareness of signs and symptoms consistent with pesticide poisoning is likely to create confusion in differentiating APP symptoms and symptoms from other diseases conditions. This appeared to be a general problem in many farmers and probably contributed to over-reporting of APP symptoms by the inclusion of symptoms arising from causes other than pesticides. However, underreporting may have resulted from exclusion of APP symptoms due to failure to recognize them. The net effect may have cancelled out any misclassification but further studies would be needed to clarify the relative effects. Moreover, despite the limitations listed above, the test for trends in poisoning frequency against poisoning symptoms was statistically significant (Chi square Mantel Haenszel $p < 0.05$).

4.7. Conclusion and recommendations

This study has revealed potential opportunities for human and environmental exposure to pesticides in a selected community in rural Tanzania. Although based on a non-random sample, the farmers in this study appear typical of farmers in rural Tanzania. The results therefore may indicate a potentially serious public health problem that may be widespread in the country. The study findings are also important in contributing to advocacy for sound interventions especially with decision-makers in Tanzania who are currently considering amendments to the Plant Protection Act of 1997 (United Republic of Tanzania, 1997). The findings can also be used to contribute to the establishment of a national surveillance system for APP.

Interventions are needed to improve pesticide storage conditions at local level and to ensure surveillance strategies that capture all the poisoning cases, including those that do not present to health care facilities. Efforts to develop community monitoring (Murphy et al, 2002) should be supported.

Farmers in this study had quite good knowledge about routes of exposure and hazards but had poor safety practices, particularly for disposal, equipment calibration, storage and use of PPE. To some extent, these are safety practices that require practical knowledge for implementation, although costs may be prohibitive. Training of the farmers on safety practices is recommended but should be practically-oriented involving farmer field schools because evidence shows that these schools are the most effective ways to change farmer behaviour (Lund et al, 2010). Also, training should be complemented by measures that reduce cost barriers to the adoption of safe behaviours.

Where provided, training must address adverse health effects associated with pesticide exposure, safe handling and reading and interpretation of pesticide label instructions, which were found to be a major source of information to the farmers in this study. Label instructions should be written in simple language, easily understood by the user taking into account the requirements of the National Law (United Republic of Tanzania, 1997) and the Globally Harmonized System for Chemical Hazard Classification and Labelling (GHS) (Rother et al, 2008). Training and oversight of pesticide retailers by the

National Authority through programs that are currently in place is also critical to ensuring safety along the supply chain. Training of farmers on the use of control measures other than PPE should be stressed since some farmers seem to rely on PPE as the only control measure for exposure. In principle, PPE should be the last resort in the hierarchy of control measures. Many of the above measures will not be effective without adequate enforcement. Finally, the issue of farmers' unsafe practices, found in this and many other studies, is complex because it involves interventions to change farmer behaviour. Although recommendations made here seek to address this problem, further qualitative studies need to be done to address this issue in a comprehensive manner.

CHAPTER 5.0: HOSPITAL-BASED SURVEILLANCE FOR ACUTE PESTICIDE POISONING (APP): RESULTS OF PROSPECTIVE AND RETROSPECTIVE STUDIES IN SELECTED REGIONS OF TANZANIA, 2000 - 2006.

ABSTRACT

Background and Aim

APP is a particularly important occupational and public health problem in Tanzania and also in other developing countries. Data on injuries caused by pesticides exposure are rare in most countries and therefore the magnitude of pesticide poisoning is not well known.

Scant data on pesticide poisoning cases in Tanzania are available within the hospital system (HMIS) and other Government departments. The data sources are not properly coordinated and, as a result, the data do not reflect the actual burden caused by pesticide poisoning. The major purpose of this study was to characterize the patterns of APP reported in health care facilities in Tanzania in order to recommend corrective interventions.

Methodology

Two sub-studies were conducted - namely retrospective analysis (2000-2005) and a prospective study conducted in 2006. The population included all admissions from referrals to regional and district hospitals located in four coffee and vegetable agricultural areas of Tanzania namely Mwanza, Iringa, Kilimanjaro and Arusha and also a sub-set of health centres and dispensaries selected from the Arusha district. The retrospective study included 30 facilities and the prospective study focused on 10 facilities with the highest reporting of APP. The data were collected using a standardized data collection sheet. A case of APP in this study was defined as any person who after having been exposed to one or more pesticides presented clinical manifestations of poisoning or specific laboratory test results compatible with poisoning within 14 days of exposure or presented a medical history of having been poisoned or whose relative or accompanying person gave a history of the patient having been poisoned. The circumstances, outcomes, agents responsible for poisonings, age and gender of patients were described using frequencies and proportions. Comparisons were made using χ^2 tests for categorical data and t-tests for continuous age data. The analyses were conducted using SPSS statistical package Version 16.0 and STATA statistical package Version 10.0. The strength of associations was estimated in terms of PRR with 95% CI. Multivariate logistic regression was conducted by modelling a fatal outcome as the independent variable with age, gender and circumstances of poisoning as dependent variables. Morbidity and mortality rates were calculated and stratified for gender, geographical area and age. Rates were analysed assuming a Poisson distribution for rare events using STATA statistical software (Stata Corporation, 2006).

Results

This study found a total 656 APP cases in the retrospective study over 5 years and 230 in the prospective study over 1 year. The majority of cases were reported from regional and referral hospitals in both studies. The highest proportion of cases in both prospective and retrospective studies was in the age

group 21 – 30 years. Suicide accounted for highest proportion (45.7%) and (58.7%) in both retrospective and prospective studies, respectively. Occupational poisoning was highest in the age group 21 – 30 years in the retrospective (51.5%) and prospective (36.8%) studies. Fatal cases represented a CFR of 9.3% (n=45) in retrospective study and 7.0% (n=13) in the prospective study. The majority of fatal cases in retrospective and prospective studies were due to suicide - 64.4% and 84.6%, respectively. The study found that in both prospective and retrospective studies there were significant associations between suicide and certain variables, namely unknown agents, fatal outcome, being older than 30 and being female. Multivariate analysis found that in both retrospective and prospective studies, respondents attempting suicide was significantly more likely to be fatally poisoned. The study estimated Annual Incidence Rate, Annual Mortality Rate and Annual Case Fatality Rate in Tanzania as 1.43/100000, 0.11/100000 and 7.8% in the retrospective study, and 4.05/100000, 0.22/100000 and 5.6% in the prospective study, respectively

Conclusion

This study concluded that APP had a significant impact on the community's health in the four selected regions of Tanzania, particularly through suicides. The rates of APP generated in this study, although needing refinement in further studies, are the first estimates in Tanzania and can be useful for quantifying the burden of disease caused by pesticides in Tanzania. Further, several poisoning agents reported as responsible for APP in this study included OP and WHO Hazard Class I and II pesticides, products that are highly or moderately hazardous and which may become subject to provisions of the Rotterdam Convention over time. Interventions such as the establishment of a surveillance system for APP, effective regulatory control of pesticide use and handling should be given priority and should aim towards reducing the burden of APP.

5.1. Introduction

APP is a particularly important occupational and public health problem in Tanzania (Ngowi, 2002a) and in other developing countries (Jeyaratnam et al, 1985; Jeyaratnam, 1990; WHO/UNEP, 1990; He et al, 1999; Kishi, 2001). The majority of fatalities arising from pesticide exposure occur in less industrialized countries and small scale farmers are the most vulnerable to pesticide exposure and poisoning (Schlosser, 1999). Data on injuries caused by pesticide exposure are rare in most countries (Corriols et al, 2001; Murphy et al, 2002; Calvert et al, 2008) and therefore the magnitude of the pesticide poisoning problem is not well known.

Scant data on pesticide poisoning cases in Tanzania are available within Government departments but the data sources are not properly coordinated and, as a result, the data do not reflect the actual burden caused by pesticide poisoning. Health care facilities in Tanzania are potentially important sources of information on APP. Hospital notification through the Health Management Information System (HMIS), is a compulsory system for reporting disease conditions in Tanzania. The HMIS covers various levels in the health care system, including community health at the village level (dispensaries), health care centres serving a number of villages, and district, regional and referral hospitals (Kaija, 1995).

Dispensaries provide basic curative and Maternal and Child Health (MCH) care at village level. One level up, health centres offer basic curative, maternal, obstetric and child health services to a broader population. They are larger facilitiess than dispensaries, have a small number of beds for in-patients and have a larger staffing complement (Gilson, 1995). District hospitals are admission facilities to which health centres serving the district refer patients. Regional hospitals are admission facilities to which district or health centres serving the region might refer patients. Referral hospitals are the facilities which accommodate more complex cases which cannot be handled at the regional or lower facilities.

In 2004/2005 Tanzania had a total of 5379 health facilities including 219 hospitals, 481 health centres and 4679 dispensaries. The number of facilities in the 26 regions of Tanzania varies between region. The regions with the highest number of facilities are Mwanza and Iringa (United republic of Tanzania, 2006). Most health facilities in Tanzania are state-owned (64.2%) while the minority are owned by private firms (15%), parastatal organizations (3%) and voluntary organizations (17.7%). There is a total of 33835 beds in Tanzanian health care facilities with the majority (n=18581; or 54.9%) in state health care facilities. Others are provided by voluntary agencies (41.5%), private institutions (4.5%) and parastatal organizations (2%) (United Republic of Tanzania, 2006). The region with highest number of beds is Mwanza (n=3195).

The HMIS in Tanzania accommodates notifications of ‘notifiable’ or reportable conditions such as cholera and meningitis and of poisoning cases arising from all causes. However, the system classifies cases as poisoning without specific details on the type of poisoning. Because APP is not among the priority reportable diagnoses in the HMIS, the HMIS does not effectively capture APP and the current health system in Tanzania is hampered by the unavailability of reliable pesticide poisoning data. Important details on circumstances, severity, agents responsible, and outcome of poisoning are therefore not systematically documented in the HMIS.

Low coverage of APP cases in the system could also be attributed to a lack of expertise in the diagnosis of pesticide poisoning cases by some HCPs. For example, a survey of Tanzania HCPs in agricultural areas conducted from 1991 – 1994 indicated that 80% had never attended to a pesticide poisoning case and over 30% of them were not conversant with the diagnosis and treatment of pesticide poisoning (Ngowi et al, 2001b).

The National Designated Authority (DNA) for pesticides in Tanzania is responsible for pesticides registration and monitoring of distribution and use as outlined in the Plant Protection Act of 1997 but it does not include in its mandate surveillance for APP or health injuries arising from pesticide exposure. There is therefore no dedicated system for surveillance of APP in Tanzania and, as a result, the burden of injury caused by pesticides in not known.

To address this gap, this study was undertaken to estimate the burden of injuries arising from APP. The major purpose of this study was to characterize the patterns of APP reported in health care facilities in Tanzania in order to recommend corrective interventions. This will provide data for scientists, policy makers and communities to plan and implement appropriate intervention strategies in order to reduce the APP burden in Tanzania.

5.2. Specific Objectives

(i) To characterize APP in selected regions in Tanzania retrospectively for the period of 2000 – 2005 and prospectively for the period January to December 2006 with emphasis on:
  - (a) Describing the agents responsible for APP, the circumstances of poisoning, the population groups affected and the outcome of the poisoning.
  - (b) Estimating the incidence, mortality rate and case fatality rates for APP by region, age and gender.

(ii) To determine associations between:
  - (a) circumstances of poisoning and: outcome, gender, age and agents responsible for poisoning.
  - (b) outcome of poisoning and: gender, age and agents responsible for poisoning
  - (c) agents responsible for poisoning and: gender and age.

(iii) To compare the patterns of poisoning and risk factors obtained under conditions of retrospective data collection with that obtained under prospective data collection.

5.3. Methodology

5.3.1. Population, sample and data collection

(i) Population and sample

There were two sub-studies, the first, a retrospective analysis (2000-2005) and the second, a prospective study (2006). The population included all admissions to regional, referral and district hospitals located in four coffee and vegetable agricultural areas of Tanzania where pesticides were extensively used. Additionally, the study included a subset of health centres and dispensaries selected from the Arusha district near TPRI, chosen for logistic reasons (See figure 3.1 in chapter 3).

Health facilities visited for retrospective record review were those in the regions of Arusha, Iringa and Kilimanjaro and in the city of Mwanza. The survey involved all regional hospitals in the study area (n=4) including Mawenzi (Kilimanjaro region), Iringa (Iringa region), Sekouture (Mwanza region) and Mount Meru (Arusha region); both referral hospitals in the study area, Kilimanjaro Christian Medical Centre (KCMC) in Kilimanjaro and Bugando in Mwanza; and 2 district hospitals, one in the Arumeru district and Kaloleni (Arusha municipality), represented 2 of the 5 district hospitals in Arusha region. The 3 district hospitals not included were geographically far from TPRI and hence not easily accessible. The other facilities included in the population were health centres and dispensaries in Arusha region (See figure 3.1 in chapter 3). These 22 facilities were included due to their easily accessible geographical location and willingness to participate in the study. The purpose of including a subsample of smaller facilities was to explore whether useful data on APP could be derived from lower level health care facilities.

Thus, in total, the retrospective review involved 30 health care facilities representing about 21% of all health facilities in the regions of Northern Tanzania (Arusha and Kilimanjaro), Lake Zone (Mwanza) and Southern Highlands (Iringa). This included 100% of regional hospitals in the study area, 100% of referral hospitals in the study area and 40% of district hospitals in Arusha region

Of the 21 facilities reporting pesticide poisoning on retrospective review, ten facilities, namely Mawenzi regional hospital, KCMC referral hospital, Arumeru district hospital, Bugando referral hospital, Saint

Elizabeth private hospital, Mount Meru regional hospital, Shree Hindu health center, Ithasnasheri private hospital, Nkoaranga private hospital and Sekouture regional hospital, were selected for prospective study. The selection of these 10 health facilities for prospective review was based on their reporting at least 7 APP cases over the review period of retrospective study (with the exception of Shree Hindu which reported only 2 cases). Participating hospitals were also willing to send their staff to a surveillance training workshop held in January 2006 at TPRI. The populations for the sub-studies were all patients presenting with APP at the facilities from 2000 to 2005 (retrospective study) and in 2006 (prospective study) (Fig 5.1).

Figure 5.1: Mount Meru regional hospital in the Arusha district

(ii) Data collection.

The retrospective review covered a period of 6 years from 2000 to 2005 and prospective cases were collected for the period January to December 2006. Data regarding injury or death from APP were collected by reviewing health facility records. The data collected in both prospective and retrospective surveys were, firstly, retrieved from the register book at the facility and included patient registration number, date of poisoning, location, gender, circumstances of poisoning and outcome. Secondly, the patient registration number was used to locate the patient folder from which further information was extracted including agents responsible, circumstances and treatment of poisoning and comparisons made to data in the poisoning register (Figure 5.2 and 5.3). The data were collected using a standardized data collection sheet (Annex 8).

Figure 5.2: Data collection from one of the health facility.

Figure 5.3: One of the register books used for data collection.

Both retrospective and prospective data collection was conducted by medical data recorders trained by the PI. Data collection for the retrospective sub-study commenced on 1st January 2005 and was concluded by 31st December 2005. For the prospective study data collection commenced in 1st February 2006 and concluded by 31st December 2006, though the data was collected for the period 1st Jan to 31 Dec 2006.

5.3.2. Validity and reliability of data collected

Training of data abstractors was conducted in January 2006 to maximise the validity and reliability of data collected. During training emphasis was placed on the accuracy of data collection and the need to capture data correctly.

In addition to the professional medical data recorders who participated in both the retrospective and prospective studies, training was also open to medical officers, health officers and nurses from participating hospitals (55%) who are also in some situations involved in the documentation of Injuries data. Agriculture extension officers and police officers (30%) were also involved in the training under assumption that APP may also be collected from sources other than hospital system as outlined in chapter 9.

5.3.3. Data analysis

The distributions of circumstances, outcomes, agents responsible for poisonings, age and gender were described using frequencies and proportions.

Poisoning circumstances were classified in two ways – firstly, circumstances as: a) Suicide; b) Accidental; c) Occupational; d) Homicide; e) Unknown; and secondly, as known versus unknown circumstances. Known circumstances were further categorized into suicide versus non-suicide. The information on circumstances was obtained from histories recorded in the diagnostic sections of the patient folders. In some situations, circumstances of poisoning were directly documented in the patient register books but for others, circumstances had to be inferred from the way cases were reported in the patient folders. For example, a person who was reported to have deliberately ingested a pesticide was classified as a case of suicide and a child who was reported to have ingested a pesticide thinking it was juice was categorized as an accidental circumstances. A person who was injured by pesticide exposure during application, handling in storage areas or during transportation was categorized as occupational poisoning. A person who was reported to be deliberately poisoned by others, for whatever reason, was categorized as homicide case. Where there was uncertainty about the circumstances of poisoning, the case was classified as unknown circumstances.

Outcomes of APP were classified in two ways – firstly, a) Recovery, b) Absconded c) Referred d) Disability f) Death and g) Unknown and, secondly, as known versus unknown outcomes. The known outcomes were further reduced to two categories, fatal versus non-fatal. Agents responsible for APP were classified in three ways – firstly as a) specific (known by the active ingredient), b) Non-specific (known by general category) and c) Unknown. Secondly, the agents were classified into a) known and b) unknown and finally the known agents were classified into OP and non-OP.

Cross tabulations were constructed involving circumstances and outcome of poisoning, agents, gender and age. In the first set of analyses, circumstances of poisoning (firstly as known versus unknown, and then dichotomized into suicide and non-suicide with the unknowns omitted) were analysed by gender, age, outcome, and agents responsible for poisoning. In the second set of analyses, the outcome of poisoning (firstly as known versus unknown, and then dichotomized into fatal and non-fatal with the unknowns omitted) was analysed by gender, age and agents responsible for poisoning. Lastly, agents (known versus unknown) were analysed by gender and age. The age of the poisoned victims was analysed both as a dichotomous variable (age of 30 years or younger and over 30 years) and a continuous variable, with unreported age omitted.

Comparisons were made using χ^2 tests for categorical data and t-tests for continuous age data. The analyses were conducted using SPSS statistical package Version 16.0 (SPSS, 2007) and STATA statistical package Version 10.0 (Stata Corporation, 2007). The strength of associations was estimated in terms of Prevalence Risk Ratios (PRR) with 95% Confidence Intervals. Multivariate logistic regression was done by modelling fatal outcome as dependent variable with age, gender and circumstances of poisoning as dependent variables.

Data on APP cases and deaths were used as numerator data to calculate morbidity and mortality rates stratified for gender, geographical area and age. To calculate denominators for rates, population census data was obtained from the Tanzania Bureau of Statistics based on a national census conducted in 2007 adjusted for annual population growth of 2.091% (CIA, 2008).

The Cumulative Incidence Rates of poisoning were calculated with 95% Confidence Intervals and comparisons by area, age category and gender were done to identify whether confidence intervals overlapped. Rates were analysed assuming a Poisson distribution for rare events.

In the calculations of rates, cases with unreported age in both retrospective and prospective studies were distributed equally across the 5 study age categories and added to known cases in each age category.

The results of analysis of retrospective data are presented first in section 5.4.1. below, followed by results for analysis of prospective data in section 5.4.2. For a comparison of retrospective and prospective data, 10 facilities common to the retrospective and prospective sub-studies were included and this is reported in section 5.4.3. Estimates of study poisoning rates in Tanzania are presented in section 5.4.4.

5.3.4. Case definitions

A case of APP in this study was defined as a diagnosis of APP made by the clinician attending the patient and recorded in the register, patient folder or both. In general, the diagnosis was based on a history of exposure (from the patient, relative or accompanying persion) to one or more pesticides and clinical manifestations of poisoning or specific laboratory test results compatible with poisoning, within 14 days of exposure. .

5.3.5. Ethical Considerations

The study involved record review and no direct data collection from patients so no consent was sought from patients. To ensure confidentiality, patient names were replaced by codes which were used for data analysis. As indicated in chapter 3 (3.5.4), ethical approval was secured from the TPRI, the NIMR in Tanzania (REF NIMR/HQ/Vol XI/371) and the Univerisity of Cape Town (REF:328/2004).

5.4. Results

Results in this section are divided into 4 subsections. Subsection 1 and 2 (5.4.1 and 5.4.2) present findings from sub-study 1 (retrospective) and sub-study 2 (prospective), respectively. The two subsections each present (i) APP reported to the health facilities visited; (ii) characteristics of APP cases in terms of age, gender, circumstances and outcomes of poisoning (describing distributions alternatively inclusive and exclusive of missing data for each variable); (iii) cross-tabulations of circumstances of poisoning by gender, age and APP outcome; (iv) cross-tabulations of outcome of APP by gender and age and agents responsible for poisoning. The two sub-sections also explore bivariate associations of (v) gender, age, outcome and agent with circumstances of poisoning (Suicide vs. Non Suicide); (vi) gender, age, outcome and agent with circumstances of poisoning (Known vs. Unknown circumstances); (vii) gender, age and agent with outcome of poisoning (Fatal vs. Non-Fatal); (viii) gender, age and agent with outcome of poisoning (Known vs. Unknown); (ix) gender, age with poisoning agent (Known vs. Unknown).

Finally the two subsections present (x) multivariate logistic regression analysis of outcome (Fatal vs. Non-fatal) modelled on gender, age, circumstances of poisoning and facility type. In section 5.4.1., the bivariate and multivariate associations above were explored both for the full sample of facilities (n=30) (Tables 5.6, 5.8, 5.10, 5.12, 5.14 and 5.16) and for the subsample of 10 facilities that also subsequently participated in the prospective study (Tables 5.7, 5.9, 5.11, 5.13, 5.15 and 5.17).

Subsection 3 presents comparisons of findings between retrospective and prospective sub-studies in terms of epidemiological patterns in gender, age, and circumstances, outcomes and agents responsible for poisoning; associations with fatal APP outcomes derived from multivariate regression and characterization of the APP and characteristics of poisoning cases and unknown cases.

Subsection 4 (5.4.4.) presents data on poisoning rates and includes annual Incidence Rate (IR), Mortality rate (MR) and Case Fatality Rate (CFR).

5.4.1 Sub-Study 1: Retrospective Hospital APP data

(a) APP poisonings reported in the health facilities visited

A total of 30 health care facilities were visited, including both private and government facilities. The majority (80%) were small facilities. Of the total sample, 22 facilities reported pesticide poisoning data for the study period (Table 5.1). The rest of the facilities had no pesticide poisoning cases but reported poisoning due to other agents including kerosene, drugs, cassava, snake bites and other causes, which were not considered further in this study. One third of the small facilities (8 /24) reported no APP cases, whereas all the larger facilities (n=6) reported cases.

Table 5.1: Reported APPs in 30 selected health care facilities, from 4 regions in Tanzania, (2000 – 2005).

No	Region	Facility	Type of facility	Cases
1	Arusha	Mount Meru	Regional hospital	7
2	Arusha	Arumeru	District hospital	7
3	Arusha	Bagari	Dispensary	9
4	Arusha	Canosa	Dispensary	1
5	Arusha	Ithanasheri	Hospital	20
6	Arusha	Nkoaranga	Hospital	22
7	Arusha	Old Arusha Clinic	Hospital	1
8	Arusha	Moshi Arusha Occupational Health	Hospital	0
9	Arusha	Saint Elizabeth	Hospital	7
10	Arusha	Leguruki	Health centre	12
11	Arusha	Mbuguni	Health centre	14
12	Arusha	Shree Hindu	Health centre	2
13	Arusha	Usa River	Health centre	4
14	Arusha	Kingori	Health centre	0
15	Arusha	Levolosi	Health centre	0
16	Arusha	Karangai	Health centre	0
17	Arusha	Nsengon	Dispensary	4
18	Arusha	Olasiti	Dispensary	6
19	Arusha	Nambala	Dispensary	11
20	Arusha	Saint Veronica	Dispensary	3
21	Arusha	TAG	Dispensary	1
22	Arusha	Patandi	Dispensary	0
23	Arusha	Seek Temple	Dispensary	0
24	Arusha	KIA	Dispensary	0
25	Arusha	Kisongo	Dispensary	0
26	Iringa	Iringa	Regional hospital	104
27	Kilimanjaro	KCMC	Referral hospital	42

28	Kilimanjaro	Mawenzi	Regional hospital	261
29	Mwanza	Bugando	Referral hospital	75
30	Mwanza	Sekouture	Regional hospital	43
	TOTAL			**656**

The majority of poisoning cases were found in regional and referral hospitals with the exception of the regional hospital, Mount Meru hospital, which reported relatively few cases (n=7) in the retrospective study.

The geographic distribution of health care facilities reporting pesticide poisoning included the Arusha region represented by 1 regional hospital, 2 district hospitals and 14 health centres or dispensaries; Mwanza region represented by 1 regional hospital and 1 referral hospital, Iringa represented by 1 regional hospital and Kilimanjaro region represented by 1 regional hospital and a referral hospital (Table 5.1). The majority of poisoning cases (81.1%) were reported by higher level facilities including regional hospitals and referral hospitals (Table 5.1).

(b) Characteristics of APP cases in terms of age and gender, circumstances of poisoning, outcome of poisoning and agents responsible for poisoning (describing distributions alternatively inclusive and exclusive of missing data).

Table 5.2 presents the distribution of gender, age, circumstance and outcome associated with APP, both including and excluding missing data.

(i) Age and gender

In total, there were 656 poisoning cases reported in all health care facilities from 2000 – 2005, the majority of which involved males (59.8%). The age of poisoned individuals ranged from 1 year to 84 years with average age of 24.9 years. The highest number of poisoning cases (modal category) was reported in the age group 21 – 30 years (30.8%). A small proportion (5.6%) had no age reported and of these, about a third (1.8%) were female and two-thirds (3.8%) were male cases.

(ii) Circumstances of poisoning

There were a total of 269 cases (41%) whose circumstances were not reported or were unknown. The category of unknown circumstances was larger than any category of known circumstances. Considering only known circumstances, suicide (45.7%) and accidental (44.7%) cases were approximately equally common and they contributed a much larger proportion than occupational circumstances (8.5%; Table 5.2). The 177 suicide cases involved fewer females (35.6%) than males (64.5%) and the majority of the cases were in the age group 21 – 30 years (40.1%) (Table 5.3).

Table 5.2: Characteristics of APP cases in selected health care facilities from 4 regions in Tanzania, 2000-2005.

Variable		n	Circumstances of poisoning	
			% (Known + Unknown)	% Known only
Gender	Female	264	40.2	40.2
	Male	392	59.8	59.8

	Total	**656**		
Age category	1-10	104	15.9	16.8
	11-20	124	18.9	20.1
	21-30	202	30.8	32.7
	31-40	82	12.5	13.3
	41+	107	16.3	17.3
	Unknown	37	5.6	-
	Total	**656**		
Circumstances of poisoning	Accidental	173	26.4	44.7
	Occupational	33	5.0	8.5
	Suicide	177	27.8	45.7
	Homicide	4	0.6	1.0
	Unknown	269	41.0	-
	Total	**656**		
Outcome of poisoning	Recovered	387	59.0	80.2
	Absconded	42	6.4	8.7
	Death	45	6.9	9.3
	Referred	6	0.9	1.2
	Disability	2	0.3	0.4
	Unknown	174	26.8	-
	Total	**656**		

Table 5.3: Circumstances of poisoning in selected health care facilities from 4 regions in Tanzania, 2000 – 2005, by gender, age and APP outcome.

Variable	Category	Known Circumstances (n=387)	Unknown (n =269)	Total	Accidental (n =173)	Occupational (n =33)	Suicide (n =177)	Homicide (n =4)
Gender	Male	229 (58.4%)	163 (41.6%)	**392 (100.0%)**	98 (56.6%)	14 (42.4%)	114 (64.4%)	3 (75.0%)
	Female	158 (59.8%)	106 (40.2%)	**264 (100.0%)**	75 (43.4%)	19 (57.6%)	63 (35.6%)	1 (25.0%)
Age Category (years)	1-10	80 (76.9%)	24 (23.1%)	**104 (100.0%)**	77 (44.5%)	1 (3.0%)	1 (6%)	1 (25.0%)
	11-20	69 (55.6%)	55 (44.4%)	**124 (100.0%)**	32 (18.5%)	3 (9.1%)	34 (19.2%)	0 (0.0%)
	21-30	121 (59.9%)	81 (40.1%)	**202 (100.0%)**	32 (18.5%)	17 (51.5%)	71 (40.1%)	1 (25.0%)
	31-40	39 (47.6%)	43 (52.4%)	**82 (100.0%)**	11 (6.4%)	5 (15.2%)	22 (12.4%)	1 (25.0%)
	41+	61 (57.0%)	46 (43.0%)	**107 (100.0%)**	14 (8.1%)	7 (21.2%)	39 (22.0%)	1 (25.0%)
	Unknown	17 (45.9%)	20 (54.1%)	**37 (100.0%)**	7 (4.0%)	0 (0.0%)	10 (5.6%)	0 (0.0%)
Outcome	Recovered	245 (63.3%)	142 (36.7%)	**387 (100.0%)**	134 (77.5%)	15 (45.5%)	92 (52.0%)	4 (100.0%_
	Absconded	31 (73.8%)	11 (26.2%)	**42 (100.0%)**	2 (1.2%)	1 (3.0%)	28 (15.8%)	0 (0.0%)
	Death	37 (82.2%)	8 (17.8%)	**45 (100.0%)**	7 (15.6%)	1 (2.2%)	29 (64.4%)	0 (0.0%)
	Referred	5 (83.3%)	1 (16.7%)	**6 (100.0%)**	1 (0.6%)		4 (2.3%)	0 (0.0%)
	Disability	2 (100%)	0 (0.0%)	**2 (100%)**	0 (0.0%)	2 (6.1%)	0 (0.0%)	0 (0.0%)
	Unknown	67 (38.5%)	107 (61.5%)	**174 (100.0%)**	29 (16.8%)	14 (42.4%)	24 (13.6%)	

Among the 173 accidental cases, the proportion was slightly higher in females (47.4%) than in males (42.8%) but the difference was not statistically significant (χ =0.8**,** P=0.3). Accidental cases were most common in the age group 1-10 years (44.5%). There were 33 cases involving occupational circumstances (Table 5.3). The proportion of cases with occupational circumstances among females (12.0%) was significantly higher than males (6.1%) (χ =4.2, P=0.04; Unknown cases omitted). The majority of occupational cases were in the age group 21-30 years (51.5%). Homicide cases were few and involved one woman and three men (Table 5.3).

(iii) Outcomes

The outcome of the reported poisoning was fatal in 45 cases (Table 5.4). The CFR was 9.3% for cases with known outcome and 6.3% for all cases. Most deaths occurred in males (35/45 cases). Fatal outcomes were usually due to suicide (64.4%) and were less commonly due to occupational (2.2%) or accidental (15.6%) circumstances (Table 5.3). Most victims (59%) were reported to have recovered (Table 5.4). Unknown outcomes (26.5%) was the second most common category (Table 5.4). Only two cases were reported to be left with permanent disabilities.

Table 5.4: Outcomes of APP in selected health care facilities from 4 regions in Tanzania, 2000-2005, by gender and age.

Age/ Gender		**Outcomes of APP Cases**						
		Recovered	**Absconded**	**Death**	**Referred**	**Unknown**	**Disability**	**Total**
Gender	Female	161 (61%)	9 (3.4%)	10 (3.8%)	3 (1.1%)	79 (29.9%)	2 (0.8%)	264
	Male	226 (57.7%)	33 (8.4%)	35 (8.9%)	3 (0.8%)	95 (24.2%)	0 (0%)	392
Total		387	42	45	6	174	2	656
Age category	1-10	74 (71.2%)	0 (0%)	4 (3.8%)	0 (0%)	26 (25.0%)	0 (0%)	104

(years)	11-20	87 (70.2%)	6 (4.8%)	6 (4.8%)	0 (0%)	25 (20.2%)	0 (0%)	124
	21-30	106 (52.5%)	21 (10.4%)	15 (7.4%)	2 (1.0%)	57 (28.2%)	1 (0.5%)	202
	31-40	47 (57.3%)	6 (7.3%)	3 (3.7%)	2 (2.4%)	24 (29.3%)	0 (0%)	82
	40+	58 (54.2%)	5 (4.7%)	14 (13.1%)	1 (0.9%)	28 (26.3%)	1 (0.9%)	107
	Unreported	15 (40.5%)	4 (10.8%)	3 (8.1%)	1 (2.7%)	14 (37.8%)	0 (0%)	37
Total		**387**	**42**	**45**	**6**	**174**	**2**	**656**

(iv) Agents responsible for APP

In 58.7% of cases the agents were unknown or non-specific (such as related to food poisoning in 17.9%, which incorporated contaminated fruits, treated seed grains, contaminated water and food contaminated with unknown pesticides). In cases where agents were known, OPs (n=74) accounted for approximately 27.0% and zinc phosphide (rodenticide) for 9.2% (n=10) of the the total 274 specific and non-specific agents (Table 5.5).

Table 5.5: Agents responsible for poisoning in selected health care facilities in 4 regions of Tanzania, 2000-2005.

Agent	n	% (known only)	% (Including Unknown and known)	WHO Hazard Class	Chemical group
Specifically identified agents					
Chlorpyrifos	18	16.5	2.7	II	Organophosphate
Diazinon	16	14.7	2.4	II	Organophosphate
Zinc Phosphide	10	9.2	1.5	Ib	Inorganic
DDT	4	3.7	0.6	II	Organochlorine

Tetramethrin	4	3.7	0.6	IV	Pyrethroid
Cypermethrin	3	2.8	0.5	II	Pyrethroid
Deltamethrin	3	2.8	0.5	II	Pyrethroid
Endosulfan	3	2.8	0.5	II	Organochlorine
Fenitrothion	3	2.8	0.5	II	Organophosphate
Amitraz	2	1.8	0.3	III	Other
Chlorfenvinphos	2	1.8	0.3	Ib	Organophosphate
Gramoxon	2	1.8	0.3	II	Other
Permethrin	2	1.8	0.3	II	Pyrethroid
Sulphur	2	1.8	0.3	IV	Inorganic
Profenofos	1	0.9	0.2	II	Organophosphate
OP or Carbamate *	34	31.2	5.1	Unknown	Organophosphate
Subtotal 1	109	100.0			
Non-specific and Unknown agents					
Food poisoning	119		17.9	Unknown	Unknown
Rat Poison	21		3.2	Unknown	Unknown
Unspecific	14		2.1	Unknown	Unknown
Livestock Dip	11		1.7	Unknown	Unknown
Unknown	389		58.7	Unknown	Unknown
Subtotal 2	554				
Grand total	663		100.0		

* based on clinical diagnosis of cholinesterase inhibition

The most commonly reported specific poisoning agents were Chlorpyrifos (n=18) and Diazinon (n=16). The majority of the products which were specifically reported by their active ingredients (n=75) were WHO class I and II pesticides (89.3%). OPs were the most common agents (67.8%) among known products (Table 5.5).

(c) Cross-tabulations of circumstances of poisoning by gender, age and APP outcome

(i) Circumstances of poisoning: suicide versus non-suicide

There were significant associations between suicide as the circumstance for APP compared to circumstances other than suicide for the following: (i) unknown agents (PRR Unknown/Known = 1.7; 95% CI = 1.3-2.2); (ii) fatal outcome (PRR Fatal/Non-Fatal = 3.8; 95% CI = 1.8-8.0); (iii) being older than 30 years (PRR Old/Young = 2.0; 95% CI = 1.4-2.8) and being female (Inverse association - PRR Females/Males = 0.8, 95%CI =0.6-0.9) (Table 5.6).

Table 5.6: Association of gender, age, outcome and agent with circumstances of poisoning (Suicide vs. Non Suicide) in selected health care facilities from 4 regions in Tanzania, 2000-2005 (30 facilities).

Variable		n#	Suicide* (%)	Prevalence Risk Ratio (95%CI)
Gender	Female	158	40.5	Female/Male = 0.8 (0.6-0.9)
	Male	229	51.1	
Agent	Unknown	141	60.3	Unknown/Known = 1.7 (1.3 – 2.2)
	Known	246	39.0	
Outcome	Fatal	37	78.4	Fatal/Non-Fatal = 3.8 (1.8 – 8.0)
	Non-Fatal	283	45.5	
Age	Over 30	100	63.0	Old/Young = 2.0 (1.4 – 2.8)
	30 and Less	270	40.0	

Missing data on age for 37 subjects; on outcome of poisoning for 174 subjects; on agent for 389 subjects.

* Circumstances coded as suicide = 1; non suicide = 0

Table 5.7: Association of gender, age, outcome and agent with circumstances of poisoning (Suicide vs. Non Suicide) in selected health care facilities from 4 regions in Tanzania, 2000-2005 (n= 10 facilities).

Variable		n#	Suicide* (%)	Prevalence Risk Ratio* (95%CI)
Gender	Female	105	54.2	Female/Male = 0.8 (0.6-1.1)
	Male	171	62.0	
Agent	Unknown	168	45.8	Unknown/Known = 2.5 (1.7 – 3.6)
	Known	106	77.8	
Outcome	Fatal	32	78.1	Fatal/Non-Fatal = 2.3 (1.1 – 5.5)
	Non-Fatal	196	57.1	
Age	Over 30	74	70.3	Old/Young = 2.2 (1.1 – 2.7)
	30 and Less	188	52.7	

Missing data on age for 33 subjects; on outcome of poisoning for 155 subjects; on agent for 297 subjects.

* Circumstances coded as suicide = 1; non suicide = 0

When treating age as a continuous variable (excluding children under 12 years), there was no significant age difference between suicide victims (n=97) and non-suicide victims (n=45) (mean ages 30.2 years versus 30.1 years, respectively; t = 0.07, P = 0.90).

(ii) Circumstances of poisoning: known versus unknown

There were significant associations between known circumstances vs. unknown circumstances for the following: (i) fatal outcome (PRR Fatal/Non-Fatal = 2.3; 95% CI = 1.1 – 4.9), and (ii) unknown agents (inverse association - PRR Unknown/Known = 0.4; 95% CI=0.3-0.5) and being older than 30 years Old/Young (inverse association - PRR=0.8 (0.6 – 0.9) (Table 5.8).

Table 5.8: Association of gender, age, outcome and agent with circumstances of poisoning (Known vs. Unknown circumstances) in selected health care facilities from 4 regions in Tanzania, 2000-2005 (n= 30 facilities).

Variable		n#	Known circumstances* (%)	Prevalence Risk Ratio* (95%CI)
Gender	Female	264	59.8	Female/Male =1.04 (0.9-1.3)
	Male	392	58.4	
Agent	Unknown	389	36.2	Unknown/Know =0.4 (0.3 – 0.5)
	Known	267	92.1	
Outcome	Fatal	45	82.2	Fatal/Non-Fatal =2.3 (1.1 – 4.9)
	Non-Fatal	437	64.6	
Age	31+	189	52.9	Old/Young=0.8 (0.6 – 0.9)
	30 and Less	430	62.8	

Missing data on agent for 389 subjects; on outcome of poisoning for 174 subjects; on age for 37 subjects.
* Circumstances coded as known = 1; unknown = 0

Table 5.9: Association of gender, age, outcome and agent with circumstances of poisoning (Known vs. Unknown circumstances) in selected health care facilities from 4 regions in Tanzania, 2000-2005. (n=10 facilities).

Variable		n#	Known circumstances* (%)	Prevalence Risk Ratio* (95%CI)
Gender	Female	187	56.1	Female/Male =0.9 (0.8-1.2)

	Male	299	57.2	
Agent	Unknown	189	88.9	Unknown/Know =0.4 (0.3 – 0.5)
	Known	297	36.4	
Outcome	known	331	68.9	Known/Unknown =1.7 (1.5 – 2.0)
	unknown	155	31.0	
Age	31+	135	54.8	Old/Young=0.9 (0.7 – 1.2)
	30 and Less	318	59.1	

Missing data on agent for 297 subjects; on outcome of poisoning for 155 subjects; on age for 33 subjects.

* Circumstances coded as known = 1; unknown = 0

(d) Cross-tabulations of outcome of APP by gender and age and agents responsible for poisoning

(i) Outcome: fatal versus non-fatal

There was a significant association between fatal outcomes and gender (PRR Female/Male = 0.6; 95% CI = 0.3 – 0.9, P=0.02) (Table 5.10).

Table 5.10: Association of gender, age and agent with outcome of poisoning (Fatal vs. Non-Fatal) in selected health care facilities from 4 regions in Tanzania, 2000-2005 (n= 30 facilities).

Variable		n#	Fatal* (%)	Prevalence Risk Ratio* (95%CI)
Gender	Female	183	5.5	Female/Male = 0.6 (0.3 – 0.9)
	Male	297	11.8	
Age	Over 30	136	12.5	Old/ Young =1.4 (0.9-2.0)
	30 and Less	321	7.8	
Agent	Unknown	264	8.3	Unknown/Known =0.8 (0.6 – 1.2)
	Known	216	10.6	

Missing data on agent for 389 subjects; on age for 37 subjects.

* Outcome of poisoning coded as fatal = 1; non-fatal = 0

Table 5.11: Association of gender, age and agent with outcome of poisoning (Fatal vs. Non-Fatal) in selected health care facilities from 4 regions in Tanzania, 2000-2005 (n=10 facilities).

Variable		n#	Fatal* (%)	Prevalence Risk Ratio* (95% CI)
Gender	Female	118	7.6	Female/Male = 0.6 (0.4 – 1.1)
	Male	213	13.6	
Age group	Over 30	84	17.9	Old/ Young =1.7 (1.1-2.7)
	30 and Less	228	8.8	
Agent	Unknown	188	10.6	Unknown/Known =0.9 (0.7 – 1.3)
	Known	143	12.6	

Missing data on agent for 297 subjects; on age for 33 subjects.

* Outcome of poisoning coded as fatal = 1; non-fatal = 0

(ii) Outcome: known versus unknown

There was a significant inverse association between known outcome with unknown agents (PRR Unknown/Known = 0.8; 95% CI = 0.7-0.9) (Table 5.12).

Table 5.12: Association of gender, age and agent with outcome of poisoning (Known vs. Unknown) in selected health care facilities in Tanzania, 2000-2005 (n= 30 facilities).

Variable		n#	Known outcome* (%)	Prevalence Risk Ratio* (95%CI)
Gender	Female	264	69.3	Female/Male= 0.8 (0.7-1.0)
	Male	392	75.8	
Circumstance	Suicide	181	86.7	Suicide/Non Suicide =1.2 (1.0-1.9)
	Non Suicide	206	78.2	
Age	31+	189	72.0	Old/Young = 0.9 (0.7-1.1)
	30 and Less	430	74.7	
Agent	Unknown	389	67.9	Unknown/ Known = 0.8 (0.7-0.9)
	Known	275	80.9	

Missing data on agent for 389 subjects; on circumstances of poisoning for 269 subjects; on age for 37 subjects.

*Outcome of poisoning coded as known = 1; unknown = 0

Table 5.13: Association of gender, age and agent with outcome of poisoning (Known vs. Unknown) in selected health care facilities in Tanzania, 2000-2005 (n=10 facilities).

Variable		n#	Known outcome* (%)	Prevalence Risk Ratio* (95%CI)
Gender	Female	187	63.1	Female/Male= 0.8 (0.6-1.0)
	Male	299	71.2	
Age	31+	135	62.2	Old/Young = 0.7 (0.6-1.0)
	30 and Less	318	71.7	
Agent	Unknown	297	63.3	Unknown/ Known = 0.8 (0.7-0.9)
	Known	189	75.7	

Missing data on agent for 297 subjects; on circumstances of poisoning for 210 subjects; on age for 33 subjects.
* Outcome of poisoning coded as known = 1; unknown = 0

There were also a significant inverse association between the poisoning agent (known versus unknown) and being older than 30 years (PRR Old/Young =0.7; 95% CI = 0.6-0.9, P=0.02) (Table 5.14). Gender was not associated with known vs. unknown circumstances.

Table 5.14: Association of gender, age with circumstances of poisoning (Known vs. Unknown) in selected health care facilities in Tanzania, 2000-2005 (n= 30 facilities).

Variable		n#	Known circumstances (%)*	Prevalence Risk Ratio* (95%CI)
Gender	Female	158	59.8	Female/Male = 1.04 (0.9-1.3)
	Male	392	58.4	
Age	31+	189	52.8	Old/Young = 0.7 (0.6-0.9)
	30 and Less	430	62.6	

*Circumstances coded as known = 1; unknown = 0
#Missing data on age for 37 subjects.

Table 5.15: Association of gender, age with agents responsible for poisoning (Known vs. Unknown) in selected health care facilities in Tanzania, 2000-2005 (n=10 facilities).

Variable	n#	Known agents* (%)	Prevalence Risk Ratio*

				(95%CI)
Gender	Female	187	39.0	Female/Male = 1.0(0.8 – 1.3)
	Male	299	38.8	
Age	31+	135	31.9	Old/Young = 0.7(0.5 – 0.9)
	30 and Less	318	43.1	

*Circumstances coded as known = 1; unknown = 0; # Missing data on age for 33. subjects.

(e) Cross-tabulations of agents responsible for poisoning by gender and age

(i) Agent: known versus unknown

Lastly, male APP cases were significantly older than female cases (mean ages 28.6 years vs. 23.08 years, respectively; t=-4.184; P =0.000). Suicide cases were significantly older than accidental cases (mean ages 31.07 years vs. 16.92 years, respectively; t=8.82; 95% CI = 10.9-17.3, P =0.000).

(f) Multivariate logistic regression analysis of outcome (Fatal vs. non-fatal) modelled on gender, age, circumstances and facility type

Fatal outcome was modelled as the dependent variable in a multivariate logistic regression with gender, age, circumstance and type of health facility as independent variables. Table 5.16 presents the analysis for all facilities in the retrospective study, while Table 5.17 restricts the analysis to only the 10 facilities that participated in both the retrospective and prospective studies.

Table 5.16: Multivariate analysis: Fatal vs. non-fatal outcome modelled on gender, age, circumstances and facility type in retrospective study (all facilities).

Independent variable	Defined as	Odd Ratio (95% CI)
Gender	Female (n=10) versus Male (n= 35)	0.7(0.3-1.5)
Age	40+ (n= 14) versus ≤ 40 (n= 28)	2.2(1.0-4.9)
Facility	Referral or regional (n=34) versus Other (n= 11)	1.3(0.6-3.0)
Circumstances	Suicide (n=29) versus non suicide (n=8)	3.8(1.7-8.9)
Facility (1)Regional or Referral (0) Other	Outcome 1.Fatal 0.Non-fatal	1.3(0.6- 3.0)

<u>Table 5.17: Multivariate analysis: Fatal vs. non-fatal outcome modelled on gender, age, circumstances and facility type in retrospective study (n= 10 facilities).</u>

Independent variable		Odd Ratio (95% CI)
Gender	Female (n= 9) versus Male (n= 29)	0.8(0.3-1.8)
Age	40+ (n= 12) versus ≤ 40 (n= 23)	**2.4(1.0-5.8)**
Facility	Referral or regional (n= 14) versus Other (n= 24)	1.5(0.6-3.4)
Circumstances	Suicide (n= 25) versus non suicide (n= 7)	**2.5(1.0-6.2)**
Facility	Outcome	1.5(0.6-3.4)

(1)Regional or Referral (0) Other	1.Fatal 0.Non-fatal	

The analysis in Table 5.16 indicates that women were less likely to be fatally poisoned but the association was not significant (OR = 0.47; 95% CI =0.3 – 1.5). Respondents attempting suicide were significantly more likely to be fatally poisoned (OR = 3.8; 95% CI =1.7 – 8.9; Table 5.16). Respondents older than 40 years were significantly more likely to be fatally poisoned (OR = 2.2; 95% CI = 1.0-4.9). There were slightly increased risks for respondents admitted to regional or referral hospitals (OR = 1.3; 95% CI = 0.6- 3.0) but the association was statistically significant.

The analysis of the data from the 10 hospitals that also participated in the prospective study (Table 5.17) gave broadly similar results to the full sample. Women were less likely to be fatally poisoned but the association was not significant (OR = 0.8; 95% CI =0.3 – 1.8). Respondents attempting suicide were significantly more likely to be fatally poisoned (OR = 2.5; 95% CI =1.0 – 6.2) (Table 5.17). There were significant increased risk for fatal poisoning for respondents older than 40 years (OR = 2.4; 95% CI = 1.0-5.8) and for respondents committing suicide (OR =2.5; 95%CI =1.0-6.2). There was slightly increased risk to be fatally poisoned for respondents admitted at regional or referral hospitals (OR = 1.5; 95% CI = 0.6- 3.4) but the association was not statistically significant.

5.4.2. Sub-study 2: Prospective Hospital APP data

(a) APPs reported in the health facilities visited

Facilities were selected for prospective APP data collection on the basis of reporting at least 7 cases over the period 2000 to 2005 in the retrospective study. In addition, the Shree Hindu Mandal health centre was also included because, although it only recorded 2 cases, the facility manager showed interest in participating and sent a staff member to the APP training. In total, 10 facilities were included in the prospective hospital study. Training of staff was conducted in January 2006 (see section 4.3.2 (i)). Data were collected for a period of 1 year (1^{st} January 2006 – 31^{st} December 2006).

There was a total of 230 poisoning cases identified with slightly more females (n=120) than males (n=110) (Table 5.18). The majority of the poisoning cases (64.8%) were reported from 3 facilities. One facility, a regional hospital, contributed 44.3% of all cases.

Table 5.18: Reported APPs in selected 10 health care facilities from 4 regions in Tanzania, 2006.

No	Region	Facility	Type of facility	Cases (n)	Percentage of Cases
1	Arusha	Mount Meru	Regional hospital	26	11.3
2	Arusha	Arumeru	District hospital	21	9.1
3	Arusha	Nkoaranga	Private hospital	16	7.0
4	Arusha	Saint Elizabeth	Private hospital	13	5.7
5	Arusha	Ithanasheri	Private hospital	3	1.3
6	Arusha	Shree Hindu	Health centre	2	0.9
7	Mwanza	Bugando	Referral hospital	18	7.8
8	Mwanza	Sekouture	Regional hospital	19	8.3
9	Kilimanjaro	Mawenzi	Regional hospital	102	44.3
10	Kilimanjaro	KCMC	Referral hospital	10	4.3
	TOTAL			**230**	**100**

(b) Characteristics of APP cases in terms of age and gender, circumstances of poisoning, outcome of poisoning and agents responsible for poisoning

Table 5.19 presents the distribution of gender, age, circumstance and outcome associated with APP, both including and excluding missing data.

Table 5.19: Characteristics of poisoning cases in selected 10 health care facilities from 4 regions in Tanzania, 2006.

Variable		N	Percentage of all cases* (missing data included)	Percentage of cases excluding missing data#
Gender	Female	120	52.2	52.2
	Male	110	47.8	47.8
	Total	**230**	**100**	
Age category	1-10	23	10.0	10.6
	11-20	56	24.3	25.8
	21-30	76	33.0	35.0
	31-40	34	14.8	15.7
	41+	28	12.2	12.9
	Unreported	13	5.7	-
	Total	**230**	**100**	
Circumstances of poisoning	Accidental	58	25.3	31.0
	Occupational	19	8.3	10.2
	Suicide	108	47.0	57.8
	Homicide	1	0.4	1.1
	Unknown	43	18.7	-
	Total	**230**	**100**	
Outcome of poisoning	Recovered	157	68.3	84.9
	Absconded	12	5.2	6.5
	Death	13	5.7	7.0
	Referred	3	1.3	1.6
	Unknown	45	19.6	-
	Total	**230**	**100**	

* Denominator = 230;

Denominator varies depending on missing data for each variable: For gender n=230; age n=217; circumstances n = 187; outcome n = 185

(i) Age and gender

In total, there were 230 poisoning cases reported in the health care facilities visited during 2006, the majority of which involved females (52.2%). The age of poisoned individuals ranged from 1 to 87 years with average age of 26.4 years. The highest number of poisoning cases (modal category) was reported in the age group 21 to 30 years (33.0 %). A small proportion (5.7%) had no age reported and of these, (3.3%) were female and (8.2%) were male cases.

(ii) Circumstances of poisoning

There were a total of 43 cases (18.7%) whose circumstances were not reported or were unknown (Table 5.19). Of poisoning circumstances, suicide contributed the highest proportion (47.0%) followed by accidental (25.3%) and occupational circumstances (8.3%). Considering only known circumstances, suicide (57.8%) and accidental (31.0 %) contributed a much larger proportion than occupational circumstances (10.2%) (Table 5.20). The 108 suicide cases involved predominantly females (62.0%) and the majority of the cases were in the age group 21 – 30 years (30.6%). Among the 58 accidental cases, most (62.1%) were males and the largest age category of cases was in the age group 1 -10 years (37.9%). There were 19 occupational cases which involved more females (52.6%) and were mostly in the age group 21-30 years (36.8%). There were 2 homicide cases (Table 5.20), both involving women.

<u>Table 5.20: Circumstances of poisoning in prospective study by gender, age and APP outcome in selected 10 health care facilities from 4 regions in Tanzania, 2006.</u>

Variable		**Total cases**	**Known Circumstances (%)**	**Unknown Circumstances (%)**	**Total known circumstances**	**Accidental (n =58)**	**Occupational (n =19)**	**Suicide (n =108)**	**Homicide (n =2)**
Gender	Male	110	79.1	20.9	87	36 (62.1%)	9 (47.4%)	41 (38%)	0 (0%)
	Female	120	82.5	17.5	99.0	22 (37.9%)	10 (52.6%)	67 (62%)	2 (100%)
Age Category (years)	1-10	23	100.0	0 .0	23.0	33 (37.9%)	0 (0%)	0 (0%)	0 (0%)
	11-20	56	73.2	26.8	41.0	4 (6.9%)	7 (36.8%)	29 (26.9%)	1 (50%)
	21-30	76	78.9	21.1	60.0	20 (34.5%)	7 (36.8%)	33 (30.6%)	0 (0%)
	31-40	34	85.3	14.7	29.0	6 (10.3%)	3 (15.8%)	20 (18.5%)	0 (0%)
	41+	28	85.7	14.3	24.0	3 (5.2%)	1 (5.3%)	20 (18.5%)	0 (0%)
	Unknown	13	69.2	30.8	9.0	2 (3.4%)	1 (5.3%)	6 (5.6%)	1 (50%)
Outcome	Recovered	157	80.3	19.7	126.0	49 (84.5%)	14 (73.7%)	62 (57.4%)	2 (100%)
	Absconded	12	91.7	8.3	11.0	1 (1.7%)	0 (0%)	10 (9.3%)	0 (0%)
	Death	13	92.3	7.7	12.0	1 (1.7%)	0(0%)	11 (10.2%)	0 (0%)
	Referred	3	100.0	0 .0	3.0	1 (1.7%)	0 (0%)	2 (1.9%)	0 (0%)
	Unknown	45	75.6	24.4	34.0	6 (10.3%)	5 (26.3%)	23 (21.6%	0 (0%)

(iii) Outcomes

The most common outcome of poisoning in the prospective study was recovery (68.3%) and unknown outcomes (19.5%) were the second most common category. There were 13 fatal cases which represented a CFR of 5.7% for all cases and 7.0% for cases with known outcome. Most deaths occurred in females (9 / 13 cases). Fatal outcomes were usually due to suicide (n=11) and were less commonly due to accidents (n=1). No cases of occupational or homicidal circumstances led to fatal outcomes in this cohort (Table 5.21). The proportion of APP cases reported from regional and referral hospitals (76.1%) was far higher than those from dispensaries, district, health centres and other hospitals (23.9%).

Table 5.21: Outcomes of APP by gender and age in selected 10 health care facilities from 4 regions in Tanzania, 2006.

Variable		**Outcome**					
		Recovered	**Absconded**	**Death**	**Referred**	**Unknown**	**Total**
Gender	Female	78 (70.9%)	6 (5.5%)	9 (8.2%)	1 (9.0%)	16 (14.5%)	110 (100.0%)
	Male	79 (65.8%)	6 (5.0%)	4 (3.3%)	2 (1.7%)	29 (24.2%)	120 (100.0%)
Total		**157**	**12**	**13**	**3**	**45**	**230**
Age category	1-10	20 87.0%	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 13.0%	23 100.0%
	11-20	36 (64.3%)	1 (1.8%)	2 (3.6%)	1 (1.8%)	16 (28.6%)	56 (100.0%)
	21-30	52 (68.4%)	8 (10.5%)	4 (5.3%)	0 (0.0%)	12 (15.8%)	76 (100.0%)
	31-40	27 (79.4%)	0 (0.0%)	2 (5.9%)	1 (2.9%)	4 (11.8%)	34 (100.0%)
	40+	14 (50.0%)	3 (10.7%)	5 (17.9%)	0 (0.0%)	6 (21.4%)	28 (100.0%)
	Unreported	8 (61.5%)	0 (0.0%)	0 (0.0%)	1 (7.7%)	4 (30.8%)	13 (100.0%)
Total		**157**	**12**	**13**	**3**	**45**	**230**

(iv) Agents responsible for APP

In 51.3% of cases, the agents were unknown and the balance of cases were reported as related to food poisoning (14.7%), rat poison (5.6%), livestock dip (1.7%) or other non-specific agents (2.9%). The known products causing poisonings were zinc phosphide (n=7 or 12.3%), Chlorpyrifos (n=3 or 5.3%), Sulphur (3 or 5.3%) and Paraquat (n=2 or 3.5%). Only in 57 cases (24%) were the agents known and approximately half of these were cases where the agents were recorded as OP or carbamate poisoning based on clinical diagnosis but without a specific agent identified. Besides this general category of “OP poisoning”, there were 6 other poisonings where specific OPs were identified, including Chlorpyrifos (n=3), Profenofos (n=2) and Diazonon (n=1), meaning that in 35 out of the 57 cases (61%) where the agents were known involved cholinesterase inhibitors (OP or carbamates). The majority of agents which were specifically identified by their active ingredients (n=28) were WHO Class I or II pesticides (67.8%). (Table 5.22).

Table 5.22: Agents responsible for poisoning in health care facilities from 4 regions in Tanzania, 2006.

Agent	n	% (Among known only)	% (Including Unknown and known)	WHO hazard Class	Chemical group
Specifically identified agents					
Zinc phosphide	7	12.3	2.9	Ib	Inorganic
Chlorpyrifos	3	5.3	1.3	II	Organophosphate
Sulphur	3	5.3	1.3	IV	Other
Paraquat	2	3.5	0.8	II	Other
Copper	2	3.5	0.8	III	Inorganic
Profenofos	2	3.5	0.8	II	Organophosphate
Diazinon	1	1.8	0.4	II	Organophosphate
Cypermethrin	1	1.8	0.4	II	Pyrethroid
Endosulfan	1	1.8	0.4	II	Organochlorine
Arsenic	1	1.8	0.4	IV	Inorganic
Chromium	1	1.8	0.4	IV	Inorganic
Deltamethrin	1	1.8	0.4	II	Pyrethroid
Glyphosate	1	1.8	0.4	IV	Other
Boric acid	1	1.8	0.4	IV	Other
Lamda Cyhalothrin	1	1.8	0.4	II	Pyrethroid
OP or carbamate*	29	50.9	12.2	-	-
Subtotal I	**57**	**100.0**			
Non-specific and Unknown agents					

Food poisoning	35		14.7	Unknown	Unknown
Rat Poison	13		5.5	Unknown	Unknown
Non-specific	7		2.9	Unknown	Unknown
Livestock Dip	4		1.7	Unknown	Unknown
Unknown	122		51.3	Unknown	Unknown
Sub Total 2	**181**				
Grand total	**238**		**100.0**		

* based on clinical diagnosis of cholinesterase inhibition

(c) Cross-tabulations of circumstances of APP by gender, age, agent responsible for poisoning and outcome of poisoning

(i) Circumstances of poisoning: suicide versus non-suicide

There were significant associations between suicide as the circumstance for APP compared to other circumstances for the following: (i) gender (PRR Female/Male = 1.5; 95% CI = 1.1-2.0), (ii) fatal outcome (PRR Fatal/Non Fatal = 8.7; 95% CI = 1.1-65.0), (iii) being older than 30 years (PRR Old/Young = 2.3; 95% CI = 1.3-3.9) and (iv) unknown agents (PRR Unknown/Known = 1.7; 95% CI 1.1-2.4 (Table 5.23). When treating age as a continuous variable (excluding children under 12 years), there was no significant age difference between suicide victims (n=102) and non-suicide victims (n=50) (mean ages 30.1 years vs. 28.1 years, respectively; t = 0.84, P = 0.3).

Table 5.23: Association of gender, age, outcome and agent with circumstances of poisoning (Suicide vs. Non Suicide) in selected 10 health care facilities from 4 regions in Tanzania, 2006.

Variable		n	Suicide (%)	Prevalence Risk Ratio * (95%CI)
Gender	Female	99	67.7	Female/Male = 1.5 (1.1-2.0)
	Male	87	47.1	
Outcome	Fatal	12	91.7	Fatal/Non-Fatal = 8.7 (1.1-65.4)
	Non-Fatal	140	52.9	
Age group	Over 30	53	75.5	Old/ Young =2.3 (1.3-3.9)
	30 and Less	124	50	
Agent	Unknown	79	69.6	Unknown/Known/Unknown =1.7 (1.1-2.4)
	Known	107	49.5	

*Circumstances coded as suicide = 1; non suicide = 0; Missing data on agent for 122 subjects; on age for 13 subjects.

(ii) Circumstances of poisoning: known versus unknown

There were significant associations between known circumstances vs. unknown circumstances with the following v: (i) Known agents vs. Unknown agent (PRR Known/Unknown =25.3 (3.6 – 176.4) and unknown circumstances (Table 5.24).

<u>Table 5.24: Association of gender, age, outcome and agent with circumstances of poisoning (Known vs. Unknown circumstances) in selected 10 health care facilities from 4 regions in Tanzania, 2006.</u>

Variable		n	Known circumstances (%)	Prevalence Risk Ratio* (95%CI)
Gender	Female	120	82.5	Female/Male = 1.0 (0.8-1.5)
	Male	110	80.0	
Outcome	Fatal	13	92.3	Fatal/Non-Fatal =2.6 (0.4-19.3)
	Non-Fatal	172	81.4	
Age group	Over 30	62	85.5	Old/Young= 1.33 (0.7-2.4)
	30 and Less	155	80	
Agent	Known	108	99.1	Known/Unknown =25.3 (3.6 – 176.4)
	Unknown	122	64.8	

*Circumstances coded as known = 1; unknown = 0
Missing data on agent for 122 subjects; on age for 13 subjects; on outcome for 45 subjects.

(d) Cross-tabulations of outcome of APP by gender, age and agents responsible for poisoning

(i) Outcome: fatal versus non-fatal

There were significant associations between fatal vs. non-fatal outcomes for being older than 30 years (PRR Old/Young = 1.9; 95%CI =1.1-3.4). There were no associations with gender (female vs. male) or agent (known vs. unknown) (Table 5.25). Treating age as a continuous variable, fatal cases were substantially older (mean age 36.1 years) than non-fatal cases (mean age 25.7 years) (t=-3.29, P=0.001).

Table 5.25: Association of gender, age and agent with outcome of poisoning (Fatal vs. Non-Fatal) in selected 10 health care facilities from 4 regions in Tanzania, 2006.

Independent Variable		n	Fatal (%)	Prevalence Risk Ratio (95%CI)
Gender	Female	91	4.5	Female/Male =0.6(0.3 – 1.4)
	Male	94	9.6	
Age group	Over 30	52	13.7	Old/Young =1.9 (1.1 – 3.4)
	30 and Less	124	4.8	
Agent	Known	87	8.0	Known/ Unknown =0.9 (0.5 – 1.3)
	Unknown	98	6.1	

*Outcome of poisoning coded as fatal = 1; non-fatal = 0

Missing data on agent for 122 subjects; on age for 13 subjects.

(ii) Outcome: Known versus unknown

There was a significant association between known vs. unknown outcomes and known vs. Unknown agents (PRR Known/Unknown = 2.4; 95% CI = 1.4-4.2). In addition, being female was marginally inversely associated with known outcomes (PRR Female/Male = 0.8; 95%CI = 0.6-0.9; p=0.06; Table 5.26).

Table 5.26: Association of gender, age and agent with outcome of poisoning (Known vs. Unknown) in selected 10 health care facilities from 4 regions in Tanzania, 2006.

Independent Variable		n	Known Outcome(%)	Prevalence Risk Ratio * (95%CI)
Gender	Female	120	75.8	Female/Male =0.8 (0.6-0.9)
	Male	110	85.5	
Age	Over 30	62	83.9	Old/Young =1.2 (0.7-2.1)

group	30 and Less	155	80.0	
Agent	known	108	90.7	Known/Unknown =2.4 (1.4-4.2)
	Unknown	122	71.3	

*Outcome of poisoning coded as known = 1; unknown = 0

Missing data on agent for 122 subjects; on age for 13 subjects.

(e) Cross-tabulations of agent responsible for APP by gender, age and agents responsible for poisoning.

(i) Agent: known versus unknown – prospective data

There were marginally significant associations between known vs. unknown poisoning agents and the following: (i) Gender (PRR Female/Male = 1.3; 95% CI = 1.0-1.7); (ii) Age (PRR Old/ young = 1.6; 95% CI = 1.04-2.5) (Table 5.27). Male APP cases were slightly older than female cases but this difference was not statistically significant (mean ages 27.8 vs. 25.2 years, respectively (t=-1.265, p=0.21).

Table 5.27: Association of gender and age with agent of poisoning (Known vs. Unknown) in selected 10 health care facilities from 4 regions in Tanzania, 2006.

Independent Variable		n	Known Agent (%)	Prevalence Risk Ratio* (95%CI)
Gender	Female	120	40.0	Female/Male = 0.8 (0.6 - 0.9)
	Male	110	54.5	
Age group	31+	62	59.7	Old/Young = 1.6 (1.0-2.5)
	30 and Less	155	43.2	

*Agent responsible for poisoning coded as known = 1; unknown = 0

(f) Multivariate logistic regression analysis of outcome (Fatal vs. non-fatal) modelled on gender, age, circumstances and facility type

Fatal outcome was modelled as dependent variable in a multivariate logistic regression with gender, age, circumstance and type of health facility as independent variables. The analysis indicated that there was a reduced risk for women (OR= 0.4; 95%CI = 0.1-1.4) and patients admitted to referral hospitals (OR =0.6; 95%CI = 0.2-2.0) but neither association was statistically significant. Respondents attempting suicide were significantly more likely to be fatally poisoned (OR = 9.3; 95% CI =1.1 – 77.8). There were a marginally significant increased risk of fatal outcome in victims older than 40 years (OR = 3.4; 95% CI = 0.9-12.9) (Table 5.28).

Table 5.28: Multivariate analysis: Fatal vs. non-fatal outcome modelled on gender, age, circumstances and facility type in prospective study.

Variable		Odd Ratio (95% CI)
Gender	Female (n= 10) versus Male (n= 35)	0.4 (0.1-1.4)
Age	40+ (n= 14) versus $\leq$ 40 (n= 28)	3.4(0.9-12.9)
Facility	Referral or regional (n= 34) versus Other (n= 11)	0.6(0.2-2.0)
Circumstances	Suicide (n= 29) versus non suicide (n= 8)	9.3(1.1-77.8)

5.4.3. Comparison of findings between Prospective and Retrospective studies

Firstly, to assess the extent of possible bias in the selection of the 10 facilities that were included in prospective study, these 10 facilities were compared with the other 12 facilities which reported APP in the retrospective study (Annex 9) for the distribution of age, gender, fatality and circumstances reported in the retrospective data. There was no significant difference in ages of APP cases (χ = 0.4, P= 0.2), and the proportion of men was slightly higher in the selected facilities but the association was not significant (PRR selected /non selected = 1.1, 95% CI = 1.0-1.2, p= 0.1) (Annex 9). The proportion of suicide and of fatal cases were significantly higher in selected facilities (PRR Selected facilities/Non selected facilities for suicide = 1.6, 95% CI = 1.4 – 1.8; and for fatal outcome was 1.3, 95%CI = 1.1-1.5, respectively) (Annex 9). Selected facilities were also significantly more likely to be regional/referral facilities (χ = 71.9, P=0.00).

(a) Epidemiological patterns: Retrospective versus prospective data collection (10 facilities)

The patterns and risk factors from retrospective and prospective data collection were compared for the 10 hospitals common to both studies (Table 5.29).

Table 5.29: Comparison of data from prospective and retrospective studies (10 facilities).

Variable	Studies				p
	Retrospective		Prospective		
	n	%	n	%	
Gender: % female	486	38.5	230	52.2	0.00
Age: % ≤ 30 years	453	70.2	217	71.4	0.81
Circumstances: % suicide	276	58.3	186	58.6	0.97
Circumstances: % unknown	486	43.2	230	19.1	0.00
Outcome: % fatal	331	11.5	185	7.0	0.13
Outcome: % unknown	486	31.9	230	19.6	0.00
Agent: % unknown	486	61.1	230	53%	0.04
Age % Unreported (Unknown)	486	6.8	230	5.7	0.69

*p values are based on Chi Square testing

The proportion of unknown circumstances (18.7 vs. 43.2%; p= 0.00), unknown outcomes (19.6% vs. 31.9%; p=0.00) and unknown agents (53.0% vs. 61.0%; p= 0.04) were all significantly lower in the prospective study compared to the retrospective study. For outcome and circumstance of poisoning, the proportion of cases for which these variables were unknown declined by about 50% with prospective data collection whereas the reduction in unknown agents was more modest (about 20%). The proportion of female cases was significantly higher in the prospective study compared to the retrospective study (52.2% vs. 38.5%; p= 0.00). The age group with the highest proportion of cases was 21 – 30 years in both the retrospective (32.3%) and prospective studies (33%); the most common category of circumstance was suicide in both retrospective (32.5%) and prospective (47%) studies; and the CFR was 7.8% in the retrospective and 5.7% in prospective studies. There were no significant differences in age, fatalities or in the proportion attributable to suicide in the prospective study compared to the retrospective study.

A comparison of the agents responsible for poisoning (n= 10 facilities) showed that Diazinon, Zinc phosphide, Endosulfan, Chlorpyrifos, Paraquat and Sulphur were reported in both retrospective and prospective studies (Table 5.30).

Table 5.30: Agents responsible for poisoning in prospective and retrospective (n=10 facilities in each sub-study).

Agent	Study									
	Prospective					Retrospective				
	n	% (in Known)	(known + unknown)	WHO hazard Class	Chemical group	n	% (in Known)	(known + unknown)	WHO hazard Class	Chemical group
Chlorfenvinphos	-	-	-	-	OP	2	2.2	0.45	Ib	OP
Diazinon	1	1.8	0.4	II	OP	12	13	2.72	II	OP
Endosulfan	1	1.8	0.4	II	OC	3	3.3	0.68	II	OC
OP	29	52.7	12.3	-	OP	34	38	7.71	-	OP
Paraquat	1	1.8	0.4	II	OT	2	2.2	0.45	II	OT
Sulphur	3	5.5	1.3	IV	IN	2	2.2	0.45	IV	IN
Zinc phosphide	7	12.7	3.0	Ib	IN	9	10	2.04	Ib	IN
Arsenic	1	1.8	0.4	IV	IN	0	0	0	-	-
Chromium	1	1.8	0.4	IV	IN	0	0	0	-	-
Copper oxychloride	2	3.6	0.8	III	IN	0	0	0	-	-
Cypermethrin	1	1.8	0.4	II	PY	0	0	0	-	-
Profenofos	1	1.8	0.42	II	OP	0	0	0	-	-
Deltamethrin	1	1.8	0.4	II	PY	1	1.1	0.23	II	PY
Lambda Cyhalothrin	1	1.8	0.4	II	PY	0	0	0		
Glyphosate	1	1.8	0.4	IV	OT	0	0	0		
Boric Acid	1	1.8	0.4		OT	0	0	0		
Chlorpyrifos	3	5.5	1.3	II	-	16	18	3.63	II	OP
DDT	0	0	0	-	-	3	3.3	0.68	II	OC
carbofuran	0	0	0			2	2.2	0.45	II	CA
Chlorothalonil	0	0	0			1	1.1	0.23	IV	OT

Imiprothrin	0	0	0	-	-	1	1.1	0.23	IV	PY
Phenothrin	0	0	0	-	-	1	1.1	0.23	IV	PY
Amitraz	0	0	0	-	-	1	1.1	0.23	III	OT
Subtotal 1 (Specifically known)	55	100				90	100			
Food poisoning	35	-	14.8	U	U	74	-	15.1	U	U
Rat Poison	13	-	5.5	U	U	20	-	4.08	U	U
Unspecific	7	-	3.0	U	U	7	-	1.43	U	U
Livestock Dip	4	-	1.7	U	U	2	-	0.41	U	U
Unknown	122	-	51.7	U	U	297	-	60.6	U	U
Subtotal 2	181	-		-	-	400	-	-	-	-
Grand total	236		100			490		100		

Table 5.31 indicates that there was a significant decline in WHO class I & II agents from 89.2% to 65.4% and in OPs from 71.1% to 56.4% as a percentage of known agents with prospective data collection. Also, there was a significant decline in unknown agents reported (from 60.6% to 51.7%; Table 5.31). The proportion of unknown agents among suicide cases was similar in the prospective study (50.9%) to that found in the retrospective study (52.2%).

Table 5.31: Comparison of agents in prospective and in retrospective studies (n=10 facilities).

Agent	**Study**		**95%CI, P**	**Remarks**
	Prospective	**Retrospective**		
WHO Class I & II	65.4%	89.2%	23.8(12.5% – 35.10%), P < 0.001	As percentage of known agents
OP	56.4%	71.1%	14.7 (1.49% - 27.91%), P =0.014	As percentage of known agents
Unknown agents	51.7%	60.6%	8.3% (-1.05% - 17.65%), P = 0.04	As percentage of all (known and unknown) agents
Rat poison	5.5%	4.08%	1.42%(-1.46% - 4.30%), P =0.18	As percentage of all (known and unknown) agents
Food poisoning	14.7%	15.1%	0.40%(-6.45% – 7.25%), P= 0.49	As percentage of all (known and unknown) agents

Table 5.32 presents the results of the multivariate regression analyses for both prospective and retrospective studies to identify predictors of fatal outcomes.

<u>Table 5.32: Comparison of associations with fatal APP outcome derived from multivariate regression in prospective and retrospective studies (n=10 facilities).</u>

Associations with fatal APP outcome	Retrospective		Prospective	
	PRR	95%CI	PRR	95%CI
Gender (Male vs. Female)	1.2	1.0-1.5	1.4	0.9-2.1
Age (> 30 vs. ≤ 30 years)	1.7	1.1-2.6	1.9	1.1-3.4
Circumstances (Suicide versus Non-suicide)	1.4	1.1-1.7	1.7	1.4-2.1
Agents (Known agent vs. Unknown)	1.1	0.8-1.6	0.9	0.5-1.6
Facility (Referral hospital versus other facility)	1.5	0.9-2.3	n/a*	n/a*

* not applicable since no cases were fatal in facilities other than referral hospitals in the prospective study

5.4.4. Annual Incidence Rates of APP

The annual IR, MRs and CFRs in the selected 10 health care facilities are presented in Table 5.33 for the retrospective and prospective studies. Prospective data collection produced higher rates than obtained the retrospective study, almost three times as high for morbidity and about twice as high for mortality. According to geographical area, the annual IR was highest in the Kilimanjaro region in both studies. The annual MR and CFR were highest in Mwanza region in the retrospective study whereas, in the prospective study, annual mortality and CFR were highest in Arusha. Rates according to age showed that annual IR in both prospective and retrospective studies were highest in the age group 21-30 years. Annual MR and CFR were highest in the age group above 40 years (Table 5.33).

Table 5.33: Incidence, Mortality and Case Fatality Rates due to APP in the selected 10 health care facilities for the retrospective and prospective studies*.

		Variable							
		Poisoning cases per 6 years	Poisoning cases per year (mean)	Population**	Deaths per 6 years	Deaths per year (mean)	Annual IR (Per 100,000)	Annual MR (Per 100,000)	Annual CFR (%)
Retrospective									
Regions	Arusha	65	10.8	1,307,237	10	1.7	0.83	0.130	15.4
	Mwanza	118	19.7	2,974,606	23	3.8	0.66	0.128	19.5
	Kilimanjaro	303	50.5	1,396,386	5	0.8	3.62	0.057	1.7
	Total	486	81	5,678,229	38	6.3	1.43	0.111	7.8
Age groups *	1 to 10	80.6	13.4	1956351	4.6	0.8	0.68	0.041	5.7
	11 to 20	93.6	15.6	1347976	3.6	0.6	1.16	0.045	3.8
	21-30	163.6	27.3	944943	13.6	2.3	2.89	0.243	8.3
	31-40	62.6	10.4	579850	3.6	0.6	1.79	0.103	5.8
	40+	85.6	14.3	829314	12.6	2.1	1.72	0.253	14.7
	Total	486	81	5658434	38	6.3	1.43	0.111	7.8
Gender	Males	299	49.8	2796207	29	4.8	1.78	0.172	9.7
	Females	187	31.2	2882022	9	1.5	1.08	0.052	4.8
	Total	486	81	5678229	38	6.3	1.43	0.111	7.8
Prospective									
Regions	Arusha	-	79	1,307,237	-	6	6.04	0.459	7.5
	Mwanza	-	39	2,974,606	-	1	1.31	0.034	2.5
	Kilimanjaro	-	112	1,396,386	-	6	8.02	0.430	5.3
	Total		230	5,678,229		13	4.05	0.229	5.6
Age groups*	1 to 10	-	25.6	1956351	-	0	1.31	0.000	0
	11 to 20	-	58.6	1347976	-	2	4.35	0.148	3.6
	21-30	-	78.6	944943	-	4	8.32	0.423	5.3
	31-40		36.6	579850		2	6.31	0.345	5.9

	40+		30.6	829314		5	3.69	0.603	17.9
	Total		230	5658434		13	4.06	0.230	5.6
Gender	Males	-	110	2796207	-	9	3.93	0.322	8.2
	Females	-	120	2882022	-	4	4.16	0.139	3.3
	Total	-	230	5,678,229	-	13	4.05	0.229	5.6

* Missing data on age for 33 cases in the retrospective study and on 13 cases for the prospective study. Missing data were distributed across the five age categories equally, meaning that each age category receive an additional 6.6 cases in the retrospective study and 2.6 in the prospective study.
** Population for each region was derived from National Census 2002 (Annex 10)

5.4.5 APP Rates in retrospective and prospective data collection for 10 selected health facilities in Tanzania.

(i) Incidence Rates

As outlined above, the Kilimanjaro region had the highest IR of all areas. The ratio between highest and lowest IRs by area remained approximately similar, being 5.5:1 in retrospective and 6.1:1 in prospective data collection.

In terms of age, the age group 21 – 30 years had the highest IR in both the retrospective and prospective studies. The increase in rates from retrospective data collection to prospective data collection varied across age categories.

Increased IRs for both men and women were found in the prospective study. However, in women, the increase of approximately four-fold (from 1.01 to 4.16) was slightly higher than that of men (from 1.78 to 3.93; Table 5.34.)

Table 5.34: Incidence Rates analysis for APP in retrospective and protective studies (n= 10 facilities).

Variable	Retrospective Study		Prospective Study	
	Cases/ 100000	**95%CI/#**	**Cases/ 100000**	**95%CI/#**
Region				
Arusha*	0.83	0.42-1.51	6.04	4.78-7.53
Mwanza	0.66	0.41-1.04	1.31	0.93-1.79
Kilimanjaro*	3.62	2.72-4.80	8.02	6.60-9.65
Age group				
1-10	0.68	0.35-1.14	1.31	0.86-1.95

11-20*	1.16	0.67-1.93	4.35	3.33-5.65
21-30*	2.89	1.88-4.16	8.32	6.62-10.42
31-40*	1.79	0.83-3.17	6.31	4.49-8.80
41+	1.72	0.92-2.83	3.69	2.54-5.31
Gender				
Males*	1.78	1.33-2.36	3.93	3.23-4.74
Females*	1.08	0.73-1.53	4.16	3.45-4.98

* Significant difference in Prospective & Retrospective (Non overlapping) 95%CI)
# 95% CI based on Poisson distribution for rates

(ii) Mortality Rates

The Arusha region had a higher MR than the other regions in both the retrospective and prospective studies but the difference was not statistically significant (overlapping 95% CI). The ratio between highest and lowest mortality across regions rose from 2.3:1 for retrospective data collection to 13.5:1 in the prospective study.

In terms of age, the age group 41+ years had the highest MRs in both the retrospective and prospective studies but the differences compared to other age groups were not statistically significant. In terms of gender, men had a higher MR than women in studies, but the differences were not statistically significant (Table 5.35).

Table 5.35: Mortality Rates analysis for APP in retrospective and protective studies (n= 10 facilities).

Variable	Retrospective Study		Prospective Study	
	Cases / 100000	95%CI#	Cases 100000	95%CI#
Region				
Arusha	0.130	0.018-0.553	0.459	0.168-0.990
Mwanza	0.128	0.036-0. 344	0.034	0.001-0.187
Kilimanjaro	0.057	0.002-0.399	0.430	0.158-0.935
Age group				
1-10	0.041	0.001-0.285	0.000	-
11-20	0.045	0.002-0.413	0.148	0.018-0.536
21-30	0.243	0.026-0.764	0.423	0.115-1.080
31-40	0.103	0.004-0.961	0.345	0.042-1.250
41+	0.253	0.029-0.871	0.603	0.196-1.410
Gender				
Males	0.172	0.058-0.417	0.322	0.137-0.569
Females	0.052	0.008-0.251	0.139	0.035-0.331

95% CI based on Poisson distribution for rates

(iii) Case Fatality Rates

The CFRs in terms of geographical area was highest in Mwanza in the retrospective study and in Arusha in the prospective study. In terms of gender, the CFR was highest in males in both studies and in terms of age, the CFR was highest among children aged 1 – 10 years in the retrospective study and among adults over 40 years old in the prospective study. There were no significance differences between the retrospective and prospective studies in terms of geographical location, gender and age for CFRs (Table 5.36).

Table 5.36: Case fatality rate analysis in prospective and retrospective studies (n= 10 facilities).

Variable	Prospective		Retrospective	
	Cases /100	**95%CI#**	**Cases100**	**95%CI#**
Region				
Arusha	0.07	0.02-0.16	0.18	0.02-0.65
Mwanza	0.02	0.006-0.10	0.20	0.05-0.5
Kilimanjaro	0.05	0.01-0.11	0.01	0.0004 – 0.1
Age group				
1-10	-	-	0.91	0.45-1.64
11-20	0.03	0.004-0.12	0.06	0.001-0.37
21-30	0.05	0.01-0.13	0.07	0.009-0.27
31-40	0.05	0.007-0.21	0.1	0.002-0.61
41+	0.17	0.05-0.41	0.15	0.01-0.55
Total	0.05	0.03-0.09	0.07	0.02-0.16
Gender				
Males	0.08	0.03-0.15	0.1	0.03-0.23
Females	0.03	0.009-0.08	0.06	0.007-0.22

95% CI based on Poisson distribution for rates

5.5. Discussion

5.5.1. Agents responsible for poisoning

The pattern of products involved in poisoning did not show wide variations in the 2 sub-studies. For example, the proportion of poisonings caused by rat poison and food poisoning was similar across both sub-studies. There was a small decline in unknown agents in the prospective study. The finding that unknown poisoning comprised a large proportion of agents responsible for APP is also reported in other studies (Nagami, 2005; Tagwireyi, 2006; Ather et al, 2008; Murali et al, 2009). Prospective data collection slightly reduced the proportion of missing data (Table 5.29). This investigation found a decline in the proportion of WHO Class I and II agents and OP as percentage of known agents in the prospective study, which might suggest that the unknown agents were not OP or WHO Class I and II agents. Very few WHO Class III products were reported in the both sub-studies.

The most prominent identified agents responsible for poisoning in this study were OPs, such as Chlorpyrifos, Diazinon and Chlorfenvinphos, which accounted for 67.8 % of all cases with specifically known agents (Table 5.8). The agents reported as OP in this study included products diagnosed using cholinesterase inhibition. The role of OP as a big contributor to APP cases is consistent with other studies. For example, a study conducted in Japan (Nagami, 2005) reported that the most frequent specific poisoning agents (36%) were OPs, and a study conducted in Zimbabwe referral hospitals found that cholinesterase-inhibiting products, mainly OP, accounted for 42% of all cases (Tagwireyi, 2006). Also, a study conducted in India reported that the cholinesterase inhibiting products accounted for 35% of all agents responsible for poisoning (Murali et al, 2009). These data emphasise the importance of OP as a cause of APP worldwide.

Zinc Phosphide is another product which was reported to cause APP in both retrospective and prospective studies even though it is not registered in Tanzania. This suggests that the product may be penetrating the market, probably due to weak enforcement and high demand to control rats in households. Health risks arising from unregistered products may be more serious because they include highly toxic agents that have not been evaluated under local conditions. This problem of availability of unregistered pesticides has been reported in other developing countries, such as Bolivia (Jors, 2004) and India, where such agents have been associated with poisonings (Chowdhary et al, 2007).

The majority of cases where a specific poisoning agent was reported in this study involved WHO Class II (moderately hazardous), in contrast to other studies in Latin America (Cole et al, 2000; Wesseling et al, 2001; Henao, 2002; Corriols et al, 2009), South Asia (Eddleston, 2000; Buckley et al, 2004; Gunnell et al, 2007), China (Phillips et al, 2002; Buckley et al, 2004) and Africa (London et al, 2005) where WHO Class Ia and Ib pesticides are commonly involved in APP. The low frequency of WHO class I products reported in this study could be attributed to the fact that WHO class I products are not registered for general use in Tanzania but are registered under a restricted registration category which confines their use to the specific firms licensed to distribute these agents. Restriction of these products is intended to reduce their availability and subsequently their involvement in APP events. This suggest that it might be better, under circumstances of porous borders and poor enforcement, to rather keep agents such as zinc phosphide registered but under restrictive conditions and at the same time trying to ensuring that protective enforcement mechanisms work effectively.

Among the products responsible for poisoning was DDT, although reported with low frequency (four cases in the retrospective study). DDT was not registered for use in Tanzania in the study period. The product may be smuggled across borders illegally from other countries and this is probably the case in remote areas of Tanzania, as suggested from routine inspections conducted in Kigoma, Western Tanzania and Mwanza in 2003 and 2005 (TPRI, 2003; TPRI, 2005).

The problem of DDT as a cause of APP may be exacerbated in future because of plans by the Ministry of Health and Social Welfare in Tanzania to use DDT in malaria control programs for residual spraying in households (Hileman, 2006). According to the WHO, Indoor Residual Spraying (IRS) is important for malaria control (WHO, 2006) and DDT is among 12 insecticides currently recommended for IRS (WHO, 2007a). Safe use of this product will rely on the extent of compliance with local regulations (WHO, 2007a). However, in Tanzania, pesticide enforcement is weak as suggested by the cases of Zinc Phosphide poisoning reported in this study. Weak enforcement is due to several factors including the inadequate number of inspectors, inadequate funds and lack of basic equipment such as vehicles. Misuse of pesticide products, including unregistered ones like DDT, has been witnessed in parts of the country (TPRI, 2005). Farmers may use DDT intended for IRS illegally for pest control in agriculture either during pre-harvest or post-harvest treatments. If so, the increasing use of this product in malaria control may result in serious environmental and health problems, particularly given its association with breast cancer (Lopez-Cervantes et al, 2004) and neurodevelopmental delays in young children (Eskenazi et al, 2006) and the risk of contamination of food crops including those intended for export.

Illegal trafficking and use of DDT has been reported by several developing countries and enforcement of pesticide regulation is often insufficient to prevent illegal use or leakage outside the health sector, particularly in countries with long, porous borders (UNEP, 2008). An example is in Trinidad and Tobago, where DDT has been used illegally as the active ingredient in some mosquito coils (Yen et al, 1998).

OP pesticides in Tanzania are widely used in agriculture and are registered under the full and provisional registration category (United Republic of Tanzania, 2006). In principle, these categories accommodate products which are for general use and can be handled by farmers. The easy availability of these products is likely to be linked with their involvement in poisoning.

Studies report that ingestion of OP intentionally is a major problem, especially for developing countries, probably because of the wide availability of pesticides as a result of extensive use in agriculture and because of sale of these items over the counter in these countries (Eddleston, 2000; Konradsen et al, 2003).

Other prominent agents reported as used for self-harm in developing countries are Dimethoate in Zimbabwe (Tagwereyi, 2006), Paraquat in Trinidad (Hutchinson et al, 1999), Costa Rica (Wesseling, 1993) and Samoa (Bowles, 1995), Malathion in Guyana (Nalin, 1973) and Monocrotophos and Endosulfan in India (Rao et al, 2005). These products, with the exception of Endosulfan, are not among the products found to cause poisoning in either the prospective or retrospective studies in Tanzania. However, since these products are registered for use in Tanzania, it is possible that they are misclassified among the cases with unknown agents. Alternatively, restricted registration, as is the case for Paraquat in Tanzania, may limit opportunities for exposure and poisoning in this study dataset.

5.5.2. Circumstances

The circumstances of poisoning reported (excluding unknown circumstances) indicate that the most common circumstance of poisoning was suicide. This is probably because suicide results in severe health consequences and prompts the need for medical intervention compared to occupational poisoning in which the victims may treat themselves or just wait to recover naturally.Findings from the study of farmers in Arumeru district (Chapter 4) suggest that only 20% of farmers who experience APP in the course of work seek medical attention for their poisoning. Suicide cases are also more easily diagnosed and hence more easily documented than APP arising from other circumstances.

Another reason for the predominance of suicide as a circumstance of poisoning could be the general though mistaken belief that pesticides terminate life with minimal suffering and so persons intending to commit suicide may choose a pesticide as agent above other methods (Dhattarwal et al, 2001; Sharma et al, 2001). As shown in Tables 5.3 and 5.20, cases of APP due to suicide were clinically more severe than non-suicide cases and multivariate regression confirmed that suicide was more likely to lead to a fatal outcome ($OR_{retrospective}$= 4.3; 95% CI =1.9 - 9.8); $OR_{prospective}$=9.8; 95% CI =1.2 – 78.0). This is supported by a study conducted in South Korea (Jin et al, 2009) which reported that intentional poisoning resulted in a majority of the deaths (84.8%) from pesticide poisoning. It is therefore not surprising that suicide cases are likely to receive priority in the hospital system over other cases and to be reported better than cases due to other causes (London et al, 2005).

In this study, suicides cases occurred most commonly among young adults aged 21-30 years (21.4 % and 30.6% in the retrospective and prospective studies, respectively). This age group includes young people looking forward to employment and the prospect of an independent life and most are in the process of looking for life partners and/or experiencing break up of relationships. Desjarlais (1995) indicates that suicide is one of the top 2 or 3 causes of death among young people. Due to uncertainties in life expectations, poverty and lack of reliable employment opportunities, many young people become frustrated and respond impulsively in the form of suicidal actions. Similar findings have emerged in studies of suicide in young people in other countries (Senanayake et al, 1995; Dhattarwal et al, 1995; Singh et al, 1999).

The literature also confirms that suicide, particularly using pesticides as the poisoning agent, is a major problem in the developing world (Eddleston, 2000; Van der Hoek, 1998). Fourteen percent of all deaths among women aged 10 to 50 years in Bangladesh were reportedly due to pesticide poisoning, the majority following suicidal ingestion of pesticides (Yusuf et al, 2000), particularly involving Chlorpyrifos and Diazinon, agents which are also reported in this study (Table 5.5). Ndosi (2004) also found that the majority of pesticide agents used in self-poisoning in Tanzania were Chlorfenvinphos and Diazinon.

The proportion of suicide cases among cases with known circumstances in this study (58.0% for prospective study) (Table 5.29) is low compared to findings of studies in Japan (70%) (Nagami, 2005), Zimbabwe (59%) (Tagwireyi, 2006), the Asia region (73%) (Jeyaratnam, 1982) and India (96%) (Rao et al, 2005) but higher than in Costa Rica (24%) (Wesseling, 1993) and Malaysia (20.7%) (Rajasuriar, 2007**)**. The reasons for different proportions due to suicide may be the result of multiple factors. For example, in Tanzania, agents which are widely used in suicide are readily available in the pesticide retail shops at a very low cost; countries such as Costa Rica may have a better system for notification of occupational cases hence resulting in a relatively lower proportion due to suicide cases. Costa Rica also has a national social security system, which compensates workplace injury and illness, and so work-related poisonings are probably better captured.

Accidental poisoning in this study accounted for 44.7% of cases with known circumstances in the retrospective study (Table 5.3) a proportion higher than that found in Zimbabwe (27%) (Tagwireyi, 2006), Costa Rica (23%), Central America (24%) (Arbelaez et al, 2002), Nicaragua (13%) (Berroteran, 2001) and Guatemala (36%) (Samayoa et al, 2005) but similar to that reported in Malaysia (47%) (Rajasuriar, 2007). In accidental poisoning, the highest number of cases (n=57) occurred in the age group 1-10 years and the majority were due to OP and food contaminated with pesticides. This age group comprises children among whom suicide is rare. The age distribution for accidental poisoning is therefore consistent with what one would expect and with literature

Occupational poisoning cases accounted for 8.5% of cases with known circumstances in the retrospective study and slightly over 10% in the prospective study (Table 5.29). This proportion is relatively low suggesting that the majority of occupational poisoning cases are either not presenting to health care facilities or the cases that were presented were not properly recorded since the circumstance of poisoning was not given priority in the hospital reporting system. This would imply that a portion of the cases with unknown circumstances could be occupational poisonings that are misclassified. Non-reporting of occupational poisoning is evident in the household sub-study in chapter 4 which revealed a high lifetime prevalence of occupational poisoning cases, but a large proportion of which (78.3%) were not reported to the health system. Other studies in Africa have found similar proportions of occupational poisoning (Table 5.37) which may suggest similar factors affecting under-reporting in the region.

Table 5.37: Comparison of APP circumstances with other studies conducted in Africa.

Type of study	Setting	% Suicide	% Accidental	% Occupational	% Unknown Circumstances	% Homicide,	% Fatal outcome	% Known agents	Reference
Tanzanian study -Current study (Retrospective) (n=30)	Hospital based study	27.8	26.4	5.0	41.0	1.0	6.8	40.8	Chapter 5, section 5.4.1
Current study (Prospective) (n=10)	Hospital based study	58.0	25.3	8.3	19.1	0.5	5.7	47.9	Chapter 5, section 5.4.2
Kenya	Review of district hospital records1987-1990	35	-	8	-	-	-	-	Mwanthi and Kimani,1993
Zimbabwe	Teaching hospital records, January 1981 to June1986	73	-	15					Nhachi,1988
Zimbabwe	Admissions to two teaching hospitals, Harare,1987 and1988	85							Loewenson and Nhachi,1996
South Africa	Review of notifications to Ministries of Health	22							Department of Health, 1995
South Africa	Review of notification in one province,1987-1991	35	44	11					London et al.,1994

* Denominator for percentages based on all poisonings (including unknown circumstances) unless otherwise specified.

The study found that when treating age as a continuous variable in the prospective study and excluding children under 12 years, there was no significant age difference between suicide victims and persons poisoned under other circumstances. This implies that a non-linear relationship with age, seen in a peak in young adults with lower rates in older adults and very low rates in children.

5.5.3. Outcome of poisoning

The study reported very few cases of APP survivors suffering permanent disability. Given the evidence that APP can result in long term neurological and neurobehavioural effects (London et al, 1997; Farahat et al, 2003; Kamel et al, 2004), this lack of reported disability is probably due to poor follow-up of poisoning cases resulting from poor information systems. Incorrect diagnoses may also contribute to this situation because of incorrect attribution of the cause of disability to other causes. The small number of patients who absconded from health facilities before being discharged may also contribute to the low number of cases of disabled as their exact outcomes were difficult to verify. Further research is recommended in this area.

The proportion of cases with known outcomes was significantly higher in cases with known agents than in cases with unknown agents in both retrospective and prospective studies. This is to be expected as severe outcomes such as death will probably result in the health and legal system seeking details about the agents responsible. Conversely, the conditions leading to cases with unknown outcomes will probably be associated with the lack of good data recording system generally.

5.5.4. APP morbidity and mortality rates

The overall annual IRs were 1.43/100,000 and 4.05/100,000 in the retrospective and prospective studies, respectively. A previous study reported 736 poisoning cases over a period of 2 years in Tanzania for 18 regions of the country (Mbakaya et al, 1994). Based upon census data for these regions, this implied an average annual poisoning rate of 20.4 poisoning cases per region per year. The number of cases in the prospective study is approximately 3 to 4 times higher at 230 cases per year in 3 regions or 76.7 cases per region per year. The higher IR (about 3 times) in this study with prospective data collection could be a result of reduction in under-reporting resulting from training and awareness rasing of pesticide poisoning in this study.

Nonetheless, these APP rates are much lower (approximately 5 to 10 times lower) than reported in the Central America region (20/100000), Nicaragua and El Salvador (35/100,000) and Costa Rica, Belize and Honduras (less than 10/100,000 (Henao, 2002). Similarly, the overall annual MR in prospective and retrospective studies (0.1/100,000 and 0.2/100,000, respectively) were also much lower (about 10 to 20 times lower) than those reported in Central America region (2.1/100,000), Nicaragua and El Salvador (more than 4/100,000) and in Costa Rica, Honduras and Belize Less than 1/100,000) (Henao, 2002). The lower IRs in this study could be due to undercounting of poisoning cases due to an inadequate reporting system, an explanation supported by data from the farmers' self-report in Chapter 4 in which only 5% of their reports of APP could be traced in health records.

Mortality generally does not suffer the problems of undercounting to the same extent as morbidity because it is harder to miss a death notification. However, a lower MR in this study could still be a result of poor notification system in the sense that data may be reported but be lost. For example, as observed in this study, register pages might be lost or damaged. This study found poisoning register books with some pages missing or damaged to the extent that it was difficult to capture useful information (see Figure 5.4). This might also partly explain lower IR's in this study.

Figure 5.4: Example of a damaged register book with incomplete data.

The overall annual CFR in the prospective and retrospective studies (7.8/100 and 5.6/100, respectively) were only slightly lower than those found in the Central America region (10.8%) (Henao, 2002) and Zimbabwe (9.4%) (Tagwireyi, 2006), but substantially lower than found those in South India (22.6%) (Rao et al, 2005). The latter finding may be due to use of high toxicity pesticides in India where aluminium phosphide is commonly used for suicide (Rao et al, 2005) with concomitant high mortality. The fact that the CFR is broadly similar to other developing countries, suggests the problem is primarily undercounting of incident cases of APP.

(a) Rates by age, gender and region

The IR was highest in the age group, 21 – 30 years, in both prospective and retrospective studies and among men in the retrospective study.

The higher IR in males may be due to higher stress, leading men to be more likely to commit suicide compared to females, a hypothesis supported by findings in studies conducted in India (Agarwal et al, 1995; Gupta et al, 2002) and Sri Lanka (Senanayake et al, 1995). Other studies report that men's increased risk is due to greater pesticide use than women (Choi, 1991) as a result of which they suffer higher incidence of APP compared to women. However, in the prospective study, the trend was reversed with women having higher IRs (Tables 5.37 and 5.38). This trend could be due to non-recognition of women as farm workers in some situations and the resultant failure to link a clinical presentation with a pesticide exposure. Previous studies suggest that women's occupational exposures are grossly under-estimated (Garcia, 2003) because of gendered ideas about women's work (London et al, 2002).

In contrast to incidence, the MR and CFR due to APP were highest in the older age group (40+) and amongst men in both the prospective and retrospective studies. A study conducted in the US (Rogers et al, 2007), reported that older people (over 59 years) had higher odds of dying from poisoning than young people. Multivariate analysis (Tables 5.16 and 5.28) confirmed that both age (older than 30), gender (women) and circumstance (suicide) were associated with fatal outcomes.

The study found the highest APP IR in the Kilimanjaro region in both the prospective and retrospective studies, implying that under-reporting may not be area dependent. Another factor suggesting that under-reporting is not particular to area is that the ratio of highest and lowest IR of APP in both studies remained more or less similar.

The high IR in Kilimanjaro could be the result of coffee cultivation which involves the use of different types of toxic insecticides (for further discussion, refer to section 10.2). However, mortality rates were not highest in Kilimanjaro, perhaps because of good access to health facilities in this region. Because the major referral hospital is in the Kilimanjaro region, availability of good clinical care and treatment for APP cases may lowers the MR relative to other regions.

The proportion of children comprising reported APP cases in this study (prospective and retrospective) was slightly higher than that reported in a previous East African study (7%) (Mbakaya et al, 1994). One explanation for this may be that children were exposed to pesticides in agriculture through pesticide application, distribution and also accidental exposure within households. A previous study conducted in Tanzania indicated that children are exposed through the direct sale and distribution of pesticides (Mununa et al, 2000) and may also be exposed through accompanying mothers, who are retailers, onto the shop premises (Figure 5.5). Thus, while pesticide exposure is typically thought of as a problem of adult men and women, there may be grounds to anticipate that children are more exposed to pesticides than generally thought. This may mean that some of the poisonings labelled "accidental" may actually be occupational in circumstance but are misclassified because children are not perceived to be capable of working with pesticides. The retrospective study reported 1 occupational poisoning in the age group 1 to 10 years old and 3 in the age group 10 to 19. In the prospective study, there were 7 APPs in the age group 10 to 19 years old. Therefore, it is quite possible that some of the cases categorized as accidental and unknown might be occupational in nature reflecting forms of child labour.

Figure 5.5: A child in the pesticide retail shop (Her mother was on the other side of the counter attending to customers).

5.5.5. Comparison of prospective and retrospective rates

Comparing prospective and retrospective data collection, the APP incidence increased more than two-fold (from 1.43/100,000 to 4.05/100000). Similarly, mortality increased from 0.11/100000 annually in retrospective to 0.23/100000 annually in prospective data collection. This increase in reported rates could reflect a change in the underlying risks or use of more toxic pesticides. However, a more likely cause is greater awareness of the problem following sensitization efforts made through electronic and mass media, the Ministry of Health and Social Welfare and the training on APP held in January 2006 at the TPRI for which the Ministry of Health and Social Welfare sponsored 10 representatives from various local hospitals to attend. The visits and introduction of the study to each facility during data collection may also have contributed to the increase in reporting poisoning cases. For example, the CFR decreased from 7.8% in retrospective to 5.6% in prospective data collection. This may reflect (a) the improvements in treatment of cases resulting from awareness created among health care workers during the study; (b) better ascertainment and reporting of cases in the prospective study, resulting in less under-estimation of the denominator used in the CFR calculation. HCPs involved in the prospective study may also have been better oriented to the subject of pesticides and more cooperative in data collection. If it is the case that more accurate data were collected during the prospective study, the measures to improve health workers' practices should apply in any proposed future surveillance system leading to more accurate quantification of the burden of APP in the community.

5.5.6 Bivariate and Multivariate associations

(a) Factors relating to suicide

Men were more likely to be involved in suicide than women in the retrospective study but the trend was reversed in the prospective study.

The reason for high proportion of suicides among men in retrospective study could be the fact that men tend to plan suicide events more carefully than women to avoid detection (Beck et al, 1976). In contrast, women tend to plan their suicide events to express an appeal for help by conducting the attempt in a manner that favours discovery (Beck et al, 1976). In the prospective study, however, there were more women among suicide cases than among non-suicide cases. The literature on the gender predilection for suicide is conflicting. Studies in Pakistan (Khan et al, 2000), India (Latha et al, 1996) and Nigeria (Nwosu et al, 2001) indicate that men are more likely to be involved in suicide than females. However, other studies conducted in Chile (Millan et al, 1995) and Egypt (Okasha et al, 1979) indicate a higher risk for suicide associated with being female. There are thus many unexplained cultural questions around suicide that affect surveillance for APP.

The association of known agents with suicide indicates that there were fewer known agents for suicide-related APP compared to non-suicide cases in both the retrospective and prospective studies. Suicide is often committed in private such that, at times, other household members may not know what happened. Relatives may rely on evidence such as the smell of vomit, presence of a pesticide container or information from the victim, which is not available in fatal cases. This leads to low ascertainment of the specific causative agent. Association of age and suicide indicates that adults (over 30 years) reported a higher suicide frequency than younger people (30 years and less). Very young individuals (under 10 years of age) are at very low risk of suicide and most children are under the control of their parent's supervision. Unlike adults, who may be married with financial responsibilities for dependents, children do not usually have the stress of family commitments or responsibilities, which may be typical contributory social factors underlying risks for adult suicide. The exception would be children who are AIDS orphans, who may be directly responsible for running households.

(b) Factors relating to occupational poisoning and gender

The gender-specific distribution across different circumstances in this study revealed that in the retrospective study, the proportion of cases with occupational circumstances was higher among females (12.0%) than males (6.1%) but in the prospective study the proportion of males (10.2%) and females (10.1%) were almost equal (Table 5.22). In Tanzania, where men are more involved in pesticide application than women (Chapter 4) one might expect more occupational cases in men than women. However, there is some evidence to suggest that women's occupational health risks are under-estimated (London et al 2002). The fact that retrospective data collection identified more women involved in occupational poisoning is similar to the findings of London and Bailie (2000) when comparing intensified surveillance to routine notification in South Africa.

Increased risk for occupational exposures to pesticides for women has implications for their reproductive health. A study in Columbia found that women working on flower plantations experienced a high frequency of miscarriages and infants with congenital anomalies (Restrepo et al, 1990). A case-control study in South Africa reported that babies with birth defects were seven times more likely to be born to women exposed to chemicals used in gardens and fields compared to controls with no reported exposure (OR 7.18, 95% CI 3.99, 13.25) (Heeren et al, 2003). In Tanzania, there are anecdotal reports from the flower farms of similar complaints, which have occasionally appeared in local newspapers (Mallya, 2003). While the link to birth defects in Tanzania has not been proven, it is suspected that adverse reproductive outcomes may be caused by pesticide exposure in greenhouses which are closed environments. Severe occupational poisoning events have been reported in flower plants involving female workers in Tanzania (TPRI, 2003; TPRI, 2009).

(c) Known circumstances and outcome

Regarding known circumstances and fatal outcomes, the study revealed that there was a higher proportion of known circumstances for fatal than non-fatal cases. Fatal cases resulting from poisoning are likely to be subjected to more thorough police investigation. As a result, much more information about the circumstances are likely to become available.

(d) Suicide and outcome

A higher proportion of fatalities in suicide compared to non-suicide cases was found in both prospective and retrospective studies. Most suicide cases involve intentional intake of lethal products in high quantities or in concentrated form and often under conditions of secrecy, which increase the chances of a fatal outcome. This was confirmed by the ORs for the association between attempting suicide and fatal outcome, whether in the retrospective (OR = 4.3; 95%CI =1.9 - 9.8, P=0.00) or prospective studies (OR 9.8; 95%CI =1.2-78) (Table 5.16).

Multivariate analyses indicate that women were less likely to be fatally poisoned in both the retrospective study (OR=0.4; 95% CI =0.2-0.9) and prospective study (OR = 0.4; 95% CI = 0.1-1.4), though the latter finding was not statistically significant. This may indicate that it was suicidal circumstances, rather than gender that contributed to mortality. Respondents older than 40 years were significantly more likely to be fatally poisoned in both retrospective study (OR = 2.7; 95% CI=1.4-5.4) and prospective study (OR 5.4; 95%CI =1.6-18.3). This could be on a biological basis in the sense that older people may be more vulnerable to APP.

5.5.7. Quality of surveillance data

(a) Facilities

Data in both the retrospective and prospective studies confirm a general trend: that the majority of APP cases in Tanzania, particularly severe ones, are directed to regional and referral hospitals (Table 5.1). Few cases appear to be handled at lower level facilities such as health centres. This could be due to a lack of clinical capacity to diagnose and treat such cases at primary level or a belief that poisonings, particularly those associated with suicides and homicides, should be handled at regional or referral hospitals for medico-legal reasons. Nonetheless, two thirds of smaller facilities in this study did handle APP cases, albeit in small numbers (Table 5.1). It would therefore still be valuable to include these small facilities in any APP surveillance system.

Referral hospitals in this study reported fewer cases than regional hospitals. In principle, the cases that cannot be handled at regional hospitals are referred upwards to referral hospitals. It appears that regional hospitals in this study were in a position to handle the majority of the cases with fewer upward referrals. However, while regional hospitals handled the bulk of cases, one regional facility, Mount Meru, reported very few cases compared to other hospitals (Table 5.1). This was probably due to the fact that the level of awareness at Mount Meru regarding APP was very low at the beginning of the study compared to other facilities. It took a long time for the hospital to be convinced to cooperate in data collection. It is possible, therefore, that there were many more cases from this facility missed in the study.

Two facilities in this study had some computerized records but this did not necessarily make it any easier to extract data, as details of diagnosis, treatment and agents responsible for poisoning were not properly completed in the electronic database. Patient folders which were drawn to compare data showed that poisoning agents were entered in the patient history section while, in the section of diagnosis, only the term “poisoning” or “suicide” was written with no exposure information. It appears that during transfer of the information to the register, the data recorder simply entered the word “poisoning” for diagnosis and omitted details on the type of the agent responsible. There is perhaps a need to computerize all poisoning data using standard codes. However, the quality of computerized records will only be as good as the quality of attention paid by staff to the task of entering the data.

(b) Diagnosis

The diagnosis of poisoning in the hospital study in both the retrospective and prospective studies depended on a clinical diagnosis based on history, examination and clinical signs with few cases confirmed in the laboratory. The standard diagnosis recommended by IPCS is based on laboratory testing and clinical signs, although diagnosis without laboratory confirmation is also reported in other studies (Thundyil et al, 2008). However, reliance on laboratory tests would have been impractical in this study due to the lack of laboratories, consumables and expertise. The laboratories available to the majority of health facilities cannot diagnose pesticide poisoning. It would be ideal if laboratory capacity to support clinical diagnosis could be developed and equipment introduced for the diagnosis of APP. However, a study conducted in Sri Lanka to confirm cases reported by history indicated it may not be necessary to require laboratory confirmation. The diagnosis of pesticide poisoning cases reported through clinical signs and history given by relatives and patients in the Sri Lankan study were confirmed by laboratory analysis in over 80% of cases (Rao et al, 2005).

The proportion of cases for which the agent responsible was unknown (77.7% and 62.1% in the retrospective and prospective studies, respectively) was very high and about 4 to 5 times higher than study in Zimbabwe (Tagwereyi, 2006). The slight decline with prospective data collection was probably due to awareness created through the research process in visiting health facilities and engaging with the Ministry of Health and Social Welfare. Nonetheless, lack of data on poisoning agent is still an obstacle for APP diagnosis and surveillance. Poor identification of agents responsible could arise from failure to record information, unfamiliarity with pesticides or inability to identify agents among HCPs. This problem is explored more fully in the HCP survey in Chapter 6. The lack of knowledge of agents responsible for poisoning among HCPs may be reduced by training and community awareness.

The existence of many cases with unknown agents directly reflects the weakness in the health management information system. In the health statistics register book (MTUHA summaries), poisonings were reported without details on age and poisoning agents. Such information could be accessed in patient folders but, in some cases, the folders had no additional details other that the words “poison”, “intoxication” or “unknown agent”. Unknown outcomes were also noted in 31.9% of cases collected from the retrospective study and a significantly lower proportion in prospective study (19.6%). Unknown agents and unknown circumstances were correlated, suggesting that in circumstances where the agent was unknown, circumstances would be more likely to be unknown as well, and vice versa, which may simply reflect the lack of good data recording.

Detailed information about the agent responsible for poisoning is very important because the reporting system for the Prior Informed Consent (PIC) procedure requires accurate data on the specific toxic agent (including active ingredient, type of formulation, the way the formulation was used and the circumstances of poisoning), that presents a hazard under normal application conditions in developing countries. The absence of information about agents responsible for poisoning means that poisonings cases may never get into the PIC database due to a lack of product identity and unknown circumstances. As a result, a hazardous pesticide might continue to pose significant threat to human health in developing countries but remain undetected through the mechanisms set up for this purpose by the Rotterdam Convention.

Lack of information about agents responsible for poisoning will also frustrate intervention efforts to reduce exposure and poisoning at local and national levels, because it will not be known which chemicals to focus on. Similarly, the effectiveness of the clinical management of affected persons will be hindered by the lack of details on specific chemicals involved in the poisoning.

(c) Challenges and data completeness

There were many challenges in abstracting information from hospital records, which have implications for how to set up a good surveillance system; these are outlined below. The hospital records included physical folders kept on special shelves in most facilities. In a few cases, the folders were damaged due to frequent use and hence some information was missing. The missing data identified included information on outcome of poisoning, treatment and circumstances of poisoning (Figure 5.4).

Additionally, even when records were complete, the study found that many details about poisoning incidents were not properly recorded. For example, there were agents responsible for poisoning whose names were wrongly spelt or classified e.g. Red cat (Zinc phosphide) was wrongly classified as OP by one recording clinician; Paraquat classified as OP in another folder. Some trade names were mistaken, for example, Dursban (Chloropyrifos) was reported as “Daspan”. Other problems included missing pages in patient folders and the recording of a diagnosis in an incorrect location or section of the folder. These are all significant obstacles for surveillance.

5.5.8. Comparison of prospective and retrospective studies

Table 5.29 summarises the findings obtained in retrospective and prospective studies. The percentage of unknown circumstances of poisoning was significantly reduced in the prospective study (p<0.001), as was the percentage of unknown outcomes of poisoning (p<0.001). In terms of agents responsible for poisoning the unknowns were marginally reduced in prospective study (p=0.06).

The lower proportion of cases of unknown agents in the prospective study could be a result of raised awareness by the study in the broader community and among HCPs. This suggests that training and awareness creation can improve the quality of notification of APP. With appropriate knowledge about the diagnosis of APP, on how to identify and classify pesticides, how to manage pesticide poisoning cases and the use of the standard poisoning data collection tools, HCPs can provide better information on APP cases and thereby improve APP surveillance (explored in more detail in chapter 10).

The associations involving gender, age, facility, circumstance and outcome were broadly similar in both retrospective and prospective studies, which suggested that the underlying associations in the two sub-studies were more or less similar. However, there were differences in the distribution of these variables in the two populations of APP cases.

Other studies have reported improved notification as a result of surveillance interventions. For example, a surveillance exercise in Central America revealed a 98% rate of under-reporting, 76% of the incidents being work-related (Murray et al. 2002). In a South African study, a 10-fold increase of poisoning rates was found through intensive surveillance compared with routine methods (London and Bailie 2001). In this study, the rates in prospective study increased three fold for morbidity and about twice for mortality. The South African study also found that occupational cases were under-reported compared to suicides and the risks to women were underestimated (London and Baillie 2001). In this study there was no increase in the proportion of occupational cases, probably because these cases do not present to hospitals (supported by findings in Chapter 4).

5.6. Limitations

5.6.1. Limitations of the information system

A number of problems were identified in this study, which could potentially contribute to under-estimation of the burden of APP. Firstly, as outlined above, hospital data were often incomplete. Many records lacked detail about the circumstances of poisoning (43.2% for retrospective study and 19.1% for prospective study), poisoning severity and agents responsible for poisoning (61.1% for retrospective study and 51.6% for prospective study; Table 5.29). Reviewers had to scrutinize the patient history in the folders to extract information to classify poisoning cases according to circumstances and identify agents responsible for poisoning.

Secondly, low reporting of APP cases to health facilities is another data problem. The most commonly reported circumstance for APP was suicide, probably because such cases are severe poisonings. In contrast, the circumstance least reported was occupational, which is also associated with less severe poisonings as outlined in chapter 4. This suggests that cases presenting and recorded at hospitals are more likely to be severe poisonings such as suicides and less severe cases are missed. This means that, in order to compile more comprehensive data, surveillance should be extended to other data sources in the community.

Thirdly, damaged data registers with missing pages, for example, were also noted in this study as a potential limitation, which could contribute to the high level of unknown results. Computerization of data, assuming that the raw data is correctly entered, may help to address this limitation.

Fourthly, inaccurate data transfer is another problem revealed in this study. It was noted, that in some cases the correct information was not appropriately transferred to the poisoning register, resulting in under-reporting of APP cases. Cases with inadequate details in the poisoning registers had to be clarified from information in patient folders. Training in data recording should help to reduce this problem.

Lastly, due to inadequate laboratory support, the majority of diagnoses were made by reliance on clinical signs and history. Cases reported based on history may overestimate the true rates of APP by including cases caused by chemical exposures other than pesticides, which are not easily distinguished by the reporters. However, the misclassification may also work in the opposite direction, such that the link to pesticides is missed and true cases of APP are missed. The rates may also be over-estimated by including cases arising from infectious disease where symptoms mimic APP. However, given that it is known from the household survey in this study (Chapter 4) that farmers handle pesticides in ways which can result in serious health injuries, the findings regarding the rate of APP for Tanzania appear consistent with the patterns of unsafe handling practices observed.

5.6.2. Study limitations

The study reviewed poisoning data from all regional Government hospitals and referral hospitals in four regions and from 22 selected health care facilities in Arusha. Not all facilities were included due to financial constraints. To some extent, a bias may have been introduced by not including all health facilities and since the sample was not random. However, the facilities not included were smaller health centres which generally reported relatively few cases of APP. The impact of not including all health facilities on estimates of rates and patterns of APP is therefore likely to be small. The target population included all the major referral and regional hospitals in the study area, which together, accounted for over 30% of all hospital beds in Tanzania.

Another limitation could be the inconsistent participation by one regional hospital. This facility was late and unenthusiastic in participating. As a result they reported far fewer cases than equivalent regional hospitals in retrospective study. This is likely to result in under- reporting.

Further, the coverage of this study appeared to capture 16.2% of the Tanzanian population. The four regions selected in Tanzania are unlikely to represent the whole country due to different farming systems and urbanization, but are useful to predict the situation of APP in Northern Tanzania.

A consequence of the selection of the health care facilities for inclusion in the prospective study was that the proportion of suicide and fatal cases were significantly higher in selected facilities (Section 5.4.3), which were significantly more likely to be regional/ referral hospitals.

This was expected since regional and referral facilities usually accept more severe poisonings (such as suicides or APPs with fatal outcome).

5.7. Conclusion

This study revealed that APP has a significant impact on the community's health in the selected four regions of Tanzania, particularly from severe APP under suicidal circumstances. Non-severe cases, in particular occupational poisonings, which are not traditionally reported to hospitals, might need to be captured using different methods, such as community surveys or self-surveillance. For example, in Vietnam, a 12 month self-surveillance study of 50 farmers found that 54 moderate poisonings were reported per month, compared to only two per month treated at the local health care centre (Murphy et al 2002).

The rates of APP generated in this study, although needing refinement in further studies, are the first to be estimated in Tanzania and can be useful for the quantification of the burden of disease caused by pesticides in Tanzania. Further, several poisoning agents reported as responsible for APP in this study included OP and WHO Hazard Class I and II pesticides, products that are highly or moderately hazardous and which may yet become subject to provisions of the Rotterdam Convention over time.

The data collected in this study demonstrated large volumes of missing information about the agents responsible for poisoning, circumstances of poisoning and outcome of poisoning. This is largely due to an absence of good surveillance for APP. However, the improvement in data quality in the prospective study and reduction in the proportion of unknown data is an indication that with proper training and awareness creation, surveillance interventions may improve data quality. The implications for a surveillance system for APP are discussed further in Chapter 10.

It is recommended that establishment of a national surveillance system, to generate reliable data and base interventions to reduce APP, should be a public health priority in Tanzania. Coupled with effective regulatory control of pesticide use and handling, such interventions should aim towards reducing the burden of APP arising from pesticides. The incidence of APP is highest among young adults of the age 21 – 30 years, indicating that APP affects the most economically active segment of the population. It is anticipated that efforts to introduce interventions to reduce APP will attract greater government attention.

CHAPTER 6.0: KNOWLEDGE AND PRACTICES RELATING TO ACUTE PESTICIDE POISONING AMONG HEALTH CARE PROVIDERS IN SELECTED REGIONS OF TANZANIA

ABSTRACT

Background and aim

Pesticide poisoning is a commonly under-diagnosed condition in many developed and developing countries, including Tanzania. Studies in developing countries report that many HCPs are not competent in the diagnosis and management of APP, which undermines surveillance for APP. This study therefore aimed to characterize knowledge and experience of HCPs in selected health facilities in Tanzania regarding the diagnosis and management of APP, including common first aid measures and treatment options, use of reporting systems, notification practices and the ability to interpret pesticide labels.

Methodology

The population included all physicians, clinical officers and nurse practitioners practicing in the Kilimanjaro and Arusha regions and responsible for managing potential APP cases. A sample size of 66 respondents was included in this study. The data were collected in 2005 using a standardized questionnaire. Data analysis involved Univariate descriptive statistics for frequencies and percentages of all categorical or count variables. Chi square testing was used to compare distributions of dichotomous variables. The statistical software used to analyse the data was SPSS version 16 and Stata Version 10.0.

Results

The study found that half of the respondents reported past experience of handling APP cases and, among these, 34.8% reported previously handling between 1 and 5 cases. The proportion of respondents who had handled an APP case was marginally higher in staff with long experience compared to short experience (OR =1.32; 95% CI = 0.9-1.5). The study found that majority of the respondents had high knowledge of routes of exposure reporting oral exposure (98.5%), inhalational (93.9 %) and skin absorption (77%). The study further found lack of awareness on the classification of pesticides by chemical groups (71%) or by WHO hazard system (100%) and low knowledge on pesticides label instructions (55%). Among the products reported by the HCPs to be commonly associated with poisoning, OPs accounted for 35%. Some treatment options, such as administration of atropine or IV fluids, use of antihistamines, use of antibiotics, gastric larvage were incorrectly reported as first aid options. Some responses regarding first aid were either wrong or inappropriate (17.6%). For example, giving milk, antibiotics and hydrocortisone are both ineffective and potentially dangerous.

Conclusion

The study indicates that some HCPs in health care facilities in northern Tanzania lack adequate skills to diagnose and manage APP. In order to ensure that HCP practice can support effective

surveillance for APP, there is a need to include training on pesticide hazards, classification, APP diagnosis and health effects in the training programs for all categories of HCPs in Tanzania. To develop practical skills, it is recommended that HCPs undergo practical training at institutions with experience in the management and study of pesticides, such as the TPRI, which is the sole institution dealing specifically with pesticides in Tanzania and therefore best placed to support clinicians in matters related to pesticides.

6.1. Introduction

Pesticide poisoning is a commonly under-diagnosed condition in many developing (London et al, 1999; Ngowi et al, 2006; Kuye et al, 2008**)** and developed countries (Alarcon et al, 2005). HCPs, who are responsible for the diagnosis and management of APP, often receive limited training on pesticides hazards and management of pesticide-related illnesses. The majority of HCPs often have limited experience of managing cases of APP due to the fact that many injuries, in particular non-severe occupational poisoning cases, are not reported to hospitals (Murray et al, 2002; Rao et al, 2005; Cole et al, 2007 and see chapter 4).

This is exacerbated due to the fact that clinical toxicology is a dynamic field of medicine in which new diagnostic and treatment methods are constantly being developed, and the effectiveness of diagnostic and treatment techniques is constantly being updated. In addition, pesticides used by farmers change over time and new products require new diagnostic, first aid and treatment approaches. In Tanzania, for example, there is a 5-10% turnover of new products each year. Lack of experience in the management of APP will therefore contribute to the inability of HCPs to diagnose and manage APP due to pesticide products with which they are not conversant. The implications of HCPs' practice for APP surveillance is clearly highlighted in Chapter 2, section 2.6.

The health care services in Tanzania are delivered and regulated by the Ministry of Health and Social Welfare. The structure of the health system starts at village facilities and dispensaries followed by health centres located in both rural and urban areas. The health centres refer upward to district and private hospitals, regional hospitals and finally referral hospitals at the apex of the referral chain. HCPs responsible for delivering health services at different levels include physicians, clinical officers or medical assistants, public health officers and nurses, including nurse practitioners. Physicians are HCP who are licensed to practice medicine. Clinical Officers (also known as medical assistants) are HCP trained to assist physicians in clinical procedures. Nurse practitioners are staff trained to care for sick, injured patients and to assist physicians and clinical officers in providing clinical care. Public Health Officers are responsible for protecting and improving the health of a community through preventive medicine, health education, control of communicable diseases, application of sanitary measures, and monitoring of environmental hazards.

On average, the ratio of population to medical doctors in Tanzania is 138000:1 while the number of people attended by one clinical officer is 5000:1 (United Republic of Tanzania, 2006). The distribution of HCPs in Tanzania is typical of developing countries, in contrast to most developed countries where the ratio of physicians exceeds 2 per 1000 of the population (WHO, 2007b).

Although Ngowi and colleagues (2001b) addressed Tanzanian health care worker practices in relation to the diagnosis and management of APP, no studies in Tanzania have examined HCP practices in relation to APP surveillance. This study therefore addresses the gap in terms of HCP knowledge and practices related to surveillance for APP. Ngowi, et al (2001b) reported poor competence among HCPs in the recognition, diagnosis and management of pesticide poisoning cases, thought to be due to inadequate training in toxicology and occupational health (Ngowi et al, 2001b). The HCPs in the same study were also poorly equipped to deliver appropriate care to pesticide poisoning victims (Ngowi et al, 2001b). Similar findings of low awareness among HCPs of the problem of pesticide poisoning have been reported in other parts of East Africa (Mbakaya, 1994; Ohayo-Mitoko, 1997), South Africa (London and Bailie, 1999), Costa Rica (Wesseling et al,1997) and Côte d'Ivoire (Ajayi, 2000).

This study therefore aimed to characterize the knowledge and experience of HCPs in selected health facilities in Tanzania in the diagnosis and management of APP, common first aid measures, use of reporting systems, notification practices and ability to interpret pesticide labels for the purpose of strengthening surveillance of APP.

6.2. Specific Objectives

(i) To describe the knowledge among HCPs regarding pesticide hazards and routes of exposure.

(ii) To describe the practices of HCPs regarding diagnosis and management of APP.

(iii) To describe the profile of pesticides reported as commonly associated with APP among farmers.

(iv) To identify associations between practices in the management of APP and knowledge, experience and education of HCPs

(v) To describe the knowledge and practices that contribute to surveillance of APP and the documentation system for APP data reported by HCPs.

6.3. Methodology

6.3.1. Population and sample

The population included all physicians, clinical officers and nurse practitioners who were practicing in Kilimanjaro and Arusha regions and who were directly responsible for diagnosing and treating potential APP cases. An intended sample size of 91 participants was based on *a priori* estimate of 17% of HCPs treating cases of APP (as reported by Ngowi et al, 2001b), a confidence level of 95% and a margin of error of 8%.

Of the 91 HCPs approached, 25 refused to participate, leaving a sample of 66 HCPs from 32 facilities who were finally interviewed after giving informed consent. The facilities from which participants were drawn included 23 which were involved in the hospital surveillance study in Chapter 5. Staff from an additional 9 facilities (1 hospital, 1 health centre and 7 dispensaries), not involved in the retrospective study, also participated.

6.3.2. Data collection

Participants were interviewed using a semi-structured questionnaire (Annex 11) on their management of APP cases and how they record and report the cases through the Health Management Information System (HMIS). They were also asked about their knowledge and practices that contribute to surveillance of APP, their knowledge on pesticide label instructions, their experience in handling APP, the type of first aid measures recommended for APP and their knowledge of adverse health effects of pesticides, precautionary measures contained on pesticide labels and the classification of pesticides by WHO hazard class and by chemical groups. The data were collected by the PI and two assistants between January and December 2005. The assistants were laboratory technicians working at TPRI for over 15 years in pesticide-related research. For the study, they received refresher training on pesticide classification, first aid measures for pesticide poisoning, pesticide labels and how to administer the questionnaire for HCPs (Annex 11).

The data collection tool was pre-tested in January 2005 using a small sample of HCPs (n=10) in selected facilities in Arusha Municipality before use in the main study.

6.3.3. Data analysis

Univariate descriptive statistics were estimated for frequencies and percentages of all categorical or numerical variables. For the purpose of bivariate analysis, data were categorized as follows:

(i) Having handled a pesticide poisoning case was categorized into Yes and No

(ii) Knowledge on first aid was categorized into low knowledge (respondents reporting only one correct first aid option) and high knowledge (respondents reporting $\geq$ 2 correct options).

(iii) Knowledge on routes of exposure was categorized into low knowledge (respondents reporting $\leq$ 2 correct routes of exposure) and high knowledge (respondents reporting 3 or more correct routes of exposure).

(iv) High familiarity with pesticide poisoning (respondent was very familiar) and low familiarity (respondents reporting no or only fair familiarity).

(v) Knowledge on pesticide classification was categorized into low knowledge (respondents reporting no knowledge of any correct chemical group) and high knowledge (respondents reporting $\geq$ 1 correct chemical group).

(vi) Years of work experience was categorized into low experience (< 4 years) and long work experience ($\geq$ 4 years).

(vii) Education level was categorized into low education (Diploma or less) and high education (Higher than diploma).

(viii) Health care facilities were categorized into Government and private facilities.

Cross-tabulations were conducted as follows:

(i) The variable knowledge on first aid (low vs.high) was compared by the variable "ever handled a pesticide poisoning and by years of working experience to identify associations with high knowledge of first aid measures.

(ii) The variable familiarity with health effects (low vs. high) was compared by respondents' educational level to identify whether education was associated with high familiarity with health effects of pesticides.

(iii) The variable knowledge on pesticide classification (low vs. high) was compared by respondents' education level to identify whether education was associated with high knowledge of the WHO pesticide classification system.

(iv) The variable knowledge on routes of exposure (low vs. high) was compared by respondents' years of working experience to identify whether years of experience was associated with high knowledge of routes of exposure.

(v) The variable ever handled a pesticide poisoning case vs. never handled any case was compared with respondents years of working experience to identify whether increased years of experience was associated with treating cases of APP.

(vi) The variable high education vs. low education was compared with years of working experience to identify whether long service was associated with education level.

(vii) The variable type of health care facility (Government or private) was compared with Knowledge on first aid, knowledge on routes of exposure, familiarity with health effects, knowledge on pesticides classification, level of education, years of working experience and status of handling of APP cases

Chi square testing was used to compare distributions of dichotomous variables. To measure the strength of association between categorical independent and dependent variables, Prevalence Risk Ratios were estimated with 95% Confidence Intervals. SPSS statistical package version 16 (SPSS, 2007) and Stata Version 10.0 (STATA, 2007) were used to analyse the data.

6.3.4. Ethical Considersations

Participants completed consent (Annex 7) prior to participation in the study and were free to decline participation without any fine or penalty. To ensure confidentiality, names were replaced by special codes, which were used in data analysis. The participants were assured that their responses would not affect their performance assessments by their managers. The study protocol was approved by TPRI ethical committee and the National Institute of medical Research (NIMR) in Tanzania (REF NIMR/HQ/Vol XI/371) as well as the University of Cape Town (UCT) Health Sciences Faculty Research Ethics Committee (328/2004).

6.4. Results

There were 66 respondents at 32 health care facilities out of the target sample size of 91, representing a response rate of approximately 73%. In most facilities, there were 1 or 2 respondents (Table 6.1). However, in the larger facilities, the number of respondents ranged up to 6.

Table 6.1: Health care providers interviewed by Facility in northern Tanzania.

Region	Facility	Number interviewed	Facility status	Government or private
Arusha	Arumeru	1	District Hospital	Government
Arusha	Bagari	1	Dispensary	Private
Arusha	Ithanasheri	4	Hospital	Private
Arusha	Leguruki	2	Health centre	Government
Arusha	Mbuguni	2	Health centre	Government
Arusha	Mount Meru	1	Regional Hospital	Government
Arusha	Nambala	2	Dispensary	Private
Arusha	Nsengon	1	Dispensary	Government
Arusha	Olasiti	1	Dispensary	Private

Arusha	Old Arusha Clinic	3	Hospital	Private
Arusha	Shree Hindu	6	Heath centre	Private
Arusha	Saint Elizabeth	2	Hospital	Private
Arusha	TAG	1	Dispensary	Private
Moshi	KCMC	5	Referral Hospital	Government
Moshi	Mawenzi	5	Regional Hospital	Government
Arusha	Elerai	2	Dispensary	Private
Arusha	Karangai	1	Dispensary	Government
Arusha	KIA	1	Health centre	Private
Arusha	Kikatiti	1	Dispensary	Private
Arusha	Kimnyaki	1	Dispensary	Government
Arusha	Kisongo	2	Dispensary	Private
Arusha	Kwale	2	Dispensary	Private
Arusha	Maji ya chai	2	Dispensary	Government
Arusha	Maroroni	1	Dispensary	Government
Arusha	Nduruma	1	Health centre	Government
Arusha	Moshi Arusha Occupational Health	1	Hospital	Private
Arusha	Patandi	1	Dispensary	Private
Arusha	Poli	1	Dispensary	Government
Arusha	Sikh Temple	1	Dispensary	Private
Arusha	Selian	3	Hospital	Private
Arusha	Kingori	1	Dispensary	Government
Arusha	Levolosi	1	Health centre	Government

The majority of the respondents were males (63.7%) and they were from both private and government facilities in Arusha and Kilimanjaro regions. The facilities included a referral hospital, two regional hospitals, a district hospital, other hospitals (n=5), health centres (n=6) and dispensaries (n=16). The majority of the respondents were clinical officers (57.5%) and their experience in medical services ranged from 1 to over 24 years. Although the largest category had experience of 5 years or less (55%) the range of experience was wide and there were three participants with experience of over 20 years in the field (Table 6.2).

Table 6.2: Experience and knowledge of health care providers.

Variable	Parameter	n
	Medical assistant or Clinical Officer	38

Occupation of respondents	Medical Officer	18
	Assistant Clinical Officer	8
	Nurses with special qualification to treat	2
Years of experience	1 to 5	36
	6 to 10	20
	11-20	7
	20+	3
Total		66
Education level	Certificate	6
	Diploma	42
	Degree	18
Total		66
Knowledge on first aid and treatment in case of pesticide poisoning*	Do Not know	19
	Atropine injection	8
	Gastric Larvage	14
	Keep airway clear	4
	Wash contaminated area	23
	Administer antihistamine	8
	Administer IV Fluid if necessary	18
	Administer inactivated charcoal if indicated	3
	Administer oxygen if necessary	2
	Administer fresh milk	19
	Give water	3
	Give health education	1
	Induce vomiting if ingested	22
	Hydrocortisone injection	1
	Monitor vital signs	3
	Isolate victim	1
	Place in a ventilated area	3
	Administer antibiotics	3
	Give cream	1
	Use PPE	1

* respondents could give more than one answer

Respondents' knowledge on first aid and treatment in cases of pesticide poisoning indicated that the majority reported washing the contaminated area with water (n=23), inducing vomiting if ingested (n=22) and giving the poisoned victims fresh milk (n=19). Nineteen respondents (30 %) reported they do not know any first aid or treatment strategy used for victims poisoned by pesticides (Table 6.2).

Table 6.2 indicates that there were many responses incorrectly reported treatment options as first aid (such as administration of atropine or IV fluids, use of antihistamines, use of antibiotics, gastric larvage) or reported first aid measures (17.6%) that were either incorrect or inappropriate. For example, giving milk, antibiotics and hydrocortisone are both ineffective and potentially dangerous, the use of PPE is only useful for prevention and isolation of the victim is plainly mistaken.

Exactly 50% of the respondents reported that they had previously handled a pesticide poisoning case and 50% had never handled any aAPP. The majority of the HCPs who reported having handled poisoning cases, had handled between 1 and 5 cases (34.8%) (Table 6.3). The proportion of respondents who have handled an APP case was marginally higher among staff with long work experience (OR =1.32; 95% CI = 0.9-1.5) compared to low experience.

Table 6.3: Experience and knowledge of HCPs on the management of pesticides poisoning in northern Tanzania (n=66).

Variable	Experience and knowledge/parameter	Percentage (n=66)
Availability of medical laboratory testing at the facility	Available	53
Availability of laboratory testing for the diagnosis of APP at the facility	Available	0
Familiarity of the respondents with pesticides health effects	Not familiar (No knowledge)	50
	Fairly familiar (Little knowledge)	42
	Very familiar (High knowledge)	8
Knowledge of pesticide entry routes to the body (responses not mutually exclusive)	Dermal	77
	Oral	98
	Inhalation	94
	Wound	2
	Eyes	2
	Blood	2
Ever handled a pesticide poisoning case	Yes	50
Number of cases handled	0	50

	1 – 5	34.8
	6-10	9.1
	10+	6.1

When asked about the availability of medical laboratory testing, 53% of respondents indicated that their facilities had laboratories available on site, but none of these laboratories were able to conduct diagnostic tests for APP. All the respondents reported having no standard diagnostic procedure for APP and all reported that they documented poisoning cases in the Health Statistics Abstracts Reference Books ("Mtuha") and patient register book. Reporting poisoning cases and other disease conditions in this register was mandatory according to the Ministry of Health and Social Welfare in Tanzania.

Familiarity with adverse health effects of pesticides reported by respondents was poor. Only 5 respondents (8%) reported having a high familiarity with the health effects of pesticides, while 50% admitted to having no awareness of pesticide toxicity (Table 6.3). However, a much higher proportion reported knowledge of routes of absorption. The majority of the respondents reported knowledge of possible pesticide exposure routes as oral (98.5 %) and inhalational (93.9 %) while knowledge about absorption through the skin as a route was slightly lower (77%; Table 6.3).

The majority of respondents (71%) were unaware of the classification of pesticides by chemical group and all respondents were unaware of the WHO hazard classification system. Pesticide chemical groups reported correctly by the respondents included OP (37.8%), organochlorines (12.1%), Carbamates (12.1%) and pyrethroids (1.5%).

Most respondents (55 %) reported that they had no knowledge of pesticide label safety instructions. Of the 45% reporting some knowledge, the most common label instructions reported by respondents included instructions regarding storage out of reach of children (n=30) and use of PPE (n=27). Less common instructions reported were related to washing after handling (n=7), refraining from eating whilst handling pesticides (n=8), keeping pesticides away from food (n=4), and avoiding pollution of the environment or water bodies (n=5). Eleven respondents (17%) reported awareness of the signal word "poisonous."

Products reported by the HCPs as commonly associated with poisoning included both specific agents (n=31) and non-specific agents (n=19). OPs comprised 35% and pyrethroids 16% of specific agents named. However, most commonly, the respondents were not able to reported a specific pesticide agent (n=35; Table 6.4).

Table 6.4: Agents reported to be associated with poisoning as experienced by the HCPs in northern Tanzania.

Product	Chemical Group	WHO Hazard Class	Frequency
Reported by active ingredient			
Zinc Phosphide	IN	Ib	4
Copper	IN	III	2
Chlorpyrifos	OP	II	3
DDT	OC	II	2
Cypermethrin	PY	II	2
Profenofos	OP	II	5
Deltamethrin	PY	II	3
Paraquat	OT	II	2
Diazinon	OP	II	2
Bromodiolone	OT	I	1
Sulphur	IN	U	2
Endosulfan	OC	II	2
Amitraz	CA	II	1
Subtotal			31
Reported by general term			
Acaricides	-	-	5
Bed bug insecticide	-	-	1
Fumigant	-	-	2
Herbicide	-	-	1
Insecticide	-	-	3
Flower spray	-	-	1
OP	-	-	5
Rat poison	-	-	1
Sub total			19
Unknown			35

6.4.1. Associations with knowledge among HCPs

There were marginally significant associations between educational levels of the respondents and high familiarity with pesticide health effects (PRR High educated/Low educated = 2.44;

95% CI = 1.05-5.65) and with high knowledge of pesticides classification (PRR High educated/Low educated = 2.8; 95% CI = 1.3-6.2; Table 6.5).

Table 6.5: Associations of knowledge about pesticides with work experience, education and management of APP among HCP in northern Tanzania.

Variable		**Knowledge**		**p***
Knowledge on first aid				
		n	**High knowledge**	
Ever handled APP case	Yes	32	31.4	0.67
	No	34	26.5	
Years of working experience	Low	16	25	0.70
	High	50	30	
Level of education	Low	48	31.3	0.47
	High	18	22.2	
Knowledge on routes of exposure				
		n	**High knowledge**	
Ever handled APP case	Yes	32	65.5	0.21
	No	34	79.4	
Years of working experience	Low	16	62.5	0.29
	High	50	76.0	
Level of education	Low	48	27.1	0.95
	High	18	27.8	
Familiarity with health effects				
		n	**High familiarity**	
Ever handled APP case	Yes	32	9.4	p = 0.59
	No	34	5.9	
Years of working experience	Low	16	0.0	0.18
	High	50	10.0	
Level of education	Low	48	4.2	**0.08**
	High	18	16.7	
Knowledge on pesticides classification				
		n	**High knowledge**	
Ever handled APP case	Yes	32	37.5	0.21
	No	34	23.5	
Years of working experience	Low	16	37.5	0.47
	High	50	28.0	
Level of education	Low	48	20.8	**0.006**
	High	18	55.6	

*"p" value is based on α^2 test

There was a significant association between the status of health care facility with High knowledge on pesticides classification (PRR Private facility/Government facility =1.5, 95% CI = 1.1 – 2.1) (Table 6.6).

Table 6.6. Associations of status of health facility and Knowledge on first aid, Knowledge on routes of exposure, Familiarity with health effects, Knowledge on pesticides classification, Level of education, Years of working experience and handling of APP cases among HCP in northern Tanzania.

Facility	**Variable**		**p***
Knowledge on first aid			
	n	**High knowledge**	0.82
Government	23	30.4	
Private	43	27.9	
Knowledge on routes of exposure			
	n	High knowledge	0.87
Government	23	73.9	
Private	43	72.1	
Familiarity with health effects			
	n	High knowledge	0.80
Government	23	8.7	
Private	43	7.0	
Knowledge on pesticides classification			
	n	High knowledge	**0.02**
Government	23	13.0	
Private	43	39.5	
Level of education			
	n	High education	0.46
Government	23	21.7	
Private	43	30.2	
Years of working experience			
	n	High working experience	0.34
Government	23	82.6	
Private	43	72.1	
Ever handled APP case			
	n	Yes	0.27
Government	23	39.1	
Private	43	53.5	

*"p" value is based on α^2 test

6.5. Discussion

The respondents in this sub-study were HCPs who had working experience ranging from 1 – 24 years. The study revealed poor knowledge on pesticide poisoning management, lack of familiarity with the adverse health effects of pesticides, low knowledge about pesticide chemical groups and WHO categories but better knowledge about routes of dermal exposure. One possible explanation is that clinicians with longer working experience may have been more likely to have handled APP cases which might have made them more knowledgeable. However this was not supported by data in Table 6.5. Another explanation could be the fact that the curriculum for health professional training in Tanzania does not cover details about pesticides and their toxicity, nor is APP given much priority due to a perception that it is rare in hospitals. This may explain why many poisoning agents are frequently reported with non-specific names for the causative agents, such as, acaricides, bed bug insecticide, flower spray and other 'unknown' terms (see Chapter 5). This clearly limits the extent to which HCP reports can support effective surveillance for APP.

The majority of the respondents had little experience in the management and treatment of APP. Half of the respondents had never handled any pesticide poisoning cases and among those who had, the majority had attended to less than 5 cases in their careers. One reason for low experience could be the fact that pesticide poisoning cases infrequently present to hospitals in Tanzania (see Chapter 5; and Ngowi et al, 2001b), a finding also reported in India (Mancini et al, 2005). This implies that HCPs infrequently come into contact with APP cases. Alternatively, if they did attend cases but the diagnosis was missed, the provider did not know that they had treated an APP case.

The study also revealed that a large proportion of respondents had misconceptions about appropriate first aid. For example, 19 respondents (29%) considered milk a first aid option for APP and about a third of respondents (33%) reported inducing vomiting as one of the options for first aid for APP. In fact, providing milk may give a false sense of security and delay proper treatment and hence may increase health risks. Similarly, induction of vomiting is not appropriate for all products, and may be contraindicated for certain agents. For example, pyridyls are corrosive products which can damage the oesophagus and upper airway if vomiting is induced. If the victim is unconscious, inducing vomiting could also result in the patient choking to death on vomitus. The recommendation of using milk reflects a widespread misconception among HCPs. A previous Tanzanian study involving extension officers between 1991 and 1993 also reported the use of milk and inducing vomiting as options for first aid, along with other options such as use of lamb oil, fresh cattle dung and salted water (Ngowi et al, 2002a). This suggests that perceptions about the use of milk as an antidote for poisoning is prevalent not only among HCPs but also the agriculture extension officers. Misconceptions about the use of milk as an antidote to a range of workplace hazards is widespread in the region (Rees, 2002; Goring, 2003).

The responses regarding the availability of laboratory testing indicate that, although laboratories are available, none conduct any testing specific to diagnose pesticide poisoning. This finding agrees with data from record reviews at health care facilities in this study (Chapter 5) in which the majority of the cases were diagnosed through history and clinical signs. This probably reflects a lack of equipment, expertise and the necessary consumables. The lack of laboratory capacity to confirm diagnosis, a widespread phenomenon worldwide, but particularly in the Southern African region (WAHSA, 2008), which may contribute to under-diagnosis of APP cases reported in hospitals. If few cases are reported, policymakers may not see the importance of building capacity for laboratory diagnosis, which in turn, exacerbates the problem of under-reporting. There is therefore a need to advocate for better diagnostic facilities, especially in rural health facilities to make the laboratory diagnosis of APP possible. Also, given that there is poor knowledge among HCPs, better training in clinical diagnosis is also critically important.

The majority of HCPs (55%) could not report any safety instructions when interpreting pesticide labels. Failure to interpret the label instructions is likely to result in poor diagnosis and treatment since the label carries important information for the diagnosis and management of APP. Even if the label is available in an APP case, it would appear that the HCP will not be able to interpret the label and handle the patient appropriately. Taking into account that laboratory diagnosis is unavailable, HCPs should be trained on, among other things, how to interpret label instructions and the treatment of APP cases.

It is striking that the proportion of HCPs reporting previous experience in managing a case of pesticide poisoning was much lower in this study (50%) than reported by Ngowi et al. (2001b) (80%). The difference could be due to the nature of facilities visited. While the study by Ngowi and colleagues visited mainly dispensaries and lower level facilities (65.3%), this study included health care workers from fewer dispensaries (44%). Since dispensaries are mostly located in rural areas they are more likely to attend poisoning cases, potentially including less severe occupational injuries. HCPs working in these facilities may therefore have more experience in handling APP cases because they attend to the few cases reported in their facilities (Chapter 4) as well as others which might be attended at homes. Since facilities with higher status e.g. hospitals receive more severe cases, which are less common, this could account for the smaller proportion of HCPs in this study experienced in the management of poisoning cases. The findings in this study are consistent with that of a study conducted in East Africa more than a decade ago (Mbakaya et al, 1994), which found that more than 40% of the HCPs interviewed could not recognize pesticide poisoning cases.

The problem of management of APP found in this study is also a problem in developed countries. For example, in a study conducted in Washington DC and surrounding areas, it was reported that the majority of the HCPs interviewed frequently did not diagnose pesticide toxicity from patient history and examination. Most relied on Poison Control Centres (PCC) for assistance with management of APP cases. They expressed less understanding and more uncertainty about chronic toxicity. Exactly 64% of practitioners and 69% of nurses felt poorly prepared to answer patients' questions. Forty percent of practitioners and 26% of nurses felt it was important to obtain more information on pesticides (Balbus et al, 2006).

This study found that knowledge about pesticide classification was significantly higher in private than government facilities (39.5% versus 12.0%; p=0.02). This could arise from the fact that the proportion of health care workers who have handled APP was somewhat higher in private facilities than government facilities (53.5% vs. 39.1%) but not statistically significantly so (p=0.27). By handling APP cases, HCPs may come across different agents and their labels or containers, and this may, over time, make them knowledgeable.

Knowledge about pesticide classification and adverse health effects of pesticides was higher in respondents with high education (Table 6.5). This was expected as respondents who are graduates usually receive more intensive training; hence would be likely to have more knowledge on pesticide health effects and classification.

Regarding documentation of poisoning cases, it was found that all HCPs reported documenting all poisoning cases in the Health Statistics Abstracts Reference Books ("Mtuha") and patient register book. However, this high level of reporting may be biased because, in theory, documentation of poisoning cases is mandatory. Taking into account that MTUHA summaries reviewed in the hospital study (Chapter 5) revealed much incomplete data, it is likely there is substantial over-reporting because the HCPs do not want to admit to breaking the law.

Regarding agents, the study found that majority of the specifically known agents reported to be associated with poisoning (87%) were of WHO Class I or II. These products are, by definition, either highly or moderately hazardous and their association with poisoning by the HCPs was consistent with their toxic nature. Although these products are restricted in Tanzania, their handling and use is not well controlled due to weaknesses in enforcement. Further, among the specifically known agents, 25% of the products reported as associated with APP were OPs. OPs are cholinesterase-inhibiting agents and, although they were reported in low proportion in this sub-study, their involvement in poisoning cannot be underestimated. The proportion of unknown agents (41.3%) was high indicating that many HCPs either rarely handle APP cases or the limited cases reported to them lack information. All these findings are generally consistent with the findings of the farmers' household study (Chapter 4) and the hospital review (Chapter 5).

6.6. Study Limitations

The study was vulnerable to a number of possible biases:

Information bias: HCPs might have claimed greater familiarity with adverse health effects of pesticides than actually was true, implying that knowledge and familiarity might, in reality, have been worse than found in this study.
Selection Bias: Selection bias might also have affected the findings in that HCPs who declined to participate might have done so because they were not conversant with APP, or may have been reluctant to disclose their lack of experience in managing APP. Again, this implies that estimates for knowledge and for experience with APP reported in the study were higher than likely to be the case in reality – i.e. a problem of over reporting. However, the omission of the HCPs from facilities in far-off remote areas may countereffect this overestimation if non-participants were used to seeing APP cases. Consequently, the direction of misclassification due to this selection bias is not obvious.

Representivity: The health facilities involved in the study included at least one respondent from referral hospitals, regional hospitals, district hospitals, health centres, dispensaries and other hospitals. Although not selected in a truly random manner, the spread of facilities and practitioners suggest that the sample includes HCPs who typically staff such facilities and see cases of APP. Nonetheless, it is possible that the sample of facilities may differ from other facilities in the country. The findings should not be generalized without further studies to confirm the patterns in a representative sample of HCPs.

Reporting bias: Although interviews were conducted on an individual basis, in some situations respondents had opportunity to interact with other interviewed respondents before they underwent their own interview. In such situations, their answers were potentially influenced by their colleagues resulting in some degree of homogeneity of reporting. This would cause respondents to provide unrealistic responses which could have either underestimated or overestimated the knowledge and practices of HCPs in relation to APP

Another important limitation is recall bias. Respondents may have poor memory of some events in particular events that took place more than 3 months earlier. This may partly explain low reported experience with APP.

6.7. Conclusion

The findings suggest that most HCPs in the selected health care facilities in northern Tanzania lacked adequate skills in the diagnosis and management of APP and had very poor knowledge about what to do about APP. The limited ability to diagnose APP cases results in failure to recognize all poisoning cases arising from pesticide exposure and this contributes to under-reporting of APP cases. A strong surveillance system requires HCPs who are sufficiently skilled to make the diagnosis of APP and report it effectively.

In order to fill this gap, there is a need to include training on pesticide hazards, classification and health effects in the training programs for all categories of HCPs in Tanzania. To develop practical skills, it is recommended that HCPs undergo practical training at institutions with experience in the management and study of pesticides, such as the TPRI, which is the sole institution dealing specifically with pesticides in Tanzania and therefore best placed to support clinicians in matters related to pesticides. Currently TPRI has training programs on pesticides in place conducted twice annually.

Although this study was undertaken in 2 regions of northern Tanzania, and can only be generalized to these areas, the services and farming areas are typical of other part of Tanzania. For this reason, it is believed that the findings might well reflect a similar situation in the rest of the country. However there is a need to conduct further studies in other parts of Tanzania to see if the findings are similar to this study.

CHAPTER 7.0: STAKEHOLDERS' AWARENESS OF ACUTE PESTICIDE POISONING AND VIEWS ON A NOTIFICATION SYSTEM AND RISK REDUCTION STRATEGIES FOR ACUTE PESTICIDE POISONING

ABSTRACT

Background and aim

APP is a serious problem in Tanzania, particularly among farmers who handle pesticides and family members who are indirectly exposed to pesticides. Potential pesticide stakeholders, in particular those involved in decision-making, have a big role to play in sensitizing communities to reduce health and environmental risks of pesticides.

The aim of this sub-study is to describe pesticides stakeholders' views on the importance of APP and their contribution to the improvement of the notification system for APP.

Methodology

The population included stakeholders in community leadership positions and across government departments and agencies, including the agricultural, health and research sectors. The sample targeted 72 stakeholders and 60 participated in the study. Data was collected using a semi-structured questionnaire. Data analysis involved Univariate descriptive statistics for frequencies and percentages of all categorical and numerical variables. Chi square testing was used to compare distributions of dichotomous variables. SPSS version 16 and Stata Version 10.0 were used to analyse the data.

Results

The study found that most respondents (88%) perceive APP as a serious problem in the community and the circumstance of poisoning reported by the majority (65%) as the most problematic was occupational poisoning. Products commonly linked with poisoning among the known agents were OPs (60.2%). Strategies most frequently recommended by stakeholders for reducing poisoning in the community included education and training of farmers (82%) and use of Personal Protection Equipment (PPE) (22%). Strategies recommended for improving reporting of APP included involving staff from other government departments, the establishment of Poison Control Centres (PCC) and sensitization of the community to report pesticide poisoning cases to the health care facilities.

Compared to public officials, community leaders were more likely to view occupational as the most problematic circumstance of poisoning (35.9 % vs. 0%; Fisher's exact $p < 0.001$). Compared to other stakeholders, extension officers were significantly more likely to determine occupational as the most problematic circumstances of poisoning (28.2 vs. 5.6%; Fisher's exact $p = 0.04$).

Conclusion

In conclusion, the study suggests that the majority of stakeholders recognize that APP is a serious problem in Tanzania although they have little detailed knowledge on adverse health effects arising from pesticides. Occupational circumstances were seen to be the major problem in the farming communities, more so than other circumstances, and OP's were reported as the major agents linked with poisoning. The findings further suggest that training on safe handling and use of pesticides is perceived as an important strategy for reducing poisoning and that notification can be improved by involving staff from various government departments as well as community members in the collection of APP data.

7.1. Introduction

APP is a serious problem in Tanzania, particularly for farmers who handle pesticides and family members who are indirectly exposed to pesticides. The registration, manufacturing, distribution, handling and usage of these pesticides in Tanzania are guided by the Plant Protection Act (1997) and the Plant Protection Regulations of 1999. Laws and regulations guiding the registration, use and distribution of pesticides in Tanzania are proposed, prepared, approved, and enforced by stakeholders at various levels. However, the major responsibility lies with the Ministry of Agriculture, Food Security and Cooperatives in Tanzania.

Before implementation, laws and regulations are approved by the national parliament after a thorough evaluation involving consultation with diverse stakeholders and relevant professionals. Potential pesticide stakeholders in Tanzania from the Ministry of Agriculture, Food Security and Cooperatives, Ministry of Health and Social Welfare, community leaders, Members of Parliament and others may play a role in sensitizing communities to health and environmental risks of pesticides. Some stakeholders are also better placed to influence implementation of strategies for risk reduction due to their role in decision-making.

In order to promote reduction of pesticide hazards effectively through public awareness, stakeholders should be conversant with a wide range of information including the adverse health effects arising from pesticide exposure; sources of information on risks and the correct understanding of these risks; the appropriate methods for safe handling and use of pesticides; alternative pest control strategies that reduce reliance on pesticides; the existence of pesticide application "hot spots"; the distribution system for pesticides; institutional incentives for pesticide usage; and the determinants of farmers' perceptions, which shape their pesticide application choices. Awareness on these issues related to pesticides is important to motivate stakeholders to advocate for APP surveillance because of its serious health implications. Stakeholder involvement with APP surveillance should also encourage reporting of APP cases not presenting to hospitals, as described in Chapters 4 and 5.

The aim of this sub-study was therefore to describe the pesticides stakeholders' views on the importance of APP and their contribution to improving surveillance for APP.

7.2. Specific Objectives

(i) To describe pesticide stakeholders' views on the importance of APP in the community, most common circumstances of poisoning, products linked to poisoning and the optimal reporting system for APP.

(ii) To describe pesticide stakeholders' views on strategies for reducing the incidence of

APP in the community.

(iii) To describe pesticide stakeholders' views on the strategies for improving reporting of APP in the community.

7.3. Methodology

7.3.1. Population and sample

The population included stakeholders in community leadership positions and across various related government departments and agencies, including the agricultural, health and research sectors.

The study aimed to sample 70 stakeholders in relevant departments in the sectors of Agriculture, Livestock and Health and community and political leaders. This sample represented categories of stakeholders with different responsibilities in the community ('specialisations'): HCPs, health officers, agriculture extension officers, community leaders, political leaders, pesticide inspector's researchers, officials responsible for training as well as medical data recorders.

7.3.2. Data collection

Data was collected using a standardised semi-structured questionnaire (Annex 12) which included both closed and open-ended questions (Fiure 7.1).

Figure 7.1: Interviews of pesticide stakeholders.

Data collected from stakeholders included their perceptions regarding the status of pesticide poisoning in the community, the most common circumstances of poisoning, the pesticides frequently associated with APP strategies for reduction of health injuries and means of improving reporting of APP.

7.3.3. Data analysis

Data analysis involved univariate descriptive statistics for frequencies and percentages of all categorical and numerical variables. SPSS version 16 (SPSS, 2007) and Stata Version 10.0 (STATA, 2007) were used to analyze the data. Chi square testing was used to compare distributions of dichotomous variables. Bivariate analyses were conducted to determine any association between stakeholder views and respondent specialization.

For the purpose of bivariate analysis, data were categorized as follows:

(i) Ability to identify specific products related to APP was categorized into (a) $\geq$ 1 (respondents identifying at least one product) and (b) "None" (unable to identify any products).

(ii) The most problematic circumstances of poisoning were categorized in two ways: Firstly, as (a) occupational and (b) non occupational (including any circumstance other than occupational); secondly, as (a) suicide and (b) non-suicide (including any circumstance other than suicide).

(iii) Agents responsible for poisoning were categorized into (a) Known (where at least one active ingredient was reported) and (b) Unknown (where unspecific agent or unknown was mentioned).

(iv) Perception of the stakeholders regarding whether pesticide poisoning is a serious problem in the community was categorized as (a) Yes and (b) No or Uncertain.

(v) Strategies for reduction of APP were categorized in two ways: Firstly, as (a) use of PPE and (b) methods other than PPE; secondly, as (a) educational strategies and (b) methods other than educational strategies.

(vi) Gender was categorized into (a) male and (b) female.

(vii) Respondents' specialization was categorized into (a) community leaders and (b) public officials, including officials from the Ministries of Health (medical officers and policy makers) and Agriculture (district/ward agriculture and livestock development officers)

(viii) Education level was categorized into (a) High ($\geq$ diploma) and (b) Low (< diploma).

Cross tabulations were constructed involving respondents' specialization (community leaders vs. public officials) compared by gender, strategies for reducing poisoning, perception of the importance of poisoning in the community, products reported to be associated with APP and perception of the most common circumstances of poisoning.

Cross tabulations were constructed involving respondents education level ($\geq$ diploma and < diploma) compared by strategies for reducing poisoning. Perceptions of the importance of poisoning in the community were compared by gender. Comparisons were made estimating prevalence risk ratios and χ^2 statistics for categorical data and t-tests for continuous age data with statistical significance taken at p<0.05. Analyses were conducted using SPSS statistical package Version 16 (SPSS, 2007) and Stata Version 10.0 (STATA, 2007).

7.3.4. Ethical Considerations

The participants completed a consent form (Annex 7) before participating in the study and they were free to decline participation without any fine or penalty. To ensure confidentiality, their names were replaced by special codes which were used in the data analyses. Participants were assured that their responses would not affect their performance assessments by their managers. The study protocol was approved by TPRI ethical committee and the National Institute of medical Research (NIMR) Tanzania (REF NIMR/HQ/Vol XI/371) as well as University of Cape Town (UCT) Ethic committee (328/2004).

7.4. Results

A total of 60 stakeholders participated, representing a response rate of 86%. The majority (80%) were from the Arusha and Arumeru districts and 20% were from Dar es Salaam region. Most respondents were male (70%). Ages ranged from 31 to 57 years with the average age of

43.8 years. There were no significant differences in age between male and female respondents. The majority of respondents were drawn from the health department (n=20; 33.3 %), the community (n=14; 23.3 %) and from agriculture (n=13; 21.6 %) (Table 7.1).

Respondents had different responsibilities in the community, most commonly as community leaders (23%), or agriculture extension officers (22%). The respondents' education level was mainly diploma level (38%) or university graduates (37%) (Table 7.1). Forty-one percent of the respondents were also directly involved in farming activities.

Most respondents (n=53 or 88 %) reported they believed pesticide poisoning was a serious problem in the community. The proportion of respondents who perceived APP as a serious problem in the community was higher among community leaders (100%) than health/agriculture specialists (84.8%) but this was not significant ($\alpha^2 = 2.41$, $P = 0.12$). The circumstances of poisoning perceived by the stakeholders as the most common were occupational poisoning (n=39 or 65%) or suicide (n=30 or 50%) (Table 7.1).

Specific products reported as perceived to be associated with poisoning included Chlorpyrifos (n=10), Diazinon (n=4), Endosulfan (n=4) and Paraquat (n=3) (Table 7.2). Among products reported by category rather than active ingredient, rat poisons (n=10), livestock dip (n=8) and coffee-farming products (i.e. pesticides used in coffee farming; n=3) were most commonly reported. Among the known agents commonly linked to poisoning by stakeholders, OPs accounted for the majority (60.7%; Table 7.2).

A variety of strategies were recommended by stakeholders for reducing poisoning in the community. These included education and training of farmers (82%), use of PPE (22%), use of alternative safer products (13%), raising awareness about the adverse health effects of pesticides (10%), and banning or restriction of highly poisonous products (7%). Other recommendations related to farming practice and included the use of non-synthetic pesticide products for pest control, advice to farmers on organic farming, observation of Pre- Harvest Intervals (PHI) as prescribed on pesticide labels and ensuring pesticide labels have simple instructions easily followed by farmers. Proposals related to health care included increasing the number of health facilities in rural areas, distribution of antidotes for poisoning to the farmers and training farmers in first aid. Research into the causes of suicide in the community was also suggested.

Strategies proposed that related to surveillance included increased monitoring of food products in the market to assess the extent of contamination with pesticides and updating the current pesticide legislation to include a legal requirement for the reporting of poisoning injuries. Some respondents indicated unhappiness with the current distribution system for pesticides by dealers who do not abide by the law. They linked unsafe handling practices involving pesticides like repacking, decanting and adulteration of pesticides with the occurrence of poisonings in the community. They therefore recommended that the distribution system for pesticides in the country be directly handled by the government.

Strategies recommended for improved reporting of APP cases centred around increasing the number of persons involved in reporting, including staff from different government departments (Agricultural Extension Officers; n=9, Health Officers; n=5 and TPRI Law Pesticides inspectors; n=8) and others such as community leaders (n=15) and pesticide retailers (n=1). Other strategies recommended included the establishment of PCCs (n=4), sensitization of the community to report pesticide poisoning cases to the health care facilities (n=5) and computerization of the data collection system (n=4). There were few respondents (n=5) who did not propose any strategies for improving the reporting system for APP.

7.4.1. Associations with circumstances of poisoning

Compared to public officials, community leaders were more likely to view occupational as the most problematic circumstance of poisoning (35.9 % vs. 0%; Fisher's exact p <0.001). Although they were also less likely to determine suicide as the most problematic circumstance of poisoning (20% vs. 29.6%; Fisher's exact p 0.3), to name specific agents responsible for poisoning (14.3% vs. 26.1%; Fisher's exact p= 0.3), to opt for the use of PPE as a strategy for reduction of APP in the community (15.4% vs. 25.5%; Fisher's exact p =0.4) and more likely to opt for education as a strategy for reduction of pesticide poisoning in the community (26.7% vs. 13.3%; Fisher's exact p =0.2), none of these differences were statistically significant. However, community leaders were significantly less likely to have high education (6.8% vs. 68.8%; Fisher's exact p <0.001) compared to public officials.

Although extension officers were more likely to be male (23.8% vs. 16.7%; Fisher's exact p = 0.1); less likely to suggest suicide as the most problematic circumstance of poisoning (13.3% vs. 29.6%; Fisher's exact p 0.1); more likely to determine specific agents responsible for poisoning (35.7% vs. 17.4%; Fisher's exact p= 0.1); less likely to opt for the use of PPE as a strategy for reducting APP in the community (15.4% vs. 23,4%; Fisher's exact p =0.4); less likely to opt for education as a strategy for reduction of pesticide poisoning in the community (20% vs. 26.7%; Fisher's exact p =0.4) and more likely to have high education (22.7% vs. 18.8%; Fisher's exact p =0.5), none of these differences were statistically significant. The highly educated respondents were more likely to report poisoning agents more accurately with active ingredients (78.6% vs. 71.1%) compared to those who were less educated but this association was not statistically significant.

Table 7.1: Stakeholders' survey: Demography and beliefs about pesticide poisoning (n=60).

Parameter	Response	%
Gender	Males	70
	Females	30
Education	Std VII	3
	Form IV	17
	Certificate	5
	Diploma	38
	Graduate	37
Responsibility	Agricultural Extension officers	22
	Community/ political Leaders	23
	Medical Data collectors	3
	Health Officers	18
	Hospital I/C	12
	Pesticide law enforcers	8
	Pesticide researchers	10
	Pesticide trainers	3
Is pesticide poisoning a problem in community	Yes	88
	No	5
	Unknown/ uncertain	7
Common poisoning circumstances*	Suicide	50
	Accidental	10
	Occupational	65
	Unknown	5

* Categories not mutually exclusive

Table 7.2: Products commonly reported to be responsible for poisoning in stakeholders survey (n=60).

Products reported by active ingredient	Frequency	Chemical group
Chlorpyrifos	10	OP
Diazinon	4	OP
Endfosulfan	4	OC
Paraquat	3	OT
Pirimiphs methyl	2	OP
Deltamethrin	2	PY
Bromodiolone	1	OT
Dimethoate	1	OP
DDT	1	OC
Sub Total	28	
Unspecific products reported by category		-
Rat poison	10	-
Livestock dip	8	-
Coffee products	3	-
Insecticide	2	-
OC	1	-
PY	1	-
Storage products	1	-
Crop products	1	-
OP	1	-
Sub Total	28	
Grand total	56	

7.5. Discussion

The study suggests that the majority of stakeholders (88%) believe that pesticide poisoning iss a serious problem in the community. Since the respondents were informants close to the community (e.g. about 41% of them were farmers), their responses were likely to reflect what is going on at grassroots level. The view that pesticide poisoning is a serious problem was expressed by all the community leaders, 91.7% of extension officers and 82.4% of others stakeholders. Furthermore, there is no obvious reason to believe that community leaders' interests would induce them to over-state the problem of pesticide poisoning in their communities.

The stakeholders' perceptions that poisoning was a serious problem in the community was linked to the fact that community leaders considered occupational poisoning to be a bigger problem than did extension officers and other stakeholders. This was because the majority of community leaders, some of whom were farmers living in rural areas, probably observed first-hand the poisoning experienced by the farmers due to pesticide handling. Although occupational pesticide poisonings in farming are less severe than cases of suicide involving pesticides (Chapter 5), they are more common and this may explain why community leaders would see occupational circumstances as more problematic.

In a previous study conducted among extension officers in Tanzania, 24% of respondents perceived pesticide poisoning as a major problem in the community (Ngowi et al, 2002a) a proportion far lower than reported among extension officers in this study (91.7%). This high proportion of extension officers advocating that APP is a serious problem in the community could be a result of bi-annual training programs on awareness, safe handling and use of pesticides conducted by TPRI in past years. .

Professionals from the health sector, on the other hand, do not see many occupational poisoning cases in hospitals, where suicide and accidents are the most common circumstances (Chapter 5). Even when they do present to health care facilities, occupational poisonings are poorly captured (Chapter 4). This may explain why health professional decision-makers were less likely to recognise occupational poisoning as a serious issue. This phenomenon may also explain why epidemiological studies on circumstances of APP produce widely divergent results across different countries, depending on the data sources used to profile APP. For example, London et al (2005) showed that in studies in African countries, suicide was reported as the most common circumstance for APP, while in Central America, a number of studies ranked occupational as the most problematic circumstance. These differences may also be linked to different sources of data (See table 5.37 in chapter 5).

Among the 9 specific products reported by stakeholders in this study to cause pesticide poisoning, 7 were also reported in the earlier study of extension officers (Ngowi et al, 2002a). This suggests that this particular group of stakeholders' perceptions of the agents involved in APP had not changed substantially. Whether these perceptions of agents responsible are correct in reality is discussed in Chapter 10, where the findings are compared to agents responsible for APP reported by farmers (Chapter 4) and in hospital data (Chapter 5).

In both this study and that of Ngowi (2002a), respondents indicated the need for training and for policies to promote alternative pest control agents and substitution of pesticides with lowest toxicities. However, in this study, the proportion of respondents proposing the use of alternative pest control products to reduce health risks arising from pesticides was surprisingly low (13%). Extension officers would be expected to promote the use of alternatives as a measure to reduce poisoning. If the extension officers, as experts in the field, were not advocating for the use of alternative pest control methods, uneducated farmers would be unlikely to have any commitment to using alternatives. This indicates that alternative pest control options had not been adequately popularized nor integrated into the work of officials, and much further work in this area is needed.

The use of legal approaches to reduce pesticide poisoning was reported by few respondents. This could indicate that the majority of stakeholders do not believe legal mechanisms were sufficiently effective, based on their experience of the existing laws. Enforcement of national pesticide legislation operates under difficult conditions, including staff shortages, lack of transport and inadequate funding, which may explain why stakeholders had little confidence in the option.

Regarding possible improvements to the reporting system for APP, recommendations were made to involve community leaders, health officers and agriculture extension officers, most of who are close to community members. This appears to be a potentially valuable means of collecting data on APP cases, particularly given that most occupational cases do not reach health care facilities. However, implementation will require considerable training to familiarize these persons with pesticide classifications, modes of action and simple data collection tools. This is particularly important because some categories identified for involvement in APP data collection, such as community leaders, have less formal education than other stakeholders, are not conversant with the kinds of agents causing APP, and may be unfamiliar with adverse health effects of pesticides. Agricultural extension officers and scientists, appeared to be the decision-makers most likely to be familiar with pesticides, as illustrated in their responses to questions, about which pesticides are commonly used and commonly thought to cause poisoning, and could therefore serve as trainers of other stakeholders.

7.6. Study limitations

The study did not involve a representative sample, being chosen through convenience, which limited the generalizability of the findings. However, the sample sought to include a wide range of different categories of stakeholders in order to capture a diversity of opinions from each stakeholder category. Moreover, there was some consistency with a previous study by Ngowi et al (2002a) in the responses of extension officers, which strengthens an argument for using these findings as a reasonable approximation of stakeholder views regarding APP.

Another potential limitation was the interaction among respondents when answering the instrument. Some respondents, in particular community leaders, worked in common areas which may have led them to answer questions similarly. This was addressed by ensuring that the questionnaire was administered on the same day so as to avoid comparison of notes between interviewed and uninterviewed respondents.

Lastly, although there were many suggestive differences in opinions across different groups of stakeholders, the sample size was too small to determine significant differences. Thus, evidence suggesting that views of community leaders differed from officials could not be confidently asserted, given lack of statistical power; a larger sample size may have shown clearer differences.

7.7. Conclusion

In conclusion, the study suggests that the majority of stakeholders recognized that APP was a serious problem in Tanzania although they had little detailed knowledge on adverse health effects arising from pesticides. Occupational circumstances were seen to be the major problem in the farming communities, more so than other circumstances. OPs were reported as the major agents commonly linked to poisoning. Notably, extension officers seemed to show little interest in non-chemical methods of pest control as a strategy for reducing the burden of APP.

The findings further suggested that training on safe handling and use of pesticides was perceived as an important strategy for reducing poisoning and that improving notification which could be greatly improved by involving staff from various government departments as well as community members in the collection of APP data.

CHAPTER 8.0: PESTICIDE RETAILERS' KNOWLEDGE AND HANDLING PRACTICES IN SELECTED REGIONS OF TANZANIA

ABSTRACT

Background and aim

Pesticide retailers in Tanzania are licensed under the Plant Protection Act of 1997. Currently, there are about 300 pesticide retailers registered in Tanzania to deal with pesticide distribution. Inadequate knowledge and unsafe handling practices among retailers is believed to contribute to pesticide exposure and environmental contamination. This study describes pesticide retailers' qualifications and safety practices, their work experience and the products distributed in relation to APP.

Methodology

The population included all pesticide retail shops in Iringa, Kilimanjaro, Mwanza, Arusha, Mbeya and Kagera (n = approximately 200). Seventy-five retailers participated in this study. Data were collected in 2005 using a standard questionnaire and by physical inspection of premises. Additionally, information on products distributed was collected from Arusha and Arumeru firms for the period 2004 and 2005 to estimate the risk facing end-users. Statistical testing was done by estimating the χ^2 statistic with statistical significance taken at $p<0.05$.

Results

The study found that the firms visited had a total of 175 staff, most (76%) being male and 58.6% of the firms were not registered. The majority of the agents on sale in Arusha included WHO Class I and II products (61.7%) and the mean number of cholinesterase inhibiting agents was 5.8 (range 2 – 8). Major deficiencies found in the firms visited included semi-trained staff (57.3%), lack of first aid kits (38.6%), repacking and decanting of pesticides (25.3%) and lack of fire-fighting equipment (22.6%). There were significant associations between the absence of leaking containers (compared to $\geq$ 1 leaking containers) with the variables such as absence of any unlabelled products vs. presence of unlabelled products ($\geq$ 1) (17% vs. 82%, respectively; p = 0.00); registered vs. unregistered firms (36% vs. 15%, respectively; p=0.04).

Conclusion

Pesticide distribution in Tanzania by pesticide retailers was accompanied by many unsafe practices including the sale of products repackaged or decanted into secondary containers, distribution of products with spillage, unsafe disposal of empty containers and distribution of hazardous pesticides which may have direct or indirect effects resulting in APP in the community. The majority of products distributed by pesticide retailers in Arusha were highly or moderately hazardous products (WHO Class I and II, respectively). Further, some of the retailers distributed unauthorized products which had not been tested nor registered in Tanzania. These unsafe practices are believed to contribute to the burden from APP, not only

affecting the distributors but also farmers who bought and use these products. Interventions to strengthen enforcement mechanisms by increasing the number of pesticide inspectors and providing adequate financial support for running enforcement activities and to provide training opportunities for pesticide retailers are strongly recommended.

8.1. Introduction

Pesticides retailers in Tanzania are licensed under the Plant Protection Act of 1997 and Plant Protection Regulations of 1999 (United Republic of Tanzania, 1997; United Republic of Tanzania, 1999). Currently there are about 300 pesticide retailers registered in Tanzania to deal with pesticide distribution (TPRI, 2007). The law imposes statutory obligations on licensed retailers. For example, they must distribute only authorized products and maintain safe practices during the handling and distribution of pesticides in order to minimize possible health hazards and environmental pollution.

In terms of the law, pesticide retailers are required to have, at minimum, a technical advisor who is competent with regard to pesticides and their adverse health effects. Such persons are responsible for supervising all technical operations on the shop premises in order to ensure that pesticides are distributed in a safe manner. In addition, sales personnel are required to have sufficient knowledge about pesticides to enable them to handle pesticides safely and to advise end-users appropriately. Well informed and competent retailers may help to support notification of the agents involved in APP among farmers, the majority of which were not found in hospital reports (Chapter 5) and they may also help to reduce APP incidence by better informing farmers about pesticide hazards. Other requirements included safety equipment, well ventilated premises, fire-fighting equipment, first aid kits and warning signs.

This sub-study describes pesticide retailers' qualifications and safety practices, their work experience and the products distributed in relation to APP.

8.2. Specific Objectives

(i) To characterize the pesticide products distributed in the Arusha region of Tanzania by pesticide retailers.

(ii) To characterize hygiene practices likely to cause risks to farmers such as selling pesticides that are unlabelled, unregistered, in poor packaging or of poor quality as well as poor disposal practices.

(iii) To describe retailers' academic qualifications and experience, in relation to their capacity to improve awareness of health hazards among farmers.

8.3. Methodology

8.3.1. Population and sample

The population included all pesticide retail shops in Iringa, Kilimanjaro, Mwanza, Arusha, Mbeya and Kagera (n= approximately 200). Assuming the appropriate qualifications among the pesticide retailers of 50%, and a margin of error of 5 %, with a total population of 200, a sample size of 132 was chosen.

8.3.2. Data collection

Data from pesticide retailers were collected in a semi-structured questionnaire (Annex 13) which included predominantly closed-ended and a few open-ended questions. Data collected included the firm's registration status, staff demographic characteristics, storage conditions, the availability of standard safety measures and disposal methods. Physical inspection of the premises was conducted by the researcher to verify the safety features reported and to identify the presence of products that were leaking, repackaged or unlabelled (Figure 8.1).

Figure 8.1: Inspection and data collection in a pesticides retail shop (repacking of pesticides).

In addition, information on products, distributed by Arusha and Arumeru firms for the period 2004 and 2005, was collected to estimate the risk facing end-users of these products.

8.3.3. Data analysis

Univariate descriptive statistics were estimated for frequencies and percentages of all categorical or numerical variables.

For the purpose of bivariate analysis, data were categorized as follows:

(i) Regions visited were categorized based on their proximity to TPRI into close regions (located close to TPRI - Moshi and Arusha) and other regions (located far from TPRI).

(ii) Staff qualification was categorized as qualified (firms with at least one staff member with the TPRI pest management training certificate or a relevant certificate in either livestock, agriculture, health or other relevant science subjects) or non-qualified (firms with no qualified staff – this included staff with form IV certificates, primary school education and qualifications in professions other than science).

(iii) Firms' registration status was categorized into registered (with an up–to-date permit) and unregistered (firms with no permit or out-of-date permits).

(iv) Container disposal practice was categorized into safe practices (burning or burying) and unsafe practices (such as dumping in the municipal disposal sites).

(v) Container leakage was categorized into none (no observed leaking containers) and $\geq$ 1 (At least one leaking container).

(vi) Standard safety requirements was categorized into available (firms with all standard safety requirements available including, PPE, first aid kits, fire-fighting equipment, well ventilated premises, display of warning signs and washing facilities) vs. missing (firms with one or more missing standard safety items).

(vii) Staff work experience for each firm was estimated as total person-years by summing the years staff member worked and then categorizing total person-years for each firm into short (1 – 9 years of experience) and long ($\geq$ 10 years of experience).

(viii) Pesticide container labelling status was categorized into None (No unlabelled containers) vs. $\geq$ 1 (at least one unlabelled container).

Cross-tabulations using firms as the units were conducted to identify associations with hygiene practices as follows:

(i) The variable container disposal practice (safe vs. unsafe) was compared by registration status, standard safety requirements, staff qualification and region.

(ii) The variable leaking containers (none vs. $\geq$ 1) was compared by absence of labelling, staff qualification, registration status, requirements and region, registration status, requirements and region.

(iii) The variable staff qualification ($\geq$ 1 vs. none) was compared by region.

(iv) The pesticide container labelling status (none vs.> 1) was compared by registration status.

The analyses were conducted using SPSS statistical package version 16 (SPSS, 2007). Statistical testing on cross-tabulations was done by estimating the χ^2 statistic with statistical significance taken at $p<0.05$.

8.3.4. Ethical considerations

Participants were invited to participate after the study was fully explained to them, and they indicated a willingness to participate by completing consent forms (Annex 7). Those participating firms found to be operating contrary to the law were advised accordingly verbally and were sent official warning letters from the registrar of pesticides after data collection. The warning letters indicated that the registered dealers had to take corrective measures before their annual permit renewal. Firms operating without permits were advised to apply for permits immediately and register their firms.

The knowledge gained through this study is expected to contribute in the prevention of APP in future through planning of the appropriate interventions. Participants who consented to participate were free to withdraw their participation at any time without any penalty but no participants withdrew. The original plan was that those who are found to be in violation of the law or withdrew would be subjected to regular enforcement visits.

The data for individuals obtained in this study was kept strictly confidential and individuals were not named in the reports. However, those operating contrary to the law did receive warning letters.

The study protocol and data collection procedures were reviewed and approved by the Tropical Pesticides Research Institute in Tanzania, University of Cape Town (UCT) Health Sciences Faculty Research Ethics Committee in South Africa (REF:328/2004) and the Ministry of Health and Social Welfare in Tanzania through the National Institute of Medical Research (REF NIMR/HQ/Vol XI/371).

8.4. Results

The survey involved 75 pesticide retail shops in 6 regions namely Arusha (n=15), Kilimanjaro (n=11), Iringa (Makambako) (n=10), Mbeya (n=14), Mwanza (n=18) and Kagera (n=7). Of the targeted 132 retail shops, only 75 consented to participate reflecting a response rate of 57%. The 75 shops had a total of 175 workers including 40 shop owners; 76% of employees were male (n= 133). The number of workers per retail shop ranged from 1 to 5 but the majority (66.7%) had 1 or 2 workers. Among the firms visited, 44% were not registered but were in the process of registration. Most staff (52%) working in different retail shops had either form IV certificates with no additional training (n=39) or had certificates in agriculture and or livestock (n=38) (Table 8.1).

The staff reported work experience of 1-5 years (42.6%), 6-10 years (28%), 11-15 years (6.7%), 16-20 years (13.3%) and 20+ years (9.3%).

Pesticides distributed in Arusha by the 15 retailers surveyed in the Arusha region whose records were additionally inspected for details on sales in 2004 and 2005, are listed in Table 8.2. The following were found:

(i) The median number of active ingredients per shop was 22 (range 5 to 31) with 8 firms distributing over 20 active ingredients each.

(ii) The mean number of WHO Class I and II agents on sale was 10.8 (range 4 to 18).

(iii) The percentage of WHO class I and II agents among products on sale in Arusha was 61.7% (Table 8.2).

(iv) The mean number of cholinesterase inhibitors on sale (OP and Carbamates) was 5.8 (range 2 to 8).

A total of 47 different active ingredients were reported as distributed to farmers by the 15 pesticide retailers in Arusha and Arumeru. Among the active ingredients distributed in Arusha, there were carbamates (n=85), inorganics including mainly Copper fungicides (n=42), Ivamectins (n=7), organochlorines (n=21), OP (n=100), pyrethroids (n=93), Chloronitriles (n=27), Dithiocarbamates (n=67), Phenoxy carboxylic acid (n=9), Triazoles (n=11) and others (n=49). In terms of the WHO Hazard classification system, products distributed were Class I (9.4%), Class II (43.7%), Class III (18.1%) and Class IV or U (28.7%).

Of the 75 firms visited, various deficiencies regarding handling practices were noted. These included employment of one or more untrained sales attendants (i.e. who had no appropriate qualification to sell pesticides) (57.3%), lack of suitable PPE (14.7%), including 11 retail shops which reported no PPE at all, selling of unregistered pesticides (9.3%) a lack of a first aid kits (38.6%), repacking of pesticides (25.3%), lack of fire-fighting equipment (22.6%), pesticide containers with poor labelling (14.6%), lack of handwashing facilities (9.3%), sale of expired pesticides (8.0%) and lack of warning signs (6.6%).

Most of the products with no label or with poor labelling were those which had been repackaged or decanted and were usually copper-based fungicides including Cobox, Funguran and Perecopper. However, others with no or poor labels included a number of OPs such as actellic 50 EC (Pirimiphos Methyl), Selecron 720 EC (Profenofos), Dursban 4E (Chlorpyrifos), Gladiator 4TC (Chlorpyrifos), as well as Thionex 35EC (Endosulfan).

Only 9.3 % of the firms had all necessary safety items available. Approximately half of the firms (50.7%) reported 3 or less items of PPE available. The varieties of PPE reported to be used by the 38 retail shops included gloves (n=35), respirators (n=29), masks (n=34) hats (n=4), long coats (n=36), overalls (n=10), gum boots (n=17) and goggles (n=6).

Products with no or poor labels found during inspection are listed in Table 8.3, of which 40% were copper-based fungicides, and 40% were WHO Class II pesticides, although two cases involved Class I agents. Twelve products, which were repackaged or decanted into secondary containers (Table 8.3), showed signs of spills due to lack of proper seals and damaged containers; these included copper (n=7), Pirimiphos methyl (n=1), Chlorpyrifos (n=2), Endosulfan (n=1) and Profenofos (n=1). WHO Class II accounted for 41 % of products with spillage.

The retailers reported disposing of pesticides through burning (n=15) and burying (n= 10). However, about half of the retailers reported disposal of pesticides in municipal disposal sites (n=37). Similar patterns applied to the disposal of empty containers, which the retailers reported disposing of through burning (n=13), burying (n= 4) and dumping in the municipal disposal sites (n=49).

Problems appeared to vary by area. For example, in Mwanza and Kagera (n = 25) the most serious problems were the sale of unregistered products (52%), lack of washing facilities (52 %) and the presence of semi-trained shop attendants (56%), while in Moshi repacking and decanting of pesticides (36%) was the biggest concerns. The presence of untrained shop attendants was noted in all areas (40% to 56%).

8.4.1. Associations with safe hygiene practices

(a) There were marginally significant associations between safe container disposal practices (compared with unsafe disposal practices) for the following variables:

  (i) Registered vs. unregistered firms (40% vs. 19%, respectively, p=0.06).

  (ii) Firms located in close regions vs. other regions (44% vs. 23%; p = 0.05).

There were no associations between safe container disposal practice, staff qualification and availability of standard requirements.

(b) There were significant associations between the absence of leaking containers (compared to ≥ 1 leaking containers) for the following variables:

(i) the absence of any unlabelled products vs. the presence of unlabelled product (≥ 1) (17% vs. 82%, respectively; p = 0.00).

(ii) Firms which were registered vs. those which were not registered (36% vs. 15%, respectively; p=0.04).

There were no associations between leaking containers with standard requirements, region location and staff qualification. There were also no associations between staff qualification with standard requirements, unlabelled products, leaking containers, containers and pesticide disposal, nor were there any significant associations between unlabelled containers with registration status, standard requirements, region location and staff qualification.

Firms with high cumulative staff experience were more likely to practice safe disposal of containers than firms with lower cumulative staff experience (59% vs. 33%, respectively; p=0.03). Of the 11 firms that had unlabelled products, 9 (82%) also had evidence of leaking containers. In contrast, those firms with no unlabelled products (n=64), only 11 (17%) had evidence of leaking containers, a highly significant difference (p=0.00).

Table 8.1: Academic qualification for staff working in the visited pesticide retail shops.

No	Qualification	Frequency
1	Degree level (Agriculture, livestock, other)	12
2	Diploma in Livestock, agriculture, other	30
3	Certificates in Livestock, agriculture, other	38
4	Form IV with no additional training	39
5	Std VII with no additional training	31
6	TPRI PM 2 Certificate	6
7	Dpl/ certificate in Administration/ Accounts	18
8	Unreported	1
Total		**175**

Table 8.2: Products distributed by pesticide retailers in Arusha region, 2004 – 2005.

Pesticide retailer identifier	Total active ingredients	Total WHO I & II	Total OP& CA
A	18	12	8
B	5	4	2
C	17	11	7
D	22	13	7
E	11	7	4

F	24	15	7
G	31	14	8
H	15	11	6
I	22	11	6
J	22	13	7
K	10	7	3
L	8	6	4
M	27	18	8
N	6	4	3
O	26	17	8

Table 8.3: Active ingredients for the products found with substandard labels.

Product active ingredient	Frequency	Repackaged	Chemical group	WHO Class
Copper	14	Yes	IN	III
Cynbush	1	No	PY	II
Diazinon	2	No	OP	II
Mancozeb	3	No	OT	IV
Chlorpyrifos	2	Yes	OP	II
Permethrin	1	No	PY	II
Pirimiphos methyl	2	Yes	OP	II
Paraquat	1	No	OT	II
Gammalin(Lindane)	1	No	OT	II
Deltamethrin	1	No	PY	II
Amitraz	1	No	CA	III
Zinc phosphide	1	No	IN	Ib
Lambda Cyhalothrin	1	No	PY	II
Snip (Unknown)	1	No	UN	
Endosulfan	1	Yes	OC	II
Profenofos	1	Yes	OP	II
Carbofuran	1	Yes	CA	Ib

Total	**35**			

8.5. Discussion

The biggest problems found among retailers appeared to be eminently controllable through the provision of first aid kits, training of sales personnel, provision of PPE and preventing sale of unregistered pesticides and repackaging. Repackaging appears to be associated with considerable spillage of pesticides, was conducted without appropriate PPE or labelling and involved potentially toxic OPs. This practice generates a high risk of exposure for both the sellers and end-users buying the unlabelled products. Repackaging appears to be driven by price and logistics. Expensive products are not affordable to low-income farmers, as a result of which, farmers prefer to buy small quantities of pesticides, often stored in drinking water or soft drink bottles. Large pack units are not only unaffordable for small-scale farmers, but also exceed actual demand, given the small size of the farms owned by the majority of small-scale farmers.

Repackaging is also driven by opportunities for greater profit-making by retailers. For example, a 50 kg unit of Cobox 50 WP costs around US$50, equivalent to US$1/kg. A 2 kg unit of the same product retails at US$ 5.4 which is equivalent to US$ 2.7/kg, a mark-up of 170%. The high price for small packages is partly attributable to the costs of the containers and the cost of printing labels, but is also an opportunity to profit. This encourages retailers to purchase big volumes for the purposes of repackaging to smaller units in order to extract high profits even though the equivalent small package is available in the market. The presence of repackaged pesticides on farms in this study (25%) was higher than previously found (Ngowi et al, 2001a; 11%) and, in contrast to the previous study, involved hazardous cholinesterase-inhibiting pesticides. This difference could be attributable to an expansion of private entrepreneurs encouraged by market reforms in Tanzania (Lekei et al, 1999) whose safety practices are difficult to control.

The study indicates different degrees of compliance with the National Law regarding pesticides distribution in the North (Moshi) and Lake (Mwanza and Kagera) Zones. The most serious problems in Lake Zone were the selling of unregistered products and lack of safety facilities while in Moshi they were repacking and decanting. This may be explained by the fact that Moshi and Arusha are close to TPRI and frequently visited for enforcement monitoring. As such, retailers may be discouraged from selling unregistered products in these areas, which are subject to inspection.

Apart from close monitoring undertaken in Moshi/Arusha, decanting and repacking seemed to be a problem in Moshi because of an absence of legal repacking plants and the temptation to make huge profits. In the Lake Zone, dealers appeared able to make large profits from unregistered products due to the fact that these products could be sold very cheaply because dealers are not paying for company registration fees. In Moshi, the majority of products distributed were registered which means the supplier's retail price is higher to offset the costs of registration. The dealers in Moshi therefore practiced repacking and decanting in order to recover the costs involved in procurement of their products.

In contrast, Mwanza and Kagera regions are not regularly visited by inspectors due to their geographical distance and inadequate funds to support travel for inspection. Unregistered products may find their way in these areas from neighbouring countries and inadequate enforcement efforts encourage firm owners to continue distributing these illegal products. The distribution of these unregistered products is also widespread in this area because the majority of farmers are not conversant on how to distinguish registered and unregistered products. Although the list of registered pesticides is published every year and available at TPRI, it is not easily accessible to the farmers and pesticide dealers. A solution to this is training and awareness creation and distribution of the list of registered pesticides to the pesticide dealers and the farmers.

The study indicates that a large proportion of products distributed in the study area (35%) were cholinesterase inhibitors and 52% were WHO Hazard Class I and II products. These findings suggest that farmers were highly exposed and at risk to APP due to the nature of products distributed. This was reflected in the high frequency of poisoning incidents and symptoms reported by the farmers in the household sub-study conducted in the same region (Chapter 4). In a similar study conducted in Bangladesh, 66% of the products found in circulation were WHO class I and 11.2% were WHO class II products (Dasgupta et al, 2005a). The higher proportions found in the Bangladesh study may be due to the different nature of products registered and/or illegally imported in Tanzania and Bangladesh. .

A bigger concern was the fact that among the products distributed, there were products whose containers had no labels and among these there were products repackaged or decanted into other containers originally intended for storing drinking water, juices, wine and other liquids. Some dry products were repackaged in plastic or paper bags which resembled bags used for edibles like sugar or common salt. Such containers can potentially be mistaken for non-chemical containers and so cause accidental poisonings. They may also be prone to spillage since they can easily break if mishandled during transportation and storage.

The high frequency of unsafe container disposal practice (for example, dumping in the municipal waste stream) among unregistered firms and firms located far away from Arusha could be the result of inadequate monitoring. Because unregistered firms were not in the TPRI database, they were rarely visited. The association of safe container disposal practice and provision of all standard safety requirements is probably a reflection of a high standard of professionalism in firms seeking to comply with good hygiene and housekeeping practices in terms of the law.

The study indicated that there was no association between having qualified staff and safe practices in pesticide and container disposal. This was an unexpected finding since one would expect trained staff to practice better hygiene. This may arise because firms' staff included both qualified and non-qualified staff. It is possible that some qualified staff were contracted simply to fulfil registration requirements, after which they were not involved in the actual implementation of safety practices. Another reason could be that the more highly trained staff was allocated responsibilities for different assignments like importation and marketing rather than ensuring safe handling and use, leaving these sensitive assignments to less qualified staff. These are issues that require active follow-up in inspection and enforcement activities, as well as improvements in company practice.

The study revealed a significant association between disposal of pesticides and containers with working experience. The higher proportion of safe disposal practice for pesticides and containers among firms with staff with high cumulative years of working experience could reflect the status of the firms. Larger firms were likely to have more staff, be more likely to be able to comply with regulations and be more professional in their approach than smaller firms.

8.6. Study limitations

TPRI is an Institute responsible for enforcement of pesticide legislation, and the researcher's affiliation to the TPRI as a pesticide inspector may have discouraged participation by firms with poor safety as well as deterred respondents from admitting to unsafe practices. This may have resulted in an unrealistic overestimate of safety practices. To some extent, this potential bias was controlled for by making participants aware of the study objectives and the research nature of the visit, and ensuring confidentiality. For situations where retailers were breaking the law, they were verbally advised to take corrective measures and an official letter was sent to the retailers after data collection to recommend corrective steps.

Further, there might have been some measurement errors unrelated to respondent bias. Companies might have had missing data for unrelated reasons such as poor record-keeping. Further, observation of spilling and unlabelled products could only be done for products on the shelf. Records for poorly labelled products that had already been sold were therefore missed.

However, the likely impact of the different forms of under-reporting would have been to underestimate the extent of poor safety practices in this population so these findings are probably an underestimate of the true situation. Despite the lack of random sampling, it is likely to be typical of hygiene practices and pesticides distribution in Tanzania.

8.7. Conclusion and recommendations

Pesticide distribution in Tanzania by pesticide retailers is accompanied by many unsafe practices including the sale of products repackaged or decanted in secondary containers, distribution of products with spillage, unsafe disposal of empty pesticide containers and distribution of pesticides which may have direct or indirect effects resulting in APP in the community. The majority of products distributed by pesticide retailers in Tanzania are highly and moderately hazardous products (WHO Class I and II, respectively). Further, some of the retailers distributed unauthorized products which had not been tested nor registered in Tanzania. These unsafe practices are believed to contribute to the burden from APP, not only affecting the distributors but also the farmers who buy and use these products. It also appeared that almost half of the staff working in pesticide retail shops in Tanzania were not properly qualified and hence are unlikely to be able to advise farmers on safe practices. The implication of pesticide distribution by retailers, in particular their poor handling practices and distribution of hazardous products, is to increase the risk of human exposure for farmers buying these products and this probably contributes to APP cases in the community. Interventions are strongly recommended including strengthening of enforcement mechanisms by increasing the number of pesticide inspectors, providing adequate financial support for inspection duties and providing training opportunities to pesticide retailers.

CHAPTER 9.0: SOURCES OF DATA ON ACUTE PESTICIDE POISONING OTHER THAN HOSPITAL RECORDS IN TANZANIA: FINDINGS FROM MINISTRY OF HOME AFFAIRS RECORDS AND LOCAL NEWSPAPERS

ABSTRACT

Background and Aim

APP data in Tanzania is scant due to a lack of a pesticide poisoning surveillance system. Data available on APP obtained from the hospital system are limited but could be supplemented from other Government departments and from the media. This study therefore explored APP data from sources outside the health sector with the objective of evaluating the potential contribution of these data sources to the characterization of the burden of injuries caused by pesticide in Tanzania.

Methodology

Approaches made to the Police under the Ministry of Home Affairs, the Government Chemistry Laboratory Agency (GCLA) and the Tanzanian Occupational Safety and Health Authority (OSHA) found that no data on APP were recorded in their systems. The population for this sub-study was therefore confined to a media survey involving 4 Swahili newspapers namely “Majira”, “Nipashe”, “Mtanzania” and “Uhuru.” The sample included all editions issued in 2003 and 2004. The APP data were abstracted from the papers using a standard data collection sheet. The distribution of circumstances and outcome of poisoning, age, gender and agents responsible for poisoning were described.

Results

The study found 46 APP cases reported in the local newspapers over the 2-year period which included events involving single (n=23) and multiple persons (n=4). The age group with highest number of victims was 1-10 years (n=11) and the leading circumstances of poisoning were accidental (n=23) followed by suicide (n=14). The outcome of poisoning was dominated by fatal cases (70%). The agents responsible for poisoning were mainly non-specific (n= 26) or unknown (n=13); only 9 were specifically named, all of which were WHO Class I or II pesticides and 3 of which were OPs.

Conclusion

Media review might be helpful as a supplementary data source for APP surveillance bearing in mind the limits and bias of newspaper-based reports. The wide range of possible data sources for APP surveillance should be coordinated under one umbrella to facilitate integration of the potential data sources and hence increase efficiency and validity.

9.1. Introduction

APP (APP) data in Tanzania are scant due to a lack of a pesticide poisoning surveillance system. The limited data available on APP are generally obtained from the hospital system (outlined in chapter 5). The hospital system itself cannot capture all APP data due to the fact that many cases, particularly poisonings in occupational circumstances and/or milder poisonings, are not reported to these facilities. Also, due to the poor recording system, it may be difficult to retrieve data on cases even when they have presented to the health system because of missing information. In some remote rural areas, health facilities may not be available and this means that no data on APP can be reported in the health system.

Limited data on APP in Tanzania may, in theory, be available from other sources including the Police under the Ministry of Home Affairs, the Government Chemistry Laboratory Agency (GCLA) and the Tanzanian Occupational Safety and Health Authority (OSHA). In addition, cases of APP are reported in local newspapers. This sub-study therefore explored APP data from sources outside the health sector with the objective of evaluating the contribution of these data sources to the potential characterization of the burden of injuries caused by pesticides in Tanzania.

9.2. Specific objectives

To characterize APP in Tanzania reported to the Ministry of Home affairs (Police department), the Government Chemistry Laboratory Agency (GCLA), the Tanzanian Occupational Safety and Health Authority (OSHA) and articles in local newspapers.

9.3. Methodology

The study aimed to evaluate four possible data sources for information on APP – viz. the Ministry of Home Affairs (Police department), the GCLA, the OSHA and articles published in local newspapers. However, only the latter source provided access to any meaningful data on APP. For this reason, only the methods and results for the review of newspaper articles is presented below, although the discussion reflects on some of the difficulties experienced in seeking APP data from police records, the GCLA and the OSHA.

9.3.1. Population and sample

The population for this sub-study was all four Swahili national daily newspapers commonly read by the community, namely “Majira”, “Nipashe”, “Mtanzania” and “Uhuru” which were archived at the TPRI library. The sample included all editions issued in 2003and 2004. These were reviewed manually to document cases of APP reported during the period.

9.3.2. Data collection

Poisoning data were abstracted from reports using a standard data collection sheet (Annex 14). Information collected included the date of poisoning, number of APP cases, circumstances of poisoning, agents responsible for poisoning and the outcome of the poisoning. APP for extraction from the newspapers was defined as any case reported to result from pesticides exposure and published in prescribed period.

9.3.3. Data analysis

The distribution of circumstances and outcome of poisoning, age, gender and agents responsible for poisoning were described. Descriptive statistics included frequencies and percentages. The data were analyzed using SPSS version 16 (SPSS, 2007) and Stata Version 10.0 (STATA, 2007).

9.3.4 Ethical Considerations

There were no human subjects involved in the study, being a record review. However, to ensure confidentiality, the names of victims identified were replaced by codes which were used in the data analysis. The results were anonymised. The study protocol was approved by TPRI ethical committee and the National Institute of medical Research (NIMR) in Tanzania (REF NIMR/HQ/Vol XI/371) as well as University of Cape Town (UCT) ethics committee (328/2004).

9.4. Results

The Police reporting database listed the type of agent responsible for poisoning as either "poisons" or "drugs" and included no information on APP. The GLCA was not in a position to participate in the study, and, while OSHA showed enthusiasm to participate, they had no data on APP. Data from these sources were therefore discounted in this sub-study, which concentrated on the press review.

Reports in the local newspapers over the period 2003 and 2004 identified 46 poisoning cases arising from 27 poisoning events (Table 9.1). More cases were reported in 2004 (n=33) than in 2003 (n=13). Twenty-three events included poisoning of single persons and 4 were multiple poisoning cases. The multiple poisoning events included 6 family members and 7 students, respectively, who ate food suspected to be contaminated with unknown pesticides; a third mass poisoning involved 3 children who were purposely poisoned by their father who mixed their food with an unknown formulation. The father later ingested the same contaminated food; all four family members died. The last event involved 6 children who ingested pesticide misplaced in a juice bottle.

The poisoned victims' ages ranged from 1 to 88 with an average age of 21.4 years and the majority (82%) were male. The age group with highest number of victims was 1-10 years (n=11). The leading circumstance of poisoning was accidental (n=23) followed by suicide (n=14) (Table 9.1). These two circumstances alone accounted for 80% of all cases reported in the newspapers (Table 9.1). No cases of occupational poisoning were reported.

The outcome of poisoning was dominated by fatal cases (n=32, or 70%) (Table 9.1), which were more likely to involve men (n=26 or 81.3%) than women (n=6 or 75%) but the difference was not statistically significant (P=0.4). The distribution of fatal cases was spread across all age groups, with the largest category between the ages of 1 to 10 years (n=10). The agents responsible for poisoning were mainly non-specific (n= 26) or unknown (n=13); only 9 were specifically named (Table 9.2), all of which were WHO Class I or II pesticides and 3 of which were OPs (Table 9.2).

Table 9.1: Poisoning cases from the local newspapers reviewed (2003 and 2004).

Variable		n (%)
Gender	Female	8(17.4%)
	Male	38(82.6 %)
Age group	1-10	11(23.9%)
	11-20	4(8.7%)
	21-30	7(15.2%)
	31-40	7(15.2%)
	41+	1(2.2%)
	Unreported	16(34.8%)
Circumstances	Accidental	23(50%)
	Occupational	0
	Suicide	17(37.0)
	Homicide	4(8.7%)
	Unknown	2(4.3%)
Outcome	Recovery	14(30.4%)
	Death	32(69.6%)
	Referred	0
	Disability	0
	Unknown	0

Table 9.2: Products reported to cause poisoning in the selected newspapers in Tanzania, 2003-2004.

Product	Frequency	Chemical group	WHO hazard Class
Specific products			
Endosulfan	4	OC	II
Fenitrothion	1	OP	II
Zinc Phosphide	2	IN	Ib
Chlorfenvinphos	2	OP	Ib
Sub total	9		
Non-specific products			
Acaricide	3	-	-
Bed bug pesticide	1	-	-
Rat Poison	3	-	-
Food poisoning	19	-	-
Sub total	26		
Unknown	13	-	-

(i) Chemical groups: OP (Organophosphates), OC (Organochlorines), CA (Carbamates), PY (Pyrethroids), OT (Others)
(ii)WHO Hazard classes: Ia: Extremely hazardous, Ib: Highly hazardous, II: Moderately hazardous, III: Slightly hazardous

9.5. Discussion

The Police reporting database was geared to support criminal investigations, as a result of which no data on APP were collected, rendering it unsuitable for APP surveillance. Further, the police managing the database have no formal training on pesticides, a further obstacle for APP surveillance. A similar study conducted in a Forensic Department in Costa Rica (Wesseling et al, 1997) was able to identify all agents responsible for poisoning including specific pesticides such as Paraquat (60%), cholinesterase inhibiting products (36%) and others including 2,4-D and Endosulfan. This suggests that, if police records in Tanzania were to be incorporated into a national APP surveillance system, training for the officers would be required to enable them to keep good quality records using a standard data collection tool. The fact that training for APP surveillance conducted at TPRI Arusha in January 2006 (Chapter 5) was attended by 5 police officers suggests that collaboration with police on APP data collection is potentially possible.

The GLCA might be a valuable source for APP data, as would the OSHA. While the OSHA operate both in rural as well as urban areas and have a mandate to compile such a database, it appears they keep data on workplace injuries from causes other than pesticides. Higher level policy interventions would be needed to reorient these agencies to be receptive to participating in APP surveillance effectively.

Cases reported in the media tended to be severe poisonings. Among the 46 poisoning cases reported in local newspapers in the period 2003-4, almost 70% were fatal. Because less severe cases of poisoning (such as occupational poisonings) do not attract public interest, reliance on newspaper-based reporting of poisoning cases for surveillance would be biased towards more severe and sensational cases and so under-represent occupational APP.

Nonetheless, there are examples in which newspaper reviews, despite its bias, have contributed to APP surveillance. In a study conducted in Florida, which reviewed data for the period 1998 – 2005, the media was one potential data source used for APP surveillance (Barrett, 2006). Another study in Pakistan in 1996 – 1997 investigated suicide from pesticide ingestion and used newspaper reports based on police inquiries as the only national source of data on suicide methods (Khan et al, 2000). Data from newspapers could be abstracted at low cost either through local papers or through the internet. These data sources can pick up severe cases missed elsewhere, and can be used to verify data in the existing reporting system. Thus, although it provides limited data, newspaper reporting should not be ignored in surveillance for APP.

9.6. Conclusion

In conclusion, this sub-study indicates that there were possible potential sources of APP data in other governmental agencies but these were not oriented to APP surveillance. Action to engage other departments would require formal agreements between the Ministries concerned (specifically Health, Internal Affairs and Agriculture and Food Security). To achieve good quality data, common data collection tools, common case definitions and training of staff who capture data on APP are needed.

Further, media review might be helpful, bearing in mind the limits and bias of newspaper-based reports. However, the most important finding was that different sources are poorly coordinated. The wide range of possible data sources for APP surveillance could be coordinated under one umbrella in order to facilitate integration of the potential data sources and hence increase efficiency and validity. The TPRI may be best placed to play that role but this is further discussed in Chapter 10 (Section 10.6.3).

CHAPTER 10.0: REVIEWING THE DATA ON ACUTE PESTICIDE POISONING IN TANZANIA

ABSTRACT

This chapter integrates the findings across all sub-studies with reference to the implications for APP prevention, data comparison, estimation of the burden of under-reported poisoning and analysis of data completeness in order topropose a national APP surveillance system for Tanzania. Firstly regarding implications for prevention, the study points to the need for interventions to correct unsafe handling practices, encourage reporting of APP cases to health care facilities, increase the number and accessibility of health care facilities and strengthen enforcement. Secondly, regarding data comparison the study found that the most problematic circumstances of poisoning were suicide in the prospective and retrospective studies, occupational in the household and stakeholders' surveys and accidental in the newspaper review. The agents responsible for poisoning included OPs, which accounted for over 20% in all sub-studies and WHO Class I and II products, which accounted for over 60% in all sub-studies. In the hospital review, annual MR and IR were higher in the prospective than in retrospective study. Further, the annual IR was highest in the age category 21 – 30 years in both retrospective and prospective sub-studies but annual MR was higher in the age group above 40 years in both retrospective and prospective studies.

Thirdly, a method is presented to estimate the burden from APP in Tanzania. The method takes into account under-reporting of APP from community sources and redistributing the group of APP cases with unknown circumstances across different categories of known circumstances in a sensitivity analysis with different assumptions for the redistribution. In the household survey, only 5 out of the 112 farmers (4.5%, 95% CI = 1.4% - 10.4%) who reported experiencing a past poisoning were traced in hospital records. This proportion was used to calculate underestimation factors (22.2 for lower margin and 9.6 for higher margin) for rate estimates. Based on this modelling, occupational poisoning could comprise anything from 52.2% to 96% of all APP cases.

Fourth, regarding data completeness the study found that only 33% - 50% of the information needed for PIC notification was available in the hospital notification system using prospective data collection. Even for those agents specifically reported by trade name or active ingredient, about 50% of the data required for a PIC notification for a Severely Hazardous Pesticide report would be missing. The lack of important details regarding hazardous pesticides formulations under normal conditions of use in developing countries may result in many poisoning cases not qualifying for review under the PIC provisions and chemicals avoiding possible inclusion in the PIC list even when they pose serious hazards.

Lastly, a system for surveillance of APP is proposed for Tanzania for the purpose of addressing poisoning arising from pesticides in workplace and non-workplace settings. The proposed surveillance system is expected to identify outbreaks of APP, circumstances and outcomes of pesticide poisoning, agents responsible for poisoning, poisoning patterns by gender, age, population groups and geographical areas most affected. Finally, the system is expected to generate rate estimates and trends for pesticide poisoning, identify opportunities for

prevention, further research needs and, ultimately, assist in reducing health risks arising from pesticide poisoning. Data sources for surveillance include health care facilities, community self-surveillance, media and other sources. In order to achieve the above targets the system should be able to meet the attributes of a good surveillance system namely simplicity, flexibility, data quality, acceptability, sensitivity, representativeness, timeliness and reliability.

10.1 Introduction

The previous chapters in this study have critically discussed findings from different sub-studies related to APP. These studies included farmers' knowledge, practices and experience of poisoning associated with pesticides in 7 rural farming areas of Tanzania (Chapter 4); retrospective and prospective hospital data review in selected four regions of Tanzania, 2000 – 2006 (Chapter 5); characterization of knowledge, diagnosis and management of APP among HCPs in selected health care facilities in Kilimanjaro and Arusha regions of Tanzania (Chapter 6); evaluation of selected pesticide stakeholders in Tanzania regarding awareness of APP and views on a notification system and risk reduction strategies for APP (Chapter 7); pesticide retailers' knowledge and handling practices in selected regions of Tanzania (chapter 8) and sources of data on APP other than hospital records in Tanzania, including government agencies and local newspapers (Chapter 9). All these studies were designed to ascertain the state of APP in the country, the extent of reporting, and the challenges and opportunities for surveillance for APP.

This chapter integrates APP data across all the above-mentioned sub-studies. It starts with a discussion about implications for APP prevention arising from the data obtained in the different sub-studies. It then goes on to compare APP data from different sources in terms of age, circumstances, outcome and agents responsible for poisoning. It then reviews rates of APP in both retrospective and prospective sub-studies. The chapter then estimates the burden of under-reported APP by modelling the likely true rates for occupational APP in Tanzania and adjusting reported rates for the burden of missing cases. This is followed by an analysis of data completeness across the different methods of surveillance examined in the different sub-studies and reflects on the implications for surveillance under the PIC reporting system. Finally, this chapter draws on the preceding data to propose a national surveillance system for APP for Tanzania.

10.2. Implications for Acute Pesticide Poisoning prevention

This sub-section outlines implications for APP prevention arising from the findings of this study.

10.2.1. Farming community

Data from the household survey pointed to the need for interventions to improve pesticide storage conditions at local level. For example, farmers can collectively construct safe pesticides storage premises as it is done for keeping harvested crops in some parts of Tanzania (TPRI annual report, 2004). This would reduce the free availability of pesticides within households and reduce opportunities for exposure. Farmers suffering APP should be encouraged to report to health care facilities in order to have their data captured in surveillance system. Reporting will increase awareness and potentially prevent future cases.

Regarding decanted or repackaged pesticides, national pesticide authorities should ensure that, where such products are needed, manufacturers supply properly labelled products in small packaging, which is affordable for farmers. This can be enforced during product registration and importation because control, once in the market, is difficult given inadequate enforcement capacity. Since all pesticide importation is accompanied by a pesticide importation permit (PIP), the National Authority can propose small package units (e.g. 10mls or grams and less), which will be more affordable to the majority of farmers. Moreover, these units can be made to bear details on product identity so as to support surveillance in the event of a poisoning. The National Authority should also enforce restrictions on unsafe repackaging by retailers through regular monitoring. Current national economic policy discourages direct government involvement in pesticides distribution.

Better registration conditions should be complemented by training of farmers to ensure that they only purchase required quantities for immediate use to reduce storage risks. Farmer training programs should be introduced and should address, among other things, the use of alternative products such as natural products and also self-recording and reporting of APP.

Label instructions should be written in simple language, which can be easily understood by the user, again, so as to support surveillance in the event of a poisoning. The introduction of the Globally Harmonized System for Chemical Hazard Classification and Labelling (GHS) (United Nations, 2004) will contribute significantly to ensuring international adherence with labelling requirements. Regarding protection, farmers should be encouraged and sensitized to use PPE in order to minimize direct exposure and hence reduce health risks. This can be done through training undertaken by extension staff. Training would be more effective if complemented by distribution of PPE at subsidized costs and demonstrations on proper PPE usage. The subsidy of PPE can be paid for by the Government but implemented through Cooperative Unions which buy crops directly from the farmers.

However, there are a range of other interventions to reduce pesticide exposure before resorting to PPE. Firstly, farmers should be trained to apply pesticides only when necessary. Training in scouting is important because it will help farmers to avoid routine spraying, which is often unnecessary, expensive and causes both pest resistance and high residues on harvested crops. Rather than relying on routine pesticide application, pesticides should only be used when they are necessary for economic pest control. This will require farmers to change their attitudes towards pesticide application, which should be a goal of farmer training and awareness programs. Moreover, training of retailers is also critical to ensuring safety along the supply chain because they influence farmers' practices. This training can be conducted by TPRI and the Ministry of Agriculture with support from the Government. The training shall be in the form of Training of Trainer and will involve sending trainers directly to the farming communities.

The agrochemical industry and researchers should aim to develop PPE suitable for use in tropical areas since many farmers claim that standard PPE is too uncomfortable to use during hot weather conditions. Use of empty pesticide containers can also be discouraged if industry develops containers that cannot be reused for domestic or other purposes. A good example in Tanzania is the package for actellic super dust, which, once opened for use, is rendered useless for any other purposes (Figure 10.1).

Figure 10.1: Actellic super dust package which cannot be re used.

Policy interventions through national legislation to ensure discontinuation of highly hazardous products and replacement by safer alternatives should be accompanied by support for research into new alternatives for pest control, including less toxic natural products. This can be conducted by TPRI through its research units - namely Natural Products and National Hebarium - with support from the Government and relevant potential donors.

An Indonesian study showed that, through adoption of IPM techniques, farmers used less pesticides and fewer highly toxic pesticides but still achieved equal or higher yields and captured greater profit than before (FAO, USAID report, 1991). International examples have shown that restricting the availability of highly toxic products can be effective in reducing poisoning cases. For example, actions to ban Paraquat in Trinidad (Daisley et al, 1998), Aluminium Phosphide in India (Siwach et al, 1995) and Parathion in Argentina (Piola et al, 2001) have been shown to be effective in reducing mortality due to suicide.

Those highly hazardous products for which there are no alternatives should be restricted to handling by licensed users who are well trained. Experience of pesticide reduction policies in other countries has been promising and this strategy should be considered in Tanzania. For example, in Jordan a steady rise in fatal pesticide poisoning was reversed by increased awareness of the problem, decreased imports and banning imports of particular products (Abu et al, 1989). Similar effects have been observed in Western Samoa (Bawles, 1995) and Sri Lanka (Konnradsen et al, 2003) after restriction of Paraquat and campaigns to raise awareness of suicide.

10.2.2. Health care system

Within the health care system, there is a need to increase the number of primary health care facilities, which would serve many functions. For example, HCPs working in intensive agricultural areas could deliver biological monitoring services for the prevention of occupational APP. This can be achieved by making available cholinesterase testing for detecting OP or carbamate exposure and training HCPs on how and when to test, and how to interpret test results. Field kits are available for determination of cholinesterase using relatively non-invasive methods such as finger-prick blood sampling, which provide reasonably reliable methods suited for biological monitoring of exposed workers (TestMate OP) (London et al, 1995). These are particularly valuable in remote agricultural areas with access to health facilities. This is important since most poisoning cases occur in rural agricultural areas. Given that many farmers, particularly small scale farmers, have limited disposable income, they will be more likely to access health care if the facilities are closer to them.

10.2.3. Law enforcement

There is a need to increase the number of pesticide inspectors so as to ensure enforcement of the National Law (United Republic of Tanzania, 1997). Apart from enforcement responsibilities, these inspectors may be useful for collection of APP data and hence contribute to surveillance.

The government should also provide sufficient funding and capacity building to enable them to monitor all parts of the country effectively. Recent initiatives by the Ministry of Agriculture, Food Security and Cooperatives increased the number of pesticide inspectors 5-fold (United Republic of Tanzania, 2006). In total, 165 inspectors were appointed to serve 21 regions in Tanzania. The new inspectors were posted particularly to border towns through which pesticide consignments pass during importation. A training program for the new inspectors was implemented. However, of the total number of new inspectors, about 40% are still to received training. Thus, although these measures are to be commended, the expansion of capacity is still insufficient to meet demand since the number of fully trained and competent inspectors , even if fully trained, is enough to serve only 5 regions in Tanzania. Further, the 3 weeks training given to inspectors may not be sufficient time to equip them for the complexities of pesticide inspection duties. Longer training, integrated with practical measures, will be needed to ensure nspectors are effective in their roles.

Also, because the standard requirements for pesticide retailers include possession of a business licence from the municipalities, there is a need to work in collaboration with local authorities in the enforcement of safety in pesticide handling as well as documentation of injuries arising from pesticides in their working areas. This will facilitate monitoring programs for the distribution, use and handling of pesticides. The National authority can also play an important role in reducing risk of APP by developing and or amending regulations regarding highly poisonous products through the restriction and distribution system.

10.3. Associations with Acute Pesticide Poisoning - age, circumstances, outcome and agents

Table 10.1 summarises the patterns of main circumstances and outcomes of APP in four of the sub-studies. The modal category among cases with known circumstance was suicide in both the retrospective (45.8%) and prospective (46.9%) studies (Table 10.1).

Table10.1: Comparison of different sub-studies – Circumstances of poisoning and outcome.

Circumstances/ Outcomes	Sub-study				
	Hospital review (Retrospective study) [a]	Hospital review (Prospective study) [b]	Newspapers review [c]	Househol d survey [d]	Stakeholders survey [e]
Main	Suicide	Suicide (57.8%)	Accidental	Occupatio	Occupational

Circumstances reported	(45.7%) Occupational (8.5%) Accidental (44.7%)	Occupational (10.2%) Accidental (31.0%)l	(50%) Suicide (37%)	nal (92.5%)	(65%)
Main Outcome reported	Recovery (80.2%) Absconded (8.7) Referred (1.2%) Death (9.3%)	Recovery (84.9%) Absconded (6.5%) Referred (1.6%) Death (7.0%)	Recovery (30.4%) Death (69.6%)	Recovery (100.0%)	N/A

a (Table 5.02) b(Table 5.19) c(Table 9.01) d(Table 40.2) e (Table 7.01)

In contrast to hospital surveillance, which showed that suicide was the major cause of APP, the household survey reported only occupational cases with no mention of other circumstances (Table 10.1). This might be the result of fear of reporting cases involving suicide, homicide or poisonings resulting in fatal outcomes, which are subject to police investigation and possible arrest. Another reason could be the fact that mild occupational poisonings are so common and numerous that farmers remember them more easily than the other less common circumstances, which are not openly reported. This suggests that occupational poisoning cases could be collected at community level to supplement the low levels of reporting of occupational exposures seen in APP cases presenting at health care facilities**.** Examples of studies reporting collection of APP at community level include a cotton growers' study in India (Mancini et al, 2005) and also farmers' self-surveillance of pesticide poisoning in North Vietnam (Murphy et al, 2002).

Review of newspapers showed a pattern in which the majority of cases reported were accidental with a few suicide cases but no occupational cases were reported. The accidental cases involved events in which there were multiple poisonings (13 individuals in 2 poisoning events), which attracted the editors' interest. The lack of occupational circumstances was probably due to the fact that most of these cases result in mild non-fatal poisoning, which are of less interest to readers and so are less likely to be published.

Among the agents identified as responsible for poisoning (those with known active ingredients), OP products accounted for over 20% in all sub-studies while WHO Class I and II products accounted for over 60% in all sub-studies (Table 10.2). This implies that OP and WHO class I and II agents play a significant role in APP events in the community.

Table10.2: Categories of agents reported to be associated with poisoning across different sub-studies

Agent Category	Sub-study					
	Retrospective	**Prospective**	**Media**	**Household**	**HCP**	**Stake-holders**
1. Known active ingredient	32.4%	48.7%	72.9%	70.5%	58.7%	Not Applicable
2. OP's as proportion of known active ingredients*	71.2%	59.6%	33.3%	42.4%	25.8%	25%
3. WHO Class I & II as proportion of known active ingredients *	78.5%	67.8%	100%	77.6%	87%	100%
4. Rodenticides as proportion of non-specific and known agents **	5.9%	8.4%	0.17%	0.0%	0.10%	0.19%
5. Non-specific agents but active ingredient unknown	21.0%	36.9%	54.1%	0.5%	22.3%	50%
6. unknown agents	60.6%	51.3%	28.3%	29.5%	41.3%	0%

*The proportion was calculated from Specific products with known active ingredient.
** The proportion was calculated from Specific products with known active ingredients and non specific products.
OP: Organophosphates
WHO Hazard classes: Ia: Extremely hazardous, Ib: Highly hazardous, II: Moderately hazardous,

Table 10.3: Active ingredients reported to cause poisoning by different sources of data.

Retrospective [x] study		Prospective study [x]		Newspapers survey		Household survey		HCP survey		Dec makers survey	
Product	**Frequency**	**Product**	**Frequency**	**Product**	**Frequency**	**Product**	**Frequency**	**Product**	**Frequency**		**Frequency**
OP (not specified)	34	OP (not specified)	29	Endosulfan	4	Profenofos	34	Profenofos	5	Chlorpyrifos	10
Chlorpyrifos	16	Zinc Phosphide	7	Zinc Phosphide	2	Chlorpyrifos	20	Zinc Phosphide	4	Diazinon	4
Diazinon	12	Paraquat	3	Chlorfenvinphos	2	Lambda Cyhalothrin	18	Chlorpyrifos	3	Endfosulfan	4
Zinc Phosphide	9	Sulphur	3	Fenitrothion	1	Mancozeb	14	Deltamethrin	3	Paraquat	3
DDT	3	Chlorfenvinphos	3			Cypermethrin	13	Copper	2	Pirimiphos methyl	2
Endosulfan	3	Copper	2			Endosulfan	9	DDT	2	Deltamethrin	2
Chlorfenvinphos	2	Lambda cyhalothrin	1			Triadimenol	5	Cypermethrin	2	Bromodiolone	1
Carbofuran	2	Deltamethrin	1			Chlorothalonil	5	Paraquat	2	Dimethoate	1
Sulphur	2	Glyphosate	1			Abamectin	3	Diazinon	2	DDT	1
Paraquat	2	Boric acid	1			Malathion	3	Sulphur	2		
Chlorothalonil	1	Endosulfan	1			Deltamethrin	2	Endosulfan	2		
Deltamethrin	1	Arsenic	1			Dieldrin	2	Bromodiolone	1		
Amitraz	1	Diazinon	1			Copper	2	Amitraz	1		
phenothrin	1	Cypermethrin	1			Amitraz	1				
Imiprothrin	1	Profenofos	1			P methyl	1				
		Chromium	1			Sulphur	1				
						Permethrin	1				
						Prochloraz manganese	1				
						Metalaxyl	1				

						2,4-D	1				
						Dimethoate	1				
						Propineb	1				
Total	**90**	**Total**	**57**	**Total**	**9**	**Total**	**139**	**Total**	**31**	**Total**	**28**

x (The data in this table come from the 10 facilities that were included in both retrospective and prospective studies**)**

Table 10.4: Non-specific agents reported to cause poisoning by different sources of data.

Source of Data											
Retrospective study [x]		**Prospective study** [x]		**Newspapers survey**		**Household survey**		**HCP survey**		**Pesticides stakeholders survey**	
Product	**Frequency**	**Product**	**Frequency**	**Product**	**Frequency**	**Product**	**Frequency**	**Product**	**Frequency**	**Product**	**Frequency**
Livestock dip	2	Bed Bug Pesticides	2	Acaricide	3	Bed bug pesticides	1	Acaricides	5	Pyrethroids	1
Bed Bug Pesticide	2	Acaricide	4	Bed bug pesticide	1	-	-	Bed bug insecticide	1	Rat poison	10
Fruit contaminated with pesticide	8	Food poisoning	35	Rat Poison	3	-	-	Fumigant	2	Livestock dip	8
Rat Poison	20	Rat poison	13	Food poisoning	19	-	-	Herbicide	1	Storage products	1
Insecticide	3	Insecticide	2	-	-	-	-	Insecticide	3	Crop products	1
Contaminated water	1	Local medicine	3	-	-	-	-	Flower spray	1	Insecticide	2
Treated seeds	2	-	-	-	-	-	-	Organophosphates	5	Organophosphates	1
Food poisoning	74	-	-	-	-	-	-	Rat poison	1	Coffee products	3
Termite poison	1	-	-	-	-	-	-				
Total	**113**	**Total**	**59**	**Total**	**26**	**Total**	**1**	**Total**	**19**	**Total**	**29**

Unknown	**297**	**Unknown**	**122**	**Unknown**	**13**	**Unknown**	**58**	**Unknown**	**35**	**Unknown**	**0**

x (The data in this column come from the 10 facilities that were included in both retrospective and prospective studies**)**

Table 10.5: Specific agents linked with poisoning in 6 sub-studies.

Agent	Retrospective	Prospective	Newspaper	Household	HCPs	Stake-holders	Total #
Endosulfan	√	√	√	√	√	√	6
Deltamethrin	√	√	X	√	√	√	5
Chlorpyrifos	√	X	X	√	√	√	4
Zinc phosphide	√	√	√	X	√	X	4
Diazinon	√	√	X	X	√	√	4
Sulphur	√	√	X	√	√	X	4
DDT	√	X	X	X	√	√	3
Chlorfenvinphos	√	√	√	X	X	X	3
Amitraz	√	X	X	√	√	X	3
Copper	X	√	X	√	√	X	3
Cypermethrin	X	√	X	√	√	X	3
Profenofos	X	√	X	√	√	X	3
Paraquat	X	√	X	X	√	√	3
Chlorothslonil	√	X	X	√	X	X	2
Lambda Cyhalothrin	X	√	X	√	X	X	2
Pirimiphos Methyl	X	X	X	√	X	√	2
Dimethoate	X	X	X	√	X	√	2
Carbofuran	√	X	X	X	X	X	1
Phenothrin	√	X	X	X	X	X	1
Glyphosate	X	√	X	X	X	X	1
Arsenic	X	√	X	X	X	X	1
Chromium	X	√	X	√	X	X	1
Fenitrothion	X	X	√	X	X	X	1

Dieldrin	X	X	X	√	X	X	1
Triadimenol	X	X	X	√	X	X	1
Abamectin	X	X	X	√	X	X	1
Permethrin	X	X	X	√	X	X	1
Malathion	X	X	X	√	X	X	1
Prochloraz Manganese complex	X	X	X	√	X	X	1
Mancozeb	X	X	X	√	X	X	1
Metalaxyl	X	X	X	√	X	X	1
2,4-D	X	X	X	√	X	X	1
Propineb	X	X	X	√	X	X	1
Bomodiolone	X	X	X	X	X	√	1

#number of studies in which agent was reported of 6 sub-studies.
Key √ - Reported X – Not reported

Products reported as causing APP include Chlorfenvinphos, Diazinon, Profenofos and Chlorpyrifos, all OPs that are extremely, highly or moderately hazardous (WHO Class I and II) and some are easily available on the market. This widespread availability, particularly for those which are under full and provisional registration, could be the reason for their common association with poisoning, as identified in many studies conducted in developing countries (London et al, 1997; Clark et al, 1997; Kimani et al, 1995; Ruijten et al, 1994; WHO, 1990) and developed countries (Ames et al, 1995). Moreover, based on the nature of the specific active ingredients reported with high frequency across all sub-studies, the study suggests that the diagnosis informed by history and self-reporting is consistent with the pattern of products associated with poisoning. Where respondents were able to name the agent, they usually named agents that were relatively toxic. Thus, despite their limited knowledge regarding pesticides, this would suggest that their poisoning histories were valid.

The most commonly reported nonspecific agents were rodenticides, reported in 5 out of 6 sub-studies (Table 10.2). Surprisingly, rodenticides were not reported in the household survey, although the products are widely used for rat control in homes. Absence of these products in the household sub-study could be due to the fact that farmers do not regard them as pesticides but simply as 'poisons.' Further, although many farmers do not know that these agents are pesticides by definition, they understand that they are toxic and that is why they are frequently used for suicide (Chapter 5).

Apart from pesticide retail shops, rodenticides are commonly sold in street markets in the community, particularly in urban areas. Some agents which are currently sold in this manner are not registered for use as rodenticides and include highly toxic products like Termik (aldicarb) and Zinc phosphide (Figures 10.2 and 10.3). This problem of the misuse of agricultural pesticides, particularly highly toxic agents, for domestic rat control, has been reported in other developing countries such as South Africa (Rother, 2010) as a major cause for APP.

Figure 10.2: A street vendor selling rodenticides and other items in Dar es Salaam, Tanzania.

Figure 10.3: Rodenticide and other items sold on the street in Arusha, Tanzania.

There was a fair degree of consistency in the pattern of specific agents reported across studies (Table 10.5). Among the reported products, Endosulfan was reported as involved in poisonings in all sub-studies while Deltamethrin was reported by 5 of the 6 sub-studies. Zinc phosphide, Diazinon and Sulphur were reported in 4 out of 6 sub-studies (Table 10.5). About 50% of all products were reported in at least 2 sub-studies.

A comprehensive surveillance system for APP for Tanzania could make use of these different data sources in different ways. Hospital and media sources provide details on circumstances, agents and outcomes but tend to report more severe cases. Cases obtained from hospitals are notified by health care workers. Similarly cases reported in the media are likely to have sufficient details collected from hospitals before they are published. This means that besides hospitals, the media may be a potential data source for APP bearing in mind the limitations of what gets reported in newspaper articles.

The farmer and stakeholder surveys captured self-reporting and non-severe cases. It may be possible to build on this to develop a community-reported category in surveillance. The consistency of agents reported in Tables 10.3, 10.4 and 10.5 across different studies, suggests that community self-report has some validity. Nonetheless, surveillance relying on community reporting should be supported by measures to verify cases, either directly by HCPs or through a Poison Information Centre, if available. Rather than trying to verify all self-reported cases from community surveillance, it might be possible to select a random sample (e.g. 5% of self-reported cases) for verification to ensure that they all meet an agreed case definition. The information to be collected from the random sample of reported cases shall be the circumstances and outcome of poisoning, agents responsible for poisoning and many others depending on case definition. Verification may also be useful for other selected cases – e.g. severe cases with fatal outcome, cases involving PIC prohibited pesticides, and cases involving children and pregnant women.

By combining the two categories, the system will capture both severe and non-severe APP cases. Given that the literature indicates that, in practice, no single source is adequate to capture all APP cases (WHO, 2004b) integration of multiple sources may be the most useful strategy for sound surveillance. This is discussed further under section 10.7.

The age distribution in both the retrospective and prospective studies was similar (mean age 24.9 years), but the gender distribution was quite different. The majority of victims in the retrospective study were males (61.5%) while in prospective study, the majority were females (52.2%). This suggests that with respect to surveillance, one should aim to institute prospective data collection rather than rely on retrospective data, which might provide a false picture of the gender profile. These findings are consistent with a South Africa study (London and Bailie, 2001) showing under-reporting by gender.

In the review of local newspapers, there appeared to be a greater focus on poisoning involving younger victims. For example, the mean age of victims in the newspaper reports was 21.4 years compared to 24.9 in the retrospective study ($p = 0.07$). The implication of this is that, as reported in chapter 9, the media is more biased towards sensational events, reporting mainly severe cases to attract readers' attention. The ages of cases in more severe APP events are not typical of the general population of APP cases.

10.4. Rates of Acute Pesticide Poisoning (3 regions – Moshi, Arusha and Mwanza)

In the hospital review, the annual Mortality and Incidence Rates increased by 2 and 6-fold, respectively, with prospective compared to retrospective data collection. This is probably due to improved awareness about APP surveillance in the participating health facilities and training of data recorders. In the Central American sub-region, the IR for APP was reported to increase three-fold from 6.5 cases/100000 in 1992 to 19.5/100000 in 2000 following an increase in APP surveillance efforts (Henao et al, 2002). Similar findings were reported in South Africa (London and Bailie, 2001) where the increased reporting was of the order of a 10-fold increase. Whereas this study relied on passive surveillance, which involved waiting for the cases to present to the hospital, the South African study implemented active case ascertainment involving ambulance drivers and others in notification, which may explain the greater increase in the South African study.

In another study in Nicaragua, the annual APP Incidence among the general population was found to be 2.3/100 (95%CI 1.7-2.8) (Corriols et al, 2009), which is far higher than found in this study and also higher than found in an earlier study conducted in the same region (Henao et al, 2002). The source of this huge difference could arise from the nature of the studies. While the 2009 Nicaraguan study was based on self-reported APP, this study and Henao's 2002 study based APP rates on diagnoses by health professionals in hospitals.

The role of active surveillance in surfacing previously unreported occupational APP was also demonstrated in a study in Texas, which increased reporting of confirmed occupational APP cases approximately 10-fold over a period of 10 years from 1987 to 1996. The increase was associated with a move from a passive system that received reports from physicians as required by law to an active surveillance program that received reports from multiple sources and followed up all reports through strengthened inter-agency collaborations (Schinitzer et al, 1999).

Secondly, the Case Fatality Rates were higher in the retrospective than in the prospective study, which may be explained by better detection of non-fatal APP cases resulting in less under-reporting of non-fatal cases with prospective data collection, and a larger numerator. This is supported by the findings in Chapter 4 that several occupational poisonings (non-fatal) are not reported in hospitals due to their low severity. In general, undercounting is less of a problem for fatalities (numerator in the CFR) than for morbidity (denominator for the CFR), which is supported by the fact that the increase in mortality (2-fold) was about a third of the increase in morbidity (6-fold) comparing prospective to retrospective data collection.

In terms of gender, the annual IR of APP was higher in males than females in the retrospective study but was approximately equal in males and females for the prospective study. The higher IR in males in retrospective sub-study could arise because pesticides in Tanzania are more commonly thought to be handled by men than by women; hence clinicians may not seek a history of pesticide exposure in women and this might explain why APP is missed in women. There is evidence that poisonings among women are under-reported, particularly for occupational circumstances (London et al, 2002). A United State study among agricultural workers found the IR was significantly higher in females (141.8/100000) than in males (61.7/100000) (Calvert et al, 2008). The fact that the prospective study showed a more balanced gender pattern suggests that occupational cases were under-reported for women in the retrospective study and that greater reliance should be placed on data from prospective surveillance.

In terms of age, the annual IR was highest in the age group 21-30 years whereas the annual MR was highest in the age group 41+. This applied to both prospective and retrospective studies

(Table 5.31) and is consistent with the results of bivariate multivariate analysis in this study (Chapter 5) and with data from a similar study in Sri Lanka (Gunnell et al, 2007), which reported the highest IR in younger populations (aged 17–35-years).

The reason for the different age peak for morbidity and mortality could be due to the fact that the age group (41+ years) contained the highest proportion (22%) of suicide cases. which have a higher likelihood of fatal outcomes than non-suicide cases. For example, the Prevalence Risk Ratios for suicide among older subjects (40+) compared to younger subjects (40 and below) was 3.67 (95% CI = 1.31 – 10.8) for the prospective sub-study. However, the multivariate analysis in Chapter 5 (Tables 5.10 and 5.2) showed that for both prospective and retrospectives studies, age was independently associated with fatal outcome, controlled for suicide. This association could perhaps be explained by biological factors in that older people, who are more likely to have other comorbidities due to aging, may be more biologically vulnerable to toxic exposures. Another explanation could be the fact that older persons may be less likely to access care than younger persons. Alternatively, in younger adults, suicide is more of a gesture, without real intent to kill, whereas older persons may have greater intent to kill themselves and so use more toxic agents at higher exposures. The age association is confirmed in a Korean study (Lee et al, 2009), where APP was more common in men over 50 years.

A study conducted in China reported that the peak suicide rate for both males and females arising from pesticides was observed in the age group 20 – 24 years, particularly in rural areas (Phillips et al, 2002). Another study in India reported that suicide using pesticides was more common in the age group 10-19 (Aaron et al, 2004). This indicates that the trend of suicide and age is likely to depend on where the study is conducted, the suicide methods used and the cultural environment.

The study also indicated that Kilimanjaro region had a higher APP IR than other regions. The region is the largest producer of coffee in Tanzania with higher pesticide use involving the application of more toxic agents compared to other crops. Nearly 50% of the products registered for use on coffee in Tanzania are extremely, highly or moderately toxic (Annex 2). In addition, coffee cultivation involves high volume of spray solution per hectare due to high vegetation cover with high potential for drift. Spraying on the majority of small scale coffee farms is done using knapsack sprayers. Findings in Chapter 4 confirmed that many knapsack sprayers were not properly calibrated (section 4.4, Table 4.2) and in poor condition, being old and leaking and hence more hazardous. Further, in the Kilimanjaro area, some residential houses tend to be located in the midst of coffee farms, as a result of which, family members who have not done the actual spraying may be contaminated (Figure 1.1). These hazardous exposures associated with coffee production may explain the higher IR in Kilimanjaro region. However, these explanations are speculative and there is a need for further studies to investigate the exact reason for the increased risk for APP in Kilimanjaro compared to other regions.

The MR in both the prospective and retrospective studies was highest in Arusha region compared to the other 2 regions. There may be a number of reasons for this finding. Livestock production, which is common in the Arusha region, involves use of acaricides, many of which are highly toxic pesticides. Further, previous studies have suggested the possibility of poor medical management of pesticide poisoning cases reaching health services, as a result of inadequate health facilities and overstretched medical staff (Ngowi, 2002a). The particularly poor state of roads in the Arusha's rural areas means that poisoned farmers may experience delays reaching the health facilities. Another reason could be the fact that Arusha is a larger region with fewer health facilities compared to Kilimanjaro region which has many facilities including a very famous referral hospital, Kilimanjaro Christian Medical Centre (KCMC). Delays in receiving medical attention and fewer health facilities may thus underlie the high MRs in Arusha

Findings from similar studies in India (Rao et al, 2005) and Sri Lanka (Van der Hoek and Konradsen, 2005) reported higher CFRs (23% and 18%) than this study. Although both the Indian and Sri Lankan studies were similar in design to this study, they included fewer hospitals, and the Sri Lankan study excluded children under the age of 16 and involved one district hospital. This study, in contrast, involved a greater number of facilities, a wide age range and a greater degree of representativity than the Asian studies. It could also be possible that the Asian studies involved more toxic pesticides used in Sri Lanka and India.

10.5. Estimation of the burden of disease due to acute pesticide poisoning

10.5.1. Modelling the true rates for APP in Tanzania

The true rate for APP in Tanzania is almost certainly higher than that found in this study, viz. (1.43 per 100 000 population; Table 5.33). In order to estimate the burden of APP in Tanzania, a method is presented below to model a 'true' rate of APP. This method involves two distinct steps: firstly, estimating a factor to take account of under-reporting of APP from community sources (all occupational in circumstances); and secondly, redistributing the group of APP cases with unknown circumstances across different categories of known circumstances in a sensitivity analysis with different assumptions for the redistribution.

(i) Proportion of unreported cases

In the household survey (Chapter 4), the proportion of farmers reporting occupational poisoning for whom records were traced in hospitals were 5 out of 23 cases who claimed to have attended hospital for their APP (21.7%) and only 5 out of the 112 cases who reported experiencing a past poisoning (4.5%). Using these proportions to model the unreported occupational cases suggests that the proportion of occupational poisonings reported in hospital information systems is 0.045 with a 95% CI of 0.014-0.104. To estimate the true number of cases involving occupational circumstances from hospital-reported APP, one would multiply by an underestimation factor, in this case 1/0.045= 22.2; for the lower margin of the 95% confidence interval; the factor required would be 1/0.014 = 71.4 and for higher margin, the factor would be 1/0.104 = 9.6. Thus three under-estimation factors are generated for sensitivity analysis to adjust for under-reporting – a point estimate of 22.2, a high estimate of 71.4 and a low estimate of 9.6.

(ii) The contribution of different circumstances

In addition to the uncertainty about the true rates, there is also uncertainty about the cases whose circumstances of APP were unknown. Some proportion of these cases would have been due to suicide, accidents, homicides or occupational poisoning. Table 10.6 provides a sensitivity analysis for APP rates, allocating in columns 5 to 9 (a) all cases with unknown circumstances to suicide; (b) all cases with unknown circumstances to accidents/homicide; (c) all cases with unknown circumstances to occupational circumstances; (d) all cases with unknown circumstances distributed equally among suicide, occupational or accidents/homicide; and (e) all cases with unknown circumstances distributed proportionally to their existing baseline distribution for known cases (in proportion to baseline rates for suicide, occupational and accident/homicide circumstances of 6.71: 1.18: 3.67 (Table 10.6). The table models the contribution of different circumstances of exposure to the overall rates, by allocating cases with unknown circumstances to the different known circumstances under different assumptions, providing a second level of sensitivity analysis. Note: the total IR in Table 10.6 remains unchanged, since all that is being adjusted with each permutation is a different distribution of existing cases with unknown circumstances.

Table 10.6: Sensitivity analysis of rates per 1000000 of APP by circumstances – redistributing ‘unknown’ circumstances.

Circumstance	APP Rates per 1000 000 under different scenarios							
	circumstance (n) from Prospective data table	% by circumstance	No Redistribution	(a) all unknown to Suicide	(b) all unknown to Accident/Hom	(c) all unknown to Occupational	(d) unknown redistributed equally* to other categories	(e) unknown allocated proportionally# to other categories
(a) Unknown	44	19.13	2.74	0.00	0.00	0.00	0.00	0.00
(b) Suicide	108	46.96	6.71	9.45	6.71	6.71	7.63	8.30
(c) Accidental/ homicide	59	25.65	3.67	3.67	6.41	3.67	4.58	4.54
(d) Occupational	19	8.26	1.18	1.18	1.18	3.92	2.09	1.46
Total	230	100.00	14.30	14.30	14.30	14.30	14.30	14.30
Sum of circumstances other than occupational			13.12	13.12	13.12	10.38	12.21	12.84

(a+b+c)								

* Of the 2.74 cases of unknown circumstance per 1000000, 0.91 cases allocated equally to suicide, occupational circumstances and accident/homicide
# Of the 2.74 cases of unknown circumstance per 1000000, cases were allocated to suicide, occupational and accident/homicide circumstances in proportion to their baseline rates of 6.71: 1.18: 3.67

(iii) Application of under-reporting of community cases to the rate of APP from hospital surveillance data

Table 10.7 models the percentage contributed specifically by occupational causes to the overall APP rate (both at facilities and in communities), using, firstly, across the columns IRs derived from the different proportions allocated to occupational poisoning seen at health facilities (c, d and e, above), and then applying the high, median and low underestimation 'factors' (71.4, 22.2 and 9.6, respectively) to include community APP cases within each successive row in the occupational poisoning rates estimated.

10.5.2. APP rates using different modelling estimates

The true rate of APP due to occupational circumstances, including both facility-reported and APP in the community, for the study sites based on the lower margin of the 95% CI for under-reporting would therefore be between 11.3 to 37.6 cases/mill (Tables 10.7 and 10.8). Based on the upper margin of the 95% CI for under-reporting of community-based APP plus the allocation of all cases with unknown circumstances to occupational circumstances, the true rate of APP due to occupational circumstances rises to a maximum of 84.3 to 279.9 cases/million (Tables 10.7 and 10.8).

Table 10.7: Estimates for Community APP Incidence Rates (Cases / million) due to occupational circumstances – results of sensitivity analyses.

Under-estimation Factor*	IRs derived from the different scenario allocations# to occupational poisoning			
	Scenario (a) and (b) 1.18	Scenario (c) 3.92	Scenario (d) 2.09	Scenario (e) 1.46
9.6	11.328	37.632	20.064	14.016
22.2	26.196	87.024	46.398	32.412
71.4	84.252	279.888	149.226	104.244

Scenarios derived from Table 10.6 above.
* Under-estimation factors derived in section 10.3(i) above

Table10.8: Incidence Rates of APP.

	Adjustment factor for under-reporting occupational APP	Incidence Rates of APP (Cases/Million population)			
		No Allocation	(c) all unknown allocated to Occupational	(d) unknown allocated equally to all other categories	e) unknown allocated proportionally to other categories
Occupational APP reported in facilities*		1.18	3.92	2.09	1.46
APP other than occupational circumstances reported in facilities*		13.12	10.38	12.21	12.84
Under-estimation factor for Occupational APP#	9.6	11.3	37.6	20.1	14.0
	22.2	26.2	87.0	46.4	32.4
	71.4	84.3	279.9	149.2	104.2

* derived from Table 10.6 above

\# Under-estimation factors derived in section 10.3(i) above

The total rate of APP due to occupational and non-occupational circumstances for the study site, based on the lower margin of the 95% CI for under-reporting of community-based APP therefore ranged from 24.45 to 48.01 cases/million. Based on the upper margin of the 95% CI for under-reporting of community-based APP, the true rate of APP due to occupational and non- occupational circumstances ranges from 97.37 to 290.27 cases/million (Table 10.9). The implication of this modelling is that occupational circumstances are a substantially higher proportion than reported in routine surveillance. Depending on which scenario and which under-reporting factor is used in Table 10.9, occupational poisoning could comprise anything from 52.2% to 96% of all APP cases.

Table 10.9: Summation of occupational and non occupational IR.

Underestimation factor	Scenario	IR of APP (Cases/million) in occupational, non occupational and all circumstances)			
		Scenario	Scenario	Scenario	Scenario

		(a) and (b)	(c)	(d)	(e)
	Non occupational*	13.12	10.38	12.21	12.84
9.6	Occupational	11.33	37.63	20.06	14.02
	Total	24.45	48.01	32.27	26.86
22.2	Occupational	26.19	87.02	46.39	32.41
	Total	39.31	97.40	58.60	45.25
71.4	Occupational	84.25	279.89	149.23	104.24
	Total	97.37	290.27	161.44	117.08

* Non-occupational APP does not change within each scenario – only the under-estimation of occupational APP changes depending on the under-estimation factor used.

The modelled IR for APP found in this study ranging from 37 cases/mill to 279 cases per million is lower than rates reported in Nicaragua (23 000/million by Corriols, 2009), Bolivia (780/million by Jors, 2004) and Sri Lanka (3180/million by Van der Hoek, 2005) but close to rates reported by Henao (2002) of 200/ million reported in Central America. The higher IR in Latin America could be a result of higher exposure problems and perhaps the products handled were more toxic in nature than in Tanzania. Also differences could arise, as explained earlier, from the different methods used for data collection, with self-reported data used in the study by Corriols et al, 2009. However, at the very least, broadly speaking, it is clear there is better characterization of APP using the data in this study that puts the APP IRs in Tanzania in the same ballpark as that obtained in studies done in other countries.

10.6. Data completeness

Surveillance depends on the availability of good quality data. Missing data in the hospital studies was often due to failure by HCPs to complete the admission register books and patients' folders. These registers are filled in by different HCPs after attending to their patients. Some HCPs fail to complete basic information, perhaps due to the high pressure of work resulting from staff shortages. A few register books reviewed had some columns incompletely filled, affecting, for example, data on outcome or circumstances of poisoning. The most critical missing information in the registers was the patient's folder registration number, which resulted in a failure to locate the folders and hence patient information. Within patient folders, details were sometimes completed in the wrong sections. For example, the diagnosis could sometimes be found in the history section, whereas the diagnosis section would only list the term "poisoning" or "suicide" or, in some cases, provide no diagnosis at all. In some cases, the register books were damaged such that some of the pages containing important information were missing or damaged.

Comparison of data collected found that there was less missing data in the prospective hospital review for the variables: poisoning agents, outcome of poisoning, circumstances of poisoning and age (Table 10.10). The improvement in data quality in the prospective study is likely to be due to training and awareness creation at the start of the study. The substantial reduction in missing data (by 24.1% for circumstances, 9.9% for agents responsible for poisoning and 12.3% for outcome of poisoning and 1.1% for age) suggests that, with good training and awareness creation, it is possible to improve reporting.

Table 10.10: Missing data across the six sub-studies.

Missing Data	**Prospective study (10 facilities)**	**Retrospective study (10 facilities)**	**Retrospective study (All facilities)**	**Local Newspapers**	**Household**
Poisoning Agent	51.2%	61.1%	59.3%	27.2%	29.5%
Outcome of poisoning	19.6%	31.9%	26.5%	0.0%	-
Circumstances of poisoning	18.7%	43.2%	41.0%	4.3%	-
Age	5.7%	6.8%	5.6%	0.0%	0

Although newspapers reports had the lowest percentage of missing data on agents responsible for poisoning, this is probably a result of the fact that it is unlikely that editors will entertain cases for publication in which the agents are unknown. In other words, reporting the pesticide agent is part of the 'news' on which the report is based so this finding is expected.

In contrast to the sources in Table 10.10, the police database included no details on agents responsible for poisoning apart from the term "chemical" and the only circumstances reported in police database was suicide. Further, all outcomes in the police database were fatal. This means that the police data are not helpful in surveillance as currently designed. To serve surveillance functions, the database would need a revision of data collection tools to accommodate all necessary parameters and to include non-fatal APP.

Circumstances of poisoning were reported more comprehensively in the hospital reviews where at least each of the three main circumstances was represented. Since the majority of cases provided a history of how the events happened, this implies that defining a case based on a history alone, though not recommended by the IPCS (Thundiyil et al, 2008), may still be a valuable approach, especially in areas without laboratory facilities and expertise.

Figure 10.4: Venn diagram showing high estimate for occupational APP in relation to non-occupational and all APP Incidence Rates.

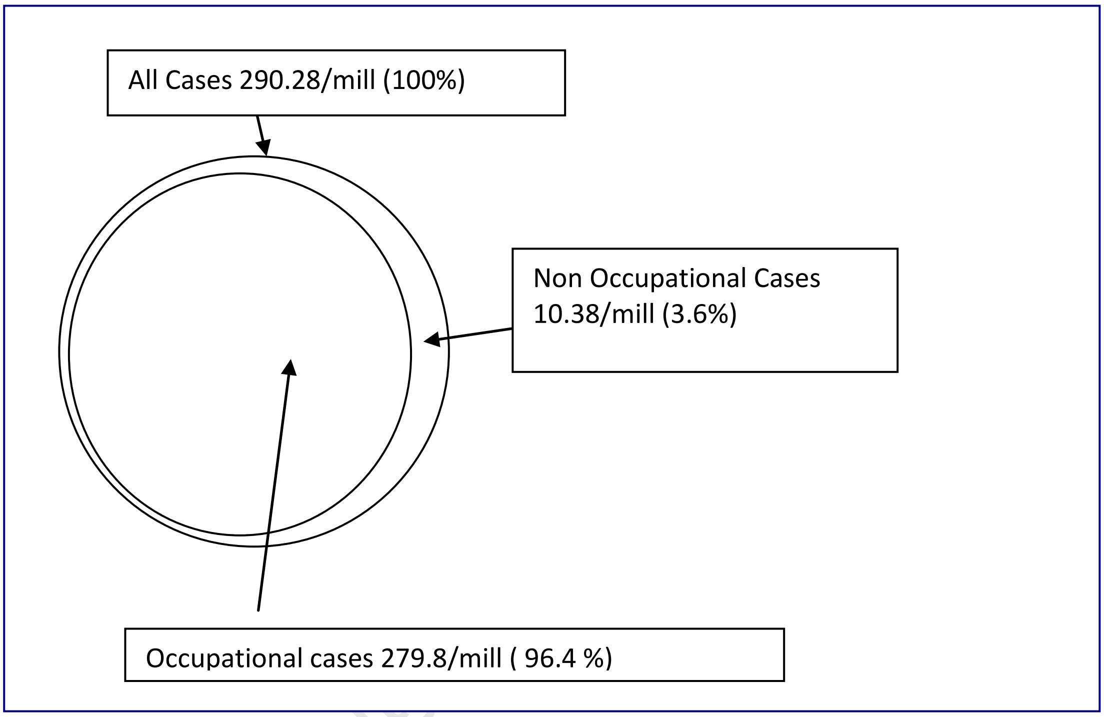
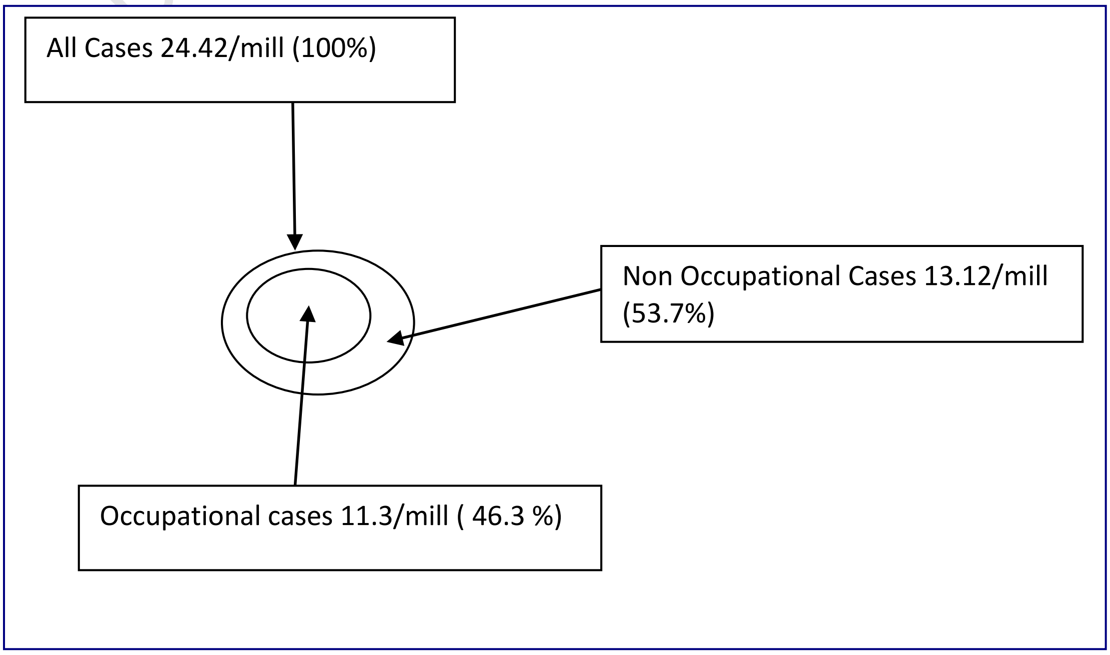


Figure 10.5: Venn diagram showing low estimate for occupational APP in relation to non-occupational and all APP incidence rates.



10.7. Implications for surveillance under the PIC reporting system

The Rotterdam Convention on Prior Informed Consent (PIC) relies on a reporting system to identify agents that are hazardous under normal use conditions in developing countries with a view to including them in the listing of chemicals falling under its provisions. Table 10.11 lists the data requirements under the PIC Convention for reporting of these Severely Hazardous Pesticides and the extent to which such data were obtainable under prospective data collection conditions in this study, which are conditions probably most favourable for comprehensive data collection (See also annex 16).

Table 10.11: Data requirements under the PIC provisions for reporting a Severely Hazardous Pesticide.

Data Element	Specific agent	Non-specific agent	Unknown agent
Trade name	√	X	X
Formulation	X	X	X
Active ingredient (s)	√	X	X
% Active ingredient	√	X	X
Copy of label	X	X	X
Common and recognized use of the product	√	√	X
A clear description on how the incident happened.	√	√	√
Date of incidence	√	√	√
Location	√	√	√
Sex	√	√	√
Age	√	√	√
Activity during exposure	X	X	X
Was PPE used	X	X	X
List PPE used	X	X	X
Application method used	X	X	X
Crops/ animals treated	X	X	X
Pesticide in original container	X	X	X
Product has label	X	X	X
Was exposed able to read label	X	X	X
Were other individuals affected	X	X	X
Signs and symptoms	√	√	√
Route of exposure	√	√	√

After how long symptoms occurred	X	X	X
Treatment given to patient	√	√	√
% Missing data elements	12/24 (50%)	15/24 (63%)	16/24 (67%)

√ - Data available X- Data missing

Table 10.11 shows that for different typical agents reported in the prospective study as responsible for poisoning, a high proportion of data would be missing when compared with PIC requirements. For cases of poisoning in which the causative agent was reported as non-specific, 63% of the required variables were missing; when agents were unknown, the proportion was 67% and for cases where the agent was specifically identified, the proportion of missing variables was 50%. In other words, only 33% - 50% of the information needed for PIC notification was available in the hospital notification system under prospective data collection. Even for those agents specifically reported by trade name or active ingredient, about 50% of the data required for a PIC notification would be missing for a Severely Hazardous Pesticide report. The lack of important details regarding hazardous pesticides formulations under normal conditions of use in developing countries may result in many poisoning cases not qualifying for review under the PIC provisions and chemicals avoiding possible inclusion in the PIC list even when they pose serious hazards.

Investigations in Senegal on two highly toxic formulations containing carbofuran for seed treatment, Granox and Spinox, showed that the products were responsible for hundreds of poisonings and at least 20 fatalities in 2000. These were reported under the PIC system and, as a result, the Senegalese authorities became the first developing country regulators to notify a highly hazardous pesticide formulation under the PIC procedures, to alert decision makers in other countries of the danger posed by these particular products (Dinham, 2002). The fact that another developing country has been able to use APP reports to action control measures on a hazardous pesticide is an important example for Tanzania. It is therefore recommended that any surveillance system to be established in Tanzania should aim to ensure an improved notification system consistent with the PIC requirements. The findings from this study, indicating large gaps in data, show the impact of the absence of a comprehensive surveillance system.

CHAPTER 11.0: Conclusions and Recommendations: A proposed national surveillance system for acute pesticide poisoning in Tanzania

11.1. Summary of findings

The study has revealed that pesticides are extensively used in Tanzania and many farmers have poor handling practices involving storage of pesticides in their houses as well as unsafe disposal of unwanted pesticides and empty pesticide containers. Many farmers have little awareness and knowledge of acute pesticide health effects. Some of the farmers do not use PPE during handling and do not practice safe storage. Although they are reasonably well aware of routes of exposure to pesticides, their hygiene practices are poor, perhaps indicating factors beyond their control influencing their safety practices.

The majority of pesticide poisonings experienced by farmers as reported in the household survey (Chapter 4) are occupational in nature and most (over 90%) are not reported to health care facilities and, as a result, they likely to be omitted in surveillance data and hence contributed to under-reporting. The study found that the proportion of APP contributed by occupational circumstances was 46.3% at lower estimates and 96.4% at higher estimates. Common poisoning symptoms encountered by farmers were documented. Products commonly used by the farmers, the majority of which were OP and WHO class II agents, were the same as those they linked to poisoning and were consistent in their toxicological profile with the symptoms reported by farmers.

Although many APP cases are seen in the hospital system, the HMIS provides only summary data with few details on circumstances, outcomes or agents responsible for poisoning. Some of the information missing in the HMIS data summaries can be retrieved manually from register books and patients' folders but this is a laborious process. APP data from sources other than hospital systems were effectively non-existent (government chemistry laboratories), unusable (Police mortality records) or severely biased and missing much information (local newspapers).

The study also examined the knowledge and practice of HCPs and found that the majority are not conversant with pesticides' adverse health effects, and not sufficiently knowledgeable about the diagnosis and treatment of APP. This means that many APP cases are not accurately diagnosed and are neither receiving appropriate treatment nor being properly reported through the HMIS, which impacts negatively on surveillance for APP in Tanzania. Common agents linked with poisoning cases as experienced by the HCPs based on the limited cases handled were identified and they included WHO Class II products. However, APP cases handled by the HCPs were reported through the HMIS with few details. The lack of diagnostic skills among the HCPs was one of the factors contributing to under-reporting of APP cases in Tanzania.

The study also confirmed that pesticide stakeholders viewed APP as a serious problem in the Tanzanian community, which they believed was mostly due to occupational circumstances.

Pesticide stakeholders made a number of important recommendations regarding improving APP notification including involvement of staff from government departments other than Ministry of Health and Social Welfare in the collection of APP data. This was an encouraging finding because some pesticide stakeholders in this study had very important responsibilities in the implementation of appropriate interventions. Due to the influential role of these stakeholders in the community and their direct involvement in decision making, their perception that APP was a serious problem in the community suggested a high probability of successful intervention strategies.

Despite much missing data, the characterisation of these APP cases suggested that: (i) among agents responsible for poisoning, OP and WHO Class II products were evident; (ii) all age groups were affected by APP but the most common age category for APP was 21 – 30 years and older victims more likely to suffer fatal outcomes; (iii) the major circumstances of poisoning for cases reported in health facilities was suicide; (iv) In general, Case Fatality Rates were low and there were few APP survivors who were recorded as developing long-term disabilities.

Taking into account that no rates for APP have ever been estimated previously in Tanzania, this study has presented the first APP rate estimates for Tanzania in terms of incidence rate, mortality rate and case-fatality ratio. Further studies are necessary to improve the accuracy and reliability of the rates established.

The data collected in this study demonstrated large volumes of missing information on the agents responsible for poisoning, circumstances of poisoning and outcome of poisoning, which is largely due to the absence of a sound surveillance system for APP. However, the improvement in data quality in the prospective study and reduction of unknowns is a clear indication that with proper training and awareness creation, surveillance systems can better capture the majority of the APP cases.

The study further found that pesticide distribution in Tanzania by pesticide retailers is accompanied by many unsafe practices including selling of products repackaged or decanted in secondary containers, many of which were unlabelled or poorly labelled, as well as the distribution of spilling products, and unsafe disposal of empty unwanted pesticide containers. This situation was likely to contribute to the burden from APP affecting the retailers themselves as well as the farmers. The study found consistency between the pattern of products sold by pesticide retailers and those found to be associated with APP, suggesting that surveillance should not only be for APP but also should keep track of retailer sales.

It has been shown in this study that the true rates for APP in Tanzania are higher than found in routine health facility surveillance. Modelling suggests that the IR for occupational poisoning is likely to range from 11.3 to 279.8 cases per million with a medium estimate of 32.4 cases per million. Despite under-reporting of APP cases, a common practice in many developing countries, the calculation of these rates is a first for Tanzania and perhaps for the SADC region. Review of the literature (Chapter 2) indicated that there are few studies on surveillance of APP in the SADC region; data generated will therefore be useful as a baseline for future studies.

Data collected on APP in this study showed that only 50% - 67% of data needed for PIC notification could be located in existing surveillance tools. This is due to the absence of a surveillance system for APP in Tanzania and the fact that PIC system demands many parameters in the data collection.

11.2. Implications for surveillance

Over the past 20 years, concerns about environmental health related to pesticide exposure have led to growing demands on health and environmental agencies to provide data on the impact of pesticide exposure on human and environmental health (CDC, 2005). A number of factors increase the pressure for surveillance in Tanzania: a) High consumption of pesticides in Tanzania (See section 1.1 in Chapter 1); b) High morbidity and mortality from APP (Chapter 5 and 10); c) diversity of agents used as pesticides in Tanzania (there are about 450 pesticide products registered for various uses in Tanzania (United Republic of Tanzania, 2008; Chapter 4 and 8 point to a diversity of productsin use; d) poor safety knowledge and practices among users of these products (Chapter 4); e) poor capacity of HCPs to identify APP cases and notify cases that are diagnosed (Chapter 6). In the absence of a reliable and valid surveillance system, the extent of poisoning caused by these chemicals is unknown. A comprehensive surveillance system, providing valid and reliable data on APP in Tanzania, is therefore essential for identifying emerging pesticide problems, estimating the magnitude of pesticide poisoning and evaluating intervention efforts for preventing APP.

The system proposed below aims to address poisoning arising from pesticides in workplace and non-workplace settings and is consistent with previous research recommending the establishment of a national surveillance system for APP (Ngowi, 2002a). The proposed surveillance system is expected to identify outbreaks of APP, identify circumstances and outcomes of pesticide poisoning, identify agents responsible for poisoning and identify poisoning patterns by gender, age, population groups and geographical areas most affected. Finally, the system is expected to generate estimates and trends for pesticide poisoning, identify opportunities for prevention, further research needs and, ultimately, assist in reducing health risks arising from pesticide poisoning.
The proposed system shall have easy case definition and data collection tool with few variables, easily accommodate changes in the proposed data sources, have proper data evaluation for quality, accommodate different data sources, conducts correct case classification to potray the realistc burden of poisoning and cover the whole country.

11.3. Proposed operation of a national Acute Pesticide poisoning surveillance system in Tanzania

11.3.1. Sources of Information

Different data sources for APP should have an agreed case definition. To define APP in each data source there should be SOPs which indicate what should be reported and what criteria a case must meet to be reported. A case should at least meet the clinical picture of APP with a history of exposure (Thundiyil et al, 2008); alternatively be self-reported from the community with about 25% of the cases verified by well-trained environmental health officers or extension officers or lastly be reported in the media.

(a) Health Care Facilities

In 2004/2005, Tanzania had a total of 5379 health facilities including 219 hospitals, 481 health centres and 4679 dispensaries (United Republic of Tanzania, 2006; Chapter 5). In order to improve the HMIS of Tanzania, there is an urgent need to collaborate with the Ministry of Health and Social Welfare to make APP a priority reportable disease condition in Tanzania. This issue was partially discussed and the Ministry was positive during the initial APP training implemented as part of the study in January 2006. The other important activity needed is to modify the data collection tools used by HMIS to accommodate necessary parameters for APP for example circumstances of poisoning, details on the agents responsible for poisoning, nature of exposure and many others.

Health facilities are likely to collect data on more severe pesticide poisoning cases but are unlikely to capture non-severe poisoning cases, most of which are usually not reported to health care facilities. For this reason, facility-based surveillance should be complemented by community-based surveillance methods.

(b) Community

Community surveillance is a system whereby health events occurring in the community are reported and recorded by the community through an established notification system. For example, the FAO Integrated Pest Management Programme for Asia (FAO/IPM) has developed a farmer self-reporting system for pesticide poisoning using special reporting forms. Trained community members (farmer field graduates) collect the completed forms weekly and then summarize the data into graphic form for presentation back to the participating community for discussion on a monthly basis. A local physician attends each of these meetings and adds any pesticide poisoning cases seen in the local clinic from the preceding month (FAO, 2001). A similar self-reporting system for APP cases by community members has also been successfully implemented in Vietnam (Murphy et al, 2002). Community surveillance in Tanzania should complement facility-based surveillance.

Given the complexity and scale, community surveillance would be best implemented by starting with regions already familiar with community monitoring like Arusha and Morogoro and then expand to regions which were earlier selected for the prospective and retrospective APP studies. Later, other regions would follow based on the availability of environmental health officers and extension officers to support community surveillance.

Data collection tool for community monitoring shall involve few variables but well collected. Tha variables shall include demographic data, place of poisoning, exposure date, symptoms/signs, agents responsible for poisoning, circumstances of poisoning, whether the person was refered and outcome of poisoning as outlined in annex 15. The tool with fewer variables is anticipated to be much better than PIC data colledction tool which has 45 sets of questions and have 14 pages (Annex 16).

The completed data forms from community surveillance would be collected by village extension officers assisted by village community leaders. Implementation of community surveillance will require thorough training and awareness-raising to be held at WHASA center at TPRI among farmers, who will be supplied with data collection tools at household level in each participating village. Farmers will report every time they are poisoned and may also collect data about other victims they know of.

Community surveillance would be done in collaboration with other partners: Agenda, Work and Health in Southern Africa (WAHSA) and through the PIC mechanism. The Work and Health in Southern Africa (WAHSA) Programme was inaugurated in October 2004, supported by the Swedish International Development Cooperation Agency (SIDA). The overall purpose of the programme was to contribute to poverty reduction by socio- economic development in the SADC region through improvements in occupational safety and health. The programme consisted of ten projects, including research, training and development aspects. Significant advances have been made in occupational health and safety in Southern Africa through the programme, as well as learning about the complexities of running regional programmes (WAHSA, 2008).

AGENDA is a non-governmental organization registered in Tanzania whose mission is to strengthen the public's role in promoting sustainable development and a clean environment by improving the efficiency of resource use, reducing risks and hazards associated with chemicals, minimizing waste, and safeguarding environmental quality (see http://www.agenda-tz.org/vision.asp). Major activities of AGENDA relate to chemicals and chemical waste management, solid waste management, biodiversity conservation, coastal and integrated environmental management and environmental planning. AGENDA uses the FAO self-reporting package from East Asia and is working with TPRI in a small farming community in Arumeru district in Arusha, and in Mgeta and Turiani districts in Morogoro to pilot community self-reporting of APP, which is also being undertaken by WAHSA at Ngarenanyuki ward in Arusha. The Ministry of Agriculture, Food Security and Cooperatives (MAFS) has also started community self-reported APP studies in Kilolo district in Iringa region (which has extensive vegetable cultivation) as part of its PIC commitments. These pilots appear to be working successfully to capture data (Ngowi, 2010), particularly non-severe poisoning cases but harmonization of these different surveillance activities will be needed in future as the surveillance system is developed.

It is anticipated that the system will capture all poisonings, including non-severe and occupational poisoning, which are usually not reported to health care facilities, other non-occupational cases, including mass poisoning cases, and severe poisoning cases which are commonly reported to health care facilities. The data collection tool should also capture information on the activity at time of exposure, and type of exposure (e.g drift, leak/spill or direct spray). Double counting will be prevented by proper completion of all entries as outlined in Annex 15 with clear patient identifiers and thorough investigation of the collected report to delete repeat entries. Cases reported at community level may need verification, which could be conducted by well-trained environmental health officers or extension officers to distinguish "confirmed" from "unconfirmed" cases. Confirmation of the poisoning cases may also be done by ACHE testing to act as a quality check of those cases where an OP has been clearly identified and where the OP exposure is less than two weeks old. This will be done taking into account that OP dominate in the agents responsible for poisoning as reported in farmers household survey (Chapter 4), stakeholders survey (Chapter 6) and hospital review (Chapter 5). The selection of cases for such measurement will be done randomly.

The proposed surveillance system could both report and track the ratio between confirmed and unconfirmed cases over time. In due course, we anticipate the ratio to increase as the capacity to verify APP improves. By combining the two categories the system will capture both severe and non-severe APP cases. In practice no single source is adequate to capture all APP cases.

(c) Media

Local newspapers will also be utilized as a collateral source of APP injury data, expected to capture mainly severe poisoning cases that are 'newsworthy'. APP cases in news reports will be matched against cases recorded in the APP database held at TPRI. If the case is not found in the database, it will be thoroughly investigated and, if found to meet criteria for reporting, it will be added. In this way, newspaper reports can bolster the hospital based system.

All local newspapers will be monitored. It is anticipated that some of the APP cases reported in the media will have information sources published. A small proportion of the reported cases (5%) will have the information source contacted for verification of the reported cases. The primary information source in this case would be a health facility, police or other government institution. In a comprehensive surveillance system for APP with different data sources, hospitals and media sources could be placed in one category because both sources provide detail on circumstances, agents and outcome although the media sources tend to report more severe cases. The comprehensive surveillance system would use the media sources to track whether such patients were admitted to hospital but missed in routine reporting. This will reduce the risk of double counting APP. Another reason could be the fact that cases reported in hospitals and media are likely to be notified by HCPs and this indicates that they may be well evaluated.

(d) Other Sources

The Ministry of Home affairs (Police Department), which collects information on mainly fatal cases resulting from criminal offences, will be requested to participate in the surveillance system. This data source will capture APP cases which are subjected to legal intervention, including suicide and homicide. Where other circumstances, such as occupational or accidental circumstances are present, but involving legal intervention, data will also be collected from this source.

For the purpose of APP surveillance, a harmonized data collection tool (see Annex 15 for draft), will meet both the forensic requirements of the police and the criminal justice system and the surveillance requirements of the Department of Health. Cases reports collected from the police will include fatalities and data collected will include victim identity, agent responsible for poisoning, exposure details and facility attended (for confirmation reasons). Hospital reports for about 10% of the cases collected by police will be further investigated for verification. The police data will be collected from each region and forwarded to the WAHSA center at TPRI for quality review prior to inclusion in the database.

Another source will be the Government Chemistry Laboratory Agency (GCLA) which is under the Ministry of Health and Social Welfare. GCLA has one main laboratory in Dar es Salaam and sub-stations in Arusha and Mwanza regions. Among other activities, GLCA is responsible for testing in forensic poisoning cases for medical and legal reasons and for tests needed for a clinical diagnosis. All APP data compiled at GLCA will be collected using a harmonized questionnaire (Annex 15). Data collected from GLCA will be submitted to WAHSA center at TPRI.

The Occupational Safety and Health Authority (OSHA) is another potential source of data on APP. OSHA is a Government Executive Agency established by the Executive Agencies Act No. 30 of 1997. Its main function is to advise the Government on all matters related to Occupational Safety and Health activities in the country by enforcing the Occupational Safety and Health Act No. 5 of 2005. It also conducts research, consultancy and training in Occupational Safety and Health. Since this agency is responsible to collect data on injuries arising from occupational activities, it will be requested to include and give priority to the collection of APP data arising from occupational circumstances, which is a major problem. This source may be useful to address the problem of under-reporting of occupational APP cases. The data will be collected using the harmonized questionnaire in Annex 15 and forwarded to WHASA centre at TPRI for compilation.

Finally, In collaboration with pesticide inspectors the proposed surveillance system will track the active ingredients distributed to farmers by retailers on quarterly basis. This information is anticipated to give an indication of the agent potentially associated with hazardous exposures and future poisonings. Data in Chapters 4 and 8 indicated that the patterns of poisoning symptoms were consistent with the pattern of products distributed to the farmers. This suggests that surveillance of usage and distribution of pesticides might be an important strategy for public health prevention.

11.3.2. Data processing and quality

Under the proposed system APP, data will be collected from health care facilities in each region using a dedicated data collection tool in a phased process. In the first 3 years of implementation, Northern Tanzania will be selected and all referral, regional, district, health centres and dispensaries will be included. In the following 3 years Southern highlands will be included. Eventually, surveillance will be rolled out to the whole country.

Various options are available for data transfer to TPRI. Preferably, the data will be submitted by electronic mail to the WAHSA centre at TPRI. This process is relatively cheap and reliable in Tanzania taking into account widespread availability of internet across the country, including internet facilities in communities and at many health care facilities. It is anticipated that the costs for internet will decrease with time due to the introduction of fibre-optic cabling. Nonetheless, periodic lack of internet connectivity may pose a problem, and the Health Services will have to invest in ensuring reliable internet services for surveillance to be functional. Staff will be earmarked to be responsible for data transfer for the system to work.

Alternative methods include posting data by public buses or courier. Bus systems are already used by the TPRI for sending documents to sub-stations in Dar es Salaam and Mbeya region. Public buses travelling from Arusha to other regions deliver mail between regions within 10 hours. Such a service is relatively cheap, reliable and reasonably fast. The data can also be sent by postal mail through private courier services (e.g. EMS Service as well as DHL systems). While these are slightly more expensive, they are reliable and deliver documents directly to the home or office.

The last option for data delivery is telecommunication. Mobile telephone communication is cheap and convenient. Both state and private operators are present in Tanzania, and competition has reduced costs for mobile telephones services tremendously. Mobile telephones can reach remote areas and data collection can be set up to receive SMS notification. Fax services are feasible but are expensive and limited to mainly urban areas.

At the start of implementation, these data delivery methods will be tested to see which method or which combination of methods would work best.

(a) Frequency of data submission.

Data from the various sources community surveillance will be reported to the WAHSA centre at TPRI at 3 monthly intervals. Community surveillance data will be directly reported to the WAHSA centre, while the data from police departments and GLCA will be compiled by the respective staff member selected as a focal person prior to forwarding. ed to the WAHSA centre every 3 months. Similarly, data from health care facilities will be the responsibility of nominated focal persons responsible for compilation and transferring. Sources who are late in submission will be routinely contacted to ensure no data are lost.

(b) Dealing with double counting

The victim's identity needs to be sufficiently detailed to avoid double counting, bearing in mind that one person can be poisoned more than once. A unique identifier namely citizen identification cards, will be introduced in Tanzania in 2012 and will be linked in the surveillance system to poisoning records, in order to screen out cases counted on multiple occasions. Cases appearing to have duplicate entries will be investigated by the staff under TPRI WHASA Centre. If the same case is reported in more than one source but the details are not consistent, clarification will be sought from the different data sources, to give an opportunity to correct data entry errors. If the findings from the data sources are still inconsistent after seeking clarification, the data reported by a HCP will be selected over data from any other source.

For all cases reported in hospitals, investigations will check if the case has been reported in any other health care facility. For cases reported from referral hospitals, the reference letter will be used to identify the referring facility in which reporting of the case may have been duplicated. After clearning for duplication, the data will be consolidated in one database.

11.3.3. Awareness campaigns and institutional collaboration

Before implementing the system, sensitization campaigns will be held to introduce the system to decision makers and relevant stakeholders in the Ministries of Health and social welfare, Agriculture Food security and Cooperatives as well as other related government departments, the OSHA, the Police and communities.

Mass media campaigns will be used to raise awareness on the need for APP surveillance system. For the public, the objective will be to promote notification of APP cases as well as reducing hazardous exposures. The media campaigns will be supervised by TPRI in collaboration with the Ministry of Health and Social Welfare, Ministry of Agriculture, Food Security and Cooperatives and other relevant government departments.

Sensitization campaigns will be conducted to ensure the inter-sectoral collaboration needed for coordinating data across different government departments and also to ensure that the surveillance activity is given priority and budget allocation within government departments. Surveillance will be coordinated at the WHASA centre at TPRI and participation will be sought through the office of the permanent secretary for each relevant Ministry. This approach proved very effective in the training on APP conducted in January 2006 (Chapter 5).

11.3.4. Training of data collectors

Training on how to complete the data collection tool will be run for nominated data collectors including public health officers, police officers extension officers, forensic staff from the GCLA, community leaders and staff from OSHA. Training will be conducted at TPRI preferably once a year and refresher training may be organized every 5 years. Where target groups require additional information, such as pesticide classification, diagnosis and treatment of APP, the tool can be adapted by each data source by adding variables. As reported in other studies, training of data collectors has been found to be critical for improving notification and the quality of surveillance data in surveillance systems (Balbus et al., 2006; Henao, 2002).

11.3.5. Data compilation and analysis

The collected data from all sources will be evaluated to check (a) whether the reported case meets the standard case definition which shall be the same for all sources; (b) whether variables related to the case are missing; Cases not meeting the criteria for the standard case definition as outlibed in 11.3.1 above will be omitted. Missing data such as the active ingredient of the poisoning agent may be obtained from other relevant references, such as, the list of registered pesticides in Tanzania or Pesticides registration dossiers at TPRI. After proper evaluation of the reported cases there will be an official authorization by the data manager at TPRI so that the case can be included for analysis.

The complete dataset will be compiled and analyzed at WAHSA centre at TPRI. There are a number of reasons why the TPRI may be the preferred location for a national APP surveillance system. Firstly, agriculture extension officers and scientists are well placed to serve as trainers of other personnel in APP surveillance and training could be coordinated from the TPRI. Secondly, pesticide researchers particularly those involved in the Toxicology section (not law enforcers) can assist data collection and training. Thirdly, the TPRI has highly trained and experienced staff and laboratory facilities available, which can assist in the diagnosis and verification of poisoning cases. This proposal was recommended in the first training on APP held in Arusha January 2006 (TPRI, 2006) and has received verball support from the Ministry of Health and Social Welfare in Tanzania during an official visit in January 2005 by the study PI and the Director of Preventive Services in Dar es Salaam (personal correspondence).

Data analysis is an essential component of the surveillance system and will assist in identifying the most problematic pesticides, the risk factors associated with APP-related illness, and emerging trends in terms of person, place, and time in order to identify factors amendable to intervention.

Person-based analysis: This shall involve case series which will focus on individuals. This is the most basic level of data analysis and presentation. It will present a distribution of case characteristics including poisoning severity, circumstances of poisoning, age, sex, agents responsible, and outcome of poisoning.

Bivariate comparisons: This shall involve examination of association between variables. For example, an analysis of pesticide active ingredients and severity categories can assist in identifying the most problematic pesticides. Also, analysis of associations between circumstances of poisoning and fatal outcomes may reveal the most problematic circumstances. Analysis can identify associations with risk factors that will enable particular populations to be targeted for outreach, education, or further study and can also examine associations between pesticide chemical class or functional class and risk factors such as demographic characteristics, occupation and industry.

Rates: Ideally, outcome data should be expressed as rates. This will require accurate characterization of denominator data. If the data sources have clear population boundaries, population denominators can easily be estimated. As the system is rolled out through the country, it will be geographically based and population denominators will be used to estimate rates. Because the population size changes over time and differs across regions, it is important to examine time and area trends through rates and not counts.

Timed-based analysis: This will be conducted to determine whether trends are evident over time. Data comparing the rates reported in different years can indicate shifts in the pattern of occurrence. Graphics can provide visual illustrations of the impact of changes in program outreach efforts, introduction of a new pesticide product or regulations restricting the use of a product.

Place-based analysis: This will involve mapping of data to show the geographic distribution of cases. This analysis can be a useful tool for presenting information and for examining the relationship between cases and sources of exposure.

Reports will be compiled every six months by an earmarked team at TPRI. The effectiveness and coverage of the surveillance system will be assessed by evaluation of trends over time of, for example, the extent to which the the surveillance system pick up poisonings from sources other compared to HMIS, a proportion which may be low to start, but rise later. Similarly changes in the proportion of confirmed, unconfirmed or discounted cases may also be tracked over time.

11.3.6. Data dissemination

Data dissemination is another critical function of the proposed surveillance system. The control and prevention of APP-related illness will depend on the timeous dissemination of surveillance data to ensure that educational, consultative, and regulatory interventions as well as programmes based on the full hierarchy of controls are effectively targeted. Keeping partners informed can promote visibility and support for surveillance. A South African study indicated that giving timeous feedback to those who notify is likely to motivate them to report better (London et al, 2001). Similarly, another US study confirmed that data distribution to potential reporters has been found to motivate them to continue reporting (Calvert et al, 2004).

A range of reports should be produced from the surveillance system and distributed to surveillance partners, depending on the intended audience and the purpose of the report. In general, reports compiled shall be detailed enough to be well understood by the stakeholders but brief enough to encourage easy reading. Reports prepared for the public or for HCPs should be brief and the content limited to one or a few key messages.

Detailed reports will be more appropriate for health care facilities and the Ministry because these are the organs responsible for planning and implementation of interventions and formulation of policies. Having detailed information on the burden of disease arising from APP will enable them to understand the risk factors and potential solutions in detail in order to design appropriate policies and interventions. Detailed summaries will also be forwarded to the Tanzania Bureau of Statistics and be made available to all stakeholders through the Tanzania Bureau of Statistics website (http://www.nbs.go.tz). In addition, materials will be prepared for distribution to the Office of Tanzania Parliament in Dodoma for distribution to parliamentarians in order to argue for recognition of APP as a priority problem in the community requiring greater budget allocation for interventions. The data will be communicated to farmers and the community through agricultural shows conducted annually in August in Tanzania along with health promotion brochures alerting them to the serious health consequences of unsafe handling and use of pesticides. This may ultimately encourage safer handling and use practices and hence reduce health risks.

The data will also be analysed and written up for publication in the relevant scientific journals and newsletters as part of information dissemination and awareness creation. These will include both local publications and other international journals. The findings will also be presented in relevant national and international conferences.

In general, all data sources for APP in Tanzania will be coordinated under the new National surveillance system for APP. The system will therefore aim to capture all injuries/illness arising from APP in Tanzania and to provide reliable estimates to the local communities, national and international organizations. Having obtained reliable data, the Government will manage to plan and implement effective interventions for the purpose of reducing health risks arising from APP. The proposal for reducing health risks and improving notification for APP should involve close cooperation of all relevant stakeholders.

The proposed surveillance system will thus seek to conform to the attributes for good surveillance system namely simplicity, flexibility, good data quality, acceptability, sensitivity, representativeness, timeliness, predictive value positive, stability, reliability and validity as outlined in the proposed surveillance system above.

11.4 CONCLUSION

The study has identified a high burden from APP in Tanzania. However, the existing HMIS under the Ministry of Health and Social Welfare fails to document APP in ways that enable useful surveillance. This highlights the need to include APP in the list of priority reportable disease conditions as part of a national surveillance system. Data collection tools used by the HMIS should be modified to include all parameters necessary to extract APP information (Annex 15).

The study highlighted further the lack of coordination of some important potential APP data sources in Tanzania. Health facility data sources tended to capture mostly severe cases, missing non-severe cases. Community reporting is an important potential APP data source and is expected to capture the majority of the APP cases not reported to hospitals. This should be coupled with a range of other sources of information to ensure comprehensive capture of APP cases in Tanzania.

Finally training of HCPs in the proper diagnosis and treatment of pesticide poisoning will be essential to obtaining reliable and precise poisoning data, as will the training of data recorders to ensure a well-functioning and effective surveillance system for APP in Tanzania.

“This thesis began first as a Masters thesis but was upgraded in 2008 to a PhD. This explains in part the gap between data collection (2006) and completion of the thesis in 2012. Nonetheless, the findings remain relevant at the time of completion and are the subject of ongoing work in Tanzania to develop a system for surveillance for acute pesticide poisoning.”

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ANNEXURES

Annex 1:Active ingredients registered for use in vegetable production in Tanzania (Experimental products omitted).

Category	Active ingredient	Chemical group	WHO Class
Insecticides	Imidachloprid	Neonicotinoid	II
	Profenofos	Organophosphate	II
	Lambda Cyhalothrin	Pyrethroids	II
	Diazinon	Organophosphate	II
	Deltamethrin	Pyrethroids	II
	Cypermethrin	Pyrethroids	II
	Phosphamidon	Organophosphate	Ia
	Quinalphos	Organophosphate	II
	Acephate	Organophosphate	III
	Carbofuran	Carbamates	Ib
Fungicides	Copper oxychloride	Inorganic	III
	Sulphur	Inorganic	U
	Mancozeb	Dithiocarbamates	U
	Thiophanate Methyl	Others	U
	Dazomet	Others	III
Source TPRI List of Pesticides registered in Tanzania by 2006.			

Annex 2: Active ingredients registered for use in coffee in Tanzania (Experimental products omitted)

Category	Active ingredient	Chemical group	WHO Class
Fungicides	Cupric hydroxide	Inorganics	III
	Copper oxychloride	Inorganics	III
	Copper hydroxide	Inorganics	III
	Azoxytrobin	Others	U
	Cyproconazole	Triazoles	III
	Propineb	Dithiocarbamates	U
	Hexaconazole	Triazoles	U
	Chlorothalonil	Others	U
	Triadimenol	Triazoles	III
	Triadimefon	Triazoles	III
	Carbendazim	Others	U
	Cuprous oxide	Inorganics	II
	Dithianon	Others	III
	Propiconazole	Trazoles	II
	Dazomet	Others	III
Insecticides	Carbofuran	Carbamates	Ib
	Deltamethrin	Pyrethroids	II
	Chlorpyrifos	Organophosphates	II
	Cypermethrin	Pyrethroids	II
	Fenitrothion	Organophosphates	II
	Endosulfan	Organochlorines	II
	Profenofos	Organophosphates	II
	Fenvalerate	Pyrethroids	II
	Diazonon	Organophosphates	II
Herbicides	Atrazine	Trazoles	U
	Ametryne	Trazoles	III
	Paraquat	Other	II
	2,4-D	Phenoxycarboxylic acid	III
	Glyphosate	Others	U
Source – TPRI, List of pesticides registered in Tanzania by 2006.			

Annex 3: General pesticide poisoning symptoms

Organophosphates and Carbamates	**Organophosphates**	**Pyrethroids**	**Bipyridyls**	**Paraquat (**is very toxic to the skin and mucous membranes (inside of mouth, nose, and eyes). Particles are too large* to get deep into the lungs, but once paraquat is in the blood it collects in the lungs. If ingested (drink) it is very lethal)	**Thiocarbamates (**are similar to the pyrethroids in that they also are irritants to the eyes, skin and respiratory tract. The symptoms came appear immediately.
Mild: Fatigue, headache, dizziness, blurred vision, watering eyes, constricted pupils, excessive sweating, nausea, vomiting, stomach cramp, salivation, numbness and tingling sensation in the hands and feet. **Moderate**: Inability to walk, weakness, chest discomfort, muscle twitching, lack of motor coordination and, slowed heartbeat. **Severe:** Loss of consciousness, severe pupil constriction, shock, excessive secretions, breathing difficulty, convulsions, coma and respiratory failure.	Mild/Moderate: Nausea, vomiting Apprehension, excitability, Headache, dizziness, disorientation, tremors, muscular weakness, muscle twitching, tingling or pricking sensation on skin. Severe: Loss of coordination convulsions, hyper-excitability, unconsciousness and coma	Mild/Moderate: Headache, runny nose, dizziness, vomiting, salivation Severe: unconsciousness, convulsions and coma	Mild/Moderate: Coughing, chest pain, blackening of nails, abnormal nails growth, Nosebleed, eye inflammation, blistering of skin, transverse cracking of nails, respiratory problems and nausea. If ingested, burning in mouth and throat, ulcers of the mouth, difficulty swallowing, vomiting, diarrheal and stomach pain. Severe: Impaired liver and kidney function and progressive pulmonary failure are experienced.	**Skin (**dryness, cracks, erythema (redness), blistering, ulcerations. **Nails** (discoloration, splitting nails loss of nails). Respiratory track (cough, nosebleeds sore throat) **Eyes:** conjunctivitis (irritation) ulceration, scarring, blindness Ingestion (lung fibrosis (stiff lungs) multi-system organ failure, specifically, respiratory failure kidney failure	Respiratory (dry throat, sore throat, burning nose, coughing) Eyes(irritation, red eyes, burning, itching) Skin (itching, white spot, scaling, red rash)

Annex 4: Insecticide active ingredients registered in Tanzania by chemical groups.

Chemical class	Frequency	Percentage
Pyrethroids	145	54%
Organophosphates	53	20%
Others	34	13%
Carbamates	18	7%
Neonicotinoids	10	4%
Organochlorines	7	3%
Total Insecticides	267	100%
Source: The List of registered pesticides in Tanzania 2006.		

Annex 5 : Studies reporting on APP in African countries.

Country	Nature of study	Findings	Reference
Zimbabwe	Survey of APP cases admitted to eight major referral hospitals in Zimbabwe (January 1998 to December 1999)	**(a)Circumstances of poisoning** – Suicide (59%), Accidental (27%), Others (14%) **(b)Agents responsible** – Rodenticides (49.1%), Anticholinesterase products (with OP majority) (42.2%) **(c)CFR for all circumstances:** 6.8 death / 100 admissions (Males higher than females) **(d)CFR for suicide:** 6.5 deaths/100 admissions **(e)CFR for accidental:** 0.8 deaths/100 admissions	Tagwireyi et al, 1996
	ILO estimates for Acute pesticide poisoning	160,000 cases per year	ILO, 1980
Uganda	Deliberate self harm survey in three general hospitals in Kampala	**(a)Victims**: Majority were Males (63%) (b)Age group most affected: 20-24 years **(c)Significance**: High education, high social economic class and poor housing was significantly associated with deliberate self harm.	Kinyanda et al, 2004
	ILO estimates	240,000 cases per year	ILO, 1980
Nigeria:	Survey of medical-legal autopsies at the mortuaries of University of Benin Teaching Hospital (UBTH) and the State Government owned Central Hospital, Benin City from January 1996 to December 1997	**(a)Circumstances**: Suicide (19%), Homicide (1.8%) **(b)Victims**: Majority Males (82%) **(c)Common Methods**: Ingestion of toxic substance (46.2%).	Akhiwu et al, 2000)
Tanzania	Hospital based survey	62 APP cases/Year Majority –Suicide	Ngowi et al, 1992
	ILO estimates	388,000 APP cases per year	ILO, 1980
	Hospital data review in Dar es Salaam -	Suicide (17%), Poisoning by pesticides (29.2%)	Ndosi et al, 2004
Kenya	Review of district hospital records in Kenya 1987 – 1990	Occupational (n=8), Suicide (n=35)	Mwanthi et al, 1993
	ILO estimates for Acute pesticide poisoning	350,000 cases per year	ILO, 1980
South Africa	Review of notification in one province 1987 – 1991	Occupational (n=11), Accidental (n=44), Suicide (n=35)	London et al, 1994
	Hospital based survey	100-150 pesticide poisoning cases per year CFR 10% - 20% of hospital cases reported	London et al, 1995

Sudan	ILO estimates for Acute pesticide poisoning	384000 cases per year	ILO, 1980
Cameroon	ILO estimates for Acute pesticide poisoning	175,000 cases per year	ILO, 1980
Malawi	ILO estimates for Acute pesticide poisoning	128,000 cases per year	ILO, 1980
Senegal	ILO estimates for Acute pesticide poisoning	112,000 cases per year	ILO, 1980
Mauritius	ILO estimates for Acute pesticide poisoning	3200 cases per year	ILO, 1980
Benin	Survey of APP - May 2007 and July 2008	105 cases, including nine deaths, due to endosulfan	Badarou, Coppieters, 2009.
	Survey of APP - May and September 1999	(a) 37 deaths and 73 poisonings (farmers and others) were documented as a result of severe poisoning from Callisulfan (endosulfan 350g) in the administrative department Borgou. (b) In the following season research found 241 acute poisonings and 24 deaths, including those of 11 children aged under 10. These poisonings are both direct (occurred during or after application) and indirect (spray drift, consumption of contaminated products).	Ton et al. 2000, Tovignan et al. 2001
Mali	FAO estimate for APP in the year 2000	FAO estimated that acute pesticide poisoning affected 329 people a year, with 30 to 210 deaths and from 1150-1980 chronic poisonings.	FAO/CILSS 2000
Morocco	Survey of Anti poisoni center in 1992-2007	2609 cases of poisoning recorded at the Moroccan Anti-Poison Centre	(Rhalem et al. 2009).
Senegal	2002-2005	258 cases of acute poisoning listed in PAN Africa database based on surveillance and interviews	Thiam, Touni 2009).

Annex 6 : Questionnaire for household survey (Chapter 4).

1. Confidentiality:

The data obtained from this study will be kept strictly confidential and individuals involved will not be identified at any way in the reports. The personal information will be coded such that the names will not appear in any of the forms used for data analysis. The PI will have access to the names associated with the codes and this information will be kept in locked cabinets in his office and destroyed at the end of the study.

2. General Instructions:

For closed ended questions you are requested to fill appropriate answers (or tick) in the space provided. For open ended questioner you are requested to provide appropriate details on space provided. You may add extra details on a separate paper if the space provided is not enough. Unanswered questions will not be considered in the general evaluation.

3. Personal Information.

3.1.Date of data collection:----------------------- 3.2. Full Name:--------------------------
3.3.Address: --------------------------------- 3.4. Village:-------------------------------
3.5.District:----------------------------------- 3.6. Tel:--------------------------------
3.7.Date of birth:----------------------------- 3.8. Sex:[1] Male [2]Female
3.9.Number of children under 10 years:
[1]One [2]Two [3]Three [4.]Four [5]Over four
3.10. Level of education: [1]None [2]Adult Education [3]Std VII
[4]Form IV [5]Form VI [6] Certificate/Dpl [7]Degree and above
3.11. What is your main source of income:
[1]Farming [4]Business
[2]Animal husbandry [5]Employment
[3]Fishery [6]Mining
Others (Specify): --
3.12. What is the status of your Land ownership:
[1]Own Land [2]family Land [3]Rented
3.13. Do you smoke: [1]Yes [2]No
If Yes, How many timed per day do you smoke: --------------------------------------
3.14. Do you drink alcohol/ wine/ local beer [1]Yes [2]No

4. Poisoning Incidences

4.1. Have you ever had a pesticide poisoning: [1]Yes [2]No [3] Uncertain
4.2. If Yes, How many times in your lifetime:
[1]Once[2]Twice [3]Thrice [4]Four times [5]Over four times
4.3. Give details on how the poisoning incidence/s happened and mention products Responsible:

4.4. When you got poisoned what steps did you take:
[1]Attend hospital/ Health center 2]Consulted pharmacist
[3]Use traditional healing treatment methods 4]Drank milk
[5]Took raw egg [6]Use cream on affected part
[7]Did not take any step [8]Consulted witch doctors
Have you ever been admitted to hospital due to poisoning: [1] Yes [2] No

5. Poisoning signs and symptoms.

5.1. In the following list select symptoms which you have ever experienced in your life time:

No	Sign or Symptom	Tick	Period
1	Skin irritation		

2	Chest pain		
3	Coughing		
4	Flue		
5	Wheezing		
6	Breathing with difficulty		
7	Throat irritation		
8	High fever		
9	Excessive sweating		
10	Nausea		
11	Vomiting		
12	Excessive salivation		
13	Diarrhea		
14	Pain during urination		
15	Stomachache		
16	Tiredness		
17	Nose bleeding		
18	Blurred vision		
19	Lacrimation		
20	Eye irritation		
21	Loss of appetite		
22	Headache		
23	Dizziness		
24	Unconsciousness		
25	Hands trembling		
26	Sleepless nights		

Other: --

6. Protective gear.

6.1. List Protective gear which you use during pesticides handling:

----

7. Hygiene conditions.

7.1. Do you do the following while handling pesticides:

Eating [1]Yes [2]No [3]Sometimes
Drinking [1]Yes [2]No [3]Sometimes
Smoke [1]Yes [2]No [3]Sometimes
Other: --

7.2. Do you put washing facility around when handling pesticides: [1]Yes [2]No

7.3. Do you wash working clothes after handling:[1]Yes [2]No

8. Exposure routes.

8.1. Mention ways through which pesticides enter the human body:

----

9. Farming activities at household level.

9.1. Size of the farm in acres for each crop cultivated:

Crop	Size	Period
-------------------------------------	-------------------------	---------------------------------
-----------------------------------	-------------------------	--------------------------------

10. Pesticides at household level

10.1. List pesticide used by the household for agriculture pest, livestock and household pests in the year 2005:

10.2. Where do you store pesticides:

[1]In the bedroom [2]Sitting room [3]Designated pesticides tore

[4]Kitchen [5]Bath room [6]In the toilet room

[7]Common store [8]Under the roof

Other (Specify): ---

10.3. Pesticides found in store/ House at the time of visit:

Pesticide	Location	Condition	Qty
---------------------	----------------------	---------------------	----------------
---------------------	-----------------------	----------------------	----------------
----------------------	-----------------------	----------------------	----------------

11. Mixing of pesticides.

Before spraying, mixing of pesticide is done in the:

[1]Spraying Equipment [2]Container for keeping domestic water

[3]Special container for mixing only [4]Other

12. Application equipment.

12.1. Do you regularly calibrate your pesticide application equipment (sprayer)

[1]Yes [2]No [3]Rarely

12.2. Is the spraying equipment washed and cleaned after use:

[1]Yes [2]No [3]Uncertain

12.3. If the answer in 12.2 is Yes, in which location particularly are equipment washed

[1]Close to nearby river [2]In the lake [3]Close to canal

[4]Close to water tape [5]In the farm

12.4. Where is the application equipment stored:

[1]In equipment Store [2]In the House

[3]In the bedroom [4]In the living room

Elsewhere, Please explain: --

----

13. Disposal of pesticides and containers.

13.1. Mention disposal methods which you use for disposal of unwanted pesticides spray that remains in the spraying equipment.

---13.2. How are the empty pesticide containers disposed off:

[1]Burned [4]Reused for keeping drinking water, milk brew

[2]Buried [5]Returned to suppliers

[3]Crushed [6]Unknown

Other (Specify): --

----

14. Instruction on pesticides use

14.1. Where do you get instruction on pesticide use

[1]Through Label [3]From pesticide seller

[2]From extension worker [4]From TPRI

Other – Specify---
----

15. End.

Annex 7: Consent form for participating in a research project (Chapter 4, 6, 7, and 8)

1.Introduction

A research project on the surveillance for acute pesticide related illness and injury encountered by farmers and their families in Tanzania" is being conducted by Mr Elikana E Lekei the (PI) in the year 2004/2012. The research project is being supervised by the following:
(i) Prof Leslie London of the University of Cape Town, South Africa (Supervisor)
(ii) Dr Vera Ngowi of Muhimbili University of Health and Allied Sciences (MUHAS), Tanzania (Co Supervisor).
The purpose of this consent form is to provide you with the information that you need to enable you to decide to participate in the study and to inform you of the nature, purpose and risks involved in the study. Your participation in this study shall involve filling of the research questionnaire or proving information for filling the questionnaire, which shall be provided by PI.

2.Purpose of the Research:

This study is aimed at collecting information on acute pesticide poisoning for the purpose of revealing health injuries caused by pesticides. It will also assist in the development of a National comprehensive surveillance system for acute pesticide poisoning and plan for the necessary interventions in order to reduce mortality and morbidity. Individuals identified to be injured by pesticides will be directed to the relevant medical facility.

3.Risks for participation:

There are no any risks associated with your participation in this study.

4.Benefit of Participation.

There is no direct benefit to any participant. However knowledge gained through this study will help us to learn how to prevent acute pesticide poisoning in future through planning of the appropriate interventions.

5.Conditions for withdrawal:

Your participation in the study is completely voluntary. You may decide not to participate and if you participate you are free to withdraw from the study at any time without any penalty.

6.Confidentiality:

The data obtained in this study will be kept strictly confidential and individuals involved will not be identified at any way in the reports. For the purpose of the study your personal information will be coded such that your name will not appear on any of the forms used for data analysis. The PI will have access to the names associated with the codes and this information will be kept in locked cabinet in his office at TPRI and destroyed at the end of the study.

7.Contact Information.

If you have any question or concerns about the study, you may contact the PI- Mr Elikana Lekei of the Tropical Pesticides Research Institute P O Box 3024 Arusha, Tanzania.

8.Agreement.

I have read and understood this consent form and I voluntary agree to participate in this study.

Full Name of Volunteer: -------------------------------- Signature: ----------------------------

Address: --

Tel: -------------------   Date: --

Annex 8 : Data Capture tool for hospital review (Chapter 5: Retrospective and Prospective sub-studies).

1. Facility/ Place/ Premises:

[1.1] Date of Data collection: ………..[1.2] Name of facility/ Place: ……………………

[1.3] Region: …………………….. [1.4] District…………………………………………..

[1.5] Address and Tel: ………………………………………………………………..

2.Victims details:

[2.1] Name …………………… [2.2] Age:……………… [2.3] Sex: ☐ F ☐ M

[2.4] Location:……………………….

3.Exposure:

[3.1] Date of poisoning/ reporting……………………

[3.2] Circumstances of exposure: ☐ Suicide ☐ Accidental ☐ Occupational

☐ Homicide ☐ Unknown ☐ Other: ………………………………………………………………

[3.3]Route of exposure: ☐ Oral ☐ Inhalation ☐ Dermal ☐ Ocular

☐ Unknown ☐ Other: ……………………………………………………………………

4. Details of poisoning agents

[4.1] Product Name:…………………………………………………………………….

5. Symptoms:

[5.1] Major Poisoning symptoms reported:

………

………………………………………………………………………….

6. Diagnosis:

[6.1]Means of Diagnosis: ☐ History ☐ Laboratory tests ☐ Clinical signs ☐ Other:………………

7. Poisoning Management:

[7.2] Treatment given:

……………………………………………………………………………………………….

……………………………………………………………………………………………….

8. Outcome:

[8.1] Outcome after poisoning: ☐ Recovery ☐ Death ☐ Disability ☐ Absconded

☐ Referral ☐ Unknown ☐ Other: ……………………………………………

Remarks: ……

Annex 9: Bivariate association of selected facilities and non selected facilities

		Gender				
		Female	Male	Prevalence Risk Ratio	95%CI	P
Facilities	Selected	187 (38.5%)	299 (61.5%)	Selected/Non selected = 1.1	1.0-1.2	0.1
	Non selected	77 (45.3%)	93 (54.7%)			
		Age				
		≤ 30 years	>30 years			
Facilities	Selected	318 (70.2%)	135 (29.8%)	Selected/Non selected = 1.04	0.9-1.2	0.5
	Non selected	112 (67.5%)	54 (32.5%)			
		Circumstance				
		Suicide	Non suicide			
Facilities	Selected	161 (58.3%)	115 (41.7%)	Selected/Non selected = 1.6	1.4-1.8	0.0
	Non selected	20 (18.0%)	91 (82.0%)			
		Outcome				
		Fatal	Non fatal			
Facilities	Selected	38 (11.5%)	293 (88.5%)	Selected/Non selected = 1.3	1.1-1.5	0.01
	Non selected	7 (4.6%)	144 (95.4%)			
		Cases from Regional or referral facilities	Cases from Other facilities			
Facilities	Selected	437 (89.9%)	49 (10.1%)	Selected/Non selected = 1.9	1.5-2.4	0.00
	Non selected	104 (61.2%)	66 (38.8%)			

Annex 10: Population of Arusha, Kilimanjaro and Mwanza by age and gender.

	Arusha			Mwanza			K Njaro				All 3 regions	
	Total	M	F	Total	M	F	Total	M	F	Total	M	F
1to10	443207	223785	219422	1078587	539861	538726	434557	218924	215633	1956351 (35%)	982570	973781
11to20	298022	143530	154492	657210	323856	333354	329744	162486	167258	1284976 (23%)	629872	655104
21to30	238153	109140	129013	506542	240571	265971	200248	896226	110622	944943 (17%)	439337	505606
31to40	140471	71198	69272	294316	149005	145311	145064	67698	77366	579851 (10%)	287901	291949
41+	168236	87289	80947	392987	198857	194132	267089	126119	140970	828312 (15%)	412265	416049
Total	1288089	634942	653146	2929642	1452150	1477494	1376702	1471453	711849	5594433	2751945 (49.1%)	2842489 (50.9%)

Annex 11: Questionnaire for the assessment of knowledge and practice of health care providers on pesticide poisoning (Chapter 6).

1. Confidentiality:

The data obtained in this study will be kept strictly confidential and individuals involved will not be identified at any way in the reports. The personal information will be coded such that the names will not appear in any of the forms used for data analysis. The PI will have access to the names associated with the codes and this information will be kept in locked cabinets in his office and destroyed at the end of the study.

2. General Instructions:

For closed ended questions you are requested to fill appropriate answers (or tick) in the boxes or space provided. For open ended questioner you are requested to provide appropriate details on space provided. You may add extra details on a separate paper if the space provided is not enough. Unanswered questions will not be considered in the general evaluation.

3. Personal Information.

3.1 Date of data collection:------------ 3.2 Full Name: --------------------------------
3.3 Title/ Position: ---------------------------- 3.4 Occupation: ---------------------
3.5 Highest level of education: -------------- 3.6 Name of Health Facility-------------------
3.7 Address of Health facility: --------------------------- 3.8 How long have you been in that post: ----------------------
3.9. General responsibilities: ------------------------------- 3.10. Date of employment: -------------------------------------

4. Handling of pesticide poisoning cases.

4.1. Have you ever handled any pesticide poisoning case [1]Yes [2]No

4.2. How many cases have you handled in your working period: -------------------------

4.3. Mention stakeholders who utilize your pesticide poisoning records:--------------------------------
----

4.4. Mention common first aid procedure which are provided in case of pesticide poisoning: ---
----

4.5. Which pesticides are commonly suspected to cause poisoning --------------------------------------
----

4.6. Do you have standard procedure for diagnosis of pesticide poisoning cases:

[1]Yes [2]No

4.7. Explain how you diagnose pesticide poisoning cases. ---

4.8. Does your health care facility have Medical Laboratory: [1]Yes [2]No

4.9. How do you document pesticides poisoning diagnosis records: --------------------------------------

----

4.10. How did you treat the poisoning cases handled and how was it reported through the system:

Case	Treatment	Reporting
----------------------	--	---------------------------
----------------------	--	---------------------------
----------------------	--	---------------------------
----------------------	--	---------------------------
----------------------	--	---------------------------

5. Knowledge on Pesticide Health effects:

5.1. Are you familiar with pesticides health effects: [1]Very Familiar [2]Not Familiar [3] Fairly familiar

5.2. Mention at least 3 ways through which Pesticides can enter the human body:

5.3. List any 4 general families of pesticides according to chemical composition.

5.3. Do you know the WHO hazard classification categories of Pesticides:

[1]Yes [2] No

5.4 If "Yes" list at 4 WHO hazard Classes for pesticides:---

5.5. Are you familiar with the Precautions detailed on pesticide labels: [1]Yes [2]No

5.6. List any 4 common precautions that are displayed on pesticide labels: ---

Annex 12: Questionnaire for pesticide stakeholders (Chapter 7).

1. Confidentiality:

The data obtained in this study will be kept strictly confidential and individuals involved will not be identified at any way in the reports. The test results/ personal information will be coded such that the names will not appear in any of the forms used for data analysis. The PI will have access to the names associated with the codes and this information will be kept in locked cabinets in his office and destroyed at the end of the study.

2. General Instructions:

For closed ended questions you are requested to fill appropriate answers (or tick) in the space provided. For open ended questioner you are requested to provide appropriate details on space provided. You may add extra details on a separate paper if the space provided is not enough.. Unanswered questions will not be considered in the general evaluation.

3. Personal Information.

3.1. Date: of data collection: -----------.2. Full Name: ------------------------------------ 3.3 Age-------------

3.3. Sex: [1]Male [2]Female 3.4. Department / Ministry where employed---

3.5. Address: --------------------------------3.6. Education Level -------------------------------- 3.7. Profession:………

3.7. Position at the Place of work: --------3.8. How long have you worked in that similar post: --------------

4. Policy Issues.

Does your department have a pesticides policy

[1]Yes [2]No [3]Not known

Within your jurisiction/ system do you have policy related to pesticide risks reduction: [1]Yes [2]No [3]Unknown

If so please explain how it work: --

Do you have a policy related to notification of injury/ poisoning arising from pesticides:

[1]Yes [2]No [3]Unknown

Please explain how notification system work: --

What is the status of acceptability of the notification policy to the public:

[1]Acceptable [2] Not acceptable [3] Unknown

What problems are you encountering with acceptability of the notification system: --

How is the notification system monitored for compliance: --

5. Pesticides

What are pesticides commonly used in your area.

Pesticide For what crops

-- ------------------------------------

-- ------------------------------------

6. Sensitization

6.1 Do you sensitize the public to report pesticide poisoning cases?

[1]Yes [2]No

6.2 If Yes, how do you perform the task.

----

7. Pesticide poisoning.

7.1. Do you think pesticide poisoning is a major problem in Tanzania.

[1]Yes [2]No [3]Uncertain

7.2. Mention most common pesticides handling operations that are responsible for pesticide poisoning in Tanzania

----

7.3. Mention the most common circumstances of poisoning:-- ---

7.4. List the products most claimed to result into poisoning: -- --

7.5. List strategies for reducing pesticide poisoning incidents in the community.

8.Proposal for reporting system.

8.1. Give proposal for reporting system of the acute pesticide poisoning and injury cases in Tanzania.

----

9. End.

9.1. General remarks--

-

Annex 13: Questionnaire for pesticide retailers (Chapter 8).

1. Confidentiality:

The data obtained in this study will be kept strictly confidential and individuals involved will not be identified at any way in the reports. The personal information will be coded such that the names will not appear in any of the forms used for data analysis. The PI will have access to the names associated with the codes and this information will be kept in locked cabinets in his office and destroyed at the end of the study.

2 General Instructions.

There is a variety of questions in this questionnaire. For short and long answers questions you are required to fill in the spaces provided. You may add extra details on a separate paper if the space provided is not enough. For selection questions you are required tick the right answer. Unanswered questions will not be considered in the general evaluation.

3. Company Information.

3.1. Date of data collection:------------------ 3.2Name and address of firm ---------
----

3.3. Name of the Firm owner ------------------------ 3.4. Telephone: ---------------

3.5. The firms registration status [1]Registered [2]Unregistered

4. Pesticide products

List all products distributed in the year 2004 and 2005 on the separate sheet attached (Appl to Arusha).

5. Protective equipment

List down body protective available and quantities:

--

6. Poor Label and spill.

6.1. List products with no label or with inappropriate label.

--

6.2. List down pesticides with leaking container

--

7.Pesticide poisoning

7.1. Is there any incidence of pesticide poisoning ever experienced in the firm.

[1]Yes [2]No [3]Do not know

7.2. If Yes list staff involved and action taken:

Poisoning incidence (Victim Name)	Period	Action taken and outcome
--	-------------	-------------------------------
--	-------------	--------------------------------

8. Staff

8.1. Staff particulars and experience

Name	Sex	Date employed	Age	Qualification
------------------------	-------	-----------------	------------	------------------
------------------------	-------	-----------------	------------	------------------

9. Disposal

9.1. How does the firm dispose off unwanted pesticides

--

9.2. How does the firm dispose off unwanted empty pesticides containers

----

--

10. Safety precautions

10.1. Does the firm possess the following:

(i)Fire fighting equipment [1]Yes [2] No
(ii) Good ventilation system [1]Yes [2] No
(iii)Warning signs [1]Yes[2] No (iv) First aid kit [1]Yes [2] No
(iv)Washing facility [1]Yes [2] No

10.2 Do the staff wear protective clothing while handling pesticides in the shop premises: [1]Yes [2] No

10.3. Is the firm involved in:

(i) Repacking or decanting pesticides [1]Yes [2]no
(ii)Selling of unregistered products: [1]Yes [2]no
(iii)Selling expired products [1]Yes [2]no

General Remarks:--

Annex 14: Data collection tool for review of local newspapers (Chapter 9).

1. Newspapers details:

   [1.1] Date of Data collection: ………. [1.2] Name of Local paper: ……………………..

   [1.3] Issue Date: ………………………………………

2.Victims details:

   [2.1] Name: …………………… [2.2] Age: …………………….

   [2.3] Sex: …………………….. [2.4] Location (Region): …………….

3.Exposure:

   [3.1] Date of exposure: …………………… [3.2] Circumstances of exposure: ☐ Suicide ☐ Accidental ☐ Occupational

   ☐ Homicide ☐ Unknown ☐

   [3.3] Main activity during exposure: …………………………..

   [3.5]Route of exposure: ☐ Oral ☐ Inhalation ☐ Dermal ☐ Ocular

   ☐ Unknown ☐ Other: ……………………………………………………………………

4. Details of poisoning agents according to the label:

   [4.1] Trade Name:………………[4.2] Active ingredient (and %): …

   [4.3] Type of formulation: ………[4.4] Other:………

5. Outcome of poisoning:

   [5.1] ☐ Recovery [5.2] ☐ [5.3] Death [5.4] ☐ Unknown

   Other: …………………………………

6. Remarks:
   ……
   ……………………………………………………………………

Annex 15: Pesticide poisoning surveillance report form for different data sources.

1. **Facility/ Place/ Premises:**

[1.1] Date of Data collection: …………………. [1.2] Name of facility/ Place: ……………………

[1.3] Region: ………………………………………… [1.4] District…………………………………………

[1.5] Address and Tel: ………………………………………………………………………………….

2. **Victims details:**

[2.1] Name/Code: ……………………. [2.2] Age:……………… [2.3] Sex: ☐ F ☐ M

[2.4] Location:……………………….. [2.5]Address:………………..

3. **Exposure:**

[3.1] Date of Consultation (For Hospital cases):…………………….

[3.2] Date of exposure……………………….

[3.3] Circumstances of exposure: ☐ Suicide ☐ Accidental ☐ Occupational ☐ Homicide ☐ Unknown ☐ Other: ……………………………………………………………….

[3.4] Main activity during exposure: ……………………………..

[3.5]Route of exposure: ☐ Oral ☐ Inhalation ☐ Dermal ☐ Ocular ☐ Unknown ☐ Other: ……………………………………………………………….

4. **Details of poisoning agents according to the label (add a separate paper if more than one agent):**

[4.1] Trade Name (s):…………………………………….

[4.2] Active ingredient (and %):…………

[4.3] Type of formulation: ……………………………………………………………………………….

[4.4] Product WHO Hazard Class: ☐ Ia ☐ Ib ☐ II ☐ III ☐ U

[4.5] Product chemical group: ………………………….

5. **Symptoms:**

[5.1] Major Poisoning symptoms reported: …… ………………………………………………………………

6. **Diagnosis:**

[6.1]Means of Diagnosis: ☐ History ☐ Laboratory tests ☐ Clinical signs ☐ Other:………………

7. **Poisoning Management:**

[7.1] Treatment given ………………………………………………………

[7.2] : Days spent in Hospital ……… ………………………………………………………………

8. **Outcome:**

[8.1] Outcome after poisoning: ☐ Recovery ☐ Death ☐ Disability ☐ Absconded ☐ Referral ☐ Unknown ☐ Other: …………………………………

Remarks:

…… ………………………………………………………………………

Annex 16: Severely Hazardous Pesticide Formulation Report Form

PART A - TRANSMITTAL FORM - DESIGNATED NATIONAL AUTHORITY

	Information required from a Designated National Authority
1	Name of the formulation : ....
2	Type of formulation: (*for example EC, WP, DP, GR, TB*).. ....
3	Trade name and name of producer, if available:...
4	Name of the active ingredient or ingredients in the formulation:.. ....
5	Relative amount of each active ingredient in the formulation: ....(*% concentration*).. ....
6	Attach copy of the label(s), if available (or describe the key aspects of the label: language, etc.).
7	Common and recognized patterns of use of the formulation within the country – ➢ the formulation is registered / permitted for use in the country? ➢ what uses are permitted?

	➢ are there any handling or applicator restrictions specified as a condition of registration; ➢ information on the extent of use of the formulation, such as the number of registrations or production or sales quantity (indicate the source of information); ➢ other information on how the formulation is commonly/typically used in the country (*this information should be submitted on a separate sheet attached to the completed form*)
8	A clear description of incidents(s) related to the problem, including adverse effects and the way in which the formulation was used (for example *Part B pesticide incident report form identifies key elements and appropriate level of detail*). Other report formats which may exist at the national level may also be used, provided they contain comparable information.
9	Any regulatory, administrative or other measure taken, or intended to be taken, by the proposing Party in response to such incidents.

Date, signature of DNA and official seal:

....
....

PLEASE RETURN THE COMPLETED FORM TO:		
Food and Agriculture Organization of the United Nations (FAO) Viale delle Terme di Caracalla 00100 Rome, Italy Tel: (+39 06) 5705 3441 Fax: (+39 06) 5705 6347 E-mail: pic@pic.int	OR	United Nations Environment Programme (UNEP) 11-13, Chemin des Anémones CH – 1219 Châtelaine Geneva, Switzerland Tel: (+41 22) 917 8296 Fax: (+41 22) 917 8082 E-mail: pic@pic.int

Severely Hazardous Pesticide Formulation Report Form

PART B – ENVIRONMENTAL INCIDENT REPORT FORM

Note: If the reported incident is associated with the use of a mixture of more than one formulation, Section 2 (Product Identity) should be completed separately for each of the formulations. The remaining Sections of the form that describe how the formulation was used, the incident, adverse effects etc., need only be completed once for each incident.

In order to help keep the form as simple as possible, the term formulation is used throughout and refers to the chemical product (herbicide, insecticide, etc). For those incidents involving more than one formulation, it is understood that the use of this term in Sections 4–7 will refer to the mixture that was applied.

SECTION 1. Number of formulations used

1. How many formulations were used when the incident took place?
(*Please circle or fill in number and proceed as indicated)*

a. One formulation was used. ☐ Yes ☐ No

If yes, *complete Section 2 (Product Identity) once.*

If no,

b. ________ (number) different formulations were used at the same time (e.g. tank mix of a herbicide and a fungicide)

c. Please list the individual formulations here:

e.g. Monitor (methamidophos 60 EC)

Formulation 1: ____

Formulation 2: ____

Formulation 3: ____

Please complete Section 2 (Product Identity) for each of the listed formulations.

SECTION 2. Product Identity: Formulation used and its preparation
Please complete this section for each formulation used

2. Name of the formulation?
____

____

3. Type of formulation *(please tick)*:

☐ Emulsifiable concentrate (EC) ☐ Wettable powder (WP) ☐ Dustable powder (DP)

☐ Water soluble powder (SP) ☐ Ultra low volume (ULV) ☐ Tablet (TB)

☐ Granular (GR) ☐ Other (please specify): ______________________

4. Trade names and names of the producer/manufacturer, if available: ____________________

____

5. Name of the active ingredient(s) in the formulation:

____

6. What is the name and relative amount of each active ingredient (a.i.) in the formulation?

% concentration: ____

grams a.i/litre or: ____

ounce a.i /gallon or: ____

grams a.i./kg or: ____

ounce a.i/pound: ____

7. Attach a copy of the label(s) and instructions for use, if available to this form (or describe the key aspects of the label: language, use instructions, etc). Label attached ☐ Yes ☐ No

____

8. What was the intended use *(please tick)*

☐ Insecticide ☐ Herbicide ☐ Tick control ☐ Rodenticide

☐ Fungicide ☐ Unknown ☐ Other (specify) ____________________

9. Are there any use restrictions or prohibitions regarding the use of this formulation or the active ingredient *(e.g. use of safety equipment, application restrictions)*?

☐ No

☐ Yes (*please specify*)

____

10. Was the formulation used as purchased or was it changed in any way?

☐ Used as purchased

☐ Changed *(please specify how)*:

____

11. Was the formulation in its original container?

a. ☐ No (*go to b*)

☐ Yes *(go to Question 13)*

b. Did the repackaged formulation have a copy of the label attached?

☐ No

☐ Yes

12. Preparation of formulation:

a. Was the formulation (as outlined in Questions 2–8) mixed with a carrier or diluent before use (e.g. mixed with liquid, powder, bran)?

- ☐ No (*go to Question 13*)
- ☐ Yes

If yes,

b. How was the mixture prepared (e.g. mixed with water, diesel)?

____

c. What was the mixing ratio? *(circle appropriate unit)*

______litre or kg/lbs of formulation per ______ litre or kg/lbs of carrier/diluent

d. Was the mixture used immediately or was it stored?

- ☐ Used immediately
- ☐ Stored (*please specify)*

For how long? __________ hours/days/weeks *(circle appropriate unit)*

13. Application rate:

(a) What was the application rate used?

____________ e.g.: g a.i./ha; litre/ha; lb/acre *(circle appropriate unit)* or specify_____

(b) How much of the chemical product / or active ingredient (a.i.) was used? For multiple applications, please estimate the total amount released.

(circle appropriate unit)

Total amount: ______ (L; gallons; kg; or lb)

Concentration: _______ (g a.i./L; oz a.i./gallon; g a.i./kg; or oz a.i./lbs)

SECTION 3. Description of application

14. Location where the formulation was used?

Nearest village/city: ________________________________

Province/state/region/district: ______________________

Country: ____

15. Date of application(s)

a. What were the date(s) (if known) the formulation was used?

Beginning: __________________________ End: ______________________________

16. Was it a single or multiple application?

☐ Single application

☐ Multiple application *(please specify)*

Number of applications: _______

Approximate date of each application: ____

17. Were any other pesticides used in the same area at the time of the incident?

____

18. Treated area and target pest:

a. What was the type of crop or situation treated (e.g. maize, grassland, forest, pond)?

____

b. What was the target pest (e.g. weeds in maize, locusts in grasslands, moths in forests, mosquitoes in ponds)?

____

19. Conduct of application

a. How was the formulation applied (method of application)?

☐ By hand ☐ Backpack sprayer ☐ Tractor-mounted sprayer

☐ Aircraft ☐ In-furrow applicator ☐ Hand-held sprayer

Other method (please specify)____

b. What were the weather conditions at the time of application?

Temperature: ☐ Hot ☐ Warm ☐ Cool

Sunny or cloudy: ____________________________

Rain: ☐ Light ☐ Medium ☐ Heavy

Wind speed: ☐ Light ☐ Strong

Direction: _______

General description of conditions: ________________________________

c. What were the weather conditions for the few days after application?

Temperature: ☐ Hot ☐ Warm ☐ Cool

Sunny or cloudy: ____________________________

Rain: ☐ Light ☐ Medium ☐ Heavy

Wind speed: ☐ Light ☐ Strong

Direction: _______

General description of conditions: ________________________________

20. Please provide any relevant information regarding the person applying the formulation (e.g. level of training, literacy)

____

Section 4. Description of the Incident

21. What was the date when the incident was first noticed?

____

22. Location of the incident.
Was the location of the incident, the same location of the area treated? *Please indicate where the incident occurred (be as specific as possible).*

☐Yes *(as specified in Section 3 Question 14)*

☐No *(please specify) Geographical coordinates, if available*

Village/city:____

Environment Affected	**Size of area or volume affected (write a number)**	**Units (circle appropriate units)**
Land ☐ Home garden ☐ Farm field ☐ Grassland ☐ Other _________________		m^2 hectare (ha) km^2 acre Other (specify) __________
Fresh Water ☐ Fish pond ☐ Stream ☐ River ☐ Lake ☐ Sediments ☐ Other _________________		**Surface Area** m^2, ha, km^2,acre or Other (specify) __________ **Volume** L, m^3 or Other (specify) __________
Salt Water ☐ Estuary ☐ Bay ☐ Ocean ☐ Sediments ☐ Other _________________		**Surface Area** m^2, ha, km^2 or Other (specify) __________ **Volume** L, m^3 or Other (specify) __________

Province/state/region/district: ________________________________

Country: ____

23. Please indicate where the incident occurred and the size of the area affected, by completing all areas of the following table that apply. Please be as specific as possible; mark all boxes as appropriate:

24. Please draw a rough map of the area around the incident. (Indicate scale if possible)
Use the box below or attach to the back of this form.
Please include:

a. the area affected;

b. any nearby waterways that were, or could be, affected and the direction of water flow;

c. location of any affected non-target organisms that were found;

d. location where the formulation was applied;

e. any other details which may further clarify the incident (e.g. topography, soil properties, water table).

SPECIES OF ANIMAL OR PLANT	NUMBER OR PROPORTION AFFECTED	AGE OR DEVELOPMENT STAGE (E.G. JUVENILE, LARVAL, SEEDLING)	OBSERVATIONS (E.G. ABNORMAL MORPHOLOGY OR BEHAVIOUR, TOXICOLOGICAL SYMPTOMS)	DURATION OF EFFECT (INCLUDING DATE OF DEATH OR RECOVERY)
Examples				
Terrestrial vertebrate *Domestic cattle*	*10*	*Adults*	*Excessive salivating, loss of balance, lethargy.*	*Recovered 26 May 2002*
Birds – Mallard ducks	*40*	*Adults and juveniles*	*Disoriented, ruffled appearance, head lesions*	*Recovered 30 May 2002*
	6	*juveniles*	*Disoriented, lethargy*	*Recovered 21 May 2002*
	5	*juveniles*	*Disoriented, lethargy*	*Died 22 May 2002*
Fish e.g.: various species	*numerous*	*All size classes*	*Dead fish on riverbank up to 3km downstream of treatment area*	*No information*
Invertebrates e.g. honey bee	*100 colonies*	*Foraging during peak of flowering period*	*Colonies dead*	*All cases reported within 20 days post-application*
Vegetation e.g. grassland	*4 acres*	*Flowering*	*Wilted, yellowing*	*Dead patches*

25. Please describe any other details, additional information or facts that are not captured elsewhere in this form that further explain the cause of the incident, how it occurred, the result and any remediation efforts (attach extra pages if required).

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Section 5. Description of adverse effects

26. Identify the non-target organism(s) adversely affected in the incident, including the number affected. Please be as specific as possible (common names and if possible scientific names) and complete as much as possible. Examples are provided in the table below.

27. Was there any indirect evidence of severe hazards to non-target organisms (e.g. unexpected population declines, disappearance of certain species in the incident area)?

☐ No ☐ Yes (*Please describe these effects*)_____________________________

____

28. Please provide any other relevant information such as:

a. links between the use of the formulation (Section 4) and observed effects in non target
organisms (question 26):

b. any analytical measurements, if available, which confirm residues of active ingredient(s) in soil, water, air or biological tissues

☐ No ☐ Yes (attach data and source)

Section 6. Management

29. What practical steps (if any) were taken at the time the incident occurred to limit or stop its further impact on the environment (excluding administrative and regulatory actions)?

30. What steps (if any) were taken to clean up the area after the incident or to rehabilitate any species affected in the incident?

Section 7. Reporting/communication

31. Date of data collection/consultation:

32. Name and address of investigator/data collector:

33. Category of investigator/data collector (e.g. environmental scientist, agricultural officer, government representative):

____

34. Contact if further information needed:

Telephone: ____________________________

Fax: _______________________________________

Email:____

35. Has this incident been reported elsewhere?

☐ No

☐ Yes *(who was it reported to)*

____

36. Have similar incidents happened in that area before?

☐ No ☐ Yes

If yes, were they reported?

☐ No ☐ Yes

Please send the completed incident report form to the Designated National Authority.

(Name and address of the DNA)

DNA- please attach all forms to Part A – Transmittal Form.