International Journal of Social Science and Economic Research

ISSN: 2455-8834

Volume:01, Issue:07

AGROCHEMICALS USE BY SMALLHOLDER FARMERS IN VEGETABLE PRODUCTION IN MATABELELAND NORTH PROVINCE.

Canisius Mpala

Faculty of Agricultural Sciences, Department of Crop and Soil Sciences,
Lupane State University. P.O. Box AC 255, ASCOT, Bulawayo, Zimbabwe.

ABSTRACT

Small scale horticultural farmers in Matabeleland North grow a variety of vegetable and cereal crops intensively under irrigation and use many types of agrochemicals to control pests, diseases and weeds. To assess the use of these agrochemicals, a survey was conducted in February to April 2014 in Hwange, Lupane and Umguza districts of Matabeleland North Province. The study sought to identify the agrochemicals used in horticultural crop protection, handling, farmers' practices, and disposal. Data was collected through focus group discussions, field observations and a questionnaire survey on forty five small holder farmers in Umguza Irrigation Lots, Chentali and Lukosi in Hwange and Tshongokwe irrigation schemes. The agrochemicals used by the farmers in the study areas were insecticides and fungicides (all respondents) and herbicides (25%). More than 80 % of the respondents applied pesticides on a weekly basis depending on the crop. Insecticides and fungicides were routinely applied by 80% of the farmers. Fifty nine per cent have primary education and cannot read and understand the instructions on the labels and only 38.7% of farmers have received training on safe use, storage and disposal of agrochemicals. The study also found out that 38.5% of the farmers re-used the agrochemical containers and reported having felt sick after routine application of pesticides. Agrochemical related health symptoms included skin itchiness, sneezing, dizziness and headache. Farmers did not use appropriate protective clothing, storage and disposal methods. The findings can be used to develop a tool to quantify the cost of agrochemicals use, awareness on safe use and handling, training of extension staff and farmers in pest management by small scale vegetable farmers in Matabeleland North and contribute to the policy reformation for safe and effective use of agrochemicals.

Keywords: Small scale horticultural farmers, vegetables, agrochemicals, irrigation, pesticides

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1.0 INTRODUCTION

A wide range of agrochemicals are used for pest, disease and vector management in agricultural areas, but many farming communities in the country are not adequately informed about the hazards associated with the chemicals. As a result, farmers use agrochemicals without full understanding of their impact on human health and the environment. Humans come in contact with agrochemicals in the field during chemical application, weeding and harvesting of vegetables. Storing agrochemicals may lead into acute and/or chronic exposures, with adverse health consequences. Although the inhalation, skin and oral routes of exposure are the most common, agrochemical residues in food and water may add to indirect exposures common in the general population.

Illness suffered by one or more members of a household can result from exposure to agrochemicals and may affect the overall performance and productivity of the family farm since labour input in agriculture is normally supplied by households especially in communal areas and smallholder agriculture in developing countries. The level of health costs has been estimated in some studies in other countries and is believed to be closely related to the level of socio-economic development and the context of the prevailing culture (Ajayi, 2000). No comprehensive study to determine the costs of adverse effects of agrochemicals usage on the environment and human health has been done in Zimbabwe. There is therefore the need to develop an appropriate tool for estimating the real cost of agrochemicals usage in Zimbabwe to fill the knowledge and information gap so as to provide better means to develop appropriate agrochemical policy in the country.

The costs of health problems and other environmental effects due to agrochemicals use in agriculture and public health are generally externalised in estimations of the economic burdens, benefits of agrochemicals in Zimbabwe and other parts of the world. Medical expenses, costs of recuperation, transportation costs, labour losses are rarely included in analysis of the costs of agrochemicals. The main reason for not costing health problems particularly, the medical costs is due to the fact that local health officials do not often diagnose symptoms in relation to exposures and are not adequately trained to identify adverse effects of agrochemicals (Ngowi *et al*, 2001; Ngowi and Partanen, 2002). Similar findings of low awareness amongst health care providers of the problem of agrochemicals poisoning have been reported in East Africa (Mbakava, 1994: Ohaya-Mitoko, 1997), Costa Rica (Wesseling *et al.,*1997) and Côte d'Ivoire (Ajayi, 2000).Health risks in agricultural production are a growing problem facing Africa (Ajayi, 2000). Distorted policies that subsidises agrochemicals worsen health hazards experienced in most African countries and there is poor access to health services and a medical profession that lacks the ability to recognise agrochemicals related morbidity raises further concerns (The Pesticide

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Trust, 1993). There is growing consensus in that farmer health issues in Africa constitute a serious threat to development and have the potential to reverse gains made in agricultural growth(Binswanger and Townsend, 2000).

Research in both economics and medicine collaborates that occupational health problems in agriculture have received scant attention (Watterson, 1988; Smith *et. al*.,2000). Yet improved health enhances functionality and productivity (Strauss *et. al*.,1998). Studies conducted in the Philippines conclude that agrochemicals use has a negative effect on farmer health, while farmer health has a positive effect on productivity (Antleand Pingali, 1994). Similar findings about the health costs of agrochemicals use have emerged from studies in Ecuador and the United States (Antle *et. al*., 1998; Crissman *et. al*., 1994;Harper and Zilberman, 1992; Sunding and Zivin, 2000), but the evidence from Africa is scanty.

The occupational health threat from agrochemicals use in the less developed countries is exacerbated by lax environmental laws and poor access to complex agrochemicals information (WHO, 1990; The Pesticide Trust, 1993). The risk of exposure is worsened by farmer illiteracy, unavailable or unaffordable protective equipment and missing health insurance markets in most poor nations (Antle and Capalbo, 1994).

Although the problem is acknowledged, the extent of the health problems among farm workers in Africa remains unclear. Few African countries keep statistics about agrochemicals poisonings and fewer yet track chronic agrochemicals health effects and moreover, health impacts may take a long time to appear and could be difficult to trace back to specific agrochemical or polluting source (Wossink, *et. al*., 1998)

In Africa, empirical studies in support of the link between agrochemicals use and farmer health are patchy. Nhachi and Loewenson (1996), looked at occupational health problems among commercial farm workers in Zimbabwe, but not among communal or smallholders. In West Africa, a survey on agrochemicals related occupational health effects found that the social cost of acute poisoning in cotton is substantial (Fleischer, *et. al*., 1998).

An increasing body of evidence suggests that the benefits of agrochemicals are obtained at a substantial cost to the society (Antle and Pingali, 1994; Antle *et. al.,* 1998; Cole *et. al*., 1998; Pingali *et. al*.,1995; Crissman and Cole, 1994; WHO, 1990).

Objectives of the study

This study was conducted to find out the usage, handling and storage practices, agrochemicals effects into the health, environmental and perception on consequence of exposure. The purpose of the research was to provide data for agrochemicals recommendations aimed at exposure reduction and hence reduced health consequences, whilst still allowing farmers to produce cost effectively, sustainably and in an environmentally friendly way.

The specific objectives were:

1. To assess the different types of agrochemicals commonly used by the small holder farmers.
2. To assess the farmers' perceptions of agrochemicals safety, handling and field spraying practices which might expose them to chemical hazards.
3. To assess the impacts of agrochemicals on farmers' health as reported by symptoms of illness.

2.0 MATERIAL AND METHODS

Target areas and population

The study was conducted between February and May 2014 and consisted of interviews with farmers and farm workers in Umguza Irrigation Lots resettlement area and the communal areas in Lupane and Hwange districts where horticultural crops were commercially grown. Forty five farmers were randomly selected from Lukosi, Chentali, Tshongokwe Irrigation schemes and Umguza Irrigation Lots. The sites were selected based on that horticultural crops were grown and agrochemicals usage.

Data collection

A questionnaire was designed and administered on the randomly selected farmers. Data was collected through face to face interviews with farmers or farm workers during farming activities. The questionnaire was designed in English and translated into the local languages during the interviews. The questionnaire was pretested using a small sample of farmers in Umguza before using it in this study.

The data collected included bio data such as sex, marital status, education, horticultural crops, production per season, pest problems, agrochemicals used, source and characteristics of

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agrochemicals, storage, type spraying equipment, servicing and calibration, disposal of containers; application techniques and symptoms due to exposure to agrochemicals.

Consent was sought for and granted by the respondents before the interviews were conducted.

The data were analysed using descriptive statistics by use of SPSS Version 16 and Ms Excel.

3.0 RESULTS

The study showed that 59.4% of respondents were male and 40.6% were female. The average age was 51years and ranging from 18 to 74 years. Fifty three per cent of the respondents were married, whilst, 21.9%, 12.5%, 9.4% and3.1% were widowed, single, separated and divorced respectively and the average number of people per household was 5.91 (Table 1).

Table 1: Socio demographic information

Variable	Respondents (%)	Age (years)
Household size	5.91±2.23	
Males	59.4	
Females	40.6	
Mean age		51±13.13
Level of education		
Primary	59.4	
Secondary	25	
More than 12 years	15.6	

Source: Survey data

All the respondents were involved in horticultural production, 71% and 29% of the respondents were communal area smallscale irrigators and resettlement area (A2) farmers respectively.

Types of pesticides used by farmers

The study revealed that of the different agrochemicals used by farmers in the area, most were insecticides (72.7%), fungicides (13.6%) and herbicides (13.6%), (Table 2).

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Table 2: Types of agrochemicals used in small-scale vegetable farms in Matabeleland North, classified using the WHO Hazard Class and health effects, (2005).

Trade name	Common name	WHO Class	Type of Chemical	Health Effects	Registration Status in Zim
Actellic Super	Pirimiphos –Methyl	III,	OP		Maize, beans, other legumes
Amitraz	Permethrin	II,	PY		
	Red Spider Kill	II,	OP		
Femamiphos	Nemacur 400EC	Ib,	OP		
Oxamyl	Nemate 310 L Ib,	C			Tobacco
Cyromazine	Trigard				
Aphid Kill	Mitac	II,	PY		
Methamidophos	Tamaron 600SC	Ib,	OP		
Bacillus thuringiensis	Biobit				
Bravo	Chlorothalonil	NK,	OC		
Carbaryl Dust	Carbaryl	II,	C		
Copper Oxychloride		III,	CU	SE, PC	
Dichlorovos	DDVP 100EC	Ib,	OP		
Diazinon	Diaz 30	II,	OP	CI	
	Diazinon 30EC	II,	OP		
Dimethoate		II,	OP	SE, PC	Veg, legume, fruits
Dipterex		II,	OP		
Dithane M45	Mancozeb	III,	C	SE, C	Vegs, legumes, fruits
Dursban	Chlorpyrifos	II,	OP	SSE, CI	Vegs, legumes, fruits
Endosulphan		II,	OP	SE	
Abamec	Dynamec				
Dipel	Chlopyrifos	II,	OP		
Mospillan	Acetamiprid				
Kontakill	Fenitrothion	II	OP		
Fenvalarate	Fenverarate 20EC	II,	PY		

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Karate	Lambda	II,	PY	SE	Tobacco
Methomyl	Lannate	Ib,	C		Tobacco
Fenthion	Fenthion 50EC	II,	OP	SE	
	Lebacid 50EC	II,	OP	SE	
Malathion	Malathion Dust	III,	OP		Grains and cereals
Monocrotophos	Nuvacron	Ib,	OC		Tobacco
Ridomil	Mancozeb	NK,	C		Vegetables
Rogor	Dimethoate	II,	OC	SE	
Thiodan	Endosulphan	II,	OP	SE	All crops
Thionex	Endosulphan	II,	OP	SE	
Oxychloride/Malathion	Vegetable Dust		CU		
Carbofuran	Curater	Ib,	C		
	Furadan	Ib,	C		
Herbicides					
Atrazine	Atrizane	III,	T		
Dual					
Glyphosate	Round up	III		SSE	Different crops
MCPA		III,	PAA		
Paraquat	Gramoxone	II,	OP		
Ronstar	Oxadiazon				

WHO Class: **I(a)**= Extremely hazardous, **I(b)**= Highly hazardous, **II**= Moderately hazardous **III**= Slightly hazardous, **U**= Unlikely, **NC**= Not Classified, **NK**= Not known
Type of Chemical: PY= Pyrethroid, C= Carbamate, CU= Copper Compound, OC= Organochlorine, OP= Organophosphate, T= Triazine Derivative, PAA= Phenoxyacetic acid derivatives
Health Effects: CI= Cholinesterase inhibitor, C= Carcinogen, PC= Possible Carcinogen, SE= Suspected Endocrine Disruptor
Registration Status: cR= Registered for General Use (Full, Provisional or Restricted) U= Not registered for General Use.

Femamiphos, Oxamyl, Methamidophos, Dichlorovos, Monocrotophos, Carbofuran and Methomyl were the only WHO Class Ib (Highly Hazardous) recorded in use. Of the Class II (Moderately Hazardous), III (Slightly Hazardous) or U (Unlikely to present acute hazard) types in use, 23% contained chemicals that were suspected to be endocrine disruptors, 5% were cholinesterase inhibitors and 7% each carcinogens and potential carcinogens. Eight out of 44 were unregistered for general use in vegetable production in Zimbabwe.

Insecticides used included 9% pyrethroids (Permethrin, Mitac, Fenvalarate, and Lambda-Cyhalothrin); 41% organophosphates (Pirimiphos-Methyl, Chlorpyrifos, Diazinon, Endosulphan, Methamidophos and Fenitrothion): organochlorines (Monocrotophos and Chlorothalonil and 16% Carbamates (Carbofuran, Carbaryl, Oxamyl and Methomyl).The most popular fungicides were copper based such as Copper Oxychloride, although Mancozeb was also in use.

The type and amount of agrochemicals used in different crops depended on the pest population and their potential damages to the crop as well as farmers' perception regarding pest management practices. The agrochemicals were supplied in containers ranging from 50 ml to 5 litres and in packets ranging from 0.5 kilograms to 25 kilograms. In most cases the 100, 200 and 500 ml and 0.5 and one kilogram containers were most common. Farmers were also dispensing smaller quantities among each other.

The study revealed that 25% of the respondents who used herbicides were those in the A2 resettlement areas and were involved in winter wheat production.

Storage of Agrochemicals

The study revealed that93.5% of the respondents kept the agrochemicals in their original containers and 6.5% stored them in other unlabelled containers. The respondents who stored agrochemicals in other containers were those who purchased or borrowed small quantities from neighbours.

Less than half (46.9%) of the respondents stored the agrochemicals in secure storerooms, whilst 28.1%, 18.8% and 6.2% stored them under their beds in bedrooms, in outside shade structures and granaries respectively (Figure 1).

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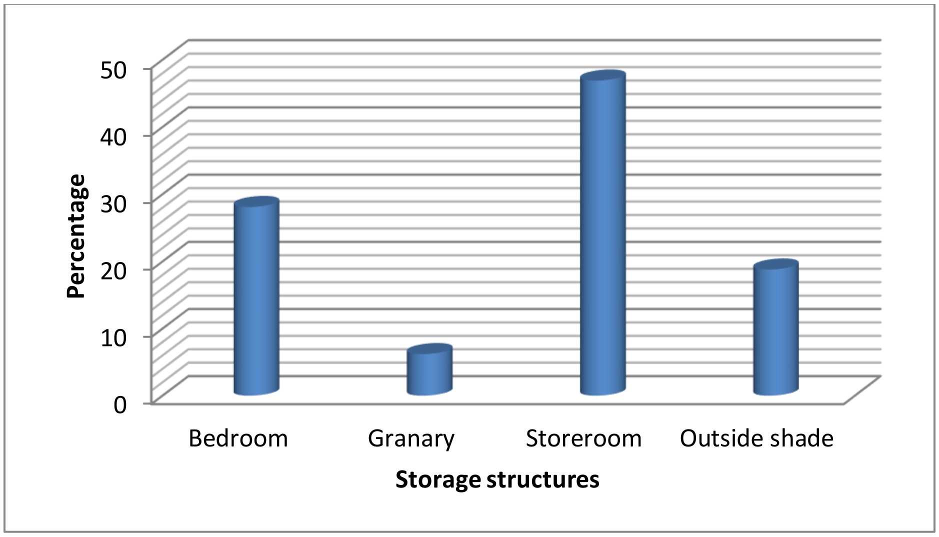

Figure 1: Agrochemicals Storage Structures

Most respondents stored the agrochemicals for periods of over a year (64.5%), whilst 32.2% and 3.1% reported storage periods of several months and weeks respectively.

Agrochemical application and use

The study found out that 65.6% of the respondents were responsible for the field application of agrochemicals with 25%and 9.4% reported that agrochemicals were applied by workers and a combination of the farmer, workers and husband respectively (Figure 2).

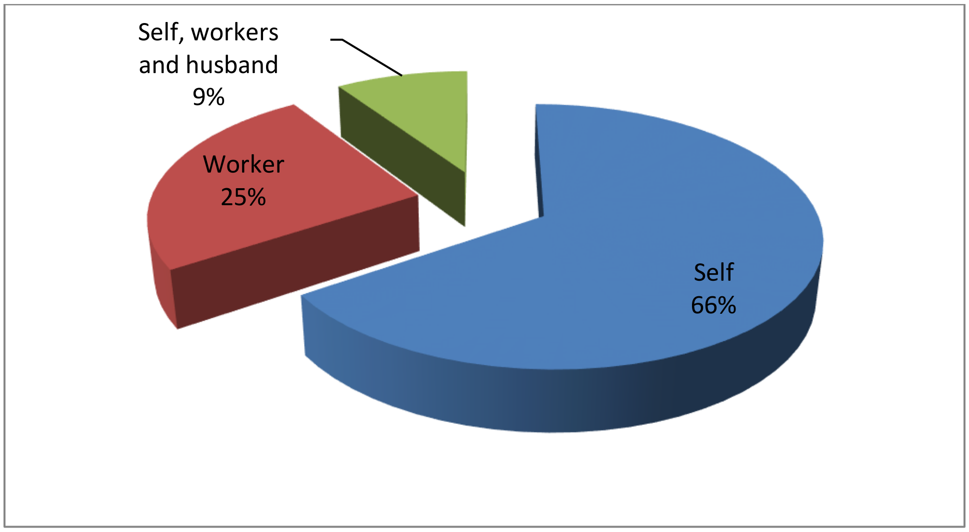

Figure 2: Responsibility for Agrochemical Application.

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It was revealed that 65.6% and 34.4% of respondents were able to read and not able to read the instructions on the labels on the agrochemical containers respectively.

Training on agrochemical application and use

Less than half (38.7%) of the respondents had received proper training on use of agrochemicals, whilst 40.6% and 21.9% had not received any training or were partly trained respectively. Those who had been partly trained received the training from the Ministry of Health and Child Welfare's Malaria Control Programme.

The main providers of the training were reported to be the agricultural extension workers (62.5%), whilst 12.5%, 15.6% and 6.2% of respondents reported being trained by friends, extension workers and suppliers and suppliers respectively (Figure 3).

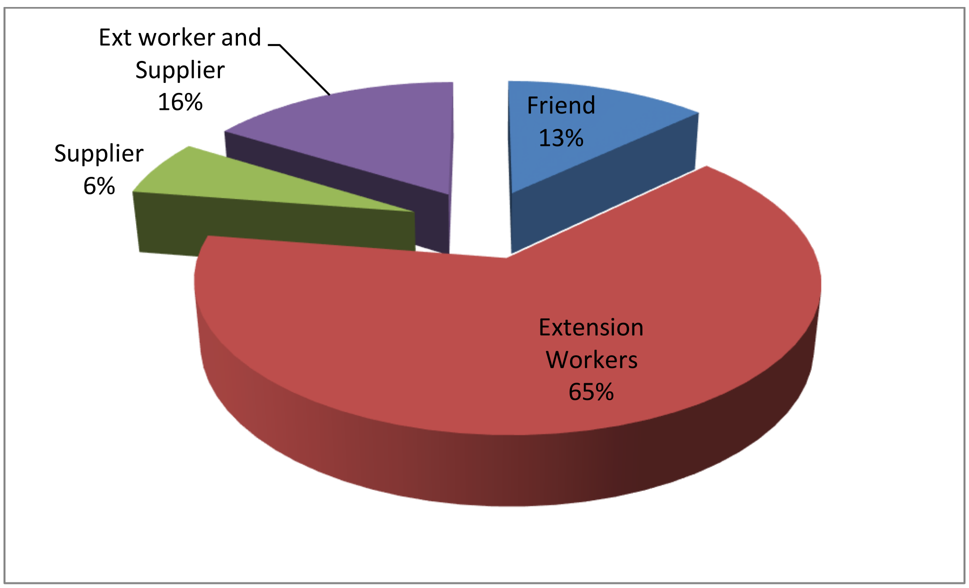

Figure 3: Providers of Agrochemicals Training

Information on chemicals was obtained from extension workers (62.5%), suppliers (18.8%) and other farmers (18.7%). Ninety four per cent of the respondents were willing and ready to be trained on the safe use and handling of agrochemicals.

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Spraying Equipment

All respondents used knapsack sprayers to apply the agrochemicals and the sprayers were reported to be in working condition (71.9%) and 28.1% reported having faulty and leaking knapsack sprayers. Only 37.5% of respondents reported ever servicing the knap sack sprayers and 62.5% did not. The study revealed that 29% of respondents ever calibrated their equipment, whilst 43.8% and 27.2% did not calibrate or were not sure of what equipment calibration was respectively.

Perception of pesticide poisoning symptoms

Sixty eight percent of farmers reported having felt sick after routine application of agrochemicals and the most common symptoms that were reported by the respondents were sneezing, headaches, eye and skin irritations, dizziness and nausea.

The study showed that 75% of the respondents marked their vegetable fields after spraying and 25% did not but told household members and friends that the fields have been sprayed. Wooden pegs were used to mark the sprayed fields.

The study showed that 61.3% of the respondents kept records of their spraying programmes and agrochemicals used and 38.7% did not keep any records.

Disposal of Agrochemical

The study found out that there were several agrochemical disposal methods used by the farmers. Thirty one per cent, 21.9%, 18.8%, 15.6% and 12.5% buried, threw in pit latrines, burnt, threw the chemicals in the veld and threw out in household waste respectively (Figure 4).

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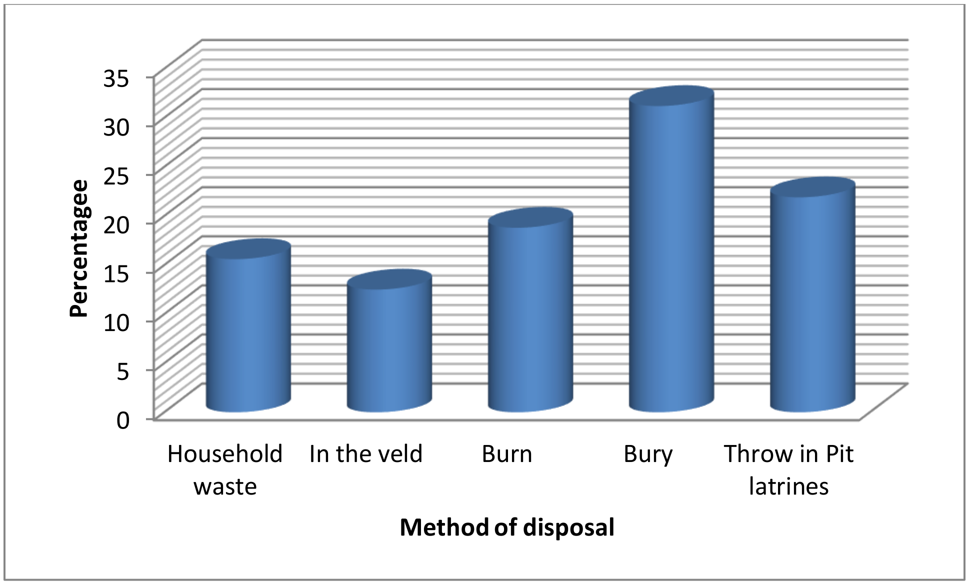

Figure 4: Method of agrochemical Disposal

It was also revealed that 38.5% of respondents re-used agrochemical containers. These containers were re-used for carrying water (18.8%), whilst 21.9% used them for storing sugar, spices and salt and 9.4% used them for decanting smaller amounts of chemicals borrowed or bought from neighbours respectively.

Use of Protective Clothing

The study found out that only 37.5% of the respondents used some protective clothing though the clothing was not the entire recommended spraying kit and 62.5% did no use any protective clothing. Some of the clothing reported to be used by respondents were tennis shoes, head scaffs used as nose masks, plastic papers as hand gloves, leather shoes and long and short pairs of trousers. No respondent mentioned ever using goggles during agrochemical applications.

Most respondents (31% and 34%) applied the agrochemicals between in the early morning (0600 to 1000 hours) and late afternoons (1600 to 1800 hours) respectively. Only 3.1% and 6.2% applied the chemicals during the hotter parts of the day (Figure 5).

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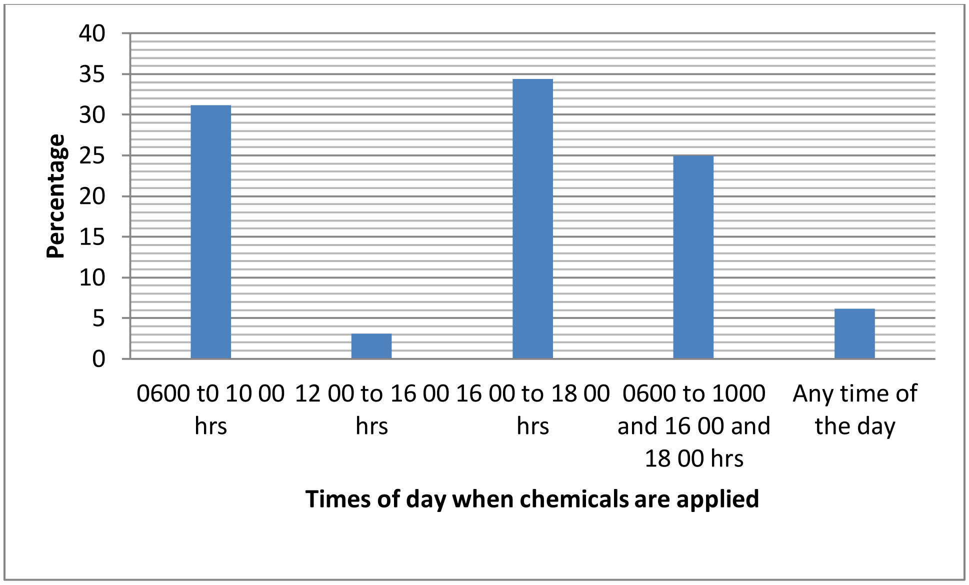

Figure 5: Times of day for Agrochemicals Application

Frequency of pesticide application

More than three quarters of the farmers interviewed (80%) reported routine application of insecticides and 77% reported routine application of fungicides. The fact that more than 15% of farmers reported applying pesticides 16 times or more per cropping season indicates a high rate of agrochemicals usage.

4.0 DISCUSSION

The use of agrochemicals was observed to be very high, with over 44 different agrochemicals of different formulations, probably because farmers assume that the only and quickest solution to pest problems is to spray more frequently and using different types of chemicals. This was in confirmation with what was found by Dinham (2003). In studies conducted in Tanzania (Ngowi, 2003), it was revealed that farmers were not receiving agricultural extension service hence have attempted various means especially in agrochemicals use when dealing with pest problems but were constrained by the lack of appropriate knowledge. In African countries, many government extension programs encourage the use of agrochemicals (Abate *et al*., 2000), but do not consider their effects in the environment and health risks. Epstein and Bassein (2003), observed that farmers used more agrochemicals because they based the applications on calendar spray agrochemicals programme without necessarily giving much priority to health and environmental considerations.

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Widespread use of hazardous agrochemicals in the fields, home, unsafe storage in bedrooms and use of empty agrochemicals containers all contribute the high exposure to agrochemicals poisoning. The non-use of proper protective clothing and the washing of pesticide contaminated work clothing pose another major risk. The easy availability of hazardous chemicals in rural and resettlement areas contributes to increased poisoning.

Insecticides and fungicides were the most used because insect pests and fungal attacks were the most serious problem in vegetable production in the study area. Herbicides were least in use probably because weeding could easily be done manually by household members. Herbicides were only used by the small holder farmers in Umguza, who are into irrigated winter wheat production. The women and children were used for duties such as transplanting, weeding and harvesting vegetable crops in the irrigation schemes. This division of labour exposed the whole family to agrochemicals hence the majority of households in the farming communities were likely to be adversely affected by agrochemicals in one way or the other.

River or dam water that was observed to be used in agrochemical application and this indicates that farmers lack basic knowledge of agrochemicals. Smit *et al*., (2002) observed that there was an interaction between fungicides, insecticides and water mineral content that influenced the efficacy of individual pesticide against fungal pathogens and insect mortality. There is limited information on the reaction and effects of the mixtures observed in this study.

The trend of agrochemicals use is probably based on farmers' knowledge on agrochemicals application in relation to effectiveness of agrochemicals, pests, farm size, prices and weather condition. The use of Carbofuran and Oxamyl, highly hazardous carbamate pesticides which are applied as granules in the soil to control nematodes can cause acute effects despite the fact that the formulation type is solid to mitigate risks from agrochemicals exposure to farmer's health, non-target organisms and the environment. These agrochemicals can be fatal if inhaled, swallowed or absorbed through the skin, even though the effects of contacts and/or inhalation may be delayed due to its formulation (Santo *et al*., 2002). The effects of exposure even of a short duration can be delayed but there is a possibility of cumulative effects (Gupta, 1994).

The risk of long term effects of the agrochemicals that were being used in the study area is high especially due to exposure to carcinogens, possible carcinogens and suspected endocrine disruptors. The agrochemicals were being mixed wrongly, calibration of sprayers was not done and there was mishandling and misuse. Although fungicides are not easily observed to cause serious and acute damage to farmer's health, they have been reported to cause some harm to farmer's skin and eyes (Novikova *et al.,* 2003). It is also reported that there is a long term risk for

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cancer development and endocrine disruption resulting from farmer's exposure to fungicides containing Mancozeb (Novikova *et al.,* 2003).

In general, the frequencies of agrochemical application in the study areas were high. Such heavy use of agrochemical may result in frequent contact with agrochemicals which can lead to significant health problems.

Health and environmental problems cannot be isolated from economic concerns due to the fact that incorrect agrochemical use results not merely in actual yield loss but also in health and possible effects of air and water pollution.

The high dependence on agrochemicals by vegetable farmers is an indication that they are not aware of other disease and pest management strategies that are effective, inexpensive and yet environmentally friendly. These management strategies include intercropping (Legutowska *et al.,* 2002) and tillage type and crop rotation (Hummel *et al.,* 2002), have been shown to significantly reduce insect pests. There is a need to bring to the attention of these farmers existing alternative pest management strategies that are cost effective and environmentally friendly. In Zimbabwe, although smallscale vegetable farmers use some cultural control methods and occasionally botanical pesticides, pest control is predominantly by the use of synthetic pesticides (Sibanda *et al.,* 2000).

5.0 CONCLUSION

1) Farmers in small holder irrigation sector are using a lot of agrochemicals indiscriminately.

2) At least five chemicals registered for use in tobacco are being used on vegetables.

3) It was found that the majority are not able to follow the instructions on the labels and used faulty spraying equipment without any calibration.

4) There was no proper, safe storage of agrochemicals and most farmers did not use the proper protective clothing.

5) The study provides valuable information on the agrochemicals used, exposures and perceptions on agrochemicals use and health symptoms by small scale vegetable farmers.

6) There are strong indications that there are human health problems that are associated with the use of agrochemicals in horticultural farming in Matabeleland North but inadequately documented. In addition, the costs of farmers' health effects and environmental problems caused

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by agrochemicals use have not been included in the total cost of vegetable production by smallscale farmers in Matabeleland North. The information can be used to develop a tool to quantify the cost of pesticide use in agriculture and hence contribute to the reformation of pesticide policy in Zimbabwe.

6.0 RECOMMENDATIONS

1) Extension workers and farmers need regular training to encourage appropriate practices for safe use and handling of agrochemicals by educating them about the risks involved in the misuse and abuse of these poisonous materials. In addition, training in integrated pest management (IPM) methods, which could reduce the quantity of pesticides used and hence reduce potential exposures, is recommended.

2) Local suppliers and agro dealers are the major distributors of agrochemicals to the farmers. Most however, lack training on usage and storage of pesticides at the shop level, information on pesticide safe handling practices and correct advice to farmers. Regulatory and adequate monitoring policies that can provide adequate extension and advisory services to agrochemicals distributors on the range of agrochemicals products available, their uses and handling are recommended. This may improve the quality of agrochemicals customer services that are available to the farmers in the province.

3) Government should intensify efforts aimed at registering and controlling distribution of agrochemicals and banning hazardous ones. This could be achieved through stricter enforcement of existing regulation and monitoring policies. Government should also make newer, less toxic agrochemicals more readily available to the farmers in ready-to-use packages. The FAO Pesticide Code of Conduct makes specific recommendations to governments on controlling hazardous pesticides and taking action to minimise health impacts. These include carrying out health surveillance, documenting poisoning cases, training health staff on treatment of cases and avoiding the use of pesticides which require the use of personal protective equipment, particularly for smallholders in tropical countries. It recognises that prohibiting the use of highly toxic Class I pesticides may be desirable.

4) Finally, agrochemicals manufacturers should be instructed and compelled to exhibit agrochemicals instructions and warning labels in the language commonly understood by the farmers and other end users, and also to package products in containers that are not attractive for subsequent re-use according to the International Code of Conduct on the Distribution and Use of Pesticides.

ACKNOWLEDGEMENTS

I would like to extend my sincere gratitude to, Mr. M. Ndlovu and Ms N. Mpala for assisting in the data collection and enumeration in Umguza and Hwange districts respectively and to all the farmers who participated in making this study a success.

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