Study on Agrochemical Handling and Use in Magu District

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Abstract

This reports on a study on handling and use of agro-chemicals in Magu District, Mwanza Region, Tanzania. It has been found that there is misuse and improper handling of the chemicals. Farmers lack enough knowledge of the dangers associated with improper handling and use of agro-chemicals. Sixty percent of the interviewed farmers apply manure in their fields but not at the recommended rates due to either ignorance or lack of transport facilities. Farmers also apply agro-chemicals in horticultural farms at rates that are, in most cases, higher than those recommended. The recommended safety intervals between applications of pesticides and crop harvesting are not observed and farmers do not use protective gears during handling and use of pesticides. Empty pesticide containers are either kept for domestic uses or are disposed of haphazardly. The reasons for this misuse and improper handling are lack of knowledge by farmers, poverty, and inadequate extension services. It is recommended that appropriate measures to ensure safe handling and use of agro-chemicals must be taken to avoid adverse effects on the environment and public health. Training of farmers, extension staff and input stockists should be enhanced to foster proper handling and use of agro-chemicals thus reduce/eradicate the rate of misuse incidents.

Key Words: Pesticides, fertilizers, environment, pollution

Introduction

Lake Victoria is the world's second largest fresh water body with a surface area of 68,800km^2, a volume of 2760 km^3, an adjoining catchment of 192,580 km^2 and reaches a maximum depth of 80 metres with an average depth of 40 metres. The lake's shoreline is about 3,500 km enclosing innumerable small and shallow bays and inlets.

The large catchment area of the lake as reported by Howard and Matindi (1998), is drained mostly by four rivers, namely Kagera (45%) originating in Rwanda and Burundi, Nzoia (15%) running from Kenya, Mara (10-15%) running from Kenya and Tanzania and the Sondu-Miriu (7-9%) from Kenya. In Tanzania other small rivers that are Ngono, Grumet, Mbalageti, Simiyu, Suguti, Magogo and Mori drain the catchment. River Nile, which originates in the Ugandan side, is the only outflow from the lake.

The lake is a major source of water for domestic, industrial and agricultural use. It is also an important source of fish and is used for transport connecting the three East African countries. The lake therefore provides support for the livelihood of the populations living in the catchment area.

In general, the lake Victoria ecosystem has drastically changed by human activities. Agriculture, the major occupation of the large population in the catchment is among the activities that are posing an environmental threat to the quality of the lake. On the other hand the lake is used as a repository for human and industrial wastes thus increasing the dangers of disruption of the lake ecological equilibria.
Agriculture contributes to a wide range of environmental quality problems through its discharge of pollutants (contaminants) and sediment to surface and/or groundwater, through net loss of soil by poor agricultural practices and through salinization,

waterlogging and desertification (FAO, 1996) The use of agrochemicals (pesticides and fertilizers) in agriculture contributes to environmental degradation through the release of pollutants and contaminants.

The risk to the environment due to agro-chemicals or their formulated products depends on many factors, such as toxic properties, the amount applied, the formulation, the method and time of application and particularly the intensity of use, mobility and persistence in the environment.

Howard and Matindi (1998) in their report noted that increased inflow of nutrients into the lake Victoria has resulted into eutrophication and nutrient inputs has increased two to three-fold since the turn of the last century, mostly since 1950. The source of these nutrients is mostly from agriculture as the use of fertilizers started to increase in the same period. There is also an anthropogenic supply of phosphorus and nitrogen in the lake as was indicated by satellite imagery (Roach, 1999). Due to the relatively high concentration of nitrogen, phosphorus and other nutrients there has been an increase in algae growth and a shift in the composition towards domination by blue-green algae causing de-oxygenation of water. The increased nutrient load has also spurred the water hyacinth infestation.

The use of agro-chemicals in the Lake basin dates back to colonial era when they were introduced to control pests of important cash crop and enhance soil fertility. Many compounds have been used and many others are being recommended for use. But it is very unfortunate that the information available on pesticide usage in the lake basin is either incomplete or quantities are not recorded. The available data does allow approximate expression of the growth and fall in agrochemical usage. For instance, from 1990/91 to date more than 15 formulations of pesticides have been introduced to control cotton pests as shown in Table 1.

In the past, Nyanza Co-operative Union was the sole distributor of agro-chemicals in Mwanza region, supplying to farmers through ginneries and primary co-operative societies**.** Table 2 shows the distribution of agro-chemicals to ginneries from 1993/94 to 1997/98 seasons in Mwanza region with Magu district having a share of 183,440 litres, which is approximately 44% of the total quantity in the region. But these data do not give the total amount, because only data for Magu district ginneries were available in the 1994/95 seasons. Considering the amount of agro-chemicals from twenty private input stockist in the same season (Table 3) the total amount of agrochemicals available in the region is higher than recorded.

Table 1: List of Common Cotton Pesticides in Mwanza region

Name of pesticide	**Quantity ('000) litres**					
	1990/91	**1991/92**	**1992/93**	**1993/94**	**1994/95**	**1995/96**
Thiodan	131.70	583.68	484.80	477.80	22.80	46.00
U-Kombi 50% U.L.V	47.70	155.19	-	-	-	-
Ripcord (Cypermethrine)	224.32	202.63	270.00	280.00	-	-
Sumicidin 3% U.L.V	86.36	143.71	179.80	158.80	60.00	-
Cymbush 3%U.L.V	15.00	-	102.40	50.00	-	-
Politrin 1.8% U.L.V	-	98.00	57.60	90.00	84.00	10.40
Karate 0.6% U.L.V	-	89.33	95.00	100.00	103.00	36.20
Melcypermethrine	-	3.00	37.40	5.00	39.00	-
Bulldog	-	-	-	80.00	160.00	10.00
Nuselle	-	-	-	-	64.00	37.00
Fasgac	-	12.40	20.00	-	-	-
Decis	-	-	-	24.60	45.00	24.60
Fenom C	-	-	-	25.20	75.00	15.60
Karate 2 ED	-	16.34	10.00	20.000	33.00	-
Cymbush 6 ED	-	19.29	2.52	-	-	-
Total	**505.08**	**1,323.58**	**1,253.52**	**1,311.40**	**891.00**	**179.80**

Source: Tanzania Cotton lint and Seed Marketing Board, 2000

Table 2: Distribution of Pesticides for Cotton in Mwanza Region (1993/94 - 1997/98)

Year	**Zone**	**District**	**Pesticides ('000)**								
'93/94		Senge-rema	Bulldog	Decis 3%	Thiodan 25% ULV	Karate 6% ULV	Karate 2ED	Rip-cord	Sumic idin	Fenom C	Total (l yr^{-1})
	Buchosa	**- " -**	-	-	4.00	1.66	0.90	-	2.00	-	**8.56**
	Buyagu	**- " -**	1.00	-	10.00	2.00	1.50	-	8.00	2.00	**24.5**
	Nyamililo	**- " -**	-	-	4.00	1.00	0.45	-	2.00	-	**7.45**
	Bukumbi	**Misungwi**	-	1.00	-	2.00	-	-	3.00	1.00	**7.00**
	Manawa	**- " -**	-	-	10.00	-	-	-	1.00	-	**11.00**
	Kasamwa	**Geita**	2.00	6.00	20.00	4.00	2.25	-	10.00	4.00	**48.25**
	Ngasamo	**Magu**	2.00	4.00	11.00	-	1.50	-	8.00	2.00	**28.50**
	Nassa	**- " -**	2.00	4.00	4.00	-	0.38	-	6.00	2.00	**18.38**
	Magu	**- " -**	1.00	2.00	11.00	-	0.38	-	6.00	1.00	**21.38**
	U'rewe	**Ukere-we**	-	-	1.40	-	-	-	-	-	**1.40**
	Farms	**N.C.U**	0.40	-	-	-	0.20	-	-	-	**0.600**
	Sub Total		**8.40**	**17.00**	**75.40**	**10.66**	**7.56**	**-**	**46.00**	**12.00**	**177.02**
'94/95	Magu	**Magu**	-	-	5.00	-	-	-	-	-	**5.00**
	Nassa	**- " -**	-	-	5.00	-	-	-	-	-	**5.00**
	Ngassamo	**- " -**	-	-	5.00	-	-	-	-	-	**5.00**
	Sub Total		**-**	**-**	**15.00**	**-**	**-**	**-**	**-**	**-**	**15.00**
'95/96	Buchosa	**S'gere-ma**	10.40	7.00	3.00	2.50	2.17	-	-	-	**25.07**
	Buyagu	**-" -**	13.00	9.20	3.00	3.80	2.68	-	-	-	**31.68**
	Nyamililo	**- " -**	7.60	6.50	3.00	2.10	1.62	-	-	-	**20.82**
	Bukumbi	**Misu-ngwi**	2.00	3.00	2.00	2.80	0.36	-	-	-	**10.16**
	Manawa	**- " -**	3.20	3.00	3.00	4.30	0.59	-	-	-	**14.09**
	Kasamwa	**Geita**	16.60	13.40	4.00	4.40	4.09	-	-	-	**42.49**
	Ngasamo	**Magu**	2.80	3.00	4.00	5.00	7.10	0.95	-	-	**22.85**
	Magu	**- " -**	-	1.40	4.00	4.00	-	-	-	-	**9.40**
	Nassa	**- " -**	1.20	1.60	3.60	4.50	0.68	-	-	-	**11.58**
	Nyambiti	**Kwimba**	2.40	2.60	3.40	5.00	2.48	-	-	-	**15.88**
	U'rewe	**Ukerewe**	0.60	0.90	-	-	-	-	-	-	**1.50**
	Sub Total		**59.80**	**51.60**	**33.00**	**38.40**	**21.77**	**0.95**	**-**	**-**	**205.52**
'97/98	Buchosa	**Sengerem**	-	-	-	1.00	1.49	1.00	-	-	**3.49**
	Buyagu	**- " -**	-	-	-	-	-	1.00	-	-	**1.00**
	Nyamililo	**- " -**	-	0.20	-	-	-	0.40	-	-	**60**
	Kasamwa	**Geita**	-	-	-	2.00	3.01	1.00	-	-	**6.01**
	Ngasamo	**Magu**	-	0.20	-	3.50	-	0.40	-	-	**4.10**
	Nassa	**- " -**	-	-	-	2.00	-	-	-	-	**2.00**
	Nyambiti	**Kwimba**	-	0.20	-	3.50	-	0.20	-	-	**3.90**
	Manawa	**Misungwi**	-	0.20	-	-	-	4.20	-	-	**0.40**
	Sub Total		**-**	**0.80**	**-**	**12.00**	**4.50**	**1.800**	**-**	**-**	**21.50**
	Total		**68.20**	**69.40**	**123.40**	**61.06**	**33.83**	**5.15**	**46.00**	**12.00**	**419.04**

Source: Nyanza Co-operative Union (1984) Ltd., data for 2000.

In general there had been an increase in the consumption of agro-chemicals from 1985/86 season reaching a peak in 1992/93 season and was followed by a decline (Ningu *at el.*, 2000). Programmes like the FAO fertilizer programme in the early 1980s' increased the use of agro-chemicals in the lake regions.

Table 3: List of Types and Amount of Pesticides from 20 Private Traders in Mwanza City

Trade Name	**Year (Amount in litres)**								**Total (litres)**
	1993	1994	1995	1996	1997	1998	1999	2000	
Nuvan	40.00	1844.00	240.00	130.00	401.00	365.00	208.00	6285.00	9513.00
Thionex	132.00	-	-	-	142.00	409.00	121.00	19.00	823.00
Actellic 50EC	60.00	5.00	32.00	1175.00	86.00	511.00	208.00	-	2077.00
Municipal fluid	108.00	108.00	52.00	64.00	72.00	471.00	208.00	-	1083.00
Rogor	60.00	5.00	340.00	-	-	-	-	-	405.00
Sumithion	-	143.00	-	48.00	242.00	300.00	2253.00	22.00	3008.00
Diazinon	-	15.50	20.00	-	682.40	37.10	367.60	144.00	1266.60
Sherpa	-	-	-	-	320.00	554.00	2.40	1.60	878.00
Buldog	-	-	-	-	175.00	108.00	210.00	22.00	515.00
Fenom C	-	-	-	280.00	-	601.00	20.00	-	901.00
Karate 2ED	-	-	-	472.00	740.40	292.00	122.00	6.00	1632.40
Thiodan 35%	-	170.00	50.40	125.90	220.00	323.00	5058.00	8.00	5955.30
Basudin	-	-	-	100.00	114.00	-	-	-	214.00
Ripcord	-	-	-	-	661.40	571.00	5.00	-	1237.40
Dursban	-	-	-	-	659.40	510.00	1420.00	-	2589.40
Gamalin	-	-	-	168.00	-	-	149.00	-	317.00
Baytical	-	-	-	-	-	7.00	7.00	-	14.00
Sumicidin	-	-	-	105.50	112.00	457.00	19.00	-	693.50
Dimethoate	-	-	-	-	-	-	22.00	51.80	73.80
Almatix	-	-	-	-	-	-	7.80	31.00	38.80
Ronstar	2004.00	-	-	184.00	-	-	-	-	2,188.00
Stomp	-	-	-	-	3.00	-	-	-	3.00
2-4D Amine	-	-	-	19.00	600.00	-	-	-	619.00
Roundup	-	-	-	60.00	45.00	115.00	38.00	-	258.00
Stelladone	520.00	140.00	125.00	125.50	194.00	381.00	63.30	530.00	2078.80
Superdip	5.00	-	-	11.00	705.40	102.00	51.00	2.90	877.30
Tactic	-	-	-	65.00	24.00	51.80	15.00	13.30	169.10
Bravo	-	240.00	178.00	426.00	971.00	861.00	765.00	39.00	3480.00
Coccide	0.03	0.12	0.30	-	0.04	0.26	0.06	-	0.81
Mancozeb	0.20	0.13	0.10	-	0.03	0.04	0.06	0.01	0.57
Topsin 7170.85	-	-	-	-	0.04	0.10	0.10	0.30	0.54
Antracol blue	-	-	-	-	0.04	0.40	0.11	0.22	0.77
Furadan	-	3.00	0.20	-	0.04	0.40	0.11	-	3.75
Sevin	-	0.20	0.30	0.20	0.33	0.30	0.10	0.01	1.44
Malathion	-	-	-	-	0.33	0.80	0.10	-	1.23
Total (lts)	**2918.23**	**2673.95**	**1038.30**	**3559.10**	**7170.85**	**7029.20**	**11340.74**	**7176.14**	**42,917.51**
Type	**Amount in kilograms**								**Total (Kgs)**
Dieldrin	12.00	-	9.00	-	-	-	-	-	21
Blue copper	2.30	0.40	0.50	2.40	2.20	1.22	1.10	-	10.12
Dithane M 45	0.40	0.40	0.20	0.45	0.40	0.70	0.60	0.35	3.50
Co-box	-	-	-	-	0.03	0.20	0.50	0.60	1.33
Actellic dust	1.30	0.20	0.40	0.62	2.70	1.60	0.10	-	6.92
Total (Kgs.)	**16.00**	**1.00**	**10.10**	**3.57**	**5.33**	**3.72**	**2.30**	**0.95**	**42.87**

Intervention of some donor funded Non Governmental Organizations (NGOs) such as Mwanza Small Holder Development Project (MSDP) and Heifer project, which have taken the role of supplying agro-chemicals to peasant farmers, is also expected to increase the use of agro-chemicals.

The quantity of artificial fertilizers increased from the 1986/87 farming season reaching a peak in 1989/90, followed by a decrease (Ningu *et al.*, 2001). The decrease in fertilizer consumption is attributed to higher prices of fertilizers that have forced farmers to stop applying artificial fertilizers. Many farmers have opted to use animal manure and others are not using fertilizers at all (NAEP II Beneficiary Assessment Report, 1999).

Private businessmen had entered the market of agro-chemicals and they get the chemicals from different sources within and outside the country. While carrying out inventory of agro-chemicals in the lake basin (Ningu *at el.*, 2000) about twenty private dealers of agro-chemicals in Mwanza city were contacted to give the quantities and types of agro-chemicals they brought into the market from 1993. As Table 3 shows, there are many types of pesticides being used in the lake basin. With this system of agro-chemicals entry, it is very difficult to exactly know the quantities of agro-chemicals in the basin. Apparently there are no recognized channels of registering the quantities and types bought by private dealers.

The general objective of the study is to obtain detailed information on the use, handling and storage of agro-chemicals by farmers, input stockists and agricultural extension workers. The specific objectives are to: identify types of agro-chemicals commonly used by farmers in the pilot area; determine how farmers handle and use agro-chemicals; explore the contribution of agricultural input stockists to misuse of agro-chemicals; and examine the effectiveness of agricultural extension services in training farmers on the proper use of agro-chemicals.

The findings would promote good practices that encourage safe and efficient use of agro-chemicals thus minimizing adverse effects on humans and the environment. The goal is to create an enabling environment that will increase the interaction between farmers who are users and experts whose goal is to minimize the adverse effects of agro-chemicals.

Study Methodology

Eighteen villages in fourteen wards of Magu district were randomly selected basing on their involvement in both the production of field and horticultural crops. Ten villages close to the lake and eight villages far from the lake were selected. This division based on the main occupation of farmers, as farmers close to the lake are involved in both farming and fishing. On the other hand, farmers close to the lake practice horticulture while those away from the lake mostly grow field crops.

Farmers were randomly selected from each village basing on their participation in agricultural activities. The total sample size was 100 farmers. The study also assessed nine village extension workers and six private input suppliers and involved mainly the use of structured questionnaires, field observations and formal discussions. Data on

agro-chemicals available in the lake basin was obtained from private input stockist, Nyanza Co-operative Union and Tanzania Cotton Lint and Seed Marketing Board.

Results and Discussion

Household Characteristics

Table 4 shows the age distribution and education level of farmers. The population is characterized by low level of education with 74% of the study group having primary education, mainly standard seven. Only 8% and 4% of the farmers have secondary and college education respectively. The remaining 11% and 3% of farmers have respectively adult education and no formal education at all (Table 4).

Table 4: Age and Education Level of Farmers

Ward	Age Group (years)			Education Level*					
	< 40	**41 - 60**	**>60**	**I**	**II**	**III**	**IV**	**V**	**VI**
Malili	4	1	0	4	1	0	0	0	0
Igalukilo	4	1	0	4	0	0	0	0	1
Ngasamo	3	2	0	3	2	0	0	0	0
Nyaluhande	2	0	3	3	0	0	2	0	0
Ng' haya	4	3	2	7	1	0	1	0	0
Sukuma	3	3	1	6	0	0	1	0	0
Kalemela	6	9	2	13	0	0	3	1	0
Kiloleli	1	2	2	4	0	0	1	0	0
Lubugu	2	0	4	3	0	0	2	1	0
Lutale	8	1	0	8	0	0	0	0	1
Nyanguge	3	1	3	5	0	0	0	1	1
Nyigogo	4	1	0	2	2	0	1	0	0
Kahangara	3	3	3	6	2	0	0	1	0
Buswelu	4	2	0	6	0	0	0	0	0
TOTAL	**51**	**29**	**20**	**74**	**8**	**0**	**11**	**4**	**3**

Agriculture is the mainstay of people living in the study area with 73% depending on crop production as the only main occupation. Twenty seven percent of the population practice both crop production and livestock keeping. However, of the 73 % who indicated their main occupation as crop production, they also keep small numbers of livestock including, cattle, goat, sheep, and poultry.

The main crops grown in the area are maize, cassava, sorghum, millet, cotton and different legumes. The main horticultural crops are tomatoes, cabbages, onions, eggplants, and watermelon. Horticulture is practiced by 54% of the farmers and is concentrated close to the lakeshore and urban centres. The reasons for this are availability of water for irrigation and market of horticultural crops in urban centres.

Problems encountered by farmers include crop pests and diseases, availability of agro-chemicals, lack of effective and efficient agricultural extension services, poor transport and unorganised marketing system.

Agro-chemical Handling and Use

The use of agro-chemicals (fertilizers and pesticides) in the study area is a long time practice. Ninety five percent of the interviewed farmers said they had in the past used and/or are currently using agro-chemicals in both field crops and horticultural crops. Crops that account for the greatest consumption of agro-chemical are cotton and horticultural crops. The use of artificial fertilizers is mainly for horticultural crops, while animal manure is used for both field and horticultural crops.

Fertilizer usage

The organic fertilizer mainly animal manure is used by 65% of farmers. Twelve percent of the farmers use artificial fertilizers only, which are Calcium Ammonium Nitrate (CAN), Urea, Sulphate of Ammonia and Triple Super Phosphate. Other farmers who constitute 22% of the study group apply both animal manure and inorganic fertilizers. Artificial fertilizers are mainly applied in horticultural farming.

Since the area has a large population of livestock and application of animal manure is increasing (NAEP II Beneficiary Assessment, 1999), the use of animal manure may raise concern on its implications to water quality. Organic manure is recognized as a major problem in fresh water leading to eutrophication and excessive nitrates in ground and surface waters.

It has been observed by this study that the majority of farmers do not follow the recommended application method and rates of animal manure. Some farmers overuse and others use lower doses due to either ignorance or lack of transport facilities to enable them ferry enough manure to the fields.

In some cases, especially in horticulture farming, artificial fertilizers and organic manure are used together leading to excessive application of nutrients. For example, a farmer in Buswelu village said that he applies 60kg of Urea or CAN per 0.1 hectare (0.25 acre) of tomatoes, after pre-planting application of two tons of animal manure. The recommended rate of organic manure per hectare is 20 tonnes while the rate for CAN is 220 kilogrammes per hectare. Thus, a rate of 22 kg/0.1 ha is enough, which is lower than the rate of 60 kg of CAN or Urea he applies. This is one example, but there are many farmers who apply by estimating the amount, thus ending up using higher or lower amounts than the recommended quantities.

Other farmers apply artificial fertilizers without adhering to their concentration. For example, CAN contain 26% and Urea 46% Nitrogen and hence, the application rate of urea should be half the amount of CAN, but this fact is not considered by farmers as they apply the two types of fertilizer at the same rate.

Horticulture is more paying and many farmers are shifting from growing cotton to horticultural crops (tomatoes, onion, cabbage, eggplants and other leaf vegetables in areas close to the lake and urban centres where there is a ready market for the crops. With the increasing rural to urban migration and the high rate of urban population growth, the demand for horticultural crops will also be increasing. This entails expansion of horticulture and since horticultural crops are higher consumers of fertilizers, the use of both organic and artificial fertilizers will be rising.

The possibility of increasing nitrogen in the soil is high in the areas close to the lake, where farms for horticultural crops are increasingly being fertilized by heavy doses of

nitrogen. In this case the excess nitrogen represents a potential environmental hazard if it leaches beyond the root zone and pollutes ground and surface water and ultimately the lake.

For maintenance of the soil productivity and at the same time minimizing the potential contribution of nutrients to environmental pollution, the introduction of organic farming and integrated soil fertility management are best approaches.

Pesticide handling and use in the area

The study has revealed that the pesticides applied to crops are mainly carbamates, pyrethroids, organophosphorus, few organochlorines and inorganics. The principal pesticides used in the study area in the 1999/2000 farming season are listed in Table 5.

Table 5: Principal Pesticide Used in the Study Area (Kilograms or Litres)

Trade Name	Common Name	Group	Type	Amount
Ripcord	Cypermethrin	Pyrethroid	Insecticide	120lts
Thiodan /Thionex	Endosulphan	Organochlorine	Insecticide	160lts
Fenom C / Selecron	Profenofos + Cypermathrin	Organophosphorus + Pyrethroid	Insecticide	80 lts
Sumicidin	Fenvalerate	Pyrethroid	Insecticide	8 lts
Buldog	Betacyfluthnin 0.5 % ULVA	Pyrethroid	Insecticide	24 lts
Karate	Lamada cyhalothrin	Pyrethroid	Insecticide	0.5lts
Diazinon	Diazinon EC, WP,G	Organophosphrus	Insecticide	2.2lts
Sumithion/N ovathion	Fenitrothion	Organphophorus	Insecticide	3.2lts
Dimethoate /Rogor	Aimethoate 40% EC	Organphophorus	Insecticide	0.2 lts
Sevin or Sapa carbaryl	Carbaryl	Carbamate	Insecticide	0.5 lts.
Blue copper (Cocide)	Copper hydroxide	Inorganic	Fungicide	40 kg
Dithane M-45	Mancozeb	Carbamate	Fungicide	25 kg
Cobox / BASF	Copper oxychloride	Inorganic	Fungicide	17 kg
Antracol	Propineb 70% WP	Carbamate	Fungicide	17 kg
Bravo	Chlorothalonil	Organochlorine	Fungicide	12 kg
Topsin / Cycosin	Thiophanate Methyl 70% WP or 40 % ULVA	Carbamate	Fungicide	13 kg
Ridomil	Metalaxyl + Mancozeb 75 or 56% WP	-	Fungicide	2 kg

Taking into account the large population of people in the lake basin and the different crops that have not been covered in this study, it is obvious that the quantity of pesticide used in the basin is high. For instance, cotton is mostly grown in Shinyanga, Mwanza, and Kagera regions while coffee is grown in Kagera and Mara regions, crops that are high consumers of agro-chemicals. If the study is extended to cover these regions the amount and type of pesticides used will inevitably increase.

The handling and use of pesticides vary greatly among farmers and in most cases there is mishandling and misuse of pesticides. A farmer either applies chemicals at lower or higher doses than recommended (Table 6), practices that have detrimental effects. The problem of misusing pesticides comes from low education level of farmers and inadequate agricultural extension services as mentioned by many farmers.

Labels are the most important source of information on the approved or recommended use of pesticides. Over 80% of interviewed farmers can read and write and therefore can follow directives on all labeled pesticides. But only 63% of farmers said they read

the labels on the containers and 60% follow the direction given on the labels. Those who don't read said that the labels are written in English, a language they can't read and understand. Others said that they are not aware of the importance of reading the label because they ask the stockist or businessmen on how to use the chemicals.

Therefore, all pesticide containers should bear labels with clear legible directions for use. Warnings and warning symbols should be prepared in language(s) that can be easily understood by the users. It is also essential that restrictions, including the pre-harvest intervals, withholding periods, limitations for use of the treated crop are indicated.

Table 6: Pesticides Application Rates by Farmers, Extension workers and Recommended Rates

Pestcide	**Crop**	**Recommended rate†**	**Rate given by VEO***	**Rate used by farmer[y]**
Ripcond	Cotton	2.5 litres per hectare applied after every 14 days for six times	2 - 2.5 litres per hectare applied after every 14 days for six times	Due to Lack of money to buy enough pesticides they apply low rates tan recommended e.g. 2.5 lts/ha applied once or twice.
Thiodan	Cotton	"	"	"
Fenomi C	Cotton			
Sumicidin	Cotton			
Buldog	Cotton			
Karate	Cotton			
Sumicidin EC	Horticulture	170 ml/litre (ULVA)		
Karate	Horticulture	5 - 7 ml/10 litres water		
Diazinon	Horticulture	8 - 16 ml of 60% EC or 15 - 25 ml of 40% EC in 10 lts of water	1 - 1.5 litres per hectare, 10 kg of 10%EC /ha	40ml/1lt, 20ml/10lts, 100mls/20lts of water
Sumithion	Horticulture	20 ml per 10lts of water	20ml/15lts of water, 30ml/20lts of water	25ml/25lts, 10ml/10lts, 30ml/15lts, 5ml/15lts, 100ml/20lts of water
Demethoate	Horticulture	10 - 15 ml/ 10lts of water (700 - 1000ml per hectare)	40ml/20lts of water, 30ml/20lts of water	-
Blue copper	Horticulture	30 gm/10 lts of water (3kgs per hectare)	30g/20lts of water, 20g/10lts of water	250g/40lts (0.25 acre), 15ml/1lt, 100ml/15lts of water
Dithane M-45	Horticulture	As for blue copper	40g/15lts, 30g/15lts of water	40g/20lts, 20g/20lts, 30g/15lts of water
Cobox	Horticulture	As for blue copper	30g/10lts of water	100g/15lts of water
Antracol	Horticulture	20 - 40gm/10lts of water (2 - 4kg/ha)	-	30g/15lts of water
Topsin	Horticulture	0.5 kg/ha, 500 1000ml of ULVA/ha	-	30g/15lts of water
Ridomil	Horticulture	30g/10lts of water (3kg/ha)	-	30g/15lts of water

* VEO Village Extension Officer.
† From Vegetable Production, Ministry of Agriculture,1998.
y Rates used by farmers do not specify the area to be coverd.

It was also observed that some agro-chemicals are not sold in their original containers. The agro-chemicals are repacked in unsuitable containers or packets. This is because, traders find it easy to sell when they divide the pesticide into smaller quantities that can be easily bought according to farmers' demand. In some cases the liquid pesticide

formulations are mixed with cooking oil and repacked in different containers. The risk to human health and the environment of using unlabelled pesticides is very high and measures to stop this practice should be introduced.

Pesticides sellers are required to give directions on proper use of the chemicals they sell. From the study, 82% of farmers said that they receive directions from input stockist, 9% they don't receive and 9% said they sometimes receive. Those who had received directions for use, 94% said that sellers of agro-chemicals are qualified and they usually give proper directives.

This response is contrary to the finding made on the knowledge of agro-chemicals use by input stockists who are not knowledgeable on agro-chemicals use and hence even if input stockists give wrong directives they regard them as correct. That is why the rates shown in Table 6 show differences to the recommended ones.

The problem is that some extension workers are not well informed on the proper use and handling of pesticides. This can be shown clearly in Table 6 that gives the recommended rates of different chemicals and the rates known by extension workers and those used by farmers. Input stockists who are always in contact with farmers and thus can be considered as potential alternatives to educate farmers on proper use and handling of the chemicals are also not mostly well trained.

Discussion with other farmers revealed that some farmers who do not have application equipment (eg. Knapsack sprayers) use tree branches or bundle of grasses to apply liquid formulations of pesticides on horticultural crops. After application the branches or bundle of grasses are either left lying on the ground or are thrown in the neighboring areas. This finding indicates that if this practice is left unabated, it will increase the potential of environmental pollution.

Pesticide applicators do not follow the wind direction and they don't put on protective clothing, and mixing is sometimes made by hand. They wear worn out clothes during preparation and application of pesticides and therefore farm workers have special risks associated with inhalation and skin contact during preparation and application of pesticides to crops.

It was also observed that equipment and facilities used for pesticide application are either washed at home or in the field. The 60% of farmers said they wash equipment in the field, while 31% wash at home and the remaining 9% wash in rivers and the lake. It has to be understood that wastewater resulting from washing the application equipment presents a risk to the environment.

Storage of Pesticides

Concerning storage of pesticides it was observed that because of the high prices most farmers buy such little quantities that are all used.. Those who remain with some pesticides said they store at a safe place not accessible to children. This shows that storage of pesticides by farmers is at the moment not a problem, as they don't buy large quantities.

Disposal of Empty Containers

Pertaining to disposal of abandoned empty containers, although recommendations for their disposal are available, no generally acceptable practices exist. Some of the empty containers are burned (10%), buried or disposed in latrines (14%), while 8% use such containers for domestic purposes like transport and storage of fuels, cooking oil or drinking water and milk.

Other farmers said that empty containers, particularly plastics are dumped on the ground in the fields, a practice that result into toxic materials leaching out to streams, rivers and ultimately into the lake where they cause serious harm to aquatic fauna. Abandoned chemicals and empty containers need special attention because the vast amount that lies around the field pose environmental threat to contamination.

Harvesting of the treated crops

The problem observed was the handling of leafy vegetables and fruits that have been treated with pesticides. Many farmers said that they don't wash the product as they apply pesticides two weeks before the time to harvest. Most farmers showed that they are unaware of the effects of pesticides to human health caused by consuming vegetables and fruits that have been treated with pesticides before the end of the safety period.

The important question to ask is on the safety period of different pesticides after they are applied to crops. The safety period of different pesticides differ as shown in Table 7, and thus it is not proper for farmers to regard a safety period of two weeks as applicable to all pesticides. It is important that farmers are educated on the importance of observing the safety periods of each pesticide applied and when to apply before the crop is harvested for consumption. Two weeks period is safe for all pesticides listed.

Table 7: Safety Periods and Toxicity of Different Pesticides

Common Name	**Safety Period**	**LD_{50} (mg/Kg)**
Cypermethrin 10%EC, 2.5%ULVA, 6%ED	14 days	251 - 4125
Endosulphan 35%EC, 25%ULVA, 5%G, 4%G, 4%D	14 days	55 - 110
Profenofos + Cypermathrin 17%ULVA (16% + 1%)	14 days	350
Fenvalerate 30EC%, 15EC%, 7EC%, 3%ULVA	7 days	451
Betacyfluthnin 0.5 % ULVA	14 days	500 - 800
Lamada cyhalothrin 5%EC, 0.6%ULVA, 2%ED	14 days	243
Diazinon 60%EC, 40%WP, 10%G	14 days	200
Fenitrothion 50%EC, 40%WP, 25%WP, 2%D	10 days	800
Aimethoate 40% EC	1 day	2350
Carbaryl 85%WP, 5%D	7 days	850
Copper hydroxide 50%WP	7 days	1000
Mancozeb 80%WP	7 days	500
Copper oxychloride 50%WP	7 days	1440
Propineb 70% WP	7 days	1000
Thiophanate Methyl 70% WP or 40 % ULVA	7 days	7500
Metalaxyl + Mancozeb 75% + 56% WP	7 days	633 + >5000

Other crops such as tomatoes and eggplants as they give fruits for a long time and during this period pest attacks continue. In reality it is not possible for a farmer to stop application of pesticides when the crop is being harvested, as they fear to lose

subsequent harvest. Therefore it is possible that application of pesticide continues while picking the fruit as reported by one farmer of Buswelu village. The farmer said that he continues to apply pesticides on tomato but he makes sure that he does not apply any chemical within three days to harvest.

With this observation, which is thought to be practised by many tomato farmers, it is obvious that tomatoes are harvested for use while the chemical are still active and they pose a threat to the health of consumers. This is true because many of the pesticides applied on this crop have safety periods ranging from 3 to 14 days.

Contact with extension services

The study also indicates that 69% of the farmers interviewed have access to extension providers. Apart from extension workers, farmers themselves help each other as more than 85% of farmers provide advise to fellow farmers. This is a problem as regards to the real situation of agro-chemical use shown in Table 5 where farmers have shown great diversion from the scientifically recommended application rates of different agro-chemicals. It means that a farmer can seek advice from a farmer who wrongly applies the pesticide and therefore there will be perpetuation of misuse of chemicals from farmer to farmer thus exacerbating the problem.

Measures to reduce misuse

The general problems of handling and management of pesticides in the study area are therefore, incorrect selection or un-recommended use of pesticides for treating crops, improper labeling and lack of safety measures and personnel protection. Others are lack of generally accepted good practice in their use, inappropriate storage (inappropriate containers), lack of trained personnel to give effective guidance on the safety and handling of chemicals, poor supervision, lack of control and monitoring of pesticides authorized for use.

Since the ratio of farmers to extension workers is very high it could be useful if farmers are trained on agrochemical use, as they will complement the low number of extension workers. The training should be through residential courses, on-site training and study tours that are organised to representative farmers from different villages. The farmers who attend the course will in turn be trainers in their respective villages provided the selection of the trainer farmers is carefully done.

There should also be a system of promoting the use of Integrated Pest Management (IPM) as an alternatives to pesticides. Plant protection agents may only be used in accordance with good agricultural practices; this includes making allowance for principles of integrated plant protection, that is, the prime application of non-chemical plant protection measures.

From the study it was observed that some farmers are controlling pests by using home-prepared solutions from locally available materials and are proving to be effective to many insect pests of cotton. For example, they mix water, soap and tobacco to make a solution that is applied in the field using an ULV applicator. The procedure of preparing one litre of the solution as explained by Mary Itogolo of Nyangili village in Magu district is to mix tobacco from two cigarettes (Sportsman or Sweet Menthol), a piece of soap and water.

The mixture is then heated for a short time and allowed to cool for four hours. After cooling the mixture is sieved through a clean piece of cloth to obtain a one litre solution that is sprayed using a ULV applicator. The solution is enough to spray one acre and it has proved to be effective. Mr. Sagarani Lukanya of Nghaya village uses a match box size piece of soap and one matchbox full of tobacco to prepare one litre of the solution. These indigenous technologies need to be developed and spread to other farmers.

Performance of Agricultural Extension Workers

The problem with the extension service at the moment is the inadequate number of extension workers to serve the large farming population. Another problem is that an extension worker is assigned a working area to train farmers on both crops and livestock production, regardless of the academic qualification of the worker. Nine extension workers were interviewed in the study area (eight in Magu and one in Mwanza districts) in order to evaluate the level of their understanding on the status of agro-chemical use and handling in their working areas. Eight of the extension workers have certificates in agriculture/animal production and one has a diploma in irrigation.

From their academic qualifications it was revealed that some extension workers are not competent on the use and handling of agro-chemicals. It was found that four certificate holders had a bias on livestock production, and they had received training on crop production through bi-monthly training workshops organized by the National Agricultural Extension Programme (NAEP II). This observation indicates that the extension workers need special training on agrochemicals use.

On the other hand the other four certificate holders had a bias on crop production, but they were also responsible for delivering services to livestock. They use the knowledge and skill obtained from the bio-monthly training workshops to control pests and diseases of livestock. Thus they also need training on veterinary drugs and their proper use.

Extension workers reported information on misuse of agro-chemicals, especially pesticides and the mishandling of their containers. These include using accaricides for cotton pests, throwing containers in rivers, ponds and the lake, leaving containers lying haphazardly in the fields, burning of crops due to overdose of agro-chemicals and application at lower rates than recommended.

Low levels of knowledge of extension workers on the proper handling and use of the chemicals in part contribute to misuse of agro-chemicals. Some extension workers are ignorant on the laws governing agro-chemical use in the country as for instance they are not aware that there are pesticides like DDT, which are banned.

From this study it shows that there is insufficient research and poor dissemination of research findings to the end users. There is a need to strengthen participatory approach on the safe use and handling of agro-chemicals and enhance linkages between extension staff and research centres. Regular training of agricultural extension workers to update their skills and knowledge is also very necessary.

Role Played by Input Stockiest in the Handling of Agro-chemicals

Under trade liberization enforcement of regulations and laws concerning agrochemicals business has become a problem.. Agro-chemicals are imported into the area and sold to farmers without proper control by the responsible authorities.

Input stockists contacted in the study area said that they get agro-chemicals, particularly pesticides from Kenya, in addition to those obtained from Mwanza, Arusha and Dar es Salaam whole salers. The pesticides are put into the market without following the laid down laws and legislations governing pesticides business.
It is also surprising to note that people who are not skilled or knowledgeable in the proper use and handling of agro-chemicals sell agro-chemicals to farmers. Of the six stockists contacted in the study area only two have certificates from Tengeru Training Institute (one having a certificate in agriculture and the other a certificate in veterinary science). The remaining four are standard seven leavers who have no formal training on agro-chemical use and handling at all.

They sell agro-chemicals in the same way they sell other commodities like rice, sugar and salt and others sell pesticides in shops together with other commodities like foodstuffs as the case with two petty traders at Ramadi village in Magu district. This is a serious problem because farmers do not receive proper advice and guidance from agro-chemical sellers and putting in mind that the extension service is also poor.

The law requires all agro-chemical dealers to receive a permit from Tanzania Pesticide Research Institute (TPRI) before being licensed to sell pesticides. In order to get a permit for retailing pesticides from TPRI the applicant have to fulfil the following conditions: acceptable premises for the business such as not to be located close to public services like hotels; provision of protective gears for the person(s) who handle pesticides; sell pesticides that are under full registration; and have qualified personnel.

The law also clearly stipulates that only pesticides that are fully registered are allowed to enter the market. Pesticides that are under experimental registration, provisional registration and restricted registration are strictly not for sell by input stockists unless a special permit is issued to the dealer.

It is very surprising to note that many agro-chemical dealers do not meet some of the above conditions. The location of the business for many dealers is intermingled between other public services. The persons who sell pesticides do not put on protective clothing and are not trained on handling and use of pesticides. Of the six stockists contacted only one had a permit from TPRI and this shows that there are many dealers who do not have permits especially in Mwanza City where the business is increasing.

There is therefore a need to provide training to input stockists so as to enable them to give proper directions of agro-chemicals use and handling to farmers. The government should strictly enforce the regulation that require all registered agrochemical suppliers to have trained personnel. The trained people should always be available to give proper directions to buyers of agro-chemicals.

Conclusion and Recommendations

The challenge of protecting crops and livestock from insects, diseases, weeds and other pests without posing hazards to people, animals and their environment requires the combined and sustained efforts of scientists, technicians, administrators, processors, distributors and farmers to establish and administer sound and acceptable standards of human health and environmental quality.

Acute contamination of basic natural resources by nutrients, pesticides and other pollutants can affect not only the safety of food products but also other environmental resources such as water, wildlife and bio-diversity.

The study of agro-chemical handling in the pilot area has revealed that agro-chemicals are used without proper guidance and therefore the potential for unecessary risks and harmful effects on humans and the environment is high. Farmers do not follow the recommended application rates and methods and in some cases they apply types of pesticides other than those recommended.

The agricultural extension service is poor with a high ratio of farmers to extension staff and in some cases the extension workers do not have the prerequisite expertize on agro-chemicals. Input stockists who could be of help to farmers during purchase of agro-chemicals are also not trained. The importation and distribution of agro-chemicals, pesticide in particular is not controlled and the existing legislation for agro-chemical business are not enforced.
There is therefore a need to develop strategic interventions that could prevent or reduce the risks of pollution at the source, including practices that conserve natural resources by reducing or eliminating pollution through increased efficiency in the use of agro-chemicals. Prevention of the adverse effects of agro-chemicals should be through optimal use of on-farm inputs and minimization of the use of external inputs in agricultural activities. Promotion of integrated pest and soil fertility management practices that are possible under local circumstances and are meant to maximize economic return to the farmer while safeguarding the environment is the best option.

The specific activities recommended for the control of adverse effects of agro-chemicals to human health and the environment are summarized below.

(i) Employ appropriate crop protection methods including IPM and agrochemicals could only be used as an important tool when necessary. This should include efforts to replace the major hazardous chemicals that are currently available.
(ii) Strengthen and undertake research to optimize the safe and effective use of those pesticides that are employed in high amounts and those that are of potential risk to human health and the environment.
(iii) Develop monitoring programmes for relevant pesticides in the soil and water taking into consideration the local practices of farmers and the prevailing climatic conditions.
(iv) Enhance agrochemical applicators education through training to foster reductions in misuse incidents. Training should be through residential courses and onsite training. Training and educational materials such as leaflets, posters, video episodes and booklets should be produced and widely

disseminated to applicators assisted with development of improved agrochemical product label directions for proper handling.

(v) Ensure that the active ingredients of pesticide formulations that are marketed correspond in identity, quality, purity and composition to the substances tested, evaluated and cleared for toxicological and environmental acceptability.

(vi) Promote agricultural practices that minimize runoff and prevent soil erosion to reduce agro-chemical hazards.

(vii) Enforce the necessary legislation for regulation, including registration of pesticides and make provisions for its effective enforcement.

(viii) Evaluate the fate and behavior of pesticides and nutrients in the environment for regulatory purposes.

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