3

CURRENT EXPERIENCES IN AND PRACTICES OF PESTICIDE USE IN THE BAGMATI ZONE

The farmers of the Bagmati Zone, like most of their counterparts in developing countries, are trying their best to improve land productivity. They are making greater use of irrigation. They are using larger amounts of chemical fertilisers, micro-nutrients, and other inputs. Cropping intensity has been increasing. Intense cropping (in terms of time and space) is increasing, wherever economic considerations justify such investments. These practices have led to a breakdown in the balance between crop pests and their bio-control agents. Natural bio-control factors might still be responding to check increases in crop pests, but, because of changed environmental contexts, these are becoming inadequate. This has given rise to the recent spurts in pest epidemics experienced by farmers in the Bagmati Zone; extensive use of pesticides is needed in order to protect crop outputs.

Recommended Pesticides

The official list of pesticides recommended by the Division of Entomology and Plant Pathology is given in Annex 3.1. Other details are given under Annexes 3.2 to 3.6. It should be noted that the recommendations are adhered to by dealers in government-supported channels such as the Agricultural Inputs' Corporation (AIC) and Sajha, as well as in special situations by District Officers of the Department of Agriculture. However, as such recommendations are not mandatory, in the absence of legal provisions many unrecommended pesticides are found in retail outlets. It is interesting here to note that farmers adopt technologies they feel work. Out of several practices recommended (see pages 33-34) they resort only to pesticides. Indeed, pest control practices rely solely on the use of agro-chemicals. Tables 3.1 and 3.2 provide lists of recommended pesticides. These are substantially abridged versions of the official list.

Table 3.1: Pesticides Recommended for Controlling Cereal Pests

No.	Compounds	Pests	Methods
1.	Organo-chlorine		
1.1	Aldrin	Seedbed beetle; Maize cutworm; White grub	Dusting
1.2	BHC	Seedbed beetle; Rice bug; Maize cutworm; White grub	Dusting
1.3	Chlordane	Seedbed beetle	Dusting
1.4	Thiodan	Gall midge; Hispa; Leaf folder; Cage worm; Army worm; Rice bug Maize army worm	Spraying

Table 3.1 (Contd.)

No.	Compounds	Pests	Methods
2.	Organo-phosphorous		
2.1	Demecron	Hispa; Leaf folder; Cage worm Mealy bug	Application
2.1a	Diazinon	Borer; Leaf hopper; Plant hopper	Granule
2.2	Dichlorvos	Army worm; Rice bug	
2.3	Dimethoate	Gall midge	Spraying
2.4	Fenitrothion	Hispa; Leaf roller; Cage worm	
		Army worm	Spraying
2.5	Methyl demeton	Leaf hopper; Plant hopper; Mealy bug	Spraying
2.6	Methyl parathion	Borer; Hispa; Leaf folder; Army worm	Spraying
		Rice bug; Maize army worm	Spraying
2.7	Padan	Leaf hopper; Plant hopper Spraying	
2.8	Sumi-alpha	Leaf hopper; Plant hopper Spraying	
2.9	Tribon	Leaf hopper; Plant hopper Spraying	
2.10	Thimet	Borer; Gall midge; Leaf hopper; Plant hopper	Granule
3.	Carbamates		
3.1	Carbaryl	Maize borer; Mealy bug	Granule
3.2	Carbofuran	Borer; Gall midge; Leaf hopper	
		Plant hopper; Mealy bug; Maize borer	Granule
3.3	Carbodem (Vitavax)	Paddy blast	Seed treatment
3.4	Hinosan	Paddy blast	Spraying
3.5	Dithane M45 st	Paddy blast; Wheat blast nut	Spraying
4.	Synthetic Pyrathroids		
4.1	Sumicidin	Lepidopterous larvae	Spraying
4.2	Decis	"	"
5.	Others		
5.1	Agromycine	Leaf blight	Spraying
5.2	Zinc phosphide	Leaf blight; Cobrot; Stockrot; Smut	Spraying

Source: Division of Entomology, HMG/Nepal

Furadan and thimet granules are the main pesticides for controlling potato insects, but farmers usually do not apply them due to the high cost. BHC is never recommended for root crops (including potato), but they are readily available in the market and farmers use them intensively. This pesticide leaves a strong odour on table potatoes, and this is often experienced by consumers. Table 3.2 gives a list of the recommended pesticides for different types of cash crops.

Table 3.2: Pests of Cash Crops and Recommended Pesticide for Control

Crops	Pests	Recommended Pesticides
Oilseeds	Aphid (*Lipaphis erysimi*)	Demeron, Dimethoate, Methyl demeton
	Sani fly (*Athalia proxima*)	Methyl parathion, Thiodan
	Alternaria	Dithane M 45
Sugarcane	Top shoot borer (*Scirpophaga nivella*) Red Rot	Carbaryl, Carbofuran Sten 50
Potato	Cutworm (*Eoxia segetum*)	Thimet, Carbofuran
	Tuber moth (*Phthorimoea operculella*)	Repcord
	Aphid (*Myzus persicae*)	Demeron, Dimethoate, Methyl demeton
	Late blight	Thimet and Carbofuran
		Hinosan, Copper oxychloride
		Dithane M 45
		Virus
		Vector control (as aphid control above)

Source: Division of Entomology, Potato Development Programme, HMG/Nepal

Due to the severity of insect and disease attack, most vegetable crops cannot be grown without the application of insecticides and fungicides on a weekly basis. This extensive use of insecticides may result in unacceptable levels of pesticidal residues in the soil, and pests may evolve into tolerant and resistant bio-types. *Plutella maculipennis*, the diamond back moth which affects cabbage, is now resistant to all chemicals.

Pattern of Pesticide Use

Nepal does not use as much pesticide as many other countries in South Asia (Table 3.3). Nevertheless problems do exist. These are vital both for man and for his environment. Appropriate policies and strategies have to be formulated and effectively implemented in order to safeguard society from the problems of pesticides.

Table 3.3: Domestic Supply of Pesticide (per hectare of agricultural land) in some Asian Countries (1987)

Country	Pesticide (Wt [gm]/ha)	Active Ingredient (Wt [gm]/ha)
Afghanistan	73	Not available
Nepal	142	26
Bangladesh	750	160
Pakistan	1000	310
Indonesia	1100	400
Thailand	1200	400
Malaysia	6500	1600
South Korea	5700	4277

Source: Agro-Chemicals "News in Brief", ESCAP/FAO/UNIDO

The prevailing situation of pesticide recommendation for agricultural use is that of transition between the old system and the new system. The old system was voluntary, but effective. It included deposition of pesticides for use with the divisions of Entomology and Plant Pathology where they underwent tests for bio-efficacy. When they were found to be effective, they were recommended and placed in the market through government and semi-government agencies. It worked well for people who did not have enough knowledge and knowhow and pesticides were used only in epidemic situations. There were not many private dealers and retailers. Pesticides were used by the staff of agricultural offices in the districts or by skilled technicians from related departments. But, as farmers' demands steadily increased, private retailers responded by bringing in all the pesticides available in India. This has resulted in increasing inflows of unsystematised, unregulated, and unregistered pesticides into Nepal. The Government has not been successful in influencing this inflow, because of the lack of adequate rules and regulations as well as the lack of ability to supply the market with pesticides through the AIC's marketing channels.

Table 3.4 gives the quantity of pesticides sold by retailers in the Kathmandu Valley expressed in kg of active ingredients.

Table 3.4: Pesticides Sold by Retailers in the Kathmandu Valley

Districts	Years											
	1986		1987		1988		1989		1990		1991	
	D	L	D	L	D	L	D	L	D	L	D	L
1. Rasuwa	0.22	23.3	0.15	50.2	0.87	47.0	2.39	29.9	0.44	29.7	0.54	9.8
2. Bhaktapur			2.0	23.0	3.9	60.0	3.2	90.0	3.6	90.0	4.2	2.10
3. Kathmandu	5.7	35.8	4.2	9.4	8.5	269.1	15.5	105.6	10.0	105.6	20.0	1812.4
4. Kabhre	-	-	-	-	-	-	-	-	-	-	13.0	54.7

Source: Survey

D = Dust in MT includes BHC; Furandan granules; and Dithane M45.
L = Liquid in litres includes Metacid and other pesticide emulsifiable concentrates.

The preponderance and growing use of organo-chlorine in the dust formulation of BHC must be viewed with great concern. They pollute the environment and contaminate food, feed, and fodder. The organo-phosphorous compounds are of various kinds and are used in liquid formulations as sprays. Dichlorvos, Demeton S methyl, Parathion methyl, Phosphamidon, and Phorate are highly hazardous, and these are the pesticides used mostly. In addition to various environment-related concerns, the operational hazards they pose are also very great. Their use by Nepali farmers and operators is a matter of serious concern.

Several important points regarding the use of pesticides in Nepal should be carefully noted.

(1) In spite of the recommendation of several alternatives by the Ministry of Agriculture, farmers buy and retailers prefer to sell pesticides that are relatively cheap. For instance, although Carbaryl - a carbamate insecticide is recommended, its use is very limited. It

should be noted that even Vitavax, the generally-used seed treatment compound belonging to the carbamate group, is not used to the desired level.

(2) Chlorinated hydrocarbons are still predominantly used for soil treatment. Soil treatment is required to protect crops against white grubs affecting maize and cutworms affecting potatoes. This results not only in environmental hazards but it is hazardous to consumers also.

(3) Farmers are still to benefit from useful pyrathroids (the fourth generation pesticides with properties of natural pyrathrins of plant origin). These compounds are expensive but their lower rate of application compensates for their higher cost. Farmers are not fully aware of their value so far.

(4) There is a lack of education and awareness among the current generation of farmers.

(5) Retailers, dealers, and extension workers are ignorant about the nature of pesticides, therefore misuse is rampant.

(6) The lack of registration provisions has resulted in many similar types of product entering the market, thereby creating confusion among farmers and extension agents.

Pesticidal Hazards

Pesticides are often considered to be necessary evils. Over the past few decades, pesticides have become an important tool for improving agricultural systems as well as public health. They have contributed to the increase in food supply and also protected human health. However, they are hazardous, and substantial efforts have been made recently to find non-chemical means of pest control. This has not resulted in a decline in the use of pesticides for pest control. It appears that they will continue to be the principal weapon against pests for some time to come. Safe, efficient, prudent, and need-based use is a key factor in arresting the increasing incidence of hazards resulting from pesticide use. Some of the hazardous consequences of pesticide application are examined in the chart below.

Records of Pesticidal Hazard Related Incidents from Important Hospitals in the Kathmandu Valley

Hospitals	Annual Records of Poisoning		Sex Ratio M/F		Recovery	
	OP Poisoning	Zinc Phosphide	OP	ZN_3P_2	OP	
1. Bhaktapur District Hospital	16	7	8/8	2/7	94	100
2. T.U. Teaching Hospital	4-5; 9 in 1990	3 6 in 1990	7/2	4/2	90	100
3. Bir Hospital	94 139 in 1990	48 69 in 1990	-	-	790°	790

Acute cases of pesticide poisoning are more or less readily diagnosed and treated. Mild to moderate cases with sub-acute, chronic, or subtle effects (such as reproductive immunity or neuro-behaviourial symptoms) are often overlooked for neither do the patients consider them to be caused by pesticides nor do the hospitals have a system of detecting them. There is not a single organisation concerned with monitoring pesticide poisoning cases.

Persistence

All organic pesticides are subject to biological and physical forces when introduced to the environment. The action of these forces results in the breakdown of compounds. Some compounds break down under the effect of the metabolic process of plants and micro-organisms, whereas others are subject to chemical changes, i.e., hydrolysis and photo-chemical decay. The rate of decomposition in the soil is influenced by moisture, temperature, soil type, absorption and leakage of nutrients, and other biological activities. Temperature has been proven to be an important factor up to a certain level for the activity of organisms.

Broadly speaking, organo-chlorine compounds are persistent. They are fat-soluble. There is a wide range of toxicity and Endrin is the most responsible for human poisoning. Acute toxicity is the result of interference in neural axonic transmission.

BHC and Thiodan are among the organo-chlorines most used in Nepal. BHC has a high vapour pressure and is least persistent among those of this class. The disadvantage, however, arises from fat solubility and accumulation. Residues on edible plants are concentrated in the fatty tissues of herbivores and are not readily excreted. Predatory birds and animals ingest them from contaminated prey and this is almost fatal. Recently, the Indian Council of Agricultural Research has recommended that BHC should be completely banned because of these reasons, although it is the most popular and extensively-used pesticide in India. Nepal should also ban its use. Studies on pesticide residues in Nepal are limited to a few references. Giri (1986) did not find BHC residue in the soil, although Joshi (1984) found DDT in most food items. However, the unpleasant smell of BHC in table potatoes has been reported in Kathmandu.

Organo-phosphorous compounds are less persistent. The acid radical containing the phosphorous atom ultimately splits off and constitutes the phosphorous content of the soil. The minimum interval between application and harvesting of some of the important compounds is given in Table 3.5. The half life[1] of these compounds is indicated by the minimum interval. Organo-phosphorous compounds are not bio-accumulative and are readily released as metabolites.

Table 3.5: The Minimum Interval between Application and Harvesting of Some Organo-phosphorous Compounds

	Commercial Name	Time in days
1.	Metacid	21
2.	Diazinon	14
3.	Rogor	7
4.	Fenitrothion	14
5.	Malathion	1-7
6.	Metasytox	28
7.	Thimet	42
8.	Demecron	21

Source: Survey

[1] The half life of pesticide is defined as time taken by the pesticide for its natural decomposition to half its strength.

Oxime carbamate is rapidly oxidised to sulphoxide, more slowly to sulphone, and afterwards to non-toxic products. The half life is about two weeks in the soil.Problems caused by persistence are not evident in the Bagmati subregion. Subsistence farming, sub-optional use of inputs, and long intervals of use often do not create persistence problems. However, Nepalese farmers are poor, functionally illiterate, and they use pesticides without knowledge of their safe use. This has resulted in misuse.

Residues

After application on plants, soil pesticide residues may persist. In the Bagmati subregion, the amounts added to the soil by successive treatments are rather small. The possibility of accumulation harming succeeding crops is low at the present level of use. More than 40 per cent of gamma BHC, sprayed or dusted on crops, disappears and never reaches the soil. The problem of residue arises if farmers are ignorant and if they spray vegetables repeatedly without paying due attention to the harvesting interval. The other reason is poor selection of pesticide compounds. If bio-accumulative BHC is sprayed on leafy vegetables and on tuber crops, such as radishes, carrots, and potatoes, this often causes problems. A similar residue problem might be faced if compounds that have not been recommended are used for storing grains and flour. Regulated use and basic information are the only solutions.

Effect on Bees

The use of pesticides on flowering plants during daytime is often counter-productive. It is, however, worth noting that if bees are kept, effective pollination of cross-pollinated crops will be affected unless proper attention is given to the time schedule for spraying and to the selection of appropriate pesticides. Heavy pesticide users in more advanced countries raise bees successfully, whereas smaller users in Nepal often report the total loss of bees (in Nuwakot district). Spraying of flowering crops should not be carried out during daytime, and this message should be incorporated into programmes in order to promote beekeeping as well as the safe use of pesticides.

Effect on Fisheries

Pesticides, e.g., Thiodan, are very harmful to fish. This pesticide is recommended for controlling leaf-eating caterpillars, especially in rice crops. Fortunately, in the Bagmati subregion, farmers hardly practice rice-cum-fish culture. However, the hill communities use this potent pesticide to kill fish in the Koshi and Narayani rivers. This causes environmental hazards, and as it is a compound of the chlorinated bicyclid sulphites' group, it accumulates in the fat tissues of fish, thereby poisoning the consumers.

Effect on Grain Storage

Over 80 per cent of the grains in the Bagmati Zone are retained for domestic consumption. These are generally well stored in structures usually made of raw sun-dried or baked clay

(*ghyampo*) or stone or wooden bins (*bhakari*). Farmers reduce the moisture content of foodgrains by sun-drying, cleaning, winnowing, and sieving. The bulk storage of cereals in this manner such as wheat, maize, and legumes, offers protection against insects. Maize cobs are also stored in *suli*[2] or hung on the eaves of houses.

Severe pest problems, however, are faced by bigger farmers who cannot give due attention to storage. Such grains have more than a safe level of moisture content. More and more farmers are using metal bins which are fumigated by tablets of aluminium phosphide. Although very toxic, these tablets are relatively safe when used properly. The number of bins distributed to farmers in the Bagmati Zone is given in Table 3.6.

Table 3.6: Distribution of Metal Bins in Bagmati Zone

S.N.	Districts	No. of Bins	Remarks
1.	Kathmandu	1394	The average capacity of each bin is 200kg
2.	Lalitpur	411	
3.	Bhaktapur	34	
4.	Kabhrepalanchowk	152	
5.	Dhading	102	
6.	Nuwakot	280	
7.	Sindhupalchowk	383	
8.	Rasuwa	181	
	Total	2892	

Source: Rural Save Grain Programme (personal communication)

Pesticide problems are most frequently reported from the storage premises of grain dealers such as flour mill owners. Here all kinds of misuse of pesticides are known to occur. These include:

1. use of BHC dust in bags and bins,

2. use of aluminium phosphide in gunny bags,

3. lavish use of pesticide powders around flour-milling areas, and

4. use of pesticides even in small bins to avoid pest damage.

BHC is procured either from India or from dealers of the Nepal Pesticide Company and then repackaged in smaller plastic bags. A local merchant is called "BHC *Sahu*" in the Panchkhal area and there are indications that such *sahus* are proliferating in other areas also. Aluminium sulphate is a safe fumigant, although it is sometimes hazardous. It is relatively safe if sealed bins are used, but its use in gunny bags is very dangerous. There is no evidence so far that food poisoning has been caused by the above-mentioned practices. However, it cannot be completely ruled out.

[2] *Suli* refers to structures raised on stilts and plastered with clay/mud.

The chances of spreading resistant strains of dreaded pests that affect stored grains, such as *Sitophilus oryzae, S. zea-mays, Rhizopertha* sp, *Callasobruchus maculatus, C. sinensis, and Sitotroga cereallella*, through the seed distribution channels of the Agricultural Inputs' Corporation are very high. *Sitophilus* and *Rhizopertha* have been reported to have developed resistance to Malathion as a result of intensive use in the seed-processing factory in Hetauda. Resistant strains of weevils and grain borers spread to remote districts and increase cross-infestation. The utility of Malathion is, thus, lost with negative consequences.

Livestock

Use of pesticides in crops affects livestock in the following ways.

1. The straw they eat might contain pesticide residues.

2. The animal feed grains may contain residue from feed ingredients.

3. The grass and greens in the crop fields might contain pesticides.

4. The water they drink from crop fields may contain traces of pesticides.

In addition to the above four factors, direct use of pesticidal solutions to get rid of ectoparasites might affect the livestock population in the region.

There have been no reports concerning the adverse effect of pesticides on livestock so far. However, their effects on animal health cannot be underestimated. Nobody has studied this aspect so far, but the following instances should be noted.

1. In the early sixties, in Gokarna, a farmer was employed as a storekeeper in the Entomology Division. He sneaked a bottle of Ethyl parathion and used it to control boophilids, and this resulted in the death of two buffaloes. He did not report this for obvious reasons. Misuse of pesticides as a result of ignorance is a real possibility.

2. In 1982, a widespread *Sogatella furcifera* epidemic affected paddy in all three districts of the Kathmandu Valley. The farmers and the Department of Agriculture used pesticides to control the epidemic. Despite instructions to the contrary, the farmers cut grass from the bunds and fed it to livestock. Young calves were reportedly affected and a few succumbed.

3. Chlorinated hydrocarbons, which are bio-accumulative, have been detected in milk samples taken from the dairy (Joshi 1984).

The amount of pesticide use may not be sufficient enough to have a marked effect on the livestock population at present, but monitoring is required to assess the situation. As pointed out earlier, there is a strong need to provide training and create mass awareness about the safe use of pesticides.

Disposal of Obsolete Stock

The Agricultural Inputs' Corporation (AIC) has accumulated tonnes of potentially dangerous pesticides in its various godowns. Scientific disposal is required to avoid possible hazards.

Table 3.7 provides data on the quantity of pesticides disposed so far. Out of the 23,771kg for which supervised disposal is required, mercury compounds account for 3,695kg. The total also includes 1,000kg of Zn phosphide used by the rural "Save the Grain" programme. Less than 20MT is to be actually incinerated in a cement cone. Arrangements are being made with Hetauda Cement Factory for this purpose, and disposal is to be accomplished by scientifically supervised methods.

Table 3.7: Disposal of Pesticides
(in kg)

Area	Total Surplus	Buried for Disposal	Re-used	Reformulated	Disposal Required
1. Birgunj	41,116	30,272	none	none	10.2
2. Siddhartha Nagar	30,851	23,161	none	2,928	4
3. Janakpur	18,089	none	10,705	none	55
4. Nepalgunj	37,471	14,870	none	5,947	269
Total	127,536	68,303	10,705	12,875	23,71

Source: Survey