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CURRENT EXPERIENCES AND PRACTICES IN PESTICIDE USE IN THE BAGMATI ZONE

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International Centre for Integrated Mountain Development

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Dr Keshava Chandra Sharma is a biologist and has been working as a pesticide specialist, entomologist, and plant protectionist for the last thirty years. He is now retired from HMG/N but is still active as an academician of the Royal Nepal Academy of Science and Technology (RONAST).

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PREFACE

The paper was prepared as a background analysis for a better understanding of the environmental problems being encountered in the Bagmati Zone. Dr. Keshava Chandra Sharma has attempted to bring together experiences regarding pesticide use in the Bagmati Zone. The study indicates that pesticide use is a potentially dangerous activity that is not carefully regulated and monitored at present. Commercial interests have almost completely disregarded its safety aspects and judicious use and could result in serious problems in the future for natural resources, the farmer, and even the wider society.

Dr. Sharma has outlined a whole host of measures that are needed to promote the development of integrated pest management. Unless more serious efforts are made immediately, the prices to be paid in terms of health hazards and destruction of natural resources could be great in the future. It is hoped that this document will not only help promote better research, monitoring, and reporting on the subject, but will also lead to some concrete action in the future.

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MAP

INTRODUCTION

The Bagmati Zone covers eight hilly districts in the Central Development Region of Nepal. This zone borders the Tibetan Autonomous Region of the People's Republic of China in the north and the Narayani Zone in the south. The Janakpur and Gandaki zones lie in the east and west respectively (Map 1).

The Bagmati Zone is climatically well suited to agriculture. The valleys are fertile, the temperature regime warm temperate, and the precipitation adequate for summer crops. Winter crops also receive precipitation from the west monsoon but in a much reduced quantity.

In the rural areas, agriculture is the way of life. The valley farmers have developed and are still developing commercially viable, intensive farming, directed towards a growing market, whereas the hill farmers follow an intricate cropping pattern that involves sequence cropping, mixed cropping, and relay cropping with a wide array of different crops to meet their subsistence needs. This is further characterised by small farm holdings, intensive cultivation, variable microclimates, and a strong dependence on forests to support livestock and maintain soil fertility. With forests receding across the hills, traditional methods of fertility management have been severely constrained and agricultural productivity is mostly declining. In addition, the rapid population growth has intensified pressure on agricultural lands. Consequently, as more rural areas become accessible, hill farmers are quickly switching over to chemical fertilisers and pesticides to sustain agricultural productivity.

Chemical fertiliser was introduced into Nepal around the early sixties. Efforts to supply fertiliser commenced in 1966 with the establishment of the Agricultural Supply Corporation which was later renamed the Agricultural Inputs' Corporation (AIC). Today fertiliser use is very popular among Nepali farmers and supply falls short of demand. Kathmandu Valley farmers use about 15 per cent of the total fertiliser consumption of the country. High nutrient fertilisers, such as urea (46%), complex (20:20:20), MOP (60%), and TSP (46%), are being used. It has been estimated that the present level of fertiliser use (20kg/cropped hectare per annum) has to be raised (to 77kg/cropped hectare per annum) in order to maintain adequate food production for the increased population by the end of this century.

The present level of fertiliser use does not pose any serious environmental threat, although instances of misuse have been observed in different places. Increase in the nitrate contents of groundwater in other countries has been due to intensive use of fertiliser. Such problems have not been reported in the Bagmati Zone.

A possible environmental problem, which may occur in future in the Bagmati Zone, is the eutrophication of inland water bodies such as the Nagdah, Taudah, etc. Eutrophication is brought about by excessive algal growth which results from the raised phosphatic content of water.

Fertiliser use, to be environmentally sustainable, should be directed towards balancing various nutrient components and their retention for use by crops. Excessive weed growth, resulting from fertiliser use, must be minimised. Another area of concern relates to the mushrooming growth of micro-nutrient fertilisers in the market. This has to be regulated to prevent farmers from being exploited by irresponsible elements selling various products under the guise of micro-nutrients and passing them off as "wonder chemicals".

Pesticides were introduced at about the same time as macro-nutrient fertilisers, but their use has increased rapidly only in recent times. Judicious and prudent use of pesticides goes a long way towards improving crop yields. Pesticides act as catalysts for generating agro-based industries. In addition, the role of pesticides in controlling vector-borne human diseases is also quite critical. Without pesticides to control malaria-transmitting mosquitoes, one cannot imagine how the settlements of low-lying fertile river belts could have taken place. Indeed, the role of pesticides in maintaining health is like a two-edged sword. They can be used with skill to increase crop yields and help prevent malnutrition; or they can be used carelessly leading to illness and death by adding the insult of pesticide toxicity to the injury of malnutrition.

Pesticides by their very nature are designed to kill or control living organisms. The success of insecticides, such as organo-chlorine and organo-phosphates, rests on their effective control of a wide range of insects and, in the case of organo-chlorine, on long persistence in the soil. Unfortunately, these same properties can result in environmental damage through injury to wild life; through damage to beneficial insects such as bees and parasites; and also through contamination of water, soil, and air. These environmental effects depend upon a number of attributes of pesticides such as toxicity, quantity, formulation, timing of application, and the chemical properties of the compound.

Environmental contamination occurs in two ways; firstly contamination occurs through the accidental release of a high concentration of pesticides usually caused by spillage or leakage during transport, storage, or when mixing pesticides, including the careless disposal of unwanted pesticides. Such disposal might contaminate a small area of land only, but it will have long lasting effects to the soil and to nearby water supplies. The second way in which environmental contamination can occur is through careless and excessive use of pesticides. One example of this is the drift of spray or dust on the trees and into streams and other areas where fish, birds, wildlife, and pollinating bees live. It could also get into nearby areas of human habitation. Repeated use of persistent pesticides, such as organo-chlorine and some herbicides, builds up residue in the soil and can be washed into rivers and streams; contaminating ponds and wells used for drinking by humans and livestock.

Residues of pesticides in food, such as fresh vegetables, ripe fruits, stored grain, or their products, pollute not only the immediate environment but also poison the food. Regulation, registration, and use of pesticide, together with training for the concerned people, and creating mass awareness in others will go a long way towards making pesticides a safer input for progressive development. The present paper is an in depth study of these issues regarding pesticides and their use in the Bagmati Zone in the Central Development Region of Nepal.

CROP PESTS IN BAGMATI ZONE

Introduction

Weeds, plant diseases, and insects adversely affect agricultural production by not only competing with crops for farm resources but also by releasing harmful substances. They increase expenditure on labour and equipment and also reduce the quality of agricultural produce. Weed seeds germinate earlier. Their seedlings grow faster; they flower earlier and mature ahead of the crop they infest. They have the remarkable capacity to germinate under varied conditions but are mostly season-bound. In non-irrigated areas the competition between weeds and crops is largely for water. On irrigated tracts, the competition is for nutrients. The successful application of weed control interventions (mainly chemicals) is determined by the knowledge one has regarding the biology of both the crops and the weeds. Plant diseases are structural abnormalities that are harmful to the plant or to any of its parts or products and reduce its economic value. It may be permanent or temporary, localised, or systemic. Plant diseases are caused by micro-organisms or may also be incited by physiological causes, including high and low temperatures, deficiency of plant nutrients, and soil acidity. In the case of seed-borne diseases, the pathogens are carried either on the surface of the seed or within it. When a pathogen is external or air-borne, it may be destroyed by treating the seed or the foliage with a chemical. For internally-borne diseases, hot water treatment and solar treatment are very efficacious. In the case of soil-borne diseases, the use of soil disinfectants is helpful. Insects are probably man's oldest enemy. In spite of the significant advances made in the war against insects, there has been little success in eradicating even one of the thousands of serious pests which damage food, agricultural products, and livestock.

Pests in Agriculture

Although maize covers the largest area in the Bagmati Zone, production-wise rice is the largest crop. The main cropping period for these two crops is during the summer monsoon when insect-related pest problems are the greatest. For crops, such as wheat and barley, grown under temperate conditions, the problem is considerably less. However, these crops do need seed treatment to prevent seed-borne diseases. Weed control is mostly manual. Table 2.1 provides a list of the key pests of cereal crops.

In the Bagmati Zone, paddy has been damaged by *Leptocoryza* sp. (1986); seed-bed beetle (1990); *Sogatella furcifera* (1982); and rice hispa (1988). Blast is an annual phenomenon in temperate rice and the effects are devastating, especially when the affected seedlings are transplanted. The existence of the tungro virus, especially in the Indrawati River Valley, has also been suspected.

Maize plants are seriously affected by white grubs and farmers resort to soil treatment. Maize borer, is a very serious problem and is managed by farmers by increasing the plant population per field and eventually replacing affected with non-affected plants. Army worms create havoc and are frequent especially in the Rasuwa and Nuwakot districts. People spray, even at night under petromax illumination, to control army worms.

Table 2.1: Key Pests of Cereal Crops in the Bagmati Zone

Crop	Pest	Estimated loss (%)	Area
Rice	1. Cnaphalocrocis medinalis (1989/90)	20-30	Extensive area in Lalitpur
		Total	4,000 ha in Nuwakot
	2. Dicladispa armigera	20%	10 ha in Thankot
	3. Leaf hopper and Plant hopper	70-80	Throughout Kathmandu Valley
	4. *Leptocoryza* sp		Kathmandu 1990
		80%	
	5. Piricularia oryzae		Extensive
		10	
	6. Sheath blight		Nuwakot
	Bandicoots, field rats, and seed-bed beetles are ever present on rice with variable losses.		
Wheat	1. *Mythimna separata*	Severe in early stages No loss	5 ha Kathmandu and Lalitpur
			Extensive
	2. Smut	5-10	
	Rust and Smut are common, endemic, and subject to pre-treatendent in the form of seed treatment throughout this region.		
Maize	1. *Mythimna separata*	Nominal	Kathmandu
	White grub (*Phyllophaga rugosa*); Maize borer (*Chilo zonellus*); Leaf blight (*Helminthosporium maidis*); and Ear/Cob Rot (*Fusarium* sp and *Cladosporium* sp) are very destructive and widespread pests		

Source: Compiled by Author

Wheat pest management is strictly limited to the use of Vitavax for seed treatment. For most of the other cereal crops, no active pest control measures are undertaken.

Pest problems in **cash crops like oil seeds and sugarcane** are very serious. Although some studies have suggested (Sharma and Khatri 1979) losses of over sixty per cent because of insects on mustard, pesticidal control measures have not been reported. Sugarcane also has serious pest problems, but attempts to control them have not yet been recorded in this sub-region. Potatoes are an exception. Here farmers do their best to arrest pest problems. Non-pesticidal methods of controlling potato pest problems, such as selection of resistant varieties (for late blight), use of tissue culture methods -biotechnology (for virus diseases), and use of pheromones to trap egg-laying moths (for tubermoth in the field) have been reported.

Pulse crops are generally either relayed with lentils after rice on lowland or intercropped with soyabeans and maize, or other crops, or grown in poor soils (horse gram, phaseolus, etc). They have pest problems such as pod bores (*Heliothis armigera, Lampedes* sp), pod flies (*Melanagromyza suji*), aphids (*Aphis glycine, A. craccivora, and Acyrthosiphon pisi*), cutworms (*Eoxia segetum,*) and hairy caterpillars (*Spilartica cosignata and Amsacta* sp). Diseases such as

leaf spots and frog eye spots are worth mentioning. However, pesticides are seldom used. When the monoculture of crops such as soyabeans is affected extensively by pests like hairy caterpillars, use of pesticides has been recorded in the Kathmandu and Panchkhal valleys.

Pests in Horticulture

There are good potentials for expansion of vegetable and fruit cultivation in the Bagmati Zone. However, development so far has been limited, and it is only recently that promising signs are beginning to emerge. Many warm temperate fruits, such as peaches, pears, and plums, are grown in the Kathmandu Valley, but cultivation is still confined to household backyards. Although good varieties have been introduced recently by the Department of Horticulture, commercial orchards for these crops are seldom seen. Citrus plantations in the Dhading and Kabhre districts are increasing. Apple growing has also been started in the Sindhupalchowk and Rasuwa districts. Floriculture is also slowly developing in the Kathmandu Valley.

Vegetables should be a vital component of our daily diet. Traditionally, they are grown in the kitchen garden for family consumption. The fast-growing population of the Kathmandu Valley has provided a steady demand in the market. Vegetable growing is more and more being adjusted to suit the seasonal demands in the market. Vegetables that can be grown only in winter in the plains of the Kathmandu Valley (around 1,260masl) are grown in higher hill areas like Kakani (around 1,800masl) in summer. Crops that can only be grown in summer in Kathmandu are grown in the winter months in the low-lying valleys of the Trishuli and in Dhunibesi and Panchkhal.

Environmental diversity provides us with a unique opportunity to test and identify successful 'niche' for needed varieties. This has added to the varieties of vegetables already grown in this zone (Table 2.2).

Table 2.2: Vegetables Grown in the Bagmati Zone

Cruciferae	*Alliaceae*	*Cucurbitaceae*	*Leguminosae*	*Solanaceae*	*Miscellaneous*
1. Cauliflower	1. Onion	1. Bitter Gourd	1. Bean	1. Tomato	1. Parsnip
2. Cabbage	2. Garlic	2. Squash	2. Cow Pea	2. Egg Plant	2. *Methi* (Fenugreek)
3. Broccoli	3. *Chhyapi*	3. Sponge Gourd	3. Pea	3. Capsicum	
4. Knolkol		4. Luffa		4. Chilli	3. Lady Finger (Okra)
5. Radish		5. *Sechium* sp.			
6. Turnip		6. Cucumber			
7. Broad-leaved Mustard		7. *Chathel* gourd			
8. Cress					
1. Spinach					
2. Swiss Chard					
3. Lettuce					

Source: Compiled by Author

To list all the pests that affect these crops is beyond the scope of this paper. Only those considered serious by farmers are provided in Table 2.3. While listing the pests, weeds have not been included as they are mostly manually managed by farmers.

Table 2.3: List of Important Pests Found on Vegetable Crops

Host Type	Pests	
	Insects	Diseases
Cruciferous	1. *Phyllotreta* spp 2. *Phyllophaga* 3. *Eoxia segetum* 4. *Lipaphis erysimi* 5. *Brevicoryne brassicae* 6. *Pieris brassicae* 7. *Plutelia maculipennis*	*Xanthomonas campestris*
Leguminous	1. *Aphis craccivora* 2. *Lampedes* 3. *Melanagromyza* 4. *Alcinodes*	*Colletrotrichlem lindemuthisi*
Cucurbitous	1. *Dacus cucurbitae* 2. *Epilachna 28-punctata* 3. *Aulacophora foveicolis* 4. *Aphis gossypii*	
Solanaceous	1. *Leucinodes orbonalis* 2. *Heliothis armegera* 3. *Aphis gossypii* 4. *Thrips*	*Phytophthora infestans* *Alternaria solani*
Miscellaneous	1. *Thrips tabaci*	

Source: Compiled by Author

Fruit Pests

Orchard development has not expanded rapidly in the Bagmati Zone. Some old mango orchards in the Indrawati and Trishuli basins have been maintained. Deciduous fruit trees in Rasuwa, Nuwakot, and Sindhupalchowk have low yields. However, citrus orchards grow in Kabhre and Dhading. The fruit trees receiving maximum attention against pests are in the Kathmandu Valley. While the amount of pesticides used is small, it nevertheless affects the environment and is therefore important. Names of pests for which farmers have sought treatment advice from concerned agencies are listed in Table 2.4.

Table 2.4 Pests Commonly Reported on Fruit Crops in the Bagmati Zone

Crop Host	Pests	Location
Mango	1. *Dacus* (Fruit fly) 2. *Rhyncophorus* (Nut weevil) 3. *Idio cercus* (Leaf hopper)	Trishuli Khimehet Bagaicha Sipaghat Throughout Lower River Basin
Litchi	Eriophyes mite	Trishuli
Deciduous Fruit	1. Peach leaf curl aphid 2. Fruit fly 3. Papery bark 4. Blossom beetles	All over the region Hills Tankaghyang, Sermathang Kakani
Citrus	1. Leaf miner 2. Scale insects 3. Aphids 4. Mealy bugs	Everywhere All over the region All over the region All over the region

Source: Compiled from the Annual Reports of the Entomology and Plant Pathology Divisions

Crop Losses on Account of Pests

The main reason for taking effective control measures against pests is the damage they incur on food crops. While scarce resources are deployed to increase production, this makes little sense if the output of such efforts is destroyed or reduced by weeds, insects, and diseases. Table 2.5 shows the percentage of farmers reporting losses to foodgrains in the middle mountain and Kathmandu Valley areas of Bagmati Zone. For paddy, insects, rats, and diseases are the main destroyers of crops, although the percentage of farmers reporting such losses is lower for the Kathmandu Valley than for the outlying hilly areas. For maize, damage by insects is reported by the largest number, followed by birds, farm animals, and monkeys. What is quite unmistakable from Table 2.5 is that insects are the single, most important factor for crop damages for all major crops.

Table 2.5: Percentage of Farmers Reporting Losses to Foodgrains in the Middle Mountains of the Bagmati Zone and the Kathmandu Valley

	Paddy		Maize		Wheat		Finger Millet		Potato		Buck-wheat	Mustard	Pulses
	MM	KV	MM	KV	MM	KV	MM	KV	MM	KV	MM	MM	MM
Insects	39	17	34	7	21	8	19	2	36	16	20	25	13
Diseases	12	0	12	-	11	-	12	-	22	-	13	12	12
Rats	20	3	10	-	12	1	24	-	-	-	10	1	7
Birds, Farm	7	+	27	-	15	-	14	-	-	-	19	-	6
Animals, Monkeys	-	-	12	-	-	-	4	-	9	-	5	-	-
Others													

Source: His Majesty's Government of Nepal and the Government of Canada Land Resources' Mapping Project (1985), Kenting Earth Sciences

Key
MM = Middle Mountains
KV = Kathmandu Valley

Different surveys of crop losses (Cramer 1962 and FAO 1977) are more or less consistent with losses caused by various factors as reported by the farmers. Based upon my own experiences and some assessments carried out in Nepal by may entomologists, I feel that the average losses of foodgrains due to various factors are not different from what Cramer provides (Table 2.6).

Table 2.6: Crop Losses due to Different Factors

Crops	Percentage loss due to			Total percentage
	insects	diseases	weeds	
Paddy	26.7	8.9	NA	35.6
Wheat	5	9.1	9.8	23.9
Maize	12.4	9.4	13.0	34.8
Potatoes	6.5	21.8	4.2	31.5
Vegetables	NA	NA	NA	

Source: Cramer 1962

The overall percentages are very large indeed. Given the overall growth rate of agricultural production in the country, which has barely kept pace with the population growth, these losses are alarming by any criterion. Over 30 per cent of the gross agricultural output of major crops is lost to pests in this region.

Kathmandu Valley farming is noted for its tradition of intense cultivation and a high level of productivity. Spurts of pest epidemics are rare and occasional, and this has been due to farmers' sound farming practices which included maintenance of quality seeds; using many crop varieties which suited various land types with their specific demands; strict adherence to crop rotation; and maintaining plant vigour by providing organic manure and water. Crop genetic diversity was maintained, and this drastically reduced pests characteristic in the monocultural farming of today. In spite of all this, crops were still ravaged, albeit in limited areas. Assorted control measures were practised which are, even today, theoretically sound and restricted to the area of epidemics. Let us enlist some of their control practices.

1. Rice cultivation and duck farming were complementary. The duck suppressed borers and provided fertiliser for the crop.

2. Soil preparation methods included sun drying which exposed gestating and hibernating larvae, spores, and cysts to the vagaries of nature and predation by birds. Inundating the land with water for some days and puddling it later drastically reduced and suppressed weeds.

3. Inter cultivation of crops, such as maize and soyabeans or cow peas, often provided micro-environments where notorious pests could not establish themselves; a fact observed by many researchers.

4. Small flag-poles littered over rice fields (to be noticed in rice fields in Bhaktapur even today) frightened away the birds above, and their moving shadows the rats below.

5. Potato and chilli farmers manually collected cutworm larvae and slugs with the help of *tuki* (local wick) at night in earthern jars and fed their ducks with them.

6. Potato tubers were stocked in cool *chhidi* (basements) over dry sand; a practice which lengthened storage duration and kept potatoes free from tubermoth attack.

7. Ashes were spread on aphid-infested vegetables which stuck to plants because of honey dew secreted by aphids and choked the pest to death.

8. Cereal grains were thoroughly sun dried before storage, reducing pest infestation.

9. Local herbs such as *titepati* (*Artemisia* sp) and *asuro* (*Adhatoda vasica*) were spread on the fields and *bakaino* (*Melia indica*) was commonly planted around the fields. All these plants are noted for their antifedant, detractant, bactericidal, and even insecticidal properties.

10. Maize farmers seeded their fields densely, borer and white grub affected plants were selectively used as fodder.

All these methods are labourious but environmentally sound. In addition, revering snakes and petting of cats were accepted norm, in the farming society.

When such a balanced system is disturbed by the introduction of new technologies, disturbances do occur. The present spurt of ravaging pests is, in essence, a consequence of such activities. Let us cite the spread of *Eupatorium* as an example which hopefully will not be out of context.

The genus *Eupatorium* inhabits mainly tropical and subtropical regions of the world. The herbarium record of the Department of Botany suggests that six species are found in Nepal of which *E. adenophorum* and *E. odoratum* have acquired pest status; and they are commonly known as *banmara* (killer of the forest). The former is native to Jamaica and Mexico, whereas the latter is found in the West Indies and continental America around Florida (Bennet 1968). These exotic species entered Nepal from the east (Sharma and KC 1977) and have now spread wherever natural forests have been destroyed. On intensely cultivated farmlands, they are meticulously controlled but are a menace during early establishment of plantation crops such as tea and citrus. Efforts to establish *Cecidocharis utilis*, a gall forming fly, on *E. adenophorum* has been a success but, due to various sociocultural necessity of Nepali farmers, they have remained a problem, especially on pasturelands and creeks and they cover smaller streams and rivulets completely with adverse ecological consequences such as lowering of the water temperature and providing shelter for rodents. Farmers now-a-days use the plant as composting and bedding material.

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

4

PESTICIDE POLICIES AND STRATEGIES

There are no policies on pesticides and their uses so far. First of all, the Ministry of Agriculture, HMG/Nepal, has still to decide who should be responsible for pesticide management. However, some policies and programmes are being undertaken in an arbitrary manner. They are more in the nature of personnel approaches and consultations rather than a comprehensive approach based on the actual use of pesticides in Nepal. 'Ad hocism' is the greatest drawback.

A basic fact about pesticides is that they are hazardous. Hazards can be minimised by risk management. Safe pesticide management practices should be followed during production, transportation, storage, and utilisation. Pesticides are used by farmers in rural areas where there is a lack of both knowledge and skills for effective and safe use. Farmers are unable to use costly pesticides and, consequently, they use broad spectrum chlorinated hydrocarbon compounds as well as highly hazardous organo-phosphates such as Methyl parathion. Inappropriate, needless, and indiscriminate use of pesticides often results in adverse effects on human health and the environment. Pesticide-related hazards are not so much related to the volume used as to the lack of knowledge regarding judicious use. New policies and strategies, therefore, should be directed towards these aspects, and this can only be achieved by generating mass awareness about the potential dangers of pesticides and ways to use them prudently and raise productivity. Generating mass awareness among farmers, retailers, dealers, workers in factories, and control through licensing schemes, can go a long way to improving pesticide use. The new Pesticide Act 1991, in addition to having regulatory mandates regarding various commercial and industrial channels, is also concerned about the quality of pesticides and the hazards of pesticide residues in food, fields, and the natural environment. It is expected that appropriate agencies will soon be established to monitor pesticide use as intended in the Act. However, the following important factors cannot be overlooked.

1. Production targets should be taken into consideration. Every risk management effort should be linked to the production target.
2. Nepal signed the International Code of Conduct declaration regarding the safe use of pesticides in 1982 and is committed to it.
3. The safe use of pesticides involves registration of safer pesticides, regulations for their safe use, and training to all involved in pesticide usage.

Judicious use of pesticides can be achieved through a set of activities, including training courses for retailers and dealers; monitoring of usage by workers in factories; setting of product standards; training courses for farmers; and generating public awareness of the benefits as well as of the hazards during different stages of manufacture, storage, transport, dilution, and actual use.

Nepal Pesticide Act 1991

The Nepal Pesticide Act 1991 was passed by the Interim Government and the royal seal was given to this act.

The Act addresses all aspects of pesticide regulation including registration, legislation, and safe use of pesticides. A National Pesticide Board (NPB) has been established according to the Act

under the chairmanship of the Secretary, Ministry of Agriculture. Members include chiefs of the Divisions of Entomology and Plant Pathology, the Deputy Director General of the Department of Agriculture, the Chief of the National Malaria Control Programme, representatives from the Ministry of Health and Nepal Standard Bureau, three members from the environmental sciences' sector, one from the pesticide industry (private sector), and one farmers' representative. The member secretary of this board is the Registrar of Pesticides and his office is the executive centre for legal control of pesticides. Based on the Act, regulations regarding pesticides are being developed including the ones outlined below.

1. Power to declare certain substances pesticides
2. Exemption
3. Applications for registration
4. Registration
5. Restricted use permits
6. Return of imports
7. Register of imports
8. Approval of labels and containers
9. Pesticides for scientific purposes
10. Licensing of pesticide resellers
11. Licensing of chemical applicators
12. Licensing of production plants
13. Transitional
14. Appointment of inspectors and demarcation of authority
15. Fees
16. Issuing guidelines

The Act is expected to provide for the establishment of a Pesticide Registration Body whose functions, duties, and powers will be to:

i) consider applications for registration of pesticides and, if deemed proper, to register that pesticide and
ii) to ascertain the criteria for rational and appropriate use of pesticides.

The pesticide registration body is the executive body of the National Pesticide Committee and will carry out its work in accordance with the policy set by the committee. It will be headed by a Registrar of Pesticides who will be the "ex officio" secretary of the National Committee. The Registrar's office will also approve labels, containers, and the language used in pesticide advertisements, including checking the quality of pesticides available in the market. Management, supervision, and control of the approved list of pesticides will also constitute its special duties.

The general aim of the Pesticide Bill is to manage the use of pesticides in Nepal in a scientific way. This is to be achieved by establishing a Pesticide Committee, the main functions of which are as follows.

1. To advise HMG regarding the formulation of national policies regarding pesticides
2. To maintain coordination between the private and government sectors in the production and distribution of pesticides

3. To encourage the private sector to invest in the pesticide industry
4. To regularise and control the quality of pesticides produced by the pesticide industry
5. To ascertain the quality of pesticides

The Bill states that the other duties and powers of the Pesticide Registration Body and its registration procedures shall be prescribed in the Rules and Regulations. The Bill has further provisions for the committee to advise HMG on the use, importance, export, production, distribution, and quality of pesticides, and this information will be published in the gazette. It is further stated in the Bill that no pesticide other than those which are gazetted may be exported, imported, produced, used, and distributed. Provisions have been made for the appointment of inspectors and for penalties.

The Bill and the draft regulations both demarcate special areas of responsibility for both the Pesticide Committee and the Registration Body. In the case of the Pesticide Committee, responsibilities include the following.

1. Appointment of subcommittees
2. Notification in the gazette
3. Recommendations to HMG regarding exemption and declaration
4. Licensing of pesticide dealers and retailers
5. Licensing of commercial applicators
6. Licensing of production plants
7. Setting fees
8. Issuing guidelines

In the case of the Pesticide Registration Body, the responsibilities are as follows:

1. registration of pesticides,
2. maintenance of requirement/import records, and
3. approval of labels and containers.

Close liaison between the two bodies is essential. The Pesticide Committee should be considered to be the policy-making group, while the Pesticide Registration Body is the executive body carrying out its work in accordance with the policy set by the committee. It is because of this that the Registrar of Pesticides should also be the Secretary of the Pesticide Committee. If this is not possible, the Registrar of Pesticides should be at least an "ex officio" member of the Pesticide Committee.

Pesticide Registration

The purposes of pesticide registration is

1. to control the use of pesticides in Nepal;
2. to control the import and manufacture of pesticides in order to avoid the use of toxic pesticides and contaminants;
3. to minimise risks to humans;
4. to provide efficient pesticides which are safe to handle;

5. to avoid introduction where it is not presently needed as a result of the existing balance between pest and bio-control agents; and
6. to ensure that pesticides are available where and when needed and are used scientifically by the farmers.

Registration of pesticides in Nepal was voluntary for a long time. The need for mandatory control was felt. The International Code of Conduct on the safe use of pesticides also envisages regulations regarding the safe use of pesticides.

Licensing of Production Plants

There is a provision in the Bill for the Pesticide Committee to ensure that all production plants are licensed. So far there is only one production plant in the country, and it is located in Bahadurgunj. The plant produces BHC dust and, to a lesser extent, Malathion dust. It operates on a part-time basis as its capacity far exceeds the demand for pesticides. The operating conditions of this factory have been the subject of a number of reports. A production plant specialist has recommended that it should not be allowed to operate in its present form.

General Principles Regarding Pesticide Registration

In deciding whether to restrict or ban a particular pesticide, the following principles are suggested for guidance.

1. By refusal of new and cancellation of old registrations, the Pesticide Board can ensure prohibition of those pesticides that pose an unacceptable level of threat to public health, livestock, beneficial insects, wild life, and the environment.
2. Class 1A pesticides of the WHO Recommended Classification of Pesticides by Hazard should be banned completely. Those in Class IB should only be permitted if their use is essential and if there are no effective alternatives available. Some form of restriction on their availability should be considered.
3. By strict implementation of the FAO/UNEP Prior Informed Consent (PIC) procedures under the International Code of Conduct on the distribution and use of pesticides, those with adverse environmental effects should be completely banned.
4. Wherever possible, alternatives to pesticide use for management of pests should be promoted.

Approval of Labels and Containers

No pesticide is to be sold unless it is in a container that is approved by the Pesticide Registration Body and no person is to sell pesticides in a container or choose a label not approved by the Pesticide Registration Body.

Any pesticide imported for scientific trial or evaluation purposes and not intended for sale is to be registered for research use only.

Retailers of pesticides require licenses issued on the basis of successful completion of training.

Chemical applicators are to be licensed.

The committee may require production plants to be licensed by the committee according to its terms and conditions.

Inspectors, for the purpose of enforcing the Pesticide Act and accompanying regulations, are to be appointed from time to time by the Department of Agriculture. They shall be empowered to inspect any land, vehicle, commercial premise, dwelling, store, or shed and inspect related documents. They shall have the power to seize pesticides that are being marketed illegally.

Dealers and Resellers' Licensing Scheme

There are more than forty dealers and retailers of pesticides in the Bagmati subregion (see Figure 4). They include corporate bodies like the AIC (Agriculture Inputs' Corporation) branch offices, dealers of multinationals such as those of Beyer, Ceiba-Geigy, etc, and other retailers who are either directly importing pesticides from India or are agents and subagents of the factories and dealers. In addition, Sajha also acts as a retailer of pesticides. They have an important role to play in the safe use of pesticides as they may be the only persons whom farmers see and from whom they seek advice before they use the pesticides.

Dealers and retailers are often ignorant of proper transportation, safe storage, and other standard practices. Poisoning has been known to occur as a result of food contamination on account of unsafe transport and storage practices in other countries. It is, therefore, necessary that the dealers are trained in safe and sound procedures. Before a dealer receives a license to open shop, he must be trained in the following practices.

1. Recommended methods of controlling pests and diseases
2. General properties of pesticides, their type and use
3. Knowledge of the chemicals that pose lesser operational hazards to farmers
4. General knowledge about pesticide toxicity and the physiology of pesticide action in the body system
5. Knowledge of the potential environmental risks involved and ways to minimise risks
6. Knowledge of safe mixing and preparation of sprays or dusts based on recommended rates
7. Working knowledge of the contents and proper use of labels
8. Knowledge of poisoning symptoms and first-aid treatment
9. Knowledge of the cardinal safety rules in transportation and the problems caused by breakage, spills, and transport accidents
10. Knowledge of pesticide storage

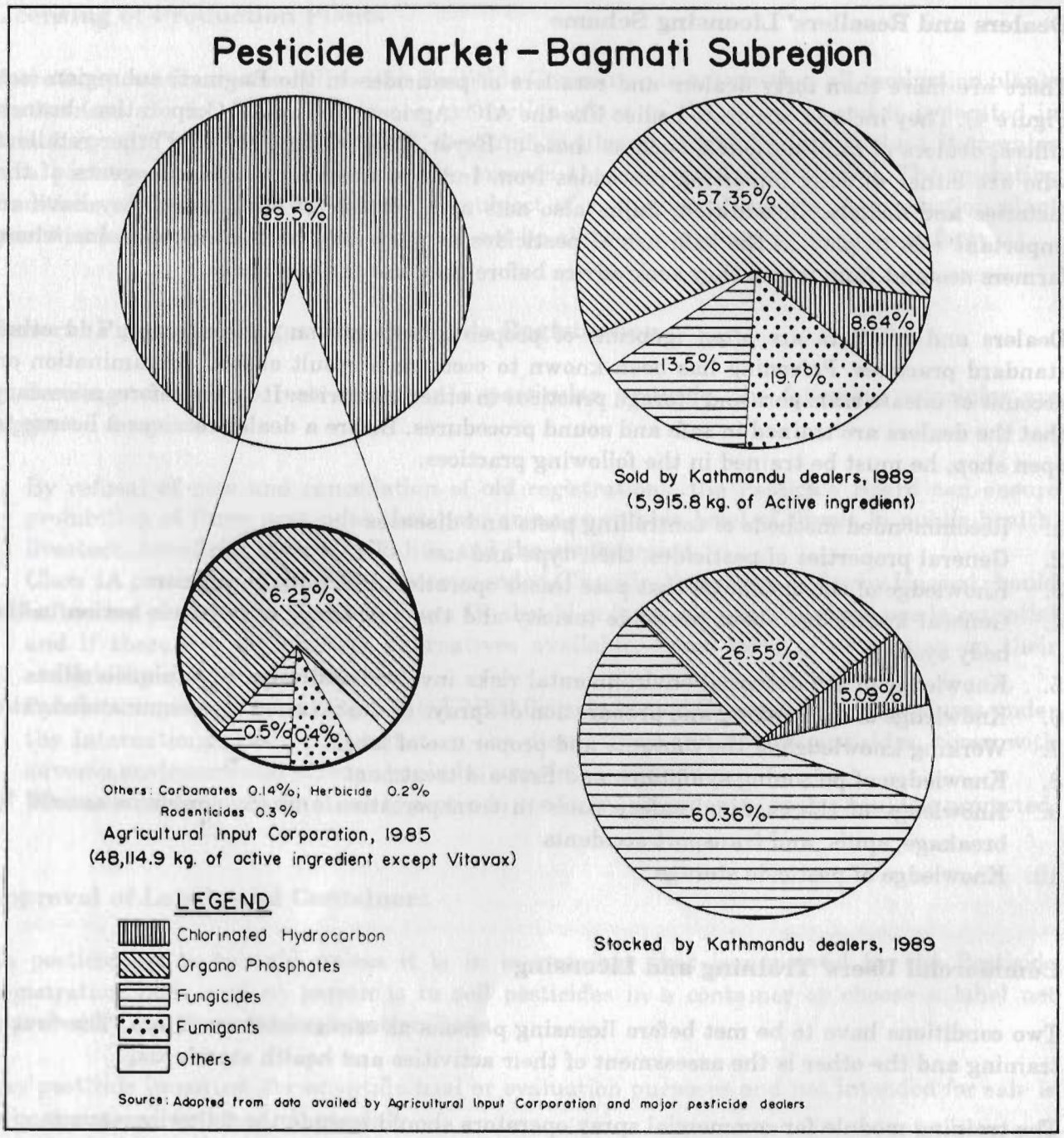
Commercial Users' Training and Licensing

Two conditions have to be met before licensing persons as commercial operators. The first is training and the other is the assessment of their activities and health standards.

The training module for commercial spray operators should include the following aspects.
1. Pest management, pesticide groups, active ingredients, formulation, risks, and benefits.
2. Pesticide toxicity, exposure, and hazards.

3. Pesticide legislation, pesticide labels, and their importance.
4. Symptoms of poisoning and first-aid treatment.
5. Storage and disposal practices.
6. Recommended pesticides, how to dilute them for safe application, and maintenance of application equipment.
7. General knowledge of the major pests that require control measures.

Figure 4



5
CONCLUSIONS AND RECOMMENDATIONS

The farmers in the Bagmati subregion fall into two distinct categories. The farmers in the midhills of Kabhre, Dhading, Rasuwa, Nuwakot, and Sindhupalchowk districts are generally subsistence farmers, although with improvements in accessibility and availability of services, some of them are beginning to commercialise their farming operations. The use of pesticides by these farmers is limited. They depend on natural diversity. There is a need to educate these farmers on the usefulness of biotic factors for pest management. The expensive production technologies with which the usage of pesticides is closely associated must also be promoted, but it should be carried out in a manner that reinforces the use of biotic factors and not recklessly, as is happening in many parts of the subregion. Extension training programmes should be implemented to educate them about the dangers of pesticides to human health and the environment. The other farmers in this region, growing commercial crops such as vegetables and potatoes in Bhaktapur and Dhading, have already been exposed to the use of pesticides. Extension programmes must ensure safety and judicious use based on the critical needs of farmers.

Their level of literacy may not enable them to clearly understand the instructions on the labels and this often results in poor selection of pesticides and misuses. Dieldrin is specifically recommended for controlling termites in houses and it proved to be effective in killing aphids in broad-leaved mustard in the course of experiments. The urban consumer is prone to pesticidal hazards and extended misuse leads to consequent environmental hazards and pest resistance. Thus, registration of safer pesticides; regulations and strict licensing schemes for trained dealers, retailers, and commercial users; and periodic monitoring of their activities are necessary. In addition, integrated pest management and use of bio-control agents, judicious use of the diverse ecosystem, for example, use of local herbs with potentials for pest control, should be considered. Training and creating mass awareness about pesticidal hazards are also important.

Integrated Pest Management

Integrated pest management (IPM) is a pest management system that uses a rational combination of biological and chemical means in economically beneficial ways. Broadly speaking, IPM is based on ecological knowledge and includes crop biology, pest biology, and biology of predators and parasites as well as other abiotic environmental factors. Pest containment is based on cultural, biological, physical, and chemical methods, and these tools of pest management are used according to the need of farmers and the economics of crop production. The strategies involved include identifying pests, estimating the number of natural enemies and pests, and determining the stages of plant growth as well as the vigour of plant health. Management costs play a decisive role. IPM requires strong, practical research input for effectiveness. However, research need not be costly as it is field-based. IPM appears complicated, but when farmers visit their farms at least once every day, and they are encouraged to develop their knowledge of pests and their natural enemies, great success can be achieved as in Indonesia, for example.

It is quite difficult to post reasonably knowledgeable experts who can work with farmers in the districts and villages. Constant working and learning with the farmers alone can make IPM

more simple, more efficient, and, therefore, more profitable. However, this can be achieved by imparting training to the JTA/JTs working in the villages and also to the subject matter specialists working in the districts. Trainers' training in IPM constitutes, therefore, the most practical approach.

Biodiversity: Aid to Pest Management

Hill agriculture has a unique feature. The same commodity is cropped in diverse micro-environments as the altitudinal range is wide. For example, rice cropped in the river valleys of the Trishuli (<600 mm) in the Kathmandu Valley (1,260m), and on the slopes of Chautara (600-1,200m), in essence resemble the humid tropics of South India, the Po Valley of Italy, and parts of the Korean peninsula. These diverse micro-environments within a short distance of the Bagmati subregion are the habitats of a whole range of pests that affect rice. These various pests, in turn, provide habitats for even more diverse bio-control agents that thrive on them. An earnest attempt to harness these resources for pest management is indeed a practical probability. One can argue that the pests are dangerous, which is indeed a possibility, but the near-complete, natural bio-control potential of subsistence farming provides better manipulative possibilities. An example can be given of this. *Brevicoryne brassicae*, an aphid pest of leafy mustard (*rayo*), cabbage, cauliflower, broccoli, etc in Kathmandu is also found in Kakani. The probability of finding thriving population of its bio-control agent in subsistent farmers' plot of Kakani is much better and this can be easily bred and released in Kathmandu in order to control the dreaded aphids. Thus, bio-diversity is an essential tool for pest management and is highly recommended for extensive practical use.

Biotic Factors

Before the advent of modern synthetic pesticides, the farmer's chief weapon against pests was the use of their natural enemies such as predators, parasites, and pathogens to control them or periodically deny them food, i.e., plants, through ordinary practices. In addition, varieties less susceptible to attack and use of more susceptible crops as traps were often employed as control measures. Biotic methods of pest management are now advocated in multiple control schemes.

Every natural organism has its natural enemies in the form of predators, parasites, pathogens, and competitors. For instance, woolly aphids, a dreaded pest affecting apples, has more than eight types of ladybirds and crysopa as natural predators, a few aphilinids as parasites, and a few entomophagous *fungi* as pathogens. These control the pest population. The main advantages of using these agents for control compared to the use of pesticides are (a) selectivity; (b) a manufacturing process is not required; (c) bio-control agents seek pests wherever they lurk; (d) bio-control agents increase in number over time; (e) pests do not get the opportunity to build up resistance; and (f) control is self-perpetuating. Bio-control agents could be conserved, inoculated, and used. This strategy should be studied and utilised extensively in strip farming practices for pest control, i.e., in the form of one strip of those of a different crop between two suitable ones which form a barrier to pest migration and consequent damage.

Several plants have pest-controlling properties; *Ageratum conyzoides, Artemisia asiatica, Acorus* sp are a few examples. These can be used by farmers in pest management.

Cropping of indigenous varieties with greater resistance to pests also provide gene diversity. Non-crop plants, e.g., weeds, growing adjacent to cropped fields are also useful control factors. These could be of immense importance.

Ecological Factors

Ecological factors are both biotic and abiotic. They exert an important influence by arresting the population explosion growth of pests. Biotic factors have already been mentioned above and some of the major abiotic factors are discussed below.

The diverse agriculture of the Bagmati Zone falls under different temperature regimes, i.e., cool temperature (over 2,800m in Sherpa and Tamang villages); warm temperate (over 800m in the Kathmandu Valley); and subtropical (river basins). The biodiversity of this region is a reflection of the abundant abiotic factors favourable to plants and animals. The major factors are annual precipitation; monsoon; light hour regimes; seasonal fluctuation of temperature; wind velocity; proximity of the solid surfaces of hill slopes providing variations in reflected warmth and light around the cropped area; and the presence or absence of frost, fogs, and mists.

It is common knowledge that in winter, when growing potato crops are subjected to several days of morning fog, they are invariably attacked by late blight. Similarly, severe insect epidemics in rice are reduced substantially if there is continuous rainfall for several days (probably due to the lower temperature). Severe winters favour sexual reproduction of some aphids in primary hosts and, consequently, in spring the offspring invade annual crops - their alternate host. Early rain in spring results in the growth of lush green vegetation and activates hibernating pests to grow and damage crops grown in summer. Abiotic factors are important mechanisms for population control but their manipulation is seldom practicable, especially in field crops. However, this principle could be successfully used to lengthen the storage period of apples in the Sindhupalchowk and Rasuwa districts. The low winter temperature can be used to contain weevils and moths in store godown as is practiced in some areas of China.

Floral Diversity

The flowering stage of plants coincides with the evolution of pollen and nectar-eating insects and birds. Wasps, bees, and syrphids fall within the *Hymenoptera* and *Diptera* categories. The majority of the natural enemies of pests fall into these orders and floral diversity helps to retain the evolutionary balance maintained by nature. The chronological sequence of non-crop, flowering plants provides food to the beneficial adult insects of these groups in the form of both pollen and nectar. Therefore, floral diversity is an important factor in natural, biological pest control. Flowering weeds in and around crop fields and hedges should, therefore, be conserved.

Quarantine Issues

Quarantine is a legal process which checks the spread of an obnoxious pest in a habitat from a similar habitat elsewhere. In Nepal, it is often considered in terms of checking the entry of pests from foreign countries and quarantine checkposts are established in the border areas. However, in-country quarantine should also be considered within the context of Nepal. The seeds of important crop varieties, fruits, vegetables, cuttings, and seedlings are distributed from one centre to another and throughout the production area. There is a possibility (as has been found

on several occasions) of pests spreading in a so far unpolluted environment. The spread of greening disease in citrus is an example. Its spread within Nepal follows the pattern of the horticultural development activities of the concerned department. A few years back, a Malathion-resistant strain of *Sitophilus oryzae* was detected in the Seed Processing Factory at Hetauda. This factory belongs to the Agricultural Inputs' Corporation which deals with the supply of improved seeds of high-yielding varieties, mainly cereal grains. The possible spread of such resistant strains to clean areas, and consequent infestation, leaves farmers with no alternatives for safe control, which can be provided by Malathion (one of the safest pesticides in current use). Therefore, quarantine is more relevant within Nepal which is a land-locked country. Bihar and U.P. pests are in no way different from *terai* pests. Similarly, the cold desert areas of Mustang and Dolpo may not differ very much from areas of the Tibetan Plateau. However, mango orchards of the low lying Indrawati Basin in Sindhupalchowk differ a lot from those of Sarlahi regarding pest infestation and control. Strong quarantine measures are necessary to prevent the spread of insects and diseases.

Marketing Constraints

In Chapter 3 we have detailed the uses of pesticides and some aspects of marketing in the Bagmati subregion. Additional issues will be discussed in some detail in the following paragraphs.

Both private sector dealers and the AIC are actively involved in pesticide marketing, but neither of them offer satisfactory services in a manner that is accessible to the farmers. Both have a very limited range of pesticides in stock which farmers are compelled to buy in the event of unavailability of recommended safer pesticides. The shops of both of these pesticide dealers are located in the district headquarters or nearby areas such as Nagadesh in Bhaktapur; Banepa in Kavre; and Bidur in Nuwakot. Farmers have to travel long distances to buy necessary pesticides, therefore valuable time is lost, sometimes resulting in crop losses due to pest damage.

The packages of solid formulations and liquid bottles pose further problems for the farmers. The land holdings of Nepalese farmers are small, hence, small amounts of pesticides are required. Packages and bottles of appropriate volume are not sold in the market. This results in unnecessary, additional costs and the extra pesticide is either lost or spilt, thereby endangering the vicinity. Accidental poisoning may occur. The labels on the packets are often written either in English or Hindi, or both. Many farmers are unable to read and understand these languages. The use of Nepali, or alternatively pictograms, would enable the farmers to clearly understand the instructions.

The registration of safer pesticides, periodic training to dealers working in various marketing chains, licensing, and constant monitoring of their activities are needed to improve the situation.

Quality Control

The quality of pesticides in the market is less than desirable as has been discussed before in this paper. Farmers are often cheated. Lack of monitoring leads to several biological problems. A sub-lethal dosage of pesticide often enhances the resistance of pests. Consequently, farmers no longer

benefit from the usefulness of control technology. Sale of substandard pesticides should be checked. For this, a series of control measures, including checks on the products for sale on the dealers' premises and tests of their quality in the pesticide laboratories. Laboratory quality assurances, good laboratory management practices, laboratory accreditational schemes, and collaborative inter-laboratory studies on pesticides are necessary as such laboratories have not been set up in Nepal. It is important to set pesticide standards similar to those of our neighbouring countries and check chemicals in their laboratories. In regional meetings on pesticide regulations, it has been recommended that such reference laboratories be established in an appropriate country for this purpose. AIC should set standards for buying pesticides and carry out quality checks. Private dealers should check all pesticides for sale and observe the ISI mark, so that only pesticides of good quality are sold in the region. Farmers must only be encouraged to buy pesticides that have been checked, and this can solve the problem of substandard pesticides to a great extent.

Policy Constraints

A remarkable feature of pesticide use in Nepal so far has been the absence of any pesticide policy. Even today, when there is great concern for the quality of life and the quality of the environment, pesticides, which are among the greatest man-made pollutants, are used carelessly. There is no clearly-defined policy controlling their sale and use. The lack of a crop protection division; the lack of capacity to enforce pesticide laws; the absence of facilities to monitor pesticide quality; and failure to check for residues in food, fodder, feed, soil, water, and air have resulted in difficulties in monitoring the existing situation objectively. However, attempts have been made. In fact, policy aspects have been documented in this paper. The existing facilities are not managed properly and are often neglected. Therefore, measures cannot be implemented properly in the absence of the smooth functioning of existing facilities. The Entomology Division, which has made pioneering attempts in this sector, instead of developing into a Plant Protection Division, remained only a cereal crop research division, whereas it was expected that it would cater to horticultural, agricultural, arboricultural food storage, and pest control aspects as well as to research. Their laboratories never received timely and sufficient funds, whereas other departments unduly poured money into a senseless array of projects in the name of research. Policy needs and implementation should also be considered.

Other Environmental Protection Measures

Birds, snakes, and frogs are important elements in maintaining natural balance. The usefulness of mynas, drangoes, and shrikes in regulating the insect population number can be easily determined by observing their voracious insectivorous behaviour during land tillage. Most frogs are carnivores in their adult life, as are snakes. Falcons, harriers, hawks, and eagles are mostly predators of small rodents and birds. Their role in balancing the population of obnoxious insects is important. Bait-poisoned rats and use of bio-accumulative, persistent, broad-spectrum poisons of the organochlorme group are the greatest hazards. Their use must be severely restricted if not completely banned. The insectivorous spiders in paddy agro-ecosystems are similarly affected by the indiscriminate use of pesticides. To avoid this, pesticide registration, regulations, safe use, and strict adherence to the international code of conduct for use of pesticides are essential. Acts and regulations in themselves have no meaning if effective training and educational schemes

are not implemented, so that the people involved in the chain of activities related to pesticides acquire knowledge of safe use. A network of people to implement IPM and promote the safe use of pesticides should be developed and delegation of responsibility is required in order to improve efficiency.

The Recommended Approach for Judicious Use of Pesticides

Pesticides are never recommended as the only pest management tool in Nepal. They should only be used as a last measure. The recommended methods for controlling the principal pests in rice are given below.

1. Paddy Pests

   Paddy Hispa (*Dicladispa armigera*)
   - Clean weeds to deprive hispa of its alternative host.

2. Borer Complex (*Tryporiza incertulas; T. annotata; Chilo supressalis; C. zonalus; Sesamia inferens*)
   - Burn the stubble to kill hibernating larvae and pupae.
   - Keep a field of volunteer plants.
   - Collect the tips of seedlings to get rid of the egg masses.

3. Plant and leaf hoppers (*Sogatell furcifera; Nephotattix* spp.; *Cicadella spectra;* and *Kolla* spp.)
   - Collect hoppers by means of light traps.

4. Rice bug (*Leptocoryza acuta*)
   - Clean gramineous weeds where alternative hosts may be present.
   - Early planting protects from pest attack.
   - Clean volunteer plants.

5. Rice Blast (*Piricularia oryzae*)
   - Use resistent crop varieties.
   - Clean cultivation.
   - Uproot and burn affected plants.
   - Use seeds that have not been infected.

Similar examples can be cited in the case of other pests as well, but more often such preventive methods do not work and use of pesticides is essential. The recommended approach for judicious use of pesticides is given below.

1. Use of pesticides for seed treatment is cost-effective, because the volume of pesticide

required is minimised and clean seeds prevent early infestation.

2. Pest control is necessary to render the crops pest-free when they are transplanted to a larger area where there is little use of pesticides and limited possibility of pesticide hazards.
3. Need-based use of pesticides, i.e., timely survey and identification of pests by standard survey methods, e.g., by estimating pest numbers by means of standard hand net, light traps, or yellow tray methods is necessary.
4. Use of safer formulations. Granular pesticides are the safest.
5. Use of gloves, boots, and goggles while mixing pesticides in containers.
6. Use of safe aprons and clothing, e.g., loose trousers and long, loose dresses.
7. Use of pesticides, either in the morning or late afternoon hours, when the wind is of low velocity and the problem of drift is minimised.
8. Read the labels of containers carefully and adhere strictly to the instructions.
9. Pesticides should be kept in a locked cupboard so that they are out of the reach of children, pets, and other domestic animals.
10. Pesticides should be stored far away from food stuffs or medicines.
11. Knives for opening pesticide containers should be kept separately.
12. Empty pesticide containers should be destroyed and should not be re-used for any other purpose.
13. Application of pesticides should never be carried out against the direction in which the wind is blowing.
14. Spilling pesticides should be avoided and clean water and soap should be used for washing.
15. Long-handled mixers should be used while mixing spray and bare hands should never be used.
16. While handling pesticides, smoking, chewing tobacco or betel nut, or even drinking water should be avoided.
17. After application, hands and other exposed parts of the body should be thoroughly washed with soap and water. New washed cloths should be used. Clothes worn during spraying or dusting should be washed thoroughly.
18. The nozzle or other parts of the equipment used should not be blown by mouth and contaminated washes from spray appliances should be buried.
19. The appliances and empty containers should not be washed near streams, wells, or ponds so that contamination is avoided.
20. In the case of suspected poisoning, the nearest physician should be called immediately and, where such facilities are far away, first-aid treatment, i.e., induced vomiting, washing, or placing the victim in a safe environment, is necessary.

In addition to these recommendations, care should also be taken during transportation and storage of pesticides in retail shops.

1. Pesticides should never be transported by porters or mules. The bullock carts used for transporting food should not be used for transporting pesticides.

ANNEXES

Annex 3.1: Recommended Pesticides

Hydrocarbon - Compounds

Common Name	Trade Name	Formulation	WHO Classification		Oral LD 50
			Based on A1	Real Commercial Formulation	
BHC	BHC, BHC 10 Nepal CH50 Nepal gammacide 10%, 5% Rasayan 10 DP Rasayan 5%	Wettable powder (WP) and Ready to use dust (DP)	II	DP III WP II	100
Aldrin*	Andrex 30 EC Aldrin 10 DP Termox 20	Emulsifiable concentrate (EC) and DP	Ib	EC II DP III	90
Chlordane	Chlordane 10	DP	II	III	460
Endosulfan	Endocil 35 EO Hexasulfan K sulfan Thiodan 35 EC	EC		II	80
Organophosphorous					
Diazinon	Basudin 10G Neocidol 20EC Suzon 20EC	Granule (G) and EC	II	Gr Not hazardous II	300
Dichlorvos	Marvex Super 100 Neocidol 20 EC Suzon 20EC DDVP Nuvan	Soluble liquid (SL)	Ib	Ib	56
Demeton S. Methyl	Metasystox 25EC	EC	Ib	Ib	40
Dimethoate	Cygon Hexagor 30 EC Krogor Rogor 30 EC		II	II	150
Edifenphos	Hinosan 50 WP	WP	II	II	150
Fenitrothion	Nepal 5 DP Nepal 50 EC Sumithion	DP	II	DP Not hazardous II III	503
Malathion	Cythion, Kthion, Malathion, Nepal M50, Nepothion	DP EC	III	Not hazardous	2100
Monocrotophos	Monocil Monophos	SL	Ib		14

Common Name	Trade Name	Formulation	WHO Classification		Oral LD 50
			Based on A1	Real Commercial Formulation	
Methyl Parathion	Camacide Keydol Metacid 50 Malamar 50 Nepcil parathion Para Tox Paramar M50EC	EC EC	Ia	EC Ib DP III	14
Phosphamidon	Dimecron Phosphamidon Samidon 85WP	SL WP	Ia	Ia	7
Phorate	Kaymet, Phorate 10g	GR	Ia	Ib	2
Carbomates and Thiocarbamates					
Carbaryl	Hexavin 50 WP Sevin Sow	WP and DP	II	III DP Not hazardous	300
Cabofuran	Carbocil Furadan 3G Hexifuran 3G	Gr	Ib	II	8
Bendiocarb Mancozeb	Ficam Dithane M45 Manzeb, Rasayan M45	WP	II Not hazardous	Not hazardous	55 >8000
Synthetic Pyarathroids					
Cypermethrin	Cileord 25EC Cyperkic 25 EC Cypermar 10 EC Fripcord, Ripcord	EC	II	II	250
Deltamethrin	Decis	EC	II	Not hazardous	135
Fenvalerate	Fenfen 20 EC Fenicron Sumicidin	EC	II	III	450
Others					
Carbendazim	Bavistin 50 WP Sten 50 WP Benganid Derosal	WP	Not hazardous		>10,000
Carboxin	Vitavax	WP	Not hazardous	Not hazardous	3820
Copper oxychloride	Blitox 50W	WP	II	Not hazardous	144
Brododiolone	Moos Moos	Readymade bait		Not hazardous	
Zinc phosphide	Nepal phos Zinc phosphide		Ib		45
Aluminium phosphide	Celphos, Quickphos	GE	-	-	-

Source: Pesticide Recommendation Committee

Annex 3.2: Pesticides Imported by Stockists in the Kathmandu Valley

Class	Unit	1988	1989
Chlorinated hydrocarbon	Kg of A.I	1908.00	1420
Organo phosphates	"	4695.14	4833.65
Synthetic parathyroids	"	6	10
Carbamates	"	60	75

Source: Compiled by Author

Annex 3.3: Pesticides Used by Bhaktapur Farmers

Class	Unit	Years				
		1986/87	1987/88	1988/89	1989/90	1990/91
BHC (OC)	Mt of Formulation	1.0	1.5	2	2.3	2.8
Vitaray	"	0.2	0.5	0.55	0.35	0.27
Carbofuran	"	0.8	0.9	0.7	0.9	1.1
Liquids	"	0.23	0.6	0.9	1.0	2.1

Source: Provided by the Agricultural Development Office, Bhaktapur (FAO/WHO)

Annex 3.4: Classification of Pesticides by Hazard Level

Class	LD 50 for rat (mg/kg body weight)			
	Oral		Dermal	
	Solids	Liquids	Solids	Liquids
Ia Extremely hazardous	5 or less	20 or less	10 or less	40 or less
Ib Highly hazardous	5-50	20-200	10-100	40-400
II Moderately hazardous	50-500	200-2000	100-1000	400-4000
III Slightly hazardous	Over 500	Over 2000	Over 1000	Over 4000

Source: Provided by the Agricultural Development Office (FAO/WHO)

Annex 3.5: Crop Loss due to Pests in the Bagmati Subregion

Commodity	Potential Production (MT)	Crop Loss due to (number in brackets indicates the percentage of actual production)				Actual Production
		Insects	Diseases	Weeds	Total	
Paddy	336429	89827 (26.7)	29942 (8.9)	Manually controlled	119769	21666
Wheat	92327	4617 (5)	8402 (9.1)	909.0 (9.8)	22068	70630
Maize	202636	25127 (12.4)	19048 (9.4)	26343 (13.0)	70518	13181
Potato	140830	9155 (6.5)	30701 (21.8)	5915 (4.2)	45771	9506
Vegetables*	Many vegetables, hence, difficult to quantify					

Source: Estimated by Author

Annex 3.6: Quality of Some Key Pesticides in the Nepali Market

	Active Ingredient indicated	Active Ingredient found
1. Metacid (Metasystox)	25% W/W	19.6% W/W
2. Metaystox (Oxyaemeton methyl)	25% W/W	5.5 W/W
3. Dichlorvos	76% W/W	83-76.4% W/W
4. Dimethoate	30% W/W	25.5-26.5 W/W
5. Carbendazim	50% W/W	46% W/W
6. Aldrin	30% W/W	27.6% W/W
7. Carboxin	50% W/W	46% W/W
8. Methyl parathion (Nepsil parathion)	50% W/W	17.9% W/W
9. Dichlorvos (Nepsil Suvan)	76% W/W	51.2% W/W
10. BHC 50	50% W/W	31% W/W
11. BHC 10	10% W/W	6.5% W/W
12. (Aluminium phosphide) Quickphos	36% W/W	32% W/W

Source: Registration, Regulation, and Use of Pesticides (ADB 1992)

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