AN OVERVIEW OF PESTICIDE POLLUTION IN NEPAL

Resham B. Thapa
Department of Entomology
Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal

ABSTRACT

Nepal consumes very low quantity of pesticides (average 142 g/ha) compared to other South Asian countries (750 to 5700 g/ha), but their use in commercial farming and freshly marketable commodities appears excessively uncontrolled and without the consideration of the health of consumers. This paper documents the various problems created by the misuse and the overuse of pesticides especially in horticultural crops in Nepal. Pesticide residues have been detected in rice, wheat and pulse grains in godowns and in milk as well. DDT was commonly used in Terai region while BHC in the Hills and Mountains. Out of 163 vegetable samples, 83% were contaminated of which 76% samples contained DDT residue above tolerance limits. Organophohate residues were also detected in 35% of the vegetables. Moreover, direct use of pesticides just before harvesting fresh vegetables and fruits have further intensified the problem. Pesticide problems have been reported in many other non-target organisms such as natural river fishes, wildlife, predators and parasites. Recommendations are made on formulation of necessary guidelines, enforcement of the Pesticide Acts/Regulations, and Plant Quarantine, including restriction on use of persistent pesticides, proper monitoring and record keeping, education and awareness, promotion of alternative measures, and introduction of Integrated Pest Management (IPM).

Additional Key Words: Pollutant, vegetables, insecticide, residues

INTRODUCTION

The use of agro-chemicals such as fertilizers and pesticides started with changing of traditional farming into modern agricultural practices. The trend in scientific agriculture practices increased with the introduction of high yielding variety of crops, massive input of chemical fertilizer and irrigation facilities which improved the agricultural productivity considerably but also created multifaced problems of pest outbreaks resulting in a large amount of crop loss and turning traditional ecological sound farming into pest problems, crop loss and pesticide pollution (Thapa, 1994; Thapa *et al.*, 1995).

At present, among the several constraints for higher or at least sustainable production of various crops, the loss caused by the pests (insects, mites, rodents, diseases) both in pre- and post-harvest conditions has been considered to be of great significance. The world estimate on the losses caused by pest damage (insects, weeds, diseases and vertebrate pests) worth US$ 30 billion per annum. The magnitude of loss is still higher in the developing country like Nepal. In Africa, 69% loss in maize and 39% loss in wheat has been reported due to insect pests, diseases and weeds (Singh, 1983). In Nepal, such losses (pre- and post-harvest) vary 10-35%. Baker and Gyawali (1994) reported that farmers in areas with high inputs are losing 15% of their crops in pre-harvest and nearly 20% in post-harvest periods. Periodic pest outbreaks and epidemics result in a complete failure of crops. In 1987, for example, an outbreak of armyworms resulted in complete loss of yield in 20% of the cropping land in Banke district. Further loss of 10-20% occurs from diseases and 10-75% from weeds (Moody, 1986).

Chemical pesticides were first introduced into Nepal in early 1950s when DDT was imported from USA for malaria control and also some chemicals were used for crop protection. DDT made its first impact in 1956. This was soon followed by a range of other pesticides i.e. organophosphates (in 1960s), carbamates (in 1970s) and synthetic pyrethroids (in 1980s). The use of pesticide has steadily increased leading to a massive amount in some commodities at present in Nepal.

PESTICIDE PROBLEMS

Presently, chemical pesticides are common weapon to control crop pests. More than 150 such types of pesticides are in use in Nepal. Agriculture and public health sectors are the major areas of pesticide uses. Pesticides are also used in small scale in industrial sector such as carpet industry. The major types include organo-chlorine, organo-phosphate, carbamate, nitro-chloro-phenol and pyrethroid (Thapa *et al.*, 1995). Due to their misuse and overuse various effects on environment are summarized in Table 1.

Table 1. Effects of pesticides on environment

Environment	Potential hazards/effects
Target pests	Develop resistance and resurgence
Secondary pests	Secondary pest outbreaks
Predator/parasites	Destroyed, killed, extinction
Plants	Presence of residues, damage due to phytotoxicity and vegetation change due to over pesticide use
Animals	Presence of residues in domestic life and physiological effects, mortality in bird, fish, mammal etc.
Man	Presence of residues in tissues & organs, poisoning and death, occupational exposure and cost burden
Food	Presence of residues
Abiotic	Presence of residues in soil, water, and air

Pesticide problems have been reported in many other non-target organisms (river fishes, wildlife, predators and parasites) and added four important costs to Nepalese society i. e., 1) health related expenses, 2) environmental pollution, 3) yield loss due to non-target pesticide application resulting in pesticide induced pest resurgence, and 4) financial burden both to poor farmers and the country as a whole.

Nepal consumes very low quantity of pesticides as compared to other South Asian countries (Sharma, 1994). Therefore, hazards caused by pesticide application in Nepal are mainly due to misuse of pesticides. However, the application of pesticides in some of the commodities such as cotton (2500 g/ha) and commercial vegetables (1450 g/ha) is exceptionally high in the Nepalese context. Thus, there appears two distinct areas of pesticide problems i.e. misuse in general and ovèruse in specific areas. The misuse and excessive use of pesticides, both disturb the natural ecosystem and produce serious environmental problems which are as follows:

Air pollution

The application of fumigating materials causes air pollution. Pollutants emitted from fumigation of stored grains pose serious health hazards. However, because of lack of proper monitoring and record keeping system, valid information are lacking in Nepal.

Water pollution

The major sources of water pollution are leaking of disposed date-expired pesticides into water, misuse and direct contact of pesticides with water and waste water from industries. Some poisoning cases are found from the direct use of poison in water for fishing. There are more information to be recorded in this area.

Land pollution

Application and misuse of agrochemicals are major source of soil pollution. The chemical disposal and dumping sites emit bad smell, pollute air and water and thus cause serious health hazards. Soil application of highly persistent pesticides and unscientific disposal of date-expired pesticides possess a serious pollution threat to living beings. Persistent insecticides (organochlorines such as, DDT, BHC, aldrin, heptachlor, dieldrin and chlordane) and herbicides remain unchanged in the soil from months to years (Table 2) and pose the most serious risks to living organisms. But there are newer synthetic compounds that have residual effects lasting for only few days.

Table 2. Persistence of pesticides in soil

Pesticides	Persistence
Insecticide	
Chlordane	12 Years
BHC	11 "
DDT	10 "
Aldrin, dieldrin	9 "
toxaphene	6 "
Herbicide	
Monuron	36 Months
Atrazine	18 "
Simazine	17 "
Divron	16 "
2,4, 5 - T	6 "

Effect on public health

There are no environment protection agency (EPA) and department of health (DOH) in Nepal to monitor pesticide poisoning cases nationwide. However, Sharma (1994) recorded over 300 pesticide poisoning cases from three hospitals in the Kathmandu valley.

Acute cases of pesticide poisoning are readily diagnosed and treated but chronic health effects are ignored, and therefore, farmers and agricultural technicians facing chronic health effects from pesticide application. Farmers use phenoxy herbicides and acetamide, both are irritating to eyes. Many of the commonly used pesticide in Nepal enter the body through the skin mouth, and respiratory tracts. Besides, many people in Nepal chew tobacco and smoke cigarettes (Table 3) which increase nicotine level and causes poisoning effect in the long run.

Table 3. Prevalence of cigarette smoking and tobacco chewing among Nepali people.

Habits	Male	Percentage	Female	Percentage
Smoker	163	26.98	40	10.10
Ex-smoker	143	23.67	33	8.33
Non-smoker	298	49.33	323	81.56
Khaini	116	19.20	10	2.52
Ex-khaini	21	3.48	3	0.76
Non-khaini	467	77.32	383	96.72

Effects on wildlife and birds

There is a very limited studies on the misuse and residual effects of pesticides on the wildlife fauna. In 1990, some poachers also used pesticides in Narayani river and killed four one-horned rhinos (Kandel and Mainali, 1993). Around the Chitwan National Park, some poachers use highly toxic pesticides in ponds for killing wild animals. Migratory birds and other wild animals also become victim of such misuse of pesticides as confirmed by dead birds and animals in the lakes.

Effects on natural river fishes

Pesticides recommended for controlling pests are also harmful to fish. For example, hill communities use endosulfan to kill fish in the Koshi and Narayani rivers (Sharma, 1994). This compound accumulates in the fat tissues of fish, thereby poisoning the fish eaters. The use of liquid pesticides is also seen in Rapti and Bagmati rivers and even in fish ponds. Some people who have consumed such fishes were admitted in hospitals (Kandel and Mainali, 1993). The high way restaurants may serve contaminated fishes with pesticides. Eating of those fishes can result in a severe physical weakness, mental disorder and sometimes immediate poisoning effects to the consumers. Over half of the farmers neglect adverse effects of pesticides on beneficial animals (IUCN, 1994). As a result, the lake, pond and river fauna including fish are killed.

Effects on predators, parasites and pollinators

Both misuse and overuse of pesticides destroy predators, parasites, pollinators etc. After the heavy use of chemical fertilizers and pesticides all domesticated bees wept out not only in Ilam (Gautam, 1991) but also in Nuwakot (Sharma, 1994). Very recently, i.e. in 1994, in Chitwan, twenty bee hives were completely wiped out due to disease and pesticide problems.

Effect on pests

Indiscriminate use of pesticides for controlling pests has created a chain of everlasting problems because of pest developing resistance to pesticides, pest resurgence, and secondary pest outbreaks. The chronological increase in the number of insect and mite species resistant to pesticides are presented in Table 4. Number of pests becoming resistant has increased in many folds after the use of organochlorine and organophosphate compounds after 1950s.

Table 4. Chronological increase of insect and mite species resistance to pesticides.

Period	Number of resistant species	
	New in decade	Total
1908	1	1
1909-1918	2	3
1919-1928	2	5
1929-1938	2	7
1939-1948	7	14
1949-1957	62	76
1958-1967	148	224
1968-1978	190	414
1979-1988	90	504

In Nepal also, spraying of DDT over last three decades caused environmental changes that minimized *Anophele minimus* and *A. fluviatilis* but increased *A. annularis* and *A. culifacies* in Terai. The first record of insecticide resistance is *A. culifacies* to dieldrin in Parsa and Bara districts of Nepal was observed in 1960 after three years of DDT sprays. DDT resistance was reported in 1962 shortly after the malaria eradication campaign lunched in 1959. At present this occur throughout the inner and outer Terai (96% of total area) and valley (52%) (White, 1982).

Sitophilus and *Rhizopertha* have developed resistance to malathion (Sharma, 1994). Similarly, pesticides from organochlorine, organophosphate and carbamate are ineffective against grown up larvae of soybean hairy caterpillar (Neupane and Thapa, 1985). The outbreak of hairy caterpillar as a secondary pest is the recent case in tea which was not mentioned as a pest of tea in Nepal. *Helicoverpa armigera* has been confirmed to be resistant to different insecticides. Laboratory testing indicated that *H. armigera* from Pokhara were 12-56 fold while from Nepalgunj were 103 fold resistant to pyrethroids (Armes and Pandey, 1995). Many insect pests develop resistance and cross-resistance to the insecticides and often such pesticides do not work at all.

Pesticide residues in fresh vegetables

Pesticide residues have been found in many fresh vegetables in Nepal. The Central Food Laboratory in Kathmandu has detected pesticide residues in many vegetable samples (Table 5). The DDT residue ranged from 0.001 to 5.05 ppm. Out of 163 samples, 83% were contaminated of which 76% samples contained DDT residue above tolerance limit. In

1992/93, 28 of 31 samples 28 contained pesticide residues i. e. 90% contamination level which indicates increasing trend of pesticide residues in fresh vegetables higher than the maximum residue level fixed by Codex Alimentaneus Commission (FAO, 1990).

Table 5. Pesticide residues in fresh vegetables

Vegetable	Tested Samples	Contaminated Samples	Residues (ppm)	Pesticides
Potato	7	4	Tr-0.60	Malathion
			0.32	Fenitrothion
Cauliflower	5	2	4.80	Malathion
			4.80	Fenitrothion
			1.60	Parathion
Radish & Carrot	7	3	Tr-0.64	Parathion
			Tr-0.40	Fenitrothion
Turnip	5	4	4.80	Malathion
			0.64-0.80	Parathion
			6.40	Fenitrothion
			0.80	Malathion
Tomato	2	2	0.80	Malathion
			0.30-1.60	Parathion
Brinjal	2	1	0.64	Malathion
			0.64	Fenitrothion
			0.36	Parathion
Broadleaf Mustard	4	3	0.40-1.20	BHC
			1.00-2.60	OP
Radish	2	2	Tr	DDT
			1.20	BHC
			2.80-5.20	OP
Bean	3	3	Tr	DDT
			Tr-1.00	BHC
			2.20-3.00	OP
Chayote	1	1	1.40	BHC
			1.60	OP
Cabbage	1	1	0.60	BHC

Note: Tr means pesticide residue amounts in traces.

The problem is more severe because of poor selection of pesticide and short harvesting interval of crops after pesticide application (Sharma, 1994). According to a survey of farmers using pesticide continuously for over five years or more, over 60% of the farmers do not wait even two weeks between spraying pesticides and harvesting the crops (IUCN, 1994).

Pesticide residues on food frains

Pesticide misuse are frequently reported from the godown and flour mills of grain dealers (Sharma, 1994). Most of the users dust BHC in bags and bins, fumigate gunny bags with aluminium phosphide, lavishly apply dusts around flour milling areas and often mix grains and flour with highly toxic insecticides. The prevalence of DDT and BHC residues in some stored grains are presented in Table 6. The results indicate residues much higher than tolerance level. However, Joshi (1988) reported a declining DDT and BHC residues in recent years (only 29% of samples) than in the past (94% of the samples). Seeds and grains polished with pesticides are kept in the market for sale. Consumers are then exposed to slow/chronic poisoning effects while handling and consuming such contaminated grains.

Table 6. Pesticide residues in food grains

Food Grains	Tested Samples	Contaminated Samples	Residues (ppm)	Pesticides
Wheat	7	3	1.70-6.70	DDT
			0.50-0.70	BHC
Rice	9	4	0.70-6.70	DDT
			0.30-4.00	BHC
Malt	5	4	4.30-4.90	BHC
Gram	6	3	Tr-7.50	DDT
Rahar Pulse	10	3	7.50	DDT
			Tr-1.00	BHC

Pesticide residues in milk

Use of pesticides in fodder and pastures affect livestock when they are fed on fodder and allowed to drink water contaminated with pesticide residues. As a result, presence of DDT has been detected in many samples above MRL (i.e. 0.05 mg/kg) (Table 7). But later in 1985/86, there was decline in the samples exceeding residue limits. Besides, direct use of pesticide on the body of animals for ectoparasite control aggravate the pesticide problem. In early sixties, for example, a farmer in Gokarna applied ethyl parathion to control boophilids and this resulted in the death of two buffaloes. Department of agriculture used pesticide to control *Sogatella* epidemic in Kathmandu valley during 1991/82. Ignoring the instruction, the farmer fed grasses to his animals which affected two of the calves finally resulting to death (Sharma, 1994).

In general, all areas are exposed to pesticide problems. However, substantial information are limited to highlight the seriousness of problems in commercial commodities such as tea, tobacco, jute, and fruits and wildlifes like birds and animals. These remain major areas of concern for the extent of use of pesticide use and their adverse effects to public health and environment. To overcome the problem, various pest control options such as cultural, biological, chemical, innovative and IPM (Thapa, 1982; 1991; 1994; Neupane and Thapa, 1985; Thapa *et al.*, 1995; Vaidya, 1993) can be practiced in combination with chemicals or alone to break the pesticide habit (Terry, 1987). Enforcement of Laws, pesticide registration, regular monitoring and record keeping and creating awareness among the users help to mitigate pesticide use in Nepal.

Table 7. DDT residues in milk samples

Year	Tested samples	Contaminated samples	Residues (ppm)
1981	42	42	0.01-0.07
1982	10	10	0.06-1.20
1983	8	8	Tr-1.00
1985	80	72	0.006-1.10
1986	33	29	Tr-1.00

RECOMMENDATIONS

Majority of the pesticides recommended in Nepal fall under highly toxic groups. Out of the recommended pesticides (with more than 70 trade names) about two-thirds belong to organochlorine and organophosphate groups. As the growing use of organochlorine such as DDT and BHC and organophosphate i.e. demeton methyl, parathion methyl, phosphamidon and phorate are highly hazardous, they should either be banned or restricted. Pesticides recommended for pest control in the past should be reviewed and modified to replace persistent and highly toxic pesticides.

As the environment and operational hazards are very high, use of such toxic chemicals by the Nepali farmers is a matter of serious concern. Misuse of pesticide has been a serious problem which is mainly due to illiteracy among the farmers' community, lack of technical know-how among dealers, retailers, stockists etc. and lack of awareness programs among the users. Therefore, it is essential to make aware these groups of safe handling and proper use of chemical pesticides through various sources of communication such as nonformal education, training/workshop/seminar, leaflets, pamphlets etc.

There is no system of regular monitoring and documentation in the country. Lack of such system affects availability of actual sources of information. For example, there is shortage of information on the entry of pesticide from India, their quality, efficiency and residual effects of food products, air, water and soil pollution etc. Therefore, regular monitoring and upto-date record keeping on each sector such as formulation, transportation, storage, dilution and application can reduce the problems.

Enforcement of Pesticide Acts (1991) and Pesticide Regulation (1992) seem imperative for authorizing sell and purchase, scientific storage and disposal of date expired pesticides including timely updating of Acts and Regulations for mitigating the pesticide use in the country. Furthermore, there appears to be inadequate facilities for plant quarantine and quality testing of pesticides at present. These facilities have to be strengthen for preventing pests from abroad and quality control of pesticides, respectively.

There exists a vast potential areas for alternative approaches of pest management in the country. However, such opportunities are not yet explored mainly because of solely reliance in a single method of pest control- pesticides. Survey, documentation and verification of these techniques and their incorporation in integrated pest management approach especially in the commercial areas can reduce misuse and overuse of pesticides significantly. Thus, there lies the potential area for pollution study and research programs especially through integrated approach because Integrated Pest Management (IPM) is the answer that includes and utilizes all the available techniques in a compatible manner aiming at sustained productivity and least possible adverse effects on public health and the environment.

REFERENCES CITED

Armes, N. J. and R. Pandey. 1995. Pyrethroid resistance in *Helicoverpa armigera* in Nepal. Newsl. Resistant Pest Mgmt. 7 (1):11-12.

Baker, S.L. and B.K. Gyawali. 1994. Promoting proper pesticide use: Obstacles and opportunities for an integrated pest management programme in Nepal. HMG/MOA/Winrock International, Kathmandu, Nepal.

FAO. 1990. Codex Alimentarius. Vol 8. Maximum limits for pesticide residues. FAO, Rome.

Gautam, J. 1991. Use of chemical fertilizers and pesticides in vegetables in Nepal (in Nepali). Environmental Journalists, Thapathali, Kathmandu, Nepal.

International Union for Conservation Network (IUCN). 1991. Environmental pollution in Nepal: A review of studies. NCS/NPC/IUCN, Kathmandu, Nepal.

International Union for Conservation Network (IUCN). 1994. A study on pesticide pollution in Nepal. NCS/NPC/IUCN, Kathmandu, Nepal.

Joshi, U. 1988. Monitoring of DDT residues in food articles of Nepal pp 420-425 *In* Proceedings of National Conference on Science and Technology, April 24-29. 1988. RONAST, Kathmandu, Nepal.

Kandel, K. R. and M. Mainali. 1993. Playing with poison. Nepal Forum for Environmental Journalist, Thapathali, Kathmandu, Nepal.

Moody, K. 1986. A literature review of weeds in rice in Nepal. Nepalese J. Agric. 11:129-140.

Neupane, F. P. and R. B. Thapa. 1985. Efficacy of various insecticides and detergents against the grown up larvae of the soybean hairy caterpillar, *Spilarctia casignata* Koll. (Lepidoptera: Arctiidae). J. Inst. Agric. Anim. Sci. 6:1-10.

Sharma, K. C. 1994. Current experiences and practices in pesticide use in the Bagmati zone. ADPI Series #9. ICIMOD, Kathmandu, Nepal.

Singh, C. 1983. Modern techniques of raising field crops. Oxford and IBH Publishing Co., Pvt. Ltd., India.

Terry, Gips. 1987. Breaking the pesticide habit- Alternatives to 12 hazardous pesticides. IASA Publication # 1987 - 1. Malaysia.

Thapa, R. B. 1982. Cultural, biological and chemical control of *Pieris rapae* (L.) on cabbage and cauliflower. M. S. Thesis, MSU, East Lansing, Michigan, USA.

Thapa R. B. 1991. Use of tissue culture for studying rice resistance to the yellow stem borer, *Scirpophaga incertulas* (Walker). Ph. D. Dissertation, UPLB, Los Banos, Philippines.

Thapa, R. B. 1994. Environmental impacts from Nepal's use of chemical pesticides. Consultancy report submitted to WWF Nepal. APROSC, Kathmandu, Nepal.

Thapa, R. B., B. Upadhaya, B. K. Gyawali and Ganesh K. C. 1995. Policy studies on the use of pesticide. Draft report submitted to NCST, Kirtipur, kathmandu, Nepal.

Vaidya, K. 1993. Agricultural pest management using animal and plant products. Report submitted to GTZ (GTZ/Gate/1991/NEP). Tribhuvan University, Kirtipur, Kathmandu, Nepal.

White, G. B. 1982. Malaria receptivity stratification and projection for malaria vector control in Nepal. WHO report submitted to SEARO. WHO/SEA/MAR. 144.