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Pesticides and Environment Situation in Pakistan

Abdul Jabbar and Seeme Mallick

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Mailing Address: PO Box 2342, Islamabad, Pakistan.
Telephone ++ (92-51) 278134, 278136, 277146, 270674-76
Fax ++(92-51) 278135, URL:www.sdpi.org

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Pesticides and Environment Situation in Pakistan

Abdul Jabbar and Seeme Mallick

Abstract

This paper reviews the environmental situation with regards to pesticides in Pakistan. It tracks the history and the current status of pesticides usage. The issues of institutional arrangement for pesticide research and development, and government policies and legislation regarding import, manufacture, registration, sale and distribution of pesticides are addressed. It also highlights incidences of occupational and accidental poisoning, and environmental contamination. The sources and chances of pesticide pollution are pointed out with suggestions for prevention of environmental degradation through them.

Introduction

Pest suppression with synthetic chemicals is the quickest and surest method of pest management. It has the advantages of speed of control in situations of massive pest outbreak against biological and cultural control practices which work over a longer span of time. However, there are serious ecological and environmental problems with over reliance on pesticides. Persistence of pesticides in the food chain (Carson 1962) and the development of resistance in pests towards pesticides (Brown 1971) are the two serious problems encountered. Hassall (1982) has traced the history of pesticide[1] development and usage which dates back to classical Greece and Rome around AD. 79. More information became available in the sixteenth century. The modern synthetic pesticides were developed around World War II when the insecticidal potential of DDT was discovered in Switzerland and insecticidal organophosphates were developed in Germany. At about the same time work was in progress in Britain which led to the commercial production of herbicide of the phenoxyalkanoic acid group. In 1945 the first soil-acting carbamate herbicides were discovered by British workers and the organochlorine insecticides, chlordane, was introduced in the USA and in Germany. Shortly afterwards, the insecticidal carbamates were developed in Switzerland. In 1950-55, herbicidal urea derivatives were developed in the USA, the fungicide captan and glyodin appeared, and malathion was introduced. Between 1955 and 1960, newcomers included herbicidal triazines (Switzerland) and quaternary ammonium herbicides (Britain). Relatively few new groups of crop protection compounds have been discovered since then. As mentioned above, post world war II era saw a boom in the synthetic pesticide production and thousands new compounds had been screened for pesticidal activity. The discovery of DDT and analogues was thought to be miracle and a permanent solution to pest problem. However, Rachel Carson's "Silent Spring" in 1962 was the first to draw our attention towards the retention and built-up of persistent organochlorine pesticides in the food chain. 'Silent Spring' has become synonymous with the massive poisoning of birds caused by DDT, from eagles to hawks to songbirds. While DDT is banned in many countries and some

1. The term pesticides is used for collective or individual description of chemicals such as **insecticides** to control agricultural, medical veterinary and household insect pests, **fungicides** to control fungal diseases, **herbicides/weedicides** to control weeds, **acaricides** for control of mites, **rodenticides** for control of rodents and other vertebrate pests, **nematicides** to control nematodes, and **fumigants** gases used for control of stored grain and soil born pests.

affected bird populations are now beginning to recover, hundreds of bird species continue to be threatened by other pesticides.

The presence of pesticides in food items and their accumulation in tissues has direct toxic effects on humans and other non-target organisms. In situations where the safety measures are not applied properly these have direct effects on human health e.g. on the spraymen and other workers (WHO 1979). The organochlorine pesticides present in human and cow's milk are transferred to the infants. This way the toxic effects are passed on to next generation. The continued and overuse of pesticides have also resulted in more serious problems by contaminating water supplies (Carey 1991) and degrading the cropland soils. The current magnitude of translocation of food grown with pesticides is seen as a danger to humankind, even in areas where very little pesticides are used. It points to the reality that the pesticide problem does not merely concerns the chemical industry and professional farmers, foresters and applicators, or one concerning only those who wish to protect wildlife or those responsible for control of malaria and other vector born diseases, rather the pesticide problem concerns every person who wants food at a reasonable price and who wants his home free from vermin.

Scientifically proven answers to the pollution problem are necessary. Change in agriculture policies should encourage farmers to convert to ecologically sound alternatives such as organic farming. Such agricultural practices may be desirable, but until such time research in the following directions is critical; i) to determine the role of pesticides in environmental pollution, ii) introduction of integrated pest management packages, and iii) to develop crop varieties resistant to pests through biotechnology and genetic engineering. This document deals with the first two issues, relying upon published work in Pakistan.

Historical Overview of Pesticides Usages in Pakistan

The pesticide era in Pakistan can be divided into distinct six periods (Table 1). Before 1980 the pesticide import and distribution was the responsibility of the Plant Protection Department, Government of Pakistan. At that time the greatest imports were for the locust control program, malaria control program, aerial spray of cotton, sugarcane, rice, tobacco, etc. It had merits and demerits. There were subsidy on pesticides and aerial spraying was free. The pesticides were shipped in large packages or containers. A number of accidents occurred during transfer to smaller containers, handling and storage of left-over toxicant (Ahmad 1988). Moreover, the farmers had to purchase pesticides on a pre-payment basis.

In 1980 the pesticide business was transferred to private sector with the agreement that the pesticides available in government stock will not be imported until they are exhausted. Therefore, the import figures for the years 1981 and 1982 are low, but since then there has been a steady increase in the pesticide consumption and imports (Table 1) owing to: (i) pesticides are offered in small unit packs, (ii) these are available in time before the start of the crop season, (iii) these are provided to the farmers on credit and deferred payment basis (this practice has been discontinued since 1988)[2] and (iv) farmers were provided advisory service through the promotional campaigns about the time and mode of application.

2. Discussions with many multinationals revealed that the companies had to suffer losses because of defaulting farmers who did not pay back the out standing dues. So they decided to provide the pesticide on cash sale. However this practice has created the agents/middlemen who buy pesticides from the company on commission and sell to farmers at full price on deferred payment.

Table 1: Stages of Pesticide Usage in Pakistan

Period	Pricing	Mode of Disribution
1947-65	Free of Cost	Public Sector
1966-74	From a flate rate of Rs0.25/ltr to 75% subsidized price	Public Sector
1975-79	50% subsidy on *ECs/Wps, 75% subsidy on granules	Public Sector –25% Private Sector – 75%
1980-85 NWFP	Complete wihtdrawal of subsidy expect in Baluchistan	Private Sector – 100% Punjab, Sindh & Public Sector in Baluchistan, FATA & AK
1986-91	Complete withdrawal of subsidy in all provinces expect Baluchistan	Private Sector – 100%
1992-93	Duty and Surchage exempted on imports of weedicides	“
1993	Duty exemption on pesticides	“

Source: Ahmad (1988); Prime Minister's 3rd Package of Incentives (1992).
Note: *EC = Emulsifiable Concentrate, WP = Wettable Powder

Magnitude of Pesticide Consumption in Pakistan

The pesticide business in Pakistan started in 1954 with the import of 254 metric tons of formulated product[3], which increased to a maximum of 20,648 m tons in 1986-87. During the past four decades, pesticides have played pivotal role in plant protection but side by side have generated problems of pesticide resistance in pests, persistence of toxicant in ecosystem, hazards to field applicators, food consumers and dealers.

Due to a lack of knowledge of farming community and absence of appropriate regulatory agencies, the pesticides in Pakistan are not used in ways likely to maximize the benefit, except in (cash crop) cotton. The Central Cotton Research Institute, Multan, and Nuclear Institute for Agriculture and Biology, Faisalabad, have played a key role in boosting up cotton production. Better pest management practices have been another important factor in boosting production.

After the transfer of pesticide sale and distribution business to the private sector in Pakistan, pesticide consumption increased from 906 metric ton (active ingredient) in 1980 to 5519 metric ton (active ingredient) in 1992, at a rate of 25% per annum (Table 2). The sprayed area has increased from 1.8 million hectare to about 3.8 million hectare (18% of total cropped area),in 1991 (Tables 3). Due to the complexities in cropping system and small holdings, ground spray has always been preferred. Aerial spraying has been restricted to epidemic outbreaks of pests like locusts, sugarcane pyrilla, white-backed plant-hoppers, crickets, etc.

Table 2: Pesticide consumption in Pakistan (000 Kg/Lit a.i.*)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992
Insecticide	734	952	1471	2162	3022	3480	3804	4173	3986	4265	4698
	(81)	(74)	(82)	(88)	(88)	(86)	(87)	(85)	(85)	(85)	(85)
Fungicide	132	171	185	204	240	283	253	277	345	365	275
	(15)	(13)	(10)	(8)	(7)	(7)	(6)	(6)	(7)	(7)	(5)

Continued…

3. A pesticide formulation comprises of an **active ingredient** and **inert material** (diluent and stabilizers) to stabilize active ingredient, make pesticides convenient and safer during storage and handling, and to render it suitable for field applications.

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992
Herbicide	34	94	119	102	103	162	253	277	341	365	542
	(4)	(7)	(7)	(4)	(3)	(4)	(6)	(6)	(7)	(7)	(10)
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992
Acaricide	2	3	6	51	60	81	19	82	-	-	3
	(-)	(-)	(-)	(2)	(2)	(2)	(-)	(2)	-	-	-
Rodenticide	4	69	29	25	8	41	39	44	4	27	-
	(-)	(6)	(1)	(1)	(-)	(1)	(1)	(1)	(.1)	(1)	-
Total	906	1289	1800	2544	3442	4047	4368	4853	4697	5296	5519

Source: Kafi and Baig, (1987), Jabbar and Inayatullah, (1990)
Pakistan Agricultural Pesticide Association, (1993)
Note: *a.i. = active ingredient
- ** = values in parenthesis represent percent of the total.

Contrary to the experience in industrialized countries like the USA where herbicides make up 85% of total pesticides[4] (USDA 1987), recent data from Pakistan (Table 2) indicates that insecticides comprise of 85% of the total pesticides consumed, and almost 65% of insecticides are used for cotton pest control. Better crop protection measures coupled with the introduction of high-yielding varieties has meant that production increased from 4.2 to 12.50 million bales from 1981 to 1992 (Economic Survey of Pakistan 1991-92). In other words, productivity increased from 2.27 bales/ha in 1980-81 to 4.52 bales/ha in 1991-92. Experience supports that high yielding varieties perform better if the external inputs like fertilizers and pesticides are applied. Generally the losses due to uncontrolled pests have been rated between 15-25%. Looking at the yield figures of 1991-92, a prevention of 8-10% loss due to pests would have added another million bales to cotton production. The discussions with experts in PARC have suggested that during current cotton season, cotton leaf curl virus disease is responsible for an estimated loss of 3 million bales (25% of 1991-92 production figures).

The herbicide use share is increasing and has reached up to 10% of the pesticides used. Imports of fungicides have more or less steady, however, the proportional share is decreasing. The list of registered pesticides in Pakistan is given at annex II.

Table 3: Area of crops (000 ha) covered by plant protection measures in 1990-91

Crop	Total Area	Ground Areas	Spray % age	# Sprays	Aerial Area	Spray % age	# Sprays
Paddy	2113	300	14.2	1-2	-	-	-
Cotton	2662	1662	62.4	3-4	1	1	3-4
Sugarcane	884	797	90.2	1-2	84	9.5	1
Maize	845	131	15.5	2	-	-	-
Oilseeds	496	7	1.4	1-2	-	-	-
Fruit/Veg.	673	542	80.6	3-15	8	1.2	2-3
Tobacco	44	22	50.0	4	-	-	-
Others	13633	310	2.3	1-3	1	-	1
Total	21350	3772	17.7		94	0.4	

Source: Agricultural Statistics of Pakistan 1991-92

4. In industrialized countries main use of the pesticides is to control weeds. These herbicides are directly applied to the soil, leach downwards and contaminate groundwater. The bulk of the insecticides on the other hand is sprayed on to crop. Photolabile pyrethroids generally are destroyed in the sunshine. However, the ones which are absorbed into the plants and the ones which are washed down with rain water are potential surface water contaminant.

Regulatory Mechanism

Pesticide manufacture, import and usage are controlled by the **Agricultural Pesticides Ordinance, 1971,** through the **Agricultural Pesticides Rules, 1973** (Annex III). Generally once a pesticide is registered, its registration is renewed periodically. However, recently the case was thoroughly reviewed and 21 pesticides have been de-registered and their import banned (Table 4).

Table 4: List of pesticides banned in Pakistan as of May 1993

1	Binapacryl	9	DDT	15	Ethyene dichloride +
2	Bromophos ethyl	10	Dibromochloropropane		Carbontetrachloride (EDCT)
3	Captafol	+	Dibromochloropropene	16	Leptophos
4	Chordimeform	11	Dicrotophos	17	Mercury Compound
5	Chlorobenzilate	12	Dieldrin	18	Mevinphos
6	Chlorthiophos	13	Disulfoton	19	Propergite
7	Cyhexatin	14	Endrin	20	Toxaphene
8	Dalapon			21	Zineb

Source: MINFA (1993b)

The provision of Pesticide Ordinance included appointment of inspectors and laid down the procedure for taking samples for quality analysis. However, the process has been unsatisfactory. There are not enough inspectors. These inspectors are not fully trained. The court procedures take a long time and consequently cases of adulteration are very common.

The government figures show (MINFA 1993) that under the Agriculture Pesticides Rules, 1973 (Amended), 294 cases for adulteration of pesticides were registered in Punjab during 1990-92, and one case was registered in NWFP. Out of these cases, 48 in Punjab and 1 in NWFP were decided by the court. Under 43 different cases punishments were awarded or fines were imposed (fines ranged from Rs.500 to Rs. 3,000). Five persons in Punjab and one person in NWFP were arrested in relation to these cases, however five persons arrested in Punjab were later acquitted. As of November 1992, 246 cases were pending in Punjab courts.

There is a genuine fear that a meagre fine of Rs. 500 - 3,000 is not a deterrent for culprits in contrast to the profits they make. Since 1988 the government has made two relaxations in pesticide imports policy: (i) the pesticides can be imported under generic names rather than brand names, (ii) if a pesticide is registered in some other country it can be imported without going through the local registration process. A large number of companies have since been registered as importers and pesticides have been imported in large quantities. Many complaints indicate that the insecticides imported under such arrangements which are supposed to contain 50% a.i. are being sold with less than 3% a.i. This under dosing will not only result in the failure of plant protection measures and economic losses but also generate a resistant population of insect pests difficult to be controlled with even higher doses of pesticides. The problem is aggravated by allowing many "fly by night" companies permission to import pesticides. There is a danger that after making profits many of these companies will disappear and the consequences will have to be born by the farmers in the form of loss of crops.

Institutional Arrangements for Pesticide Monitoring and Research

The pesticide business in Pakistan since its start has predominantly been the imports. Local manufacture is only a small proportion of total pesticides consumed. The Ministry of Food, Agriculture and Cooperatives is the controlling ministry. The Department of Plant Protection with its head office at Karachi is responsible for registration5 and other regulatory aspects of pesticides. The Agricultural Pesticide Technical Advisory Committee (APTA) advises the central government on technical matters arising out of the administration of the pesticide ordinance. The Pakistan Agricultural Research Council, as the main body responsible for agricultural research in Pakistan is assigned the task of monitoring the pesticides. There is not a single independent institute capable of conducting pesticide research Currently pesticide research is handled at 4 federal and various provincial institutions (Table 5). Most of the staff of these institutes conducts research on the efficacy trials of pesticides and developing pest management packages. Very little attention is paid to ecological studies. Scientists tend be cautious in reporting results which would cause alarm. Even if some projects and studies are conducted with utmost care and proper controls (some of them given below) there is no mechanism to verify the findings. The results appear either as reports or these are published in the local scientific journals. It is left to the readership to accept or reject. Practically these findings do not influence the policy makers.

Whereas almost all the provincial centers are mainly concerned with the quality of the pesticides, the federal agencies have gone beyond and are looking into the residues in crops and food products (Table 5).

Table 5: Summarized information on pesticide research laboratories

Institute	Year of establishment	No. of Scientists	Activity	No.of Publications
Pesticide Research Laboratory TARI, PARC, Karachi	1954	9	Quality Control, Residues in Food, Ag crops, soil, water, and human blood, etc., Insect toxicology	50
Plant Protection Institute, Faisalabad				
- Pesticide Division, Faisalabad	1971	10	Quality control, Residues in crop	8
- Pesticide Quality Control Laboratory, Lahore	1984	3	"	-
- Pesticide Quality Control Laboratory, Multan	1984	3	"	-
Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad	1969	2	Residue in food and soil	14
National Institute of Health Islamabad	1975	2	Residues in food, Human tissue	4

Continued…

5. The registration process includes submission of application by the importer/manufacturer with the chemical and toxicological data to the Dept. Plant Protection for which an appropriate fee is charged. The pesticide is subjected to chemical analysis for the active ingredient at the Federal Pesticide Labs, Karachi and the formulation is sent to the provincial Departments of Agriculture for field trials against the target pests. On receiving the recommendation from at least 2 provinces the license is issued.

Institute	Year of establishment	No. of Scientists	Activity	No.of Publications
Toxicol. & Environ. Protection/ Eco-toxicology Programme, NARC, Islamabad	1987	3	Residues in soil & water Non-target organism studies	6
Pesticide Lab, Chem. Dept. University of Agriculture, Faisalabad	1982	2	Residues in food	8
Total		34		90

TARI - Tropical Agricultural Research Institute
NARC - National agricultural Research Center
PARC - Pakistan Agricultural Research Council

Federal Pesticide Research Laboratories, Karachi

This is the oldest and best established center dealing with all aspects of pesticide research. The Federal Pesticide Research Laboratory was established in 1954 at the Central Department of Plant Protection, later transferred to the Agricultural Research Council (now PARC) in October, 1973 (Baig 1985). Its functions include: i) pesticide analytical service to public as well as the private sector for registration of products under Agricultural Pesticide Ordinance of 1971 for use in the agriculture of Pakistan; ii) advisory service to federal and provincial agencies on matters relating to use of pesticides in agriculture; iii) research on analytical methodology of pesticides, fate of their residues on crop, insect toxicology and interaction between pesticides and soil micro-flora; and iv) integration with international agencies on these matters.

The laboratory has two units. One deals with the quality control and registration and the other carries out residue and metabolism studies. Since its establishment, it has carried out research in the areas of pesticide residue in crop, soil, and human beings, insect toxicology, microbiology, product development formulation and storage stability of pesticides. The number of publications exceeds 147, out of which 50 relate to pesticide residue analysis and quality control. Some of the findings are given in the section on food contamination.

National Institute of Health, Islamabad

The Nutrition Division of the National Institute of Health is running various national programs on almost all the important aspects of human nutrition including child and mother care, nutrition surveillance, fortification programs (like iodine in northern areas) in addition to quality testing of food and feed. The pesticide research at this center started in 1981 with an FAO project on *food contamination study and control in Asia and Far East*. Since then, the pesticide residue analysis in food are carried out from time to time. Another important study conducted by this center was the analysis of food items and human biopsies in Talagang Endrin poisoning incidence in 1984. The details are given in the section on accidental poisoning. Pesticides research is not the major activity of the institute, although potential and facilities do exist. Recently another project entitled "residual effects of pesticides on cotton pickers" has been approved by the Government of Pakistan for implementation during 1994-97.

National Agricultural Research Center, Islamabad

The Toxicology and Environmental Protection section in the Entomological Research Laboratories, NARC, Islamabad was established in September, 1987, with the mandate to; i) determine the effect of pesticides on target and non-target organisms; ii) determine the role of pesticides in environmental pollution; iii) evaluate fourth generation pesticides (viruses, bacteria, protozoa, nematodes, and botanical pesticides) against insect pests; and iv) isolate and identify the sex-pheromones for major insect pests. It has initiated research on the effect of pesticides on non-target organism, human exposure to pesticides and pesticides in the environment. A project on the "Effects of pesticides and fertilizers on shallow groundwater quality" was completed during 1990-91. The findings are given in the section 8a&b. Since 1991, a UNDP sponsored project on Ecotoxicology research has been initiated with the aim of raising its status to a regional center under the Regional Network on Pesticides for Asia and the Pacific (RENPAP).

Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad

The laboratory facilities for conducting research on pesticide metabolism exist at NIAB. The research program includes use of radio-tracer techniques to study pesticide persistence and degradation in soil and follow the metabolism in mammals. These are mostly confined to controlled laboratory experimentation. No quality control or field evaluation of pesticide use is carried out. The salient findings are given in section 8b.

Provincial Institutes

At the provincial level the **Pest Warning and Quality Control of Pesticides** program has not as yet entered the pesticide monitoring service, however, the Punjab Government has established Pesticide Laboratories at Lahore, Faisalabad and Multan. Their principal objective is to check the quality of pesticides being used by the farmers. These laboratories are not carrying out any research on the residues in the environment. At the Plant Protection Institute Faisalabad a full fledged toxicology laboratory has been set-up. These laboratories have started working on the quality control of pesticides.

Role of Private Sector

The Pakistan Agricultural Pesticide Association (PAPA), Karachi founded in 1968, is the national trade association marketing agricultural pesticides in Pakistan. It represents, at the national level the companies which market more than 90% of the country's consumption of pesticides. PAPA pools the technical knowledge of the national and international organizations and disseminates it to the farmers. Its members also promote, through training courses, demonstration and field days, the safe formulation, handling, packing, transport and use of pesticides, set high safety standards in conformity with international standards.

Private companies in Pakistan have recently established an Insecticide Resistance Action Committee which has initiated a research project in collaboration with the University of Agriculture, Faisalabad, to study the level of resistance to insecticides in American bollworm and cotton white fly. As discussed later, the disaster in cotton crop through leaf curl virus disease may have been caused by the failure to control whiteflies (a vector of virus) which have developed resistance to insecticides.

Food Contamination by Pesticide

Ingestion of pesticides through contaminated food supplies is a cause of concern for almost every one. This was most serious at the time when persistent insecticides, (organochlorines)[6] were commonly used on crops. There are many examples of pesticide poisoning through food (Hayes 1982). In Pakistan, very little information is available on the subject. The few notable programs/surveys which have so far been completed are briefly discussed below.

Between 1978-85 the federal pesticide research laboratory at Karachi conducted studies on food contamination. In all these findings DDT was the only pesticide monitored. In the first instance, the pp'DDT under semi-field conditions of 5-7 sprays was found to be 0.8-1.3 ppm in cotton seed oil. Moreover, the cotton seed oil from aerial sprayed cotton contained 0.18-0.92 ppm of DDE an isomer of DDT. These values were below the FAO/WHO limits of 0.5-5.00 ppm for DDT and isomers, like DDE. These experiments were carried out about 15 years ago when DDT was used abundantly. After processing of cotton seed oil a further decline in DDT is expected. The study was inconclusive as it did not investigated market products i.e., vegetable oil and `ghee' manufactured from cotton seed oil (Baig 1985).

The federal pesticide laboratory has a continuous programme of assessing market food produces for contamination by pesticides and the results are periodically published in various journals. Such dissemination of the findings means that hardly any notice is taken and the decision whether to continue or discontinue the use of a particular pesticide rests with either voluntary withdrawal on the part of the company or through a government directive but not public reaction. These actions are based on the information generated in the other countries. If the laboratory is linked (through a working relationship) with the Environmental Protection Agencies then it might perform a more useful function. A survey by Masud and Hasan (1992) on 59 different fruit and vegetables procured from wholesale market of Karachi during July 1988 to June 1990 revealed that out a 250 samples screened, 93 samples were contaminated with a variety of pesticides. Forty five samples were found to contain residues above the maximum residue limit (MRL's) proposed by FAO/WHO. This kind of study is most useful to draw our attention towards the dangerous state of our food. However the way it was conducted it falls short in isolating the source of contamination whereby some legal or other remedial actions could be taken. This is true for the other survey conducted by NIH (1984) as well, since the market sample is a composite sample and the origin is unknown so the source of pollution cannot be located. For that matter, a detailed and continuous monitoring programme is required. With stringent international legislation prohibiting import of contaminated food and fibre items monitoring and reduction in the use of pesticides becomes even more essential.

6. The insecticides are classified into four major groups or classes. First and foremost is the class of persistent organochlorines. DDT, BHC, Dieldrin are the famous insecticides belonging to this class. Organophosphorus insecticides are the other major group. These are less persistent and their primary mode of action is on the nervous system mainly inhibiting the acetyl cholinesterase enzyme. Malathion, methyl-parathion, diazinon, endosulfan, dimethoate, chlorpyrifos, monocrotophos, are some of the important members of this class. The third group is carbamate insecticides, based on the carbamic acid. The most recently developed and least persistent of these insecticides belong to pyrethroids which are derived from the chrysanthemum. In addition to the natural group of insecticides collectively called pyrethrins some synthetic pyrethroids are also available in the market. Cypermethrin, deltamethrin and fenvalerate insecticides available in Pakistan belong to this class. These insecticides have quick knock-down effects and are most commonly used against flying insects (e.g., as aerosols for the control of household insects like flies, mosquitos, etc.).

Under the auspices of FAO a comprehensive study on food contamination and control was carried out during 1981-84 at the National Institute of Health, Islamabad. Four major areas studied were pesticide residues, metal contaminants, aflatoxins, and microbial contaminants. The reported results (NIH 1984) on pesticide residues revealed the presence of 23 out of 25 pesticides tested but to a varying degree. The food samples were collected from local markets and grouped in 6 different categories: (1) dairy products, (2) meat, fish and poultry, (3) grain and cereal products, (4) vegetables, (5) fruits, and (6) oil, fats and shortenings. To overcome some practical problems, particularly for reducing the number of samples to manageable limits, samples of produce collected from various localities were pooled. This had two implications; firstly there was a dilution of the pesticide residues by combining contaminated and pesticide free samples ; secondly it was difficult to ascertain whether the contaminant originated from a particular locality or was present in all the samples. A brief summary is given in the Tables 6-7.

Table 6: Pesticide Residues (μg/Kg) in meat, fish, poultry, dairy products, oil and fats

Commodity	HCH	BHC	DDE-	DDT-pp'	DDT-op	Aldrin pp'	Dieldrin	Endrin	Methyl parathion	Malathion
Poultry	94	83	720	277	632	Traces	253	-	348	-
Eggs	7	11	194	23	143	-	19	-	82	-
Mutton	57	31	607	97	205	-	95	-	942	-
Beef	54	51	961	234	241	-	160	-	537	-
Milk	120	44	473	Traces	180	-	137	Traces	323	-
Butter	42	Traces	298	318	484	-	474	Traces	318	905
Cheese	32	39	284	75	118	-	77	-	145	-
Oil (Veg.)	-	-	194	82	218	-	99	-	120	-
Oil (Veg.) Hydrogenated	69	4	189	8	112	-	81	-	286	-

Heptachlor, DDD-op, Ethion, Endosulfan and Diazinon were not found in these samples.
Data Source: NIH, (1984).

The salient findings included the fact that organochlorine insecticides were found in all 48 composites. Correspondingly organophosphorus residues were present in 45 (94%) composites. Malathion was found in 5 (10%) of the composites. Diazinon residue were found in only 3 (6.25%) of the composites. Among the organochlorine residues, heptachlor epoxide was found in 3 (6.25%) of the composites. Endosulfan residue was found in only one composite. Residues of DDD-pp' and ethion could not be detected. Endrin, a banned product, was detected in vegetables.

Studies conducted at the University of Agriculture, Faisalabad during 1981-1984 were of an academic nature but very useful in the sense that they provide guidelines for the use of insecticides on important vegetable crops, by way of showing persistence in crops and adverse affects on mammals. According to Ilahi, (1985) 35% market samples of cucumber showed Endrin ranging from 304 to 669 pg/100 g. Similarly 42% okra samples collected from local market and Endrin residues ranging from 243 to 629 pg/100 g. The presence of Endrin in market samples indicated that even after the ban on the use of Endirn, it somehow was reaching the farmers, may be from the old stocks held by the suppliers. However, with the passage of time it is likely to vanish.

Table 7: Pesticide residues (µg/Kg) in cereals, vegetables and fruit

Commodity	HCH	BHC	DDE-pp'	DDT-op	DDT-pp'	Aldrin	Dieldrin	Endrin	Methyl parathion	Malathion
Wheat	22	34	38	48	102	19	20	-	-	-
Rice	13	16	34	19	30	-	10	-	80	-
Maize	13	21	30	50	90	-	24	-	120	1416
Gram	153	21	27	12	25	4	16	-	48	10
Mong	144	14	37	16	27	-	10	17	88	-
Mash	22	30	39	20	41	23	9	44	124	-
Masoor	14	25	48	52	105	-	16	-	154	-
Potatoes		1	1	13	3	5	-	5	-	13 -
Tomatoes	3	3	13	4	4	-	4	-	6	-
Onions	6	-	13	3	4	7	-	20	8	-
Radish	1	-	14	5	10	-	13	67	12	-
Carrot	2	4	24	8	17	25	5	20	4	15
Fresh Beans	8	5	20	6	30	-	8	-	14	-
Spinach		5	3	40	200	30	-	5	-	10 -
Pumpkin, Cucumber	3	3	26	12	20	-	11	-	20	-
Peas	4	2	15	5	12	Traces	12	4	25	-
Apricot	7	3	22	8	6	-	12	-	44	-
Mango	7	3	9	3	3	-	8	-	18	Traces
Oranges		3	3	16	6	7	-	9	-	30 Traces
Apple	3	2	12	4	Traces	Traces	10	-	17	-

The following insecticides were found only in some products.

Heptachlor	Wheat	Traces	Endosulfan	Gram	Traces	Diazinon	Wheat	32
	Gram	Traces		Carrots	10		Gram	Traces
	Lentil	14					Peas	20
	Radish	3					Onions	450
	Pumpkin	Traces						
	Onions	10						
	Oranges	Traces						

Source: NIH (1984), Ilahi, (1985).

Human Exposure to Pesticides

When misused the pesticides can be more harmful than being beneficial. Since these are poisons, exposure of humans can be fatal or with deleterious consequences. The exposure can intentional or accidental. Survey of acute poisoning among agricultural workers in four Asian countries by Jayaratnum et al. (1987) revealed organophosphate compounds to be mostly responsible for poisoning. The pesticide poisoning in Malaysia was 53.6% (out of total poisoning cases), in Sri Lanka 69.1%, In Thailand 27% with organophosphate insecticides (OPIs) and 25% with bipyridyls. In Indonesia copper compounds were responsible for 23.4% of cases and OPI for 17.8%. In Afghanistan overall mortality rate was 6.2% due to accidental poisoning among children, OPI poisoning alone was responsible for 50% of total death (Chaudhry et al. 1987). The symptoms of commonly used pesticide poisoning are described by Jabbar (1992). General information is given in Annex IV.

Side-effects of pesticides on human health

In Pakistan, the information on side-effects of pesticides is very scarce. Only few reports are available. Within them sometimes the details of methodology are not given. Although these may not be quite representative, however, here the findings have been reproduced to give the reader some feel of the current state in this area. This also calls for an in depth study of the pesticide poisoning problem. A pilot survey for side-effects of pesticides experienced by the farming community was conducted in the districts of Bahawalpur, Rahim Yar Khan and Sahiwal by Jabbar and Mohsin (1992). A sample of 43 individuals (22 males and 21 female workers) were selected randomly and interviewed. Males were associated with the application of pesticides whereas the females with picking of cotton. Male ages range within the sample was from 24-65 years whereas the age range of females was between 18-55 years. 81 % were married and 19% were unmarried. According to village life standards 95% said that they enjoyed good health. 77% responded affirmative to the question of experiencing any health risk or side-effects. 16% had blisters on the skin, 42% experienced vomiting, 49% had headache, 26% complained of itching or allergic reactions, while 10% experienced other side-effects like depression, diarrhoea, over the last 10 years, occasionally reoccurring. The children ranged upto 11 per family, however, no visible effect on children were evident.

Female cotton pickers hardly get any medical treatment for any ill effects arising out of contact with pesticides. This is generally true for other ailments as well that females seldom go to doctors and paramedics. The male community does consult the medical staff. 45% pesticide applicators did receive medical treatment or advice. In villages where "doctor" includes experienced para-medic staff, about 27% applicators sought advice from them. 86% males claimed to be aware of the side-effects of pesticides. However, 86% female cotton pickers, on the other hand, had no information on the side-effects. 82% male applicators were taking precautionary measures whereas 95% females interviewed said that they were not taking any precautionary measure. This fits well with their level of awareness and extent of consulting and medical advice. The lack of education in the female population and the unavailability of trained female practitioners in the rural areas are likely to be the main causes of this disproportionate precautionary measures by gender.

The studies by Masud and Baig (1991) at Multan have shown that out of a total of 88 female cotton pickers, only 1% could be termed as out of danger, 74% had blood acetylcholine esterase[7] (AChE) inhibition between 12.5-50%. 25% were in dangerous conditions where blood AChE inhibition was between 50-87.5%. Out of 33 male cotton workers studied, it was revealed that 12% could be ranked out of danger, 51% had blood AChE inhibited between 12.5-50% and 36% were dangerously exposed (i.e. AChE inhibited to between 50-87.5%). Although the situation of the cotton workers at Central Cotton Research Institute, Multan was slightly better with about 28% male and female workers out of danger, but this is far from being satisfactory. Here again 57% of the female workers had their AChE inhibited to between 50-87.5%.

The investigations at Pakistan Medical Research Council Multan Center during 1987-88 have shown that out of 100 cases (96 men and 4 women) handled at the center, organophosphorus poisoning was predominant. Adverse effects were mainly on the respiratory center and central nervous system. One case died of respiratory failure due to endemic poisoning.

7. Acetylcholine esterase enzyme detoxifies acetylcholine, a neurotransmitter. By virtue of having similar structure organophosphate insecticides bind irreversibly to this enzyme, rendering it unable to detoxify acetylcholine. An inhibition to level 30% of normal activity has lead to fatalities. Such inhibition of AChE has often been use asindicator of exposure to organophosphates.

Pesticides Residues in Human

One of the characteristics of the organochlorine pesticides is to accumulate in the fat tissues of the body. It is a matter of great concern to note the presence of pesticide residues, particularly organochlorines, in human tissues. In a study conducted in Karachi area by Mughal and Rehman (1973) more than sixty samples of human adipose tissue from the general population were analyzed for chlorinated compounds by colorimetric and chromatographic procedures. The average level of total DDT-equivalent was 25 ppm, total benzene hexachloride (BHC) was 0.48 ppm, and dieldrin was 0.047 ppm. Values varied widely and the frequency distribution was positively skewed. The tendency towards lower concentrations in females was due, perhaps, to their greater fatty pool distribution of residues. The concentration of p,p'-DDD, an intermediary of DDT metabolism, was definitely higher in autopsy as compared to biopsy material due, probably, to post-mortem anaerobic microbial metabolism.

Krawinkel et al. (1989) conducted a survey monitoring the organochlorine concentrations in human blood (25 samples) and fat tissue (20 samples) of patients of the Sandeman Provincial Hospital in Quetta, Baluchistan (Table 8). The results of the analysis for Hexachlorocyclohexane (HCH) isomers, 4,4'-dichlorodiphenyl-trichloroethane (DDT) and 4,4'-dichlorodiphenyl-dichloroethane (DDE) showed that there is a great range of interindividual differences whereas the HCH- and DDT/DDE- values each are concordant in the individual samples: probands with high concentrations of DDT/DDE in blood also have higher levels of DDT/DDE in fat tissues. High levels of DDT are associated with high levels of DDE. The concentrations of pesticide-residues was not correlated with age or sex of the patients.

Table 8: Median and maximum levels (µg/l) of chlorinated hydrocarbons in blood and fat tissues in Quetta and West Germany.

		Blood		Fat tissue	
Pesticide		**Quetta**	**W.Germany**	**Quetta**	**W.Germany**
4,4'-DDT	Median	0.61	0.13	0.87	0.09
	Maximum	4.83	0.38	10.10	0.42
4,4'-DDE	Median	8.58	2.40	4.76	0.90
	Maximum	32.61	6.50	81.83	4.30
α-HCH	Median	0.08	0.004	0.06	0.002
	Maximum	1.88	0.018	4.08	0.035
ß-HCH	Median	1.39	0.33	0.89	0.13
	Maximum	6.05	1.70	21.05	0.40
r-HCH	Median	0.29	0.035	-	0.005
	Maximum	0.56	0.31	0.42	0.27

Source: Krawinkel et al. (1989)

Krawinkel et al. (1989) further observed that except the median for r-HCH in fat tissue, the median concentrations of all pesticides are much higher in Quetta than in Germany. Hexachlorobenzene is another important insecticide of this class. No measurable concentrations could be found in the samples from Quetta, and so is not given in Table 8. HCB is not applied locally and the global spread of HCB in the air alone does not cause a contamination of human blood and fat tissue as it could be suspected from the findings of other investigators (Schauerte et al. 1982).

Farvar (1975 cf Krawinkel et al. 1989) reported that in 1970, in rural areas of Guatemala, where DDT spraying for malaria control had been carried on for some fifteen years, total DDT in human mother's milk was found to be from 0.3 to 12.2 ppm. These figures suggest that Guatemalan infants feeding on breast milk were ingesting at least 15 and perhaps nearly 500 times more than the 'acceptable daily intake' of DDT established by the World Health Organization. Iranian samples of human milk obtained from areas sprayed by malaria eradication teams showed DDT concentrations of 0.4 to 2.5 ppm, which is 8 to 50 times higher than the permitted levels in cow's milk sold in the United States.

Residues in Goat Milk

Generally the human and animal bodies have mechanisms which destroy the xenobiotics or excrete them. However, some of these toxins, like pesticides, are absorbed into the circulatory system and retained by the body. The scientists at NIAB, Faisalabad conducted research with radiolabelled insecticides focusing on their accumulation in animals. These laboratory studies (NIAB 1987) have indicated that 50% of the fed monocrotophos to lactating goats was excreted in urine and 7% in faeces. Two percent was found in milk and the rest retained by various body organs and muscles. Milk samples fortified with monocrotophos were subjected to processing similar to industry. Monocrotophos was found to accumulate in fatty products. Residue enrichment declined in following order: butter > cheese > cream > khoya > curd > whole milk > skimmed milk.

Occupational Exposure to Pesticides

In the absence of a monitoring program, it is very difficult to comment on the adverse effects of pesticides on the health of the workers associated with the industry. Some cases of occupational exposure reaching accidental level have been cited by Baloch (1985).

A sample of 200 employees of the Department of Plant Protection, associated with the flying and engineering unit of their aerial section, was surveyed for cholinesterase activity in their blood. It was observed that nearly 50% of them possessed low enzyme activity (Rahman 1982).

In 1976, an epidemic of poisoning due to water-wettable powder of malathion occurred among 5,350 spraymen, 1,070 mixers and 1,070 supervisors in malaria control programs in Pakistan. During the entire epidemic there were five deaths, but these occurred before a special study began. Three brands of malathion were in use which differed substantially in (a) toxicity to rats, (b) content of isomalathion and (c) the degree of inhibition of cholinesterase produced in spraymen who applied them. Elimination of the use of two more toxic preparations, and special instructions on proper safety measures halted the epidemic (WHO 1979).

Accidental Poisoning Incidence

The examples of accidental pesticide poisoning around the world are innumerable but in Pakistan there is a lack of scientific knowledge on the subject. Most events appear as reports in the press which need verification before acceptance and quotation. Anyhow, concerns even seemingly unimportant need to be taken seriously.

A major poisoning accident occurred in Multan in 1972 when workers with improper clothing, unloading a consignment of phorate under extreme summer conditions became ill and seven of them died (Baloch 1985). In the summer of 1984, an epidemic of endrin poisoning occurred in Talagang, District Attock. Acute convulsions were recorded in 194 affected persons in 18 villages. Seventy percent of the reported cases were in the children of 1-9 years of age. Nearly 10% (19 out of 194) patients died. The epidemiology of the Talagang outbreak suggested that a shipment of sugar was contaminated en route to the city (Rowley et al. 1987).

Pesticides in the Environment

Contamination of groundwater

Agricultural activity based heavily on the usage of pesticides to increase crop yields has proved to be a potential source of groundwater contamination. The study by Ali and Jabbar (1991) revealed that the shallow groundwater in Samundri area drawn from a depth of 30-40 feet is contaminated with pesticide residues (Table 9). Monocrotophos was detected in the range of 0.04 to 0.06 ppm, cyhalothrin in the range of traces to 0.0002 ppm, and endrin is present in the range of 0.0001 to 0.0002 ppm. Although these amounts are within the WHO safety limits, however their accumulation in groundwater over the time is a serious danger.

Table 9: Pesticide contamination of shallow groundwater

Insecticides	No. of samples*	Range (ppm)	Average (ppm)
Monocrotophos	3	0.04-0.06	0.05
Cyhalothrin	4	Traces-0.0002	0.00005
Endrin	3	0.0001-0.0002	0.00017
Non	3	---	---

Source: Jabbar et al. (1993).
Note: * = Water was drawn from hand-pumps at 10 different sites.

The only report on drinking water contamination in Pakistan focuses on cattle drinking water in Karachi (Parveen and Masud 1987). These authors analyzed 79 samples. The study revealed contamination of ten samples with chlorinated pesticides or their metabolites. Six samples were found to contain r-BHC in the range of 1.0 to 16.4 ppb, one contained p,p'-DDT in traces. In two samples p,p'-DDE was found to be present in traces. Aldrin and dieldrin were present in one sample in quantities from 2.0 to 31.5 ppb, respectively.

Contamination of soil

The persistence of pesticides in soils is another major concern. Studies on the pesticide residues in the soil and environment have always lagged behind due to financial constraints and the lack of proper laboratory facilities. However, the ones which have appeared are cited below. The Federal Pesticide Laboratories, Karachi is continually monitoring pesticides in food commodities and the environment and a detailed report appeared in 1985. In these studies by Baig (1985), random sampling of soil from agricultural areas of Punjab and NWFP where DDT was in use for decades was undertaken. Upto 5.77 ppm of DDT was present in the cotton growing areas of Multan, upto 0.6 ppm in the rice fields around Kala Shah Kaku and 0.2 - 0.59 ppm in sugarcane and tobacco fields of NWFP and in the orchards of Bhalwal. These levels of DDT were a potential danger to soil micro-fauna, however, these were not considered to be a matter of great concern as far as groundwater contaminants.

At the Agricultural Research Institute, Tarnab Peshawar, the tobacco nurseries were treated with DDT and analysis of crop leaves at 39 days after treatment revealed DDT at the 2.5 ppm level. These levels were quite high consequently the use of DDT on this crop was banned in 1976. Similarly, it was found that after 10 days of aerial spray of the paddy crop in Baluchistan DDT residues diminished by 85% and 39% in straw and pinnacles, respectively, while an 18% increase occurred in the soil. There was a decline in DDT in the edible portion to much lower than tolerance limits for paddy posing no direct hazard to humans. However, accumulation in soil was not thought dangerous until there was accumulation in water.

The soil of Samundri in the cotton growing area is contaminated with pesticide residues (Table 10). Monocrotophos is detected in the top 1 foot soil in the range of 0.3331 to 0.6429 ppm. Cyhalothrin is present in the top 1 foot in the range of traces to 0.1932 whereas dimethoate was detected at one site at a concentration of 0.3858 ppm. The pyrethroids fenvalerate, cypermethrin and organophosphate profenofos are present in traces in the top 1 foot layer. The organochlorine insecticide residues of aldrin, dieldrin, endrin, p,p'-DDT and its metabolites p,p'-DDD and p,p'-DDE are detected in the lower 2 to 3 feet layers of the soil. Their concentrations varies from traces to 0.0096 ppm. In fact all the studied soils have been contaminated by varying amounts of different pesticides residues. As the most recently used insecticides were not found in the lower depths of the soil, the analysis was not further carried out.

Carefully controlled studies by Hussain and his group (1988) at the Nuclear Institute for Agriculture and Biology, Faisalabad using sandy loam soils have indicated that most of the applied DDT is retained by the top 5 cm layer. Movement down to 10 cm and 15 cm is very slow. This may be due to the fact that DDT is water insoluble. However, their important finding was that the half life dissipation for DDT in the laboratory was 890 days but under field conditions the half life was 110 days in irrigated and 112 days in rainfed soils. This trend is in conformity with other tropical and sub-tropical countries and suggests that DDT is degradable. Due to their lipophilic nature, organochlorine insecticides accumulate in fat tissues of animals and are released in situations of fasting or pregnancy. However, the situation in the soil is different from that of the tissues. Here, in the absence of O_2, these molecules are broken down through microbial activities.

Table 10: Pesticide residues (ppm) in farming land*

Insecticides	**No. of sites**	**Depths (feet)**		
		1	**2**	**3**
Monocrotophos	2	0.3331-0.6429	-	-
Cyhalothrin	2	Traces-0.1932	-	Traces
Dimethoate	1	0.3858	-	-
Fenvalerate	1	Traces	-	-
Profenofos	3	Traces	0.0007	-
Cypermethrin	2	Traces	-	-
Aldrin	4	-	0.0013-0.0018	0.0004
Dieldrin	4	-	0.0031-0.0096	Traces-0.0103
Endrin	3	-	0.0002-0.0006	Traces-0.0004
p,p'-DDD	3	-	Traces-0.002	Traces
p,p'-DDE	4	-	Traces-0.002	0.001-0.0037
p,p'-DDT	2	-	Traces	Traces-0.0002

Source: Jabbar et al. (1993).
Note: * = Soil samples were collected from 5 different sites.

Herbicide usage in Pakistan has gained momentum very recently and will further increase with the adoption of zero-tillage[8] technology in rice-wheat cropping system. This poses a dual problem i.e., i) it has a direct adverse effect on the soil microfauna and ii) it is a threat to the groundwater supplies. The laboratory studies at weed sciences program, NARC, during 1989-90 have shown that Diuron and Metametron leached down to 20 and 27 cm, respectively, in 24 hours after the application of water equivalent to 5" of rainfall. The herbicides are fairly water soluble. Extensive or long term use in fields may pose problems where groundwater tables are very high or the flushing of soil occurs.

8. Zero-tillage means sowing crop in undisturbed soil, i.e. without ploughing or land preparation.

Breakdown of organic pesticides in soils beyond that involving reactions with water is attributed to micro-organisms and catalytic effects of soils (Pratt 1985). Pesticides such as dalopon, 2,4-D, malathion and parathion that breakdown rapidly (50% decomposition in 2 weeks or less under favourable conditions) are not likely to be detected in groundwater. Some organic pesticides such as DDT and dieldrin decompose very slowly and may persist for years. These pesticides, however, are not of concern as groundwater contaminants from agricultural use because they are relatively insoluble in water and are retained strongly by soils. The uptake in plants and translocation to edible portions is serious.

The decomposition (loss of 75 to 100% of the biological activity) of different classes of pesticides in the soil varies. Studies under agricultural conditions with normal rates of application have shown various organophosphate and carbamate insecticides to persist for 1-12 weeks, herbicides from 1-18 months and chlorinated pesticides from 2-5 years. Tinsley (1979) noted that the 50% decomposition times for certain pesticides increased in the following order: malathion< 2,4-D< diazinon< atrazine< diuron< DDT. He further observed that depending upon experimental conditions, wide differences in absolute values were found. For example, the 50% decomposition time for DDT was 240 days in a tropical environment, 3840 days in a temperate environment and 33 days in a laboratory test done in the absence of free oxygen. The 50% decomposition times were greater when measured in subsoil samples than in surface soil samples, presumably due to lesser microbial activity in sub-soil samples.

The above mentioned studies in the Samundri area draw attention towards the facts that persistent organochlorine pesticides had moved downwards in the soil and even after the stopping of usage in agriculture some years ago, these still exist in the root zone. These pesticides may be taken up by crops and hence turn up in food chain. This is in addition to their constant threat to soil micro fauna. The recently developed pyrethroids with a shorter half life which are supposed to vanish from the environment in a few days, were detectable even 10 months after last sprays. Although the quantities detected in shallow groundwater were within the WHO acceptable limits, but if their use is continued at the same level it won't be long before our water supplies will be unfit for consumption. The increase in the use of herbicides is of concern for the following reasons: firstly because these are directly taken up by the plants (Breeze 1988); secondly, most of herbicides are water soluble and would easily leach through the soil (Pratt 1985); and thirdly, the soil microfauna will be affected to a great extent (Vickerman 1988). It is very important that the ecologists and biologists to highlight the damage which has already been done to the ecosystem.

Measures for Reduction of Pesticide Usage

Integrated pest management

In Pakistan, insecticides and herbicides are among the inputs that have been considered essential to the sustainability of agricultural systems. But it has been observed that farmers under 20 hectares use only half the quantities per hectare that larger farmers apply. This heavy reliance of large farmers on chemical pesticides may indicate a greater acceptance of western agricultural practices, but these practices have become obsolete in West. The current approaches to plant protection in the West and in Southeast Asia involves integrated pest management (IPM) (Hansen 1988). This involves use of the smallest possible amounts of chemical pesticides, and only after it has been found that all alternatives are inadequate.

Current agronomic practice looks to plant protection through crop breeding, management practices, and biological controls, which in turn involves harnessing the natural predators of the crop or plant pest either to appear on its own accord or to be introduced by release. On their own, such methods have yielded variable results. When incorporated as part of an overall approach to pest control, however, they have been shown to be highly cost effective (Hansen 1988).

A major concern among farmers is the declining effectiveness of chemical pesticides as insect resistance increases through natural selection. This has been demonstrated in many developing countries. Pesticides such as dieldrin, aldrin and DDT are harmful because they destroy beneficial insects and birds that serve as natural predators of crop and plant pests. The replacement pesticides are inevitably more expensive. As a result, farmers in industrial countries, at least where subsidies are low, tend to look for cheaper and relatively safer alternatives. Fourth generation pesticides (microbes, botanical, pheromones, etc.) are becoming popular because they seem to cause little damage to the environment.

It is ironic that Pakistan seems to be turning to greater use of pesticides just as others are abandoning it (section 3). The encouragement for this is even more ironic, bearing in mind that many of the chemicals being used in Pakistan are those long banned in the West. Unscrupulous traders and dealers intent upon disposing of surplus stocks of banned chemicals have offered unsuspecting farmers irresistible bargain.

The experience gained through development increasing adoption of integrated pest management systems throughout the world leads directly to a strong NCS policy - namely, minimization of the use of synthetic pesticides, insecticides, and herbicides. Proposed measures in support of this policy are two-fold: first, the adoption of integrated methods for controlling pests, based on biological and cultural methods that include the judicious use of approved and appropriate chemicals; second, a ban on the import of all pesticides that are themselves banned in their countries of origin or manufacture.

In industrialized countries and in most places where intensive farming practices have been adopted, reductions in biological diversity have been brought about by the overuse, misuse, and abuse of synthetic chemicals. However, as important has been the pursuit of monocultural cropping on a wide scale, a significant reduction in the use of rotational management practices, a decline until recently in the use of organic manures and - above all - the wanton destruction and mismanagement of wildlife habitats.

In Pakistan the NCS (1992) has also highlighted the problems posed by the use of pesticides and suggested promotion of IPM to protect the land and water resources from the contamination by the overuse of pesticides. The pest problem and the solution phenomenon is not new to Pakistan. Various efforts have been going on. The department of plant protection, Government of Pakistan, and the Pakistan Agricultural Research Council carried out a number of projects on pest management. Departments of Entomology in agricultural universities also participated in the efforts. Most of these efforts concentrated on single pest problems and a single pest control approach with little regards to the other components. The International Institute of Biological Control (IIBC), PARC Rawalpindi is the only institute in the country promoting biological control. In addition to identifying and cataloguing the natural enemies of various pests in Pakistan, it has introduced the egg parasite of sugarcane pyrilla in Sindh, and also applied pheromone eugenol for trapping fruitflies. The biological control is also a single pest control approach which is successful in very stable ecologies. The increasing awareness of the complexities and associated environmental problems of reliance on synthetic chemicals have drawn attention towards the development of IPM. An IPM approach is a decision making process in which various components are applied in sequence i.e. from natural to cultural to biological to chemical control depending upon the pest infestation and time critical for taking pest management measures. Currently two major projects are in operation. One is the IPM component of Agricultural Research Project II, a World Bank assisted project costing Rs. 57 million for 7 years. The other developed by Pakistan Agricultural Research

Council and provincial projects on IPM worth 112 million has been included in NCS implementation plan for 1993-98.

Large scale biological pest management would include mass rearing of parasites and predators for release in infested fields. Such facilities do not exist for the majority of insect pests. The other facet of natural pest management depends upon the use of plant derived antifeedants and growth regulators. These are supposed to be less harmful to the ecosystem. These offer new hope to plant protectionist in managing the pests with natural products. The work on the botanical pesticides is currently being conducted at three centers. The Tropical Agricultural Research Institute (TARI) and the Nuclear Institute of Agriculture and Biology, Faisalabad are currently looking into the use of plant material for the control of insect pests of stored grains viz wheat, rice and maize. The activity is partly supported by USAID. A three year scheme on the three plants *Acorus calamus, Annona squamosa* and *Curcuma longa* for use as stored grains protectants is underway at PMRI Karachi. Substantial amount of work has been carried out on Neem at Tropical Agricultural Research Institute (TARI), Karachi and HEJ Institute of Chemistry, Karachi. Some similar work is also underway at NARC (Anwar et al. 1992). Large scale plantation of Neem tree has been initiated by PARC under the Productivity Enhancement Program. Neem has a lot of potential as biopesticide. The use of neem products (especially azadirachtin) as a pesticide is encouraged in America, Germany, UK. and some Asian countries. A considerable amount of research is undergoing in India. UNDP has established a regional center in Thailand to develop plants (neem) based insecticides. Neem is one of the issues in biodiversity prospecting, where the rights of the exporting and importing countries are in conflict, and is very much in the debate on free trade agreement (PAN 1994).

Like most development projects in Pakistan, pest management has been a government responsibility, with little attention paid to the technologies suited to small farmers. Given that chemical control is a multimillion dollar business with vested interests, the small farmer approach does not count. Environmental degradation was never a concern. In industrialized countries the cost to redo the damages caused by agrochemicals run into billions of dollars. In Pakistan the question is virtually unattended. Public awareness is increasing and many more articles are appearing in media drawing attention towards dangers posed by these chemicals. Usually pesticides are projected as medicine for pest and disease cure. These are never depicted as poisons, how-so-ever safe these may be. Worldwide movements like Greenpeace have been very active in generating resistance to production and dumping of toxic wastes in developing countries. In Pakistan also some NGOs have started campaigning against the overuse of such chemicals. Unless there is pressure from public, shift towards safer alternatives may never become reality. A stronger public participation is required. Organic and natural farming need to be promoted. Tolerance of losses in crop produce to certain extent should be allowed. For that matter Economic Threshold Level (ETL) need to be redefined. Mix cropping and crop rotation may also help establishment of natural enemies and alleviate the need use of chemicals.

The Ecotoxicology Research

A number of consultant reports for improving environment related research in Pakistan have appeared over the years (Sadar 1981, 1986; Schwass 1986 a, 1986 b; and Anonymous 1986) but their recommendations are still far from being implemented mainly due to lack of finances. The need for an institution with appropriate set up for monitoring environmental aspects of pesticides is felt even more these days. The information on fate[9] of pesticide in the environment is a pre-requisite for the registration of any pesticide. It should include fate in soil, water, air, stability, side-effects on non-target organisms, and beneficial insects, soil and aquatic

9. Pesticides when applied may have direct effect on the target or non-target organisms. However, these also persist in the environment until degradation or broken down by the natural/biological processes. Sometimes these breakdown products/metabolites are more dangerous and harmful than the original compounds.

organisms, and mammalian toxicity including dangers to human health. It is unfortunate that there is no establishment which can generate such information. At the moment all of the pesticides are either imported as finished products or locally formulated from imported active ingredients, hence data obtained in the original country is accepted by default. Although the behavior of pesticide may vary given different environment , in accepting the alien data there is a danger of overlooking the potential hazards to local ecosystem.

A report (Calderbank 1988) has suggested the establishment of an ecotoxicology center. The objective is to develop an organization, laboratories and necessary expertise to measure and monitor environmental pollution due to pesticides in Pakistan. Once established, such facilities and expertise could be extended to monitor the impact of other potential pollutants on the environment of Pakistan. In 1991 such a laboratory started functioning at the NARC with a staff of 7 scientists, who are as yet undergoing training process. Support staff and infrastructure has yet to be provided. Similarly the Toxicology laboratories at Plant Protection Institute, Faisalabad are under construction.

Pressing Problems in Pest Management

Leaf Curl Virus Disease

Whereas a large part of success of plant protection has been attributed to the use of insecticides, the long term hidden risks involved need to be confronted. Studies at Faisalabad University have indicated the development of resistance in insects. It is observed that the resistance in *Heliothis* and cotton white fly in field crops and many stored grain insects *Tribolium, Rizopertha* has reached a stage where plant protectionists are very concerned, given the spread of cotton leaf curl virus disease. There is a close link between dryer 1986-87 seasons which favored cotton white fly population increases (Ahmed 1988), subsequent development of resistance in this insect and the outbreak of cotton leaf curl virus disease in 1991. This affected an area of 30,000 acres in 1991 and spread to 300,000 acres in 1992 with substantial loss to cotton yield. The current cotton production estimates (7.6-8 million bales) are insufficient for local cotton industry demands. The cotton price, trading at Rs. 900/40kg has already surpassed Rs. 2000/40kg. So will be the price of cotton cloths in the coming season. The loss of export market and foreign exchange (~ Rs. 15 billion) are other serious blows to our economy. The research at NARC has shown that cotton white fly is the vector of this virus disease and even a single white fly can transmit the virus (Hashmi et al. 1992). In this situation the economic threshold level of 5 white flies/leaf is so high that every plant protection measure initiated so far has failed. The scientists have to go back and rethink the whole phenomenon and select resistant varieties and apply other techniques (crop rotation, leaving land fallow as practiced in Sudan) to get rid of this menace.

Banana Bunchy Top Disease

The failure of plant protection in banana was observed when inspite being visible the indicator signs were ignored and no concrete measures were taken. This happened between 1990-92 with the banana bunchy top virus disease (Somroo et al. 1992). This has resulted in massive economic loss to the country. This virus was first observed in Pakistan in 1988, and was identified in 1991. This disease is mainly concentrated in Sindh and has totally destroyed banana crops in Badin and Mirpur Khas districts. Crops in Hyderabad, Sanghar, Nawabshah and Thatta districts were severely damaged. Now this crop has to be uprooted from the infected areas and will have to be replaced with resistant varieties or virus free varieties being produced by PARC through the tissue culture.

Sugarcane Plant Hopper (Pyrilla)

Sugarcane plant hopper (*Pyrilla perpusilla*) is causing substantial damage to the sugarcane crop in Sindh. An annual loss of ~ **6%** in crop production (worth Rs. 300 million) is anticipated. Spraying pesticides is the most favored option, as evident from the fact that during 1991-92, 90.2% of the sugarcane crop received ground spray and 9.5% was aerially sprayed. In recent years, the efforts of Pakistan Agricultural Research Council, have been on biological control. Egg parasite (*Epipyrops*), a natural enemy, has successfully been introduced to control (*Pyrilla*) in Al-Noor Sugar Mills, and Habib Sugar Mills, Sindh. This practice needs to be promoted in other areas as well.

Rice Insect Pest Complex

Yellow rice stem borer, white backed plant hopper, and leaf roller are major pests of rice. To control the rice insect pests, the Government of Punjab during 1991 carried out aerial spray in rice areas. There was mixed reaction to aerial spraying. During 1992 the Government of Punjab again publicized its intention of aerial spraying. An unpublished report of PARC revealed that the farmers did not buy pesticides and dealers did not stock it either. Later the Government dropped the idea of aerial spray for different reasons including the danger to the ecosystem. At the time of insect attack, the pesticide was not immediately available, and a loss occurred to the rice crop due to lack of policy decisions at the right time. Had the decision of aerial spraying, been taken with consultation of the experts before announcing it in the press, the situation would have been entirely different.

Vertebrate Pest Problem

Wild boar and rodents are the two major problems causing substantial losses to crops like sugarcane, maize, groundnut, rice, wheat, potatoes etc. (Khan 1990a). University of Agriculture Faisalabad, National Agricultural Research Council, and Tropical Agricultural Research Institute, PARC Karachi centers are actively involved with vertebrate pest management. The Agriculture Extension Department of the Government of Punjab, seeks advice from the University of Faisalabad. Racumin, Warfarin, T10, and Zn PH_2 are used for their control (Khan 1990b). It may be pointed out that T10 creates secondary poisoning. Its use has to be carefully monitored.

The Punjab Agricultural Extension Department carries out an exceptional practice. Temik 10% is concentrated to 100% active ingredient, filled into capsules which are then placed in dough bait. The wild boar eats it and is killed. But by this highly concentrated poison the other animals which eat this bait are also killed. Unpublished observations of the extension staff revealed that there has been extensive loss of wild life in the areas where this practice has been carried out (S. Munir, personal communications).

The rodents and wild boar problem is very serious. Upto 100% loss in crops is a common phenomenon (Khokhar 1990). The problem can not be tackled by individual farmers, like for the insect pests, but a community effort is required. The government will have to take the initiative and constitute a team of experts which should work closely with the farmers associations. A national team effort is required to control these pests.

Fruit Pests in Northern Areas

Orchards, particularly apples and deciduous fruits grow in hilly areas which are the catchment area for rain water for rivers. The use of chemicals in these areas is very dangerous. Under the Agha Khan rural development programs in the northern areas a lot of fruit plants and orchids were introduced without due consideration to the quarantine. Now a number of pest problems are arising (Gillani and Hashmi 1992), which include Codling moth, a serious pest of fruit affecting apples, pears and walnuts, in Gilgit, Skardu and Hunza valleys. Similarly, the red spider mite is another serious pest of foliage, which effects apples, plums, almonds, peaches, grapes and walnuts throughout the Northern Areas. The obvious choice would be to use pesticides, but since the northern areas are water catchment areas for rivers this will be a dangerous proposition for environment.

Summary

Pesticides have a long history of use against insect and other pests. In the beginning these were either inorganic chemicals or compounds extracted from plant and animal sources. However, around World War II, the production of synthetic organic pesticides increased tremendously. Initially, the more persistent class of organochlorine pesticides was favoured, but it did not take long to realize the side effects of pesticides including losses of wildlife, beneficial insects, residues in crops and food chain, health hazard to human and animals, etc. Moreover, many of the pests for whom these were designed to kill, developed resistant and pest resurgence became a common phenomenon. All along this time, the pesticide manufacture and consumption showed an exponential increase. The business of pesticide companies flourished through the introduction of other classes of pesticides and targeting different pests. The pesticide import in Pakistan started in 1954 through the Government of Pakistan. In a policy change, the pesticide business was handed over to the private sector in 1980. Since then, the pesticide consumption has been on the rise. The pesticide consumption figures for 1992 stand at 5519 metric tonne active ingredient. Insecticides comprise 85% of the total pesticides and cotton crop is the major recipient of these chemicals.

The pesticide production, import, registration and use are controlled by the Agricultural Pesticides Ordinance 1971 through the Agricultural Pesticide Rules, 1973. Department of Plant Protection, Government of Pakistan, is responsible for the registration of pesticides. At present the implementation of legislation is weak. Complaints on pesticide adultrations are very common, but very few actions have been taken against the culprits. There are 4 federal and 4 provincial laboratories which conduct pesticide residue research. Amongst the agricultural workers, the spraymen and female cotton pickers are at greater risks. Due to lack of awareness the pesticides are mostly handled without proper precautionary measures. A number of reports are indicative of the environmental dangers posed by these killer compounds.

During the past decade research has indicated the presence of pesticide residues in a number of food and feed items. In some cases the residues are present beyond the WHO permissible limits. Analysis of crop soils at various sites have shown the presence of pesticide residues, which are a potential danger to soil micro-fauna/flora, and after take up into plant can reach the human bodies as well. At present the groundwater does not seem to be contaminated to a dangerous level, however certain pesticides if continuously used may reach the groundwater. This is particularly true for the herbicides.

In Pakistan only limited studies are available on the exposure of humans to pesticides. Furthermore, these are limited to organochlorine and organophosphates. Organochlorine (DDT and HCH) have been detected in the blood and fat tissues from populations of Quetta and Karachi. The spraymen and cotton pickers in cotton growing area of Multan have shown activities of blood choline-esterase (an enzyme indicator of exposure to organophosphorus insecticides), diminished to dangerously low levels. In addition, a number of cases of accidental poisoning have also been reported.

The suggestions are to go for alternative safer measures of pest management, and reduction in reliance on synthetic pesticides. Encouraging biological control and integrated pest management should be the main focus. Cotton leaf curl virus disease, banana bunchy top virus disease, insect pests of rice, sugarcane planthopper, and pest complex of fruit orchards are causing economic losses. These need to be tackled with utmost care to environmental safety.

To summarize, it can be concluded that environmental impact assessment is essential before any project is developed and executed. The use of pesticides should be as low as possible, and strongly discouraged. Integrated Pest Management relying upon natural pest control should be popularized.

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Annex I

Pesticide (formulated product)[10] import in Pakistan

Year	Quantity (Tons)	Value in US$	Value in Pak Rs
1973-74	6473.6	17,310,000	171,360,000
1974-75	6927.6	26,028,000	257,682,000
1975-76	13258.3	31,355,000	310,415,000
1976-77	16225.7	46,529,000	460,639,000
1977-78	12754.4	25,703,000	254,464,000
1978-79	7727.3	19,072,000	188,810,000
1979-80	4419.1	16,935,000	167,655,000
1980-81	7105.0	22,699,000	224,717,000
1981-82	5481.0	23,296,000	230,626,000
1982-83	8860.3	30,897,000	396,712,000
1983-84	10662.5	50,803,000	685,840,000
1984-85	15889.9	77,905,000	1,196,624,000
1985-86	17498.9	88,661,000	1,416,809,000
1986-87	20647.8	108,872,000	1,878,039,000
1987-88	15765.4	101,391,000	1,769,267,000
1988-89	11326.5	74.150,000	1,382,904,000
1989-90	10543.5	58,323,000	1,249,274,000
1990-91	13030.1	68,010,000	1,489,428,000
1991-92	15258.3	78,721,000	1,945,981,000

Source: Agricultural Statistics of Pakistan 1991-92

10. Formulated products imported in Pakistan contain active ingredient from 1% to as much as 97% when these are termed as technical grade.

Annex II

List of pesticide registered in Pakistan as of January 1993

Common Name	Brand Name
Acaricides	
Bromopropylate	Neoron
Dicofol	Kelthane, Mitithane
Ethion	Cethion, Ethion
Hexythiazox	Nissorun
Tetradifon	Tedion V-18
Fungicides	
Benomyl	Benlate, Sunlate
Bupirimate	Nimrod
Captan	Captan, Orthocide
Carbendazim	Dersosal, Bavistan
Carboxin	
+ Thiram	Vitavax 200
Chlorothalonil	Daconil
Copper Compound	
+ Mancozeb	Tri-Miltox Forte
Copper Oxinate	Quinolate
Copper Hydroxide	Champion
Copper Oxychloride	Agricop, Cobox, Cupravite, Nucop, Pol-Kupritox, Vitigran Blue
Cuprous Oxide	Perenox
Difenoconazole	Score
Diniconazole	Spotless
Fenarimol	Rubigan
Fenetriaze	Raxil
Fenfuran	Panoram
Fentinacetate	
+ Maneb	Brestan
Kasugamycin	Kasumin
Mancozeb	Dithane M-45, Nemispor, Penncozeb
Mancozeb	
+ Oxadixyl	Sandofan-M
Manzeb + Zineb	Liromanzeb
Metalaxyl	
+ Manzozeb	Didomil
Metiram	Polyram Combi.
Penconazole	Topas
Phthalide	Rabcide
Propiconazole	Tilt
Propineb	Antracel
Pyrazophos	Afugan
Quinomethionate	Merestan
Stretomycin	
+ Oxytetracycline	Agrimycin
Sulphur	Kumulus-DF, Thiovit
Thiabeniazole	Tecto
Thiophanate Methyl	Topsin-M
Triadimefon	Bayleton
Triadimenol	Baytan, Baytan Foliar
Tricyclazole	Beam
Tridemorph	Calixin
Triforine	Saprol
Herbicides	
Ametryn + Atrazine	Gesapax Combi.
Abrazine	
+ Metalochlor	Primextra
Atrazine	
+ Cyanazine	Bladex Plus
Bentazon	Basagran
Benthiocrab	Saturn
Bromoxynyl + MCPA	Buctril-N
Butachlor	Machete, Sundachlor
Cinmethylin	Argold
Cholrotoluron	
+ MCPA	Dicuran-MA
Cholrotoluron	
+ MCPA-NA	Agmol Combi.
Dicamba	Banvel
Dicamba + MCPA	Banvel-M
Dipnenamid	Enide
Dimethametryn	
+ Piperophos	Avirosan
2,4-D Butyl Ester	Estron
2,4-D Dimetnyl	DMA-6
2,4-D Fluid	U-46-D
2, 4-D Sodium Salt	Pol Pielik
Diuron	Karmex
Fenosaprop-P-ethyl	PUMA-S
Fluometuron	
+ Prometryn	Cotogard
Flurocholridone	Racer
Glufosinate	Basta
Isoproturon	Arelon, Graminon, Kenoran, Nocilon, Tolkan, Matrix
Maleic Hydrazide	Royal MH-30
Metsulfuron methyl	Ally
Methabenzthiazuron	Tribunil
Metribazin	Sencor
Metolachlor	Cotoran Multi

Metoxuron	Dosanex
Menilate	Ordran
M.O.	M.O.
Oxadition	Renstar
Paraquat	Gramexone
Pendimethalin	Stemp
Piperophos 2,4-D	Rilof
Pretilachler	Rifit
Propanil	Stam F-34, Surcopur
Terbutryn + Triasulfuran	Logran Extra
Tembutryn + Terbuthylazine	Topogard
Thidiazuron	Dropp
Tralkoxydim	Grasp
Trifluralin	Treflan, Olitref
Trifluralin 2,4-D	Treflan-R
Insecticides	
Acephate	Orthene, Asophate
Alphamethrin	Bestex, Fastac
Alphamethrin + monocrotophos	Azofas
Amitraz	Mitac
Azinphos Methyl	Gusathion-M
Bacillus Thuringiensis	Bactospeine, Thuricide HP
Betacyfuthrin	Bulldeck
Betacyfuthrin + Methamidophos	Magnum
BHC	BHC
BHC + MIPC	Gamma Hytox
Biphenthrin	Talstar
Bromophos	Nexion
Carbaryl	Sevin
Carbaryl + BHC	Sevidol
Carbofuran	Agridan, Asocarb, Brifur,
Curaterr, Diafuran,	Furadan, Sunfuran
Carbosulfan	Advantage
Cartap Hydrochloride	Padan
Chlorpyrifos	Lorsban
Chlorpyrifos + Diemetheate	Dimlor
Chlorpyrifes Methyl	Reldan
Chlorinated Wax	Ostice
Chlorfluazuron	Atabron
Cyanofenphos	Surecide
Cycloprothrin	Cyclosal
Cyfluthrin	Baythroid
Cyfluthrin + Methamidophes	Baythroid TM
Lamada Cynalothrin	Karate
Cypermethrin	Arrivo, Cheeta, Cymbush, Cyperkill, Lucky Cypermethrin, Meherthrin, Nurelle, Polytrin, Peskil, Ripcord, Sherpa, Sunmerin, Ustad
Cypermethrin + Chloropyrifos	Nurelle-D
Cypermethrin + Methamidophos	Heptokill, Ammo-M
Cypermethrin + Dimethoate	Almos-D, Cypergard, Laser
Cypermethrin + Monocrotophos	Azocard, Boom, Fenom-M, Ammo-Phos
Cypermethrin + Profenofos	Polytrin-C
Cypermethrin + Mephosfolan	Cropgard
Deltamethrin	Decis
Deltamethrin + Dimethoate	Decis-D
Deltamethrin + Monocrotophos	Tiger
Deltamethrin + Triazophos	Deltaphos
Diazinon	Basudin, Diazinon, Diazinon
Dibrom	Naled
Diflbenzuron	Dimilin
Dimethoate	Amerthron, Aniron,
Dimethoate,	Cygon, Dimegro, Luxagan, Dimethion, Dimetoxal, Higonet Profokthion, Rogor, Roxion, Stinger, Sumithoate, Systoato
Endosulfan	Endon, Hexasulfan, Sialan, Sialan,Thiodan, Thioluxan
Endosulfan + Dimethoate	Aflix
Ethofenprox	Trebon
Esfenvalerate	Sumicidin Super
Etrimfos	Ekamet
Fonitrothion	Agrothien, Edthion, Folithion, Novathion, Sumithion
Fenitrothion + BPMC	Sumibus

Fenpropathrin	Danitol
Fenpropathrin + Fenitrothion	Meothrin Supper
Fenthion	Lebaycid
Fenvalerate	Edcidin, Fenkill, Sumcidin
Fenvalerate + Dimethoate	Edmitol D, Mikantop
Flucythrinate	Pay off
Flucythrinate + Dimethoate	Pay off-D
Flucythrinate + Mephosfolan	Pay Off Plus
Flufenoxuron	Cascade
Fluvalinate	Mavrik
Fluvalinate + Thiometon	Mavrik-B
Pormothion	Anthio
Furathiocarb	Deltanet, Promet
Heptachlor	Heptachlor
Imidacloprid	Confidor
Isazofos	Miral
Isothioate	Hosdon
Iscxathion	Karphos
Malathion	Emmatos, Fyfanon
Malathion	Malathion,MLT, Maladan
Mephosfolan	Cytrolane
Methacriphos	Damfin
Methamidophos	Asomide, Edron, Estrolla, Grip, Hasaron, Monitor, Master, Piron, Sundaphos, Tamaron
Mineral Oil	Triona, Winter Oil, Albolineum MIPC Mipoin
Monocrotophos	Agrioron, Apadrin, Asomono, Azodrin, Monofos, Nok-Out, Nuvacron, Suncrotophos
Nicotine Sulphate	Nicocide
Permethrin	Ambush, Coopex Dust, Permasect, Pounce, Talcord
Permethrin + Piperonyl Butoxide	Coopex liq.
Phenthoate	Agrisan, Cidial, Elsan
Phosolone	Zolone
Phosmet	Imidan
Pirimicarb	Pirimor
Pirimiphos Methyl	Actellic

Polychlorinated Petroleum Hydrocarbon	Tenekil
Profenofos	Curacron
Pyraclofos	Voltage
Pyridaphenthion	Ofunack
Prothoate + Dimethoate	Facron-S
Quinalphos	Ekalux
Quinalphos + Thiemeton	Tombel
Tetrachlorvinphos	Gardona
Thiodicarb	Larvin
Thiocyclam Hydrogenoxalate	Evisect
Thiofanox	Dacamox
Thiometon	Ekatin
Tralomothrin	Tralate
Trichlorfon	Diptorox, Ditera, Edgron
Triazophos	Hostathion
Vamidathion	Kilval
Nematicides	
Dichloropropane + Dichloropropane	D.D. Soil Fumigant
Rodenticides	
Brodifaccum	Klerat
Coumatetralyl	Racumin
Sodium Cyanide	Cymag
Zinc Phosphide	Agrinphos, Zinc Phosphide, Ratokil, Zarrow, Ratol, Rattus
Fumigants	
Aluminium Phosphide	Agtoxin, Celphos, Delicia Gastoxin, Phostek, Detia Gas Ex-T, Detia Gas Ex-B, Phostoxin, Quickphos
Methyl Bromide	Brom-o-Gas, Bromomethane, Mebron, Methybron, Methyl Bromide, Pest Master, Siabron,Tarabol, Terr-o-Gas
Sex Pheromones	
Cossyplure	Nomate
Hexadecadienyl Acetate	PB-Rope

Source: MINFA (1993a)

Annex III

Federal Legislation for Pollution Control

In Pakistan the danger posed by the chemicals including agro-chemicals was felt right from the beginning, however, no concerted efforts on the part of Government was made before 1971 when Agricultural Pesticide Ordinance was formed. However, later efforts on the global scale highlighted the dangers of excessive use of agro-chemicals not only in the industrialized countries, but also in the developing countries where misuse and overuse of these chemicals was becoming a common phenomenon. At the same time concerns about the deterioration of the global environment was taking a form of environmental movement, and emphasizing a need for a change in thinking and attitudes towards our environment. With this new awareness on global as well as on local scales brought many changes in the attitude of governments and other public agencies. In Pakistan this change in attitude became visible with the promulgation of Pakistan Environmental Protection Ordinance of 1983.

The **Pakistan Environmental Protection Ordinance** was promulgated on December 31, 1983 and two bodies were instituted:

1. **The Environmental Protection Council,** headed by the President of Pakistan, was established on February 13, 1984 with a mandate to:
   - ensure enforcement of the ordinance
   - establish national environmental policy
   - ensure incorporation of environmental considerations into the National Development Plans and Policies
   - ensure enforcement of the National Environmental Quality Standards
   - promote environment related research

In addition to the Prime Minister, the Council comprises of the Ministers in-charge of environment at Federal level as well as in the Provinces, the secretary to the Government of Pakistan from Environment and Urban Affairs Divisions and other persons who are appointed by the Federal Government. The Council held its first meeting under the chairmanship of the caretaker Prime Minister Mir Balkh Sher Mazari in May 10, 1993 to approve emissions control standards but nothing has been done so far on agro-chemicals.

2. **The Pakistan Environmental Protection Agency (PEPA)** was established on February 6, 1984, within the Environment and Urban Affairs Divisions of the Ministry of Housing and Works.

Main functions of PEPA are to:
- administer the EPO and the rules and regulations
- prepare a national Environmental Policy for approval of the Council
- publish annual reports on the state of environment
- establish national Environmental Quality Standards with the approval of the Council
- revise the above standards when deemed necessary
- coordinate environmental policies and programs nationally and internationally
- establish system for surveillance, monitoring and inspection to combat the environmental pollution
- promote research and development in environmental pollution control, the dissemination of the results of such research and the education and training of research experts.

- provide information and education to the public on environmental matters
- coordinate and consider implementation of measure to control pollution with provincial and other Government agencies.

PEPA is headed by a Director General. A Technical Advisory Committee comprises of representatives from Engineering Universities, Research Institutes, Chamber of Commerce and Industry and others assist the Director General.

As PEPA was responsible for all aspects of environmental pollution, with its main administration coming from Environment and Urban Affairs Division, Ministry of Housing and Works, the issue was debated whether due consideration will be given and full protection achieved from hazards arising out of the use of agro-chemicals. This was finally resolved by the decision that Ministry of Food and Agriculture should look after the use of fertilizers, biocides and pesticides.

The Agricultural Pesticide Ordinance

The import, manufacture, formulation, sale, distribution and use of pesticides is controlled by the **Agricultural Pesticide Ordinance, 1971**, through the **Agricultural Pesticides Rules, 1973.** The ordinance covers:

- Pesticide registration
- Period for which registration shall be effective, renewal or cancellation of registration
- guidance for import, proper labelling of packages, storage and use of pesticides
- quality check through public analyst at Federal/Provincial Pesticide laboratories
- appointment of inspectors to monitor pesticides
- penalties for defaulters
- laws relating to the above mentioned aspects

An important consequence was the establishment of the **Agricultural Pesticide Technical Advisory Committee (APTA)** to advise the central government on technical matters arising out of the administration of this ordinance. The functions of APTA include:

- Study of the working of the Agricultural Pesticide Rules with a view to recommend to the Federal Government any amendment that may be necessary therein
- registration of pesticides
- approval of specifications of technical grades of registered pesticides for
- local procurement or import

Composition of APTA

The APTA committee is headed by a Chairman and assisted by Vice Chairman(s), Members, officers of central or provincial Government, persons representing the trade and industry engaged in pesticide business as appointed by the Central Government. One of the Government officer, member of APTA acts as secretary.

In 1973 the Federal Government in consultation with the Agricultural pesticide Technical Advisory Committee made the rules called the **Agricultural Pesticides Rule, 1973.** The rules pertain to almost all aspects of pesticide business, namely:

- Registration
- Manufacture, formulation or sale
- Packing and labelling
- Storage and use
- Pesticide laboratory
- Government inspectors and analyst
- Pesticides and their antidotes
- Safety precautions

At the time of registration of any pesticide detailed information has to be provided about the products including, name, structural formulae, active ingredient, technical grade material, formulated product, flammability, efficacy, toxicological data, residue data, prediction of environmental effects, disposal of surplus pesticides and pesticide containers, labelling and direction for use, packaging and methods for analysis.

Annex IV

Insecticide Poisoning Symptoms

Pyrethroids

The acute effects resemble veratin intoxication, proceeding from excitation to convulsions to tetanic paralysis, except that pyrethrin cause muscular fibrillation also. Death is caused by respiratory failure. Rat oral LD_{50} values are 584 to 900 mg/kg; the intraperitoneal LD_{50} values are 167 to 798 mg/kg. The chief toxic action of pyrethrum in mammals is on the central nervous system. Injury to man from pyrethrum has most frequently resulted from the allergenic properties of the material rather than its direct toxicity. Pyrethrum can cause contact dermatitis. Sometimes the sensitivity is similar to that in pollinosis, including sneezing, serious nasal discharge and nasal stuffiness. Sometimes it can cause asthma, bronchitis and sinusitis.

Organochlorines

Tremor is characteristic of DDT, the onset of poisoning is mild effect that progress only gradually, but continuously, to the point of convulsions. On the contrary, BHC, aldrin, dieldrin, endrin, toxaphene and several other compounds frequently produce illness in which a convulsion is the first sign of injury. DDT and may be other insecticides act by changing the electro-physiological and associated enzymatic properties of nerve cell membranes, especially axonal membranes. Organochlorine insecticides produce little morphological changes even when given in single or repeated doses sufficient to kill. Carcinogenicity of organochlorine insecticides is debatable. Tumor formation in mouse has been detected but there is serious disagreement whether these tumors are malignant.

Organophosphates

Signs and symptoms to organophosphorus insecticide poisoning are secondary to cholinesterase inhibition. The usual symptoms include: headache, giddiness, nervousness, blurred vision, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include: sweating, miosis, tearing, salivation and other excessive respiratory tract secretions, vomiting, cyanosis, papilledema, uncontrollable muscle twitches followed by muscular weakness, convulsions, coma, loss of reflexes and loss of sphincter control. Cardiac arrhythmias, various degrees of heart block and cardiac arrest may occur.

Carbamates

Broadly speaking, poisoning by carbamates and by organophosphorus compounds is same i.e. inhibition of cholinesterase in brain. Therefore, much of the effects are the same. The most striking differences between the clinical effects of two groups are the relative brevity of poisoning by carbamates and relatively wide separation of the smallest dosage of any carbamate that produces mild illness and the dosage of the same compound necessary to produce death. This is because of the relatively rapid spontaneous reactivation of cholinesterase inhibited by carbamates. Non anticholine- esterase effects of carbamates are alteration of induced cellular and humoral immune responses.

Source: Hayes (1982)

SDPI is an independent non-profit research Institute
on Sustainable development

Mailing Address: PO Box 2342, Islamabad Pakistan

Street Address: 3rd Floor, Taimoor Chamber, 10-D West,
Fazal-ul-Haq Road, Blue Area, Islamabad.

Telephone: +(92-51) 2277146
2278134 2278136 2270674-6

Fax: +(92-51) 2278135

URL: www.sdpi.org e-mail: main@sdpi.org