UN-PAK/FAO/2001/002

Policy and Strategy for Rational use of Pesticides in Pakistan

Building Consensus for Action

August 2001

FOOD AND AGRICULTURE ORGANIZATION/ GLOBAL IPM FACILITY
UNITED NATIONS DEVELOPMENT PROGRAMME
GOVERNMENT OF PAKISTAN

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9. Recommendations and Framework for Action	*Participants of Policy Workshop*

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Executive Summary

Consumption of pesticides in Pakistan has increased many folds (i.e. from 665 tons in 1980 to 45,680 tons in 1999), without significant gains in the yield of crops. Chemical based control program in crops has actually increased the pest problems, disturbed the agro-ecosystem and has killed the non-target and environment friendly organisms such as parasitoids, predators and birds. Over and misuse of pesticides has led to tremendous economic losses and hazards to human health. It has now been realised at planning and policy levels to improve awareness and there is a commitment at highest level in the Government to rationalize the use of pesticides and to adopt the alternative approaches. Thus the Government with support of UNDP and FAO launched an intensive one year study entitled, "Policy and Strategy for Rational use of Pesticides".

In May 2000, a team of local consultants was hired and at the same time Hannover University Pesticide Policy Project (HU-PPP) Germany put up a team of international consultants to assist the national team in implementing the project. The objective of the project was to build up national capacity in pesticide policy analysis and pesticide policy reform. The procedure of the project is based on the methodology developed by the HU-PPP, which has been tested before in several countries in Asia, Africa and Latin America. The core of the HU-PPP methodology is to initiate a process of crop protection policy reform with the aim to achieving a consensus among the different stakeholders that there is indeed a problem with pesticides and that action is needed.

The method used included collection of data regarding the extent of pesticides usage on various crops, quantification of the use of banned pesticides in Pakistan, conducting of sample surveys to estimate the impact of direct and indirect effects of pesticides on human health and environment (namely, pesticide residues in soil, groundwater, and food items, and effects on agricultural biodiversity), analysis of pesticide registration and usage laws to identify the gaps/flaws which have resulted in environmental and economic deterioration, especially in cotton ecosystem. The following are the salient findings of this comprehensive study conducted by a multidisciplinary team of local and international experts.

- Pakistan's agricultural sector constitutes about 25 % of the national economy and provides employment for 44 % of the labour force. It has important forward and backward linkages, especially with regard to the supply of raw cotton to the textile industry. Real agricultural GDP increased on an average of around 3.8 % per year during the last three decades, which is almost close to population growth.

- The agricultural sector faces the challenge to increase further its productivity in a sustainable way while the easy gains in acreage and yields through the adoption of Green Revolution technologies have already been made. Pakistan has to maintain its competitiveness on international export markets and to adapt to increasingly stringent demands from foreign countries in terms of food safety, environmentally responsible production processes, and a functioning quality control system.

- Pesticide use began in the 1950s for locust control. The government privatized pest control operations in 1980 and further deregulated imports in 1993. Despite rapid growth of pesticide use to an estimated 45,000 tons in 1999, pest problems have not yet been solved.

In cotton production, which takes about 54 % of the pesticide quantity, indiscriminate use has provoked the development of resistance in insect pests and the outbreak of secondary pests. This resulted in high crop loss, increased costs for crop protection and declining cotton yields. The average number of treatments with insecticides in cotton increased significantly in the 1990s. Similarly herbicide has also increased in wheat and rice crops. Pesticide use on fruits and vegetables has also been increasing in recent years.

- The analysis of the economic factors influencing pesticide use shows that pesticide prices increased steadily during the 1990s. The increase was higher than that for fertilizer prices, but lower than that for crop output prices. Since 1997, pesticide prices declined due to increased competition from imports of generic compounds, which was made possible after the deregulation of the import and registration scheme. Import of herbicides and active ingredients for locally manufactured insecticides and fungicides is encouraged through import duty and tax concessions. These factors, together with the recurrent pest problems due to indiscriminate use patterns, have encouraged higher pesticide use levels, especially in cotton production.

- Case study results demonstrate that there is a high potential for reducing pesticide overuse on cotton because the least efficient farmers achieve the same cotton yield while spending 70 % more on pesticides than the best of their fellow farmers. There seems to exist ample scope for encouraging more efficient pesticide use without hurting incomes of farmers, e.g., by applying an input charge which would recover the implicit subsidies and signal the real costs of the inputs to the users.

- Pakistan's crop protection policy has been focused on safeguarding the supply of affordable pesticides while maintaining standards for product registration according to internationally accepted norms. Beginning in 1980, pesticide distribution was shifted entirely from the government to the private sector. A policy for stimulating local formulation of pesticide products has been in place. The registration scheme was deregulated in 1993 to facilitate imports of generic compounds already registered under trade names and imports of pesticides that are registered and used in OECD countries or China.

- The majority of pesticide products are now imported under the generics and import permission scheme as opposed to trade name registration. Regulations for distribution, storage, use and disposal have been promulgated, but generally lack enforcement. Pesticide product quality problems and adulteration reportedly increased after the introduction of the generics scheme. With regard to monitoring of residues in food, drinking water and the environment, a comprehensive national monitoring system is still missing.

- The agricultural extension system plays a major role in providing unbiased advice to farmers in pest management. The present public sector system at the provincial level is operating under a modified version of the Training and Visit approach. Effectiveness of information delivery is considered limited due to lack of operational funds, lack of coverage and too little practical training of extension personnel and farmers.

- The private sector has taken full advantage of a policy environment, which encouraged dependency on high pesticide use levels. Private companies invest a far higher amount of funds into product marketing and promotion than the public sector into advice on pest management. However, private sector information on pesticide use appears to be selective and promoting uneconomical use levels. Advertisement of pesticides through mass media and information campaigns is not yet adequately regulated.

- The public sector extension system has made little effort to fulfill its task to transform the present environment geared towards application of pesticides into a market for crop protection information in general which gives more emphasis on knowledge and decision making capacity of the users. Until now, non-governmental organizations also have given little attention to pesticide overuse patterns and related problems for human health and the environment.

- Integrated Pest Management (IPM) is seen as the most promising alternative to dependence on unilateral pesticide use. In Pakistan, IPM has been supported mainly through investment in agricultural research. Successful examples of economically viable IPM technologies include crops like sugarcane, rice, fruits and vegetables.

- Cotton pest management research has relied on the concept of economic threshold levels of insects while transferring information and advice for product application to farmers through mass media campaigns. Field level training of farmers on agro-ecosystems analysis was undertaken in a pilot scheme in cotton following the Farmer Field School approach. Among the major obstacles for the development and uptake of promising IPM technologies are the poor linkages between research, extension and farmers, the lack of participatory extension methodologies, the pronounced role of private sector interests in information delivery to farmers, and the general lack of information at the farm level.

- Apart from the intended impacts on target organisms, pesticides have negative side-effects on human health, the environment and biodiversity. These externalities have costs for the society at large, which are not necessarily borne by the individual supplier or user of the pesticide. Widespread negative effects are observed with regard to the occupational health status of workers in formulation and refilling plants, farmers applying pesticides, and female cotton pickers.

- Pesticide-related illness is causing a considerable number of fatalities, health treatment costs and income loss, especially in the poorer sections of the rural communities. Pesticide residues appear in the food chain. Analysis of samples from zones with high pesticide use show that a high share of food and animal feed products contain residues in excess of standards for marketing and consumption. Results have to be confirmed through a regular nationwide food residue monitoring system, which is still absent. Presence of residues in food and fiber products is threatening export opportunities to markets in foreign countries.

- High costs for the national economy also occur from the development and spread of resistance, the degradation of the agro-ecosystem and damage to agricultural production. Resistance of cotton pests to insecticides and the loss of natural enemies increased pest control costs and yield loss significantly in the 1990s. Other important negative effects are the loss of biodiversity and bees as honey producers and crop pollinators and the loss of domestic animals due to intoxication with pesticide residues.

- An overall economic evaluation of the externalities of current pesticide use levels shows that the external costs are quite higher than the currently paid price at the farm gate level. This means that the true cost of pesticides for the national economy are currently grossly under tated since they are above twice as high as assumed by the participants in the pesticide market. If externalities are incorporated in the market price of pesticide products, there will be an incentive to reduce inefficient use and related external effects, which subsequently benefits the national economy.

- From a strictly cost benefit approach, it appears that pesticide use is not beneficial. However, the ratio of external costs to the private cost of pesticide use is quite high (1.64), which shows other tradeoffs involving environmental quality, irreversible damages to agro-ecosystem and human health problems. Society pays about twelve thousand million rupees as environmental and public health costs.

- The adverse implications of pesticide use on health, production resources and environment required to be corrected by improved government policies. This most likely further fuels the demand of society for tighter regulations, which increases the social costs of damage prevention and mitigation. The direct and indirect benefits and costs of implementation of a policy to reduce pesticide need to be considered in promulgating future safe pesticide use strategies. Clearly, it is essential that the environmental and social costs and benefits of pesticide use be considered when future pest control programmes are being developed and evaluated.

- The findings of the study were presented and discussed in the Policy Workshop on May 1-2, 2001. The consensus was built on the recommendations during the final session of the workshop and a list of actions, responsibilities and time frame for implementation were suggested. The action plan was submitted to the Government of Pakistan. The framework for action is being vigorously pursued at all levels and various time bound actions are already being implemented at different levels. The newly established National IPM Programme has taken on itself to approach various Government Departments responsible for policy change for following through the desired actions. The Government of Pakistan has allocated an attractive amount of financial resource for IPM Programme at the National level for the next ten-year investment plan.

Chapter 1: INTRODUCTION

1.1. Background to the Study

At the inception of Pakistan in 1947, there was practically no plant protection service in the country and economic soundness of plant protection measures was not even realized for a long time. The use of preventive measures to reduce losses by insects and diseases was almost non-existent during 1960s. However, the "grow more" pressure rendered the traditional methods insufficient, to control the ever increasing pest problem from 1970s onwards. Consumption of pesticides in Pakistan has increased from 665 tons in 1980 (when direct Govt. subsidy was withdrawn) to 45,680 tons in 1999. This colossal increase in pesticide consumption has not led necessarily to increase the yield of crops, as demonstrated by Poswal & Williamson (1998) and Ahmad and Poswal (2000).

Chemical based control program in crops has actually increased the pest problems, disturbed the agro-ecosystem and has killed the non-target and environment friendly organisms such as parasitoids, predators and birds. Disturbance in an agro-ecosystem led the new pest problems through resurgence and resistance processes in the naturally occurring pest populations. A review of studies on pest resistance reveals seven (7) insect species being resistant to a wide variety of pesticides (Irshad, 2000). Indiscriminate use of pesticides has also destroyed the bio-control agents in agro-ecosystems. The populations of natural enemies in cotton growing areas have declined up to 90% during the last decade (Hasnain, 1999).

Over and misuse of pesticides has led to tremendous economic losses and hazards to human health. It is estimated that annually thousands of farmers and farm workers are poisoned due to pesticide exposure. The pressure on small, low income and resource poor farmers of developing countries like Pakistan is enormous. They are mainly concerned about the private cost of pesticide and have little regard for degradation of natural resources, health risks and future productivity.

It has now been realised at planning and policy levels that the pesticides use has not solved the pest problems and in addition increased the cost of production. It is felt that there is a need to improve awareness and commitment at highest level in the Government to rationalize the use of pesticides and to adopt the alternative approaches. The research and extension system of the country needs to be geared up to workout and popularise various alternative pest control strategies of Integrated Pest Management (IPM).

1.2. Government Strategy to Promote Rational use of Pesticides

The Government of Pakistan is promoting IPM approach in order to reduce reliance on pesticides and improve the profit margin of farmers. However, introducing and implementing

IPM as a solution to the above-mentioned problems depends on a conducive policy environment. Thus the Government with support of UNDP and FAO launched an intensive one year study entitled, "Policy and Strategy for Rational use of Pesticides". The Government of Pakistan in early 2000 requested the FAO to assist in reviewing and in improving its current pesticide policy in order to facilitate the implementation of IPM in Pakistan. The project, which is funded by UNDP was charged to the Global IPM Facility who contracted the Hannover University Pesticide Policy Project (HU-PPP) at the University of Hannover, Germany. In May 2000, a team of local consultants was hired and at the same time Hannover University put up a team of international consultants to assist the national team in implementing the project.

The Government of Pakistan has asked for this project because it had realized that the growing problem of over- and misuse of pesticides in Pakistan (and in many other countries) is not simply the result of ignorance and lack of knowledge on part of the farmer but often also the result of bad policies. For example, the very low adoption of IPM world-wide, which is now even being admitted by American entomologists, is a consequence of lacking incentives to put IPM into practice. In turn, this is often a result of poor and misguided economic thinking in pest management. The tendency to under-emphasize the economic aspects in crop protection and in IPM policy reflects the lack of involvement of non-pest management specialists in the policy-making process. Policy makers especially in poor countries often regard agricultural production from a purely technical point of view, dominated by disciplinary experts, such as agronomists, irrigation engineers, soil scientists, entomologists, plant pathologists, weed scientists etc. Disciplinary experts naturally have a strong professional interest in removing constraints on agricultural productivity associated with their field of endeavor. For example, most pest control specialists want to make sure that farmers always have access to many effective pesticides at low prices. While such recommendations may be correct from the point of view of maximizing agricultural productivity, these are often detrimental for achieving maximum economic efficiency.

Furthermore, decisions in pest control are often being made in the context of disasters such as severe pest outbreaks. This leads to consequences that can by far exceed the benefits of the short-term intervention. This is especially the case with chemical pesticides where the costs of human health and the costs of resistance to pesticides in many cases outweigh their benefits. Most importantly, on-going changes in consumer behavior in developed countries demand high standards of food quality, especially in high value food and ornamental crops. Therefore, countries who hold on to an old-fashioned pesticide-based pest control strategy quickly loose out in the "race" for potential agricultural export markets and risk to be placed on the list of "dirty producers" in the minds of consumers in importing countries.

1.3. Objectives of the Study

The objective of the project was to build up national capacity in pesticide policy analysis and pesticide policy reform, to collect data regarding the extent of pesticides usage on various crops, quantification of the use of banned pesticides in Pakistan, conducting of sample surveys to estimate the impact of direct and indirect effects of pesticides on human health and environment (namely, pesticide residues in soil, groundwater, and food items, and effects on agricultural biodiversity), analysis of pesticide registration and usage laws to identify the gaps/flaws which have resulted in environmental and economic deterioration, especially in cotton ecosystem.

1.4. Methodology of the Study

The procedure of the project is based on the methodology developed by the HU-PPP, which has been tested before in several countries in Asia, Africa and Latin America. Country case studies on pesticide policy analysis were conducted in Central America, i.e. Costa Rica, in Africa, i.e. Côte d'Ivoire, Ghana, Mali, Zimbabwe and in Asia i.e. Thailand. These studies showed that the analytical framework developed in the initial phase of the project is suitable for clearly identifying the political, economic and institutional factors that foster the deviation of current pesticide use levels from its socially optimal level defined in the context of sustainable agriculture development. Furthermore, detailed economic research studies have been conducted in addition to the country policy studies in selected cropping systems in co-operation with regional and national institutions on approaches to introduce economic evaluation and policy instruments. For example, results of the Costa Rica field study in coffee production indicate that farmers are likely to reduce pesticide use as a result of changes in the price of coffee and the price of pesticides. A study in Thailand found that at currently high use levels in citrus production, pesticides do not contribute to increased productivity. Rather by reducing pesticide use, farm-level productivity could be increased.

A study in Côte d'Ivoire, found that even in a system of still low to medium intensity of pesticide use in cotton using them for long period leads to changes in the "natural capital" which underpins the productivity of cotton and results in measurable health effects for farmers and their families.

The HU-PPP concept for policy analysis in crop protection has been widely recognised and is now being used by international and bilateral donor agencies. Regional and national pesticide policy workshops were held in several countries with the aim to broadening the scope of the discussion on formulating a policy that is conducive to a "true" IPM. Therefore the core of the HU-PPP methodology is to initiate a process of crop protection policy reform with the aim to achieving a consensus among the different stakeholders that there is indeed a problem with pesticides and that action is needed. In a stepwise approach right from the start all major stakeholders in pesticides and crop protection, such as representatives from Agriculture, Environment, Health, the Pesticide Industry and NGOs are included. Such process will also facilitate to go beyond the purely technical perspective of pest management and add a social science dimension. Through this excercise IPM can be moved from simply being a mixture of pest control methods, still dominated by chemical control, to become a crop management system that puts emphasis on the self-regulating forces of agro-ecosystems.

1.5. Steps involved in the Implementation of Study

The project on pesticide and IPM policy reform in Pakistan included several steps. It started with an awareness workshop of a large number of policy makers, researchers and other crop protection experts in June 2000. This workshop introduced the HU-PPP concept to the national team of consultants and other important decision-makers in crop protection in Pakistan. At the same time, the workshop marked the official start of a study to review the existing pesticide policy situation in Pakistan including an analysis of the distortions causing an uneconomical use of pesticides. Additional awareness workshops had been conducted for officials and experts in the four provinces of Punjab, Sindh, NWFP and Baluchistan. These workshops helped to create understanding for the role of policy and economics in pesticide use and IPM as a basis for.building up consensus for further action.

Additional special studies on pesticide residues and pesticide effects on human health were also commissioned to national experts. The initial results of the studies were presented and discussed in a workshop on "building consensus for future action" in May 2001. Here, the preliminary reports were presented by the national experts responsible in a summary format (See Appendix 1.1) and the presentations were subjected to review by discussants who were international consultants and representatives of the Global IPM Facility in Rome. Analyses from discussants, on the results presented by the national consultants, are presented in the form of reports (See Appedix 1.2 to 1.5).

1.6. Organization of the Report

The project report consists of nine chapters. It starts with the background of the pest problems and pesticide use in the country and methodological focus and steps involved in the implementation of this study (Chapter 1). Historical overview of the agricultural sector, agricultural policy and opportunities and challenges for the future are reviewed critically for their relevance to this study (Chapter 2). The next concern was the description of plant protection problems and historical trends in pesticide use. Crop wise pesticide use is specifically described in connection with the imports of pesticides (Chapter 3). The next chapter starts to deal with the productivity estimates of pesticide on cotton crop. Data and methodological problems in the pesticide productivity estimates were indicated specifically.

Pesticide price trends and non-price economic factors are also covered in this chapter (Chapter 4). Analyses of regulatory policy about pesticide use begin with the discussion on registration of chemical and biological pesticides. It further emphasizes on environment regulations, enforcement of regulations and cost of the regulatory system (Chapter 5). The structure of government and private extension system, expenditure and coverage of cliental, method for calculating economic threshold and IPM methods are given in Chapter 6. This chapter also provides critical review of the government and non-government organizations, pest and pesticide-related agricultural research and the account of available non-chemical pest control technologies. The quantitative extent of adverse impacts of pesticide on human health, natural resources, food chain, production losses and domestic animal poisoning are presented in Chapter 7. Methodological consideration for economic evaluation of externalities of pesticide use, cost of pesticide use and true price of pesticide is stated in Chapter 8. Finally, the main conclusions and recommendations for future actions at policy, research and extension levels are highlighted (Chapter 9). This report also presents the points raised in different chapters by the discussants.

Chapter 2: DEVELOPMENT OF AGRICULTURAL SECTOR IN PAKISTAN

2.1. Historical Overview of Agricultural Sector in Pakistan

2.1.1. Historical Importance of Agricultural Sector

The farming sector has an important role in the economy of Pakistan. It is maintaining the growing requirement and energizing growth and development in other industries and services, directed at both domestic and foreign markets. As the agricultural economy becomes more productive and is able to meet the needs of the growing food market, a smaller portion of consumer income is required for the necessities of food and fiber and remaining portion is available for consumption and investment in other areas of economy. Agricultural production for export greatly increases income and foreign exchange earnings. Through improved farm productivity, labuor locked in farming can be released for the expending agribusiness sector and other industries. In short, agriculture and other sectors of the economy provide resource to the rest of the economy as both sectors continue to grow.

The prominence of agricultural sector in the economy of Pakistan may be determined in three ways firstly; the sector provides food to the consumers and fiber to domestic industry. Secondly, it is a major source of foreign exchange earnings, and thirdly, it provides a market for industrial production. This sector has strong backward linkages (by buying agricultural inputs including fertilizers, pesticides, farm machinery, etc.) and forward linkages (by providing raw materials to food and fiber processing industries in the industrial sector). Also it is the main source of around two third of foreign exchange earnings in the form of raw and semi-finished products. It provides employment to over 44% of the labour force and is the main source of income in the rural areas, which constitutes about 70% of the total population (Govt. of Pakistan, 2000).

The economy of Pakistan is still largely based on agriculture. A major part of the economy depends on farming and the collection, storage, processing and distribution of agricultural commodities, as well as wages paid by farming and agribusiness to the household. The well being of the economy depends largely on the production, processing and distribution of major products such as cotton, wheat, edible oil, sugar, milk and meat. In the long run agricultural economy producing an increasing marketable surplus that is supporting sustained economic growth and the transition to a more market oriented economy.

The crucial role of agriculture in contributing to GDP has remained almost unchanged since 1980. Its share in the economy has slowly declined and that of the non-agricultural sector has been slowly increasing. The contribution of agricultural and non-agricultural sector in GDP is given in Table 1. The contribution of agricultural sector in the country' s GDP is around one-fourth Fig. 2.1. The real agricultural GDP increased on an average around 3.8% per year during the past three decades, which is almost close to population growth. Major crops remain the important sub-sector in the agricultural sector and they provide a little less than half of the value added by the sector, but their share in agricultural GDP is declining slowly. The share of livestock sub-sector in agricultural GDP is increasing slowly and now it accounts for around 40% of agricultural GDP (Kantar, 2000). The contribution from fisheries and forestry has also increased slightly.

Table 1. National account of Pakistan at current market prices (US$)

Year	Non-Agric. GDP	Agricultural GDP					Total GDP
		Crops	Livestock	Fish	Forestry	Total	
1980-81	20,367	5,328	2,033	272	78	7,711	28,078
1981-82	23,410	6,638	2,302	283	84	9,307	32,718
1982-83	20,856	5,396	2,104	245	76	7,821	28,678
1983-84	23,380	5,091	2,328	248	86	7,754	31,134
1984-85	23,224	5,288	2,402	167	83	7,940	31,163
1985-86	23,900	5,132	2,532	235	82	7,981	31,881
1986-87	25,448	4,852	2,740	231	89	7,876	33,324
1987-88	29,490	5,273	3,264	255	94	8,885	38,376
1988-89	30,479	5,815	3,385	283	96	9,580	40,059
1989-90	30,706	5,366	3,462	270	109	9,207	39,913
1990-91	35,119	6,160	3,845	271	121	10,397	45,516
1991-92	37,394	6,922	4,054	288	102	11,366	48,759
1992-93	40,209	6,461	4,537	367	106	11,472	51,681
1993-94	40,286	6,728	4,697	335	106	11,866	52,152
1994-95	46,838	8,103	5,609	339	115	14,166	61,004
1995-96	49,651	8,690	5,910	343	88	15,030	64,682
1996-97	50,179	8,077	6,317	316	83	14,793	64,972
1997-98	49,042	8,301	6,742	304	69	15,416	64,458

Note: Financial Year from July to June
Source: Economic Survey of Pakistan, 1997-98

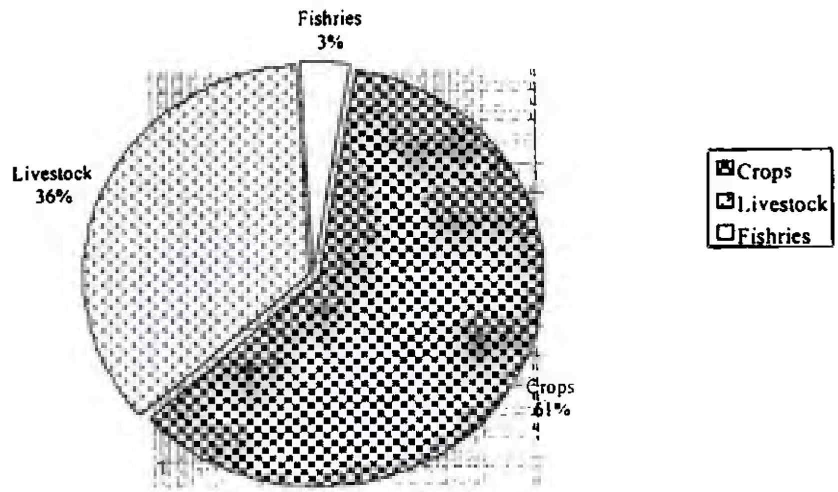


Figure 2.1 Sector wise distribution of agriculture in GDP

2.1.2. Changes in Agrarian Structure

At the beginning, Pakistan is characterized by a quasi-feudal landlord-tenant nexus in most areas of Sindh and several areas of Punjab, and a peasant system with numerous fragmented individuals and joint family farms in the NWFP and the Punjab. Pakistan had a dual agrarian structure in which a feudal system coexisted with the peasant system. The skewed pattern of ownership of land has led to even greater skewness in the distribution of farm area in the operational holding. Rapid changes have been observed over successive censuses of agriculture. According to the agricultural censuses of Pakistan, out of the total 6.21 million farms during 1997-98, around 85% of total farms were less than 5 hectares. The total number of farms increased from 3.8 million in 1970-71 to 6.21 million in 1997-98 (Akhtar, 1999). Farms are cultivated under three general tenure systems including owners, owner-cum-tenants and tenants. Besides smallholdings, the fragmentation of farms into two or more separated holdings is another major constraint to agricultural productivity in Pakistan. Fragmentation comes about mainly through sub-division of inheritance and acquisitions through marriage.

Over the years attempts have been made to improve the conditions of small and medium farmers but this has met with little success for a variety of reasons. The modern technologies and improved means of enhancing the farm productivity are capital intensive and are out of the reach of the small farmers. These are primarily accessible to the richer farmers. Small and other resource poor farmers like sharecropper and tenants have no access to the institutional credit facility; consequently they could not use or adopt the improved technologies. Even they are unable to purchase these critical inputs as and when required. Therefore, above mentioned tendril arrangements are directly influencing the level of productivity and income from farming (NCA Report, 1988).

2.1.3. Developments in Farming Sector

The agrarian economy of the country can broadly be classified with two main activities; the farming itself and the agribusiness. Farming in Pakistan is largely based in private sector. Agribusiness is both public and private enterprises and includes collection, storage, manufacturing and distribution of farm and forest products and inputs. These together with their coordinated activities are termed as the food and fiber system.

Pakistan's agriculture has made a long and difficult journey. At the beginning agriculture sector was not considered as important, therefore, the growth rate of agricultural sector was considerably low in the early years. The reason was a neglect of agricultural sector, as economic development was considered synonymous with industrialization. This neglect of the sector along with the increasing prevalence of water logging and salinity compelled agriculture sector to grow at a rate less than population growth rate. The country, which was regarded as the granary of the sub-continent resorted to import of wheat to meet severe wheat shortages. Some attention was, however, given to agrarian economy during the first plan period (1955-60). The average of annual growth rate during this period increased to 2.1 percent, which was less than the population growth rate of 2.5 percent. The food grain production during this period, however, increased by 3.4 percent. Not withstanding this increase, the country became a regular importer of food grains averaging over half million tones annually during this period as a result of rapid industrialization and urbanization.

2.2. Overview of Agricultural Policy

2.2.1. Developments in Crop Sector under Changing Policy Scenario

In the initial years of Pakistan, the agricultural sector was discriminated against and initial development efforts were directed entirely towards industry. This neglect, along with the increasing problem of waterlogging and salinity, began to take a toll on agricultural production. Yields and productivity was low during these early years and with a severe drought in 1952, the situation became serious. At that time, neglect of agriculture became apparent. Therefore, in the first Five year plan (1955-60) some attention was directed towards the agrarian economy, although it was not sufficient to have any significant effect on the declining performance of the sector. The average annual growth rate of the sector was only 2.1 percent. The major achievement of the first plan was the realm of institutional change. The first of these changes was the establishment of the Water and Power Development Authority (WAPDA) in early 1958. WAPDA's charter included the investigation, planning and execution of schemes in the field of irrigation, water supply and drainage; the prevention of waterlogging and reclamation of waterlogged and saline soils etc. Other major changes brought about were the promulgation of land reforms, the consolidation of holdings and the appointment of food and agricultural commission. These institutional changes played a major role in accelerating the pace of agriculture in the following two decades.

The situation changed rather dramatically during the next two plan periods when agriculture sector grew at 3.8 percent in the second plan (1960-65) and 6.3 percent in the third plan (1965-70). The overall growth in the production of major crops was 4.7 percent and 4.8 percent in minor crops. During the third plan, major crops grew at 9.1 percent and minor crops at 3.8 percent (Maan and Malik, 1996). The progress during this plan period was assigned to rapid adoption of the new technology, introduction of bio-chemical technology, high yielding varieties coupled with increased availability of inputs and more appropriate price policies.

In the ad-hoc plan period (1970-78), the growth rate declined sharply to 1.7 percent due tc multifarious type of problems particularly war with India in 1971, flood and droughts. Tarbela mishap of 1974 -75, Oil Producing Exporting Council (OPEC) oil prices hike and the extremely disturbed political and social condition. This period was, however, well known for re-organizing the institutional framework with equitable distribution of income as the major goal. Despite the reforms and programs, the agricultural sector displayed relatively a low growth rate of 1.7 percent; major crops grown at 0.9 percent and minor crops at 4.6 percent.

In the fifth plan (1978-83) Government again laid emphasis on the agriculture sector in order to reduce dependency on food imports and on increasing exports. Fruits, vegetables, livestock and fisheries were also given priority to capture export markets. Special emphasis was given to less developed backward and rainfed areas. The main focus was to increases the productivity level of small and low-income farmers. During the fifth plan, agricultural sector grew at a rate of 4.5 percent per annum. The supply of improved inputs particularly water, fertilizer and seed along with favorable weather conditions contributed to this growth.

During February 1980, a national agricultural policy was announced and the major emphasis was given to input/output prices. Fertilizer prices were reduced, pesticide subsidy was eliminated and water charges were raised. The agricultural prices commission was setup in 1981 to recommend such support prices that would, a) safeguard the interest of the farmers against undue fall in price in the post harvest period, b) stabilize the prices, c) raise the production of crops through interalia price intervention, particularly, those which are either exported or needing import substitution. The program was extended to 10 major and minor crops.

After the completion of fifth plan, sixth plan 1983-88 was announced. The proposed growth rate of this plan was 6.1 percent per annum. In this plan, emphasis was laid on the improvement of supply facilities for inputs and tractorization. Despite institutional changes, structural adjustments, propagation and effective use of inputs, irrigation water and mechanization, the growth rate of sixth plan was below the target and registered only 3.9 percent per annum. The performance of small farmers was least satisfactory as no package was given for this category of producers. Major polices were tilted towards large farmers.

In the seventh plan 1988-93, major emphasis was on the self- sufficiency in basic food items and improvement in productivity through efficient use of inputs and credits. The farmers were provided remunerative support prices. Research and extension services were strengthened. A new agricultural policy was announced in May 1991 with basic thrust on deregulation of the sector, establishing a macro policy climate conducive for agricultural growth and freeing the system from bureaucratic constraints. The main interventions of the new policy were, initiation of productivity enhancement program, relief package in repayment of outstanding loans, reduction in import duties on agricultural implements including tractor and liberal credit policy. In order to promote export of fruit and vegetables rebate of 25 percent was given on fright. Against the required growth rate of 4.7 percent per year, a growth rate of 3.8 percent was achieved. Achievements in plan period with regard to wheat and sugarcane were around 98.6 percent and 94.4 percent respectively. While the rice output was only 73 percent. A remarkable growth of cotton was observed during the year 1991-92, whereas declined in the next two consecutive years. It was because of the wake of cotton leaf curl virus in the area. During the seventh plan, poor progress was due to low investment in agriculture sector, meager availability of credit, lack of "crash" program and inadequate arrangements to line up inputs.

2.2.2. Food Policy

Stability of food supplies is an important aspect of food security because demand for food is consistently and progressively increasing and any sudden shortfall in supply could lead to an emergent crisis situation. Stable supply is only possible through diversification of agriculture in terms of commodities and disciplines. Heavy dependency on one commodity results in abrupt fluctuation in the food production and thus increased instability of supply.

In order to stabilize domestic production stream, the government took a number of measures to encourage the producers to attain maximum possible productivity from their land resources. The measures included provision of input subsidy, fixation of support prices of food crops like wheat, rice, sugarcane, gram, onion, potato, sunflower, soybean and safflower, increasing availability of irrigation water and making available wheat to flour mills as and when demanded by them.

In the recent years, systematic agricultural pricing policies have emerged in the developing world as important mean of tackling problems besetting the agricultural sector. For this purpose, Government of Pakistan decided in March 1981 to establish the agricultural prices commission. The principal task of the APCom was to advise the government on price policies for major agricultural commodities. This policy had been carried out vigorously which yielded tangible results in the form of expanded agriculture.

To fulfill the objectives of boosting the overall production, stabilizing the market prices, providing incentives to the growers and supplying food items to consumers at reasonable prices, the government is running a program of pricing and procurement of various commodities. Presently, there are 10 commodities for which Government is intervening in their marketing through the implementation of support price. The government intervenes when their prices tend to fall below the support price level ignored to safeguard the farmer's interest. At present, there are seven authorize agencies, which are implementing the support price program of the government. An overview of the input output prices is presented in the appendix 2.1 and 2.2.

2.2.3. Agriculture and Poverty Alleviation

Agriculture continues to provide the bulk of employment for the country's labour force, plays an important role in poverty alleviation. As poverty is multifaceted that agriculture alone cannot solve. Most poverty reducing initiatives likely will have to come from the non-farm sector. The long-term solution for rural unemployment and underemployment lies in the adoption of development strategy and economy wide policies that do not penalize labour use and that generate rapidly growing productive employment outside agriculture. In Pakistan, the poor often are marginal farmers or landless labourers whose main source of income is non-farm sector. While, agriculture sector is playing an important role in poverty alleviation. For example, income from agricultural accounts for just half of the total income of poor households, the total dependency of the poor on agriculture is much larger because of the strong linkages between the farming and non-farming sector. The skewed distribution of land ownership in Pakistan means that agricultural incomes contribute to income inequality, whereas rural non- agricultural income tends to mitigate inequality.

Presently, rural poverty level is significantly higher than urban level. Agriculture has a strong interaction with rural poverty levels. Most of the rural poors are artisans, agricultural labourers, or small farmers. Moreover, some urban poverty is the result of flight from rural areas, providing an additional incentive to ensure that agriculture and poverty interactions are managed properly.

2.2.3.1 History of Institutional Credit

At the time of independence, the credit came primarily from non-institutional sources. Credit provided by the Government and cooperative societies covered a small portion of the capital requirement of the farmers. In 1949, Board of economy enquiry conducted a study, which showed that the share of institutional credit is only 16%, remaining 84% came from non-institutional sources.

As a measure to develop institutional credit, immediate changes were made in the lending rules of the State Bank of Pakistan. The State Bank order of 1948 statutorily authorized it to advance short-term loans to the provincial cooperative banks for financing agricultural operations and marketing of agricultural produce for duration up to 9 months, which was raised in 1956 to 15 months. The State Bank of Pakistan provided credit on concessional rates of interests to cooperatives and the Agricultural Development Bank of Pakistan (ADBP), which was setup in 1961.

As a subsequent major event, the promulgation of the banking reforms of 1972 and constitution of national credit consultative council happened. The agricultural credit advisory committee assisted the council in the preparation of credit estimation the basis of planned growth rate in agriculture and acceleration in the use of agricultural inputs as envisaged in the annual development plans. The allocation were made by the NCCC to the various credit institutions in the light of their past performance and future estimated requirements.

As a measure to simplify the procedure, the agricultural purpose act was promulgated in 1973 to simplify the system of securing mortgage rights, passbooks. The pass books contains the details of the parcels of the land holdings by a land owner in a sub-district, the produce index unit of the land and its valuation together with encumbrance, if any. It was also directed towards fuller participation of the commercial banks in advancing loans and reorienting the credit system towards the small farmers. The pass book is deemed to be a title deed and accepted as such by the banks for granting different type of loans provided the loans do exceeds 80% of the land value. So far, 871,278 passbooks have been issued to the farmers of the different categories. With these facilities, there is still lot more to be done in this regard to speed up issuance process (Maan, 1996).

2.2.3.2 Market Structure of Agricultural Commodities

The marketing structure of agricultural produce in Pakistan is fairly diversified. It ranges from marketing arrangements where private enterprise is free to operate to the substantial Government interventions by way of fixation of flour price, procurement quotas and prices, export quota and credit control. A large number of agricultural commodities and livestock products are completely in the hands of private sector with no restrictions on their movement and prices being generally determined by the interaction of supply and demand. Even here the local administration may fix the prices of item like milk, eggs and meat within the area of their jurisdiction. On the other hand there is substantial public sector interventions in the marketing of the main food grains, sugarcane, sugar (white), lint cotton, tobacco, to name a few. Government agencies involved in agricultural marketing include the cotton export corporation for the purchase and export of lint, cotton. Rice exports corporation for procurement of rice and its export and Pakistan Agriculture Services and Supply corporation (PASSCO) for procurement of wheat and grams. Beside, the ghee corporation of Pakistan is responsible for domestic procurement of oilseeds, import of edible oils, manufacture of 60% of all vegetable 'ghee' and its marketing. Provincial food departments also steps in to procure and distribute wheat and other food products. Sugarcane prices are partially controlled by Government but sugar prices have been decentralized (NCA Report. 1988).

2.2.4. Agriculture and Industry Linkages

As agriculture is dominant in the economy, there is an enormous scope for the development of agribusiness and agro-industries in the country. Presently, agriculture and agribusiness products account for 80 percent of the country's total export earnings and the sector supplies many of the major industries with raw materials besides consuming 33 percent of the industrial finished goods. This sector has great potential of improving productivity both in terms of qualitatively and quantitatively generating employment, particularly, in the rural areas and creating a viable export base through development of forward and backward linkages with farm production system. However, this sector faced many physical, policy and financial constraints. Lack of infrastructure in rural areas predominantly power, gas, water, communication and roads have restrained to achieve major impact on industrial dispersal.

2.2.5. Agricultural Trade Policy

In Pakistan, agriculture is an important source of foreign exchange earnings through exports of agricultural raw and base products. Raw cotton and its manufactured products, rice, leather and its products, fruits and vegetables, spices, and fish are the major export commodities of Pakistan. Agriculture directly accounts for more than one-fourth of total exports. If one take into account all the agro-based manufactured exports, agriculture's share would be around two-thirds of total exports. The imports of agriculture commodities contribute considerably to the negative trade balance of Pakistan. The major agricultural import commodities are edible oil, grains, pulses, tea and coffee, and milk and its products. These commodities accounted for more than half of the negative trade balance (Akhtar, 1999). In addition to the drain of foreign exchange on import of food related agricultural commodities, Pakistan also spent a considerable amount of foreign exchange on the import of agricultural inputs, which include fertilizer, seeds, pesticides and agricultural machinery. Due to the declining trend in the production of major crops, Government announced a package of incentives for the farming community in April 1997 and a growth rate of 5.1 percent for 1997-98 was projected. The salient features of the package were a) increase in support prices, b) reduction in the prices of some inputs and farm machinery, c) availability of agricultural credit, d) increase water supply at farm level, e) increase in agricultural research fund for the dissemination of research results. Resultantly, the recovery in growth is fully supported by agriculture, which staged a strong "V-shaped" recovery on account of bumper cotton and wheat crops, and a good rice crop. Overall, agriculture grew by 5.5 percent in 1999-2000 as against 1.9 percent of last year and current year's target of 4.3 percent (Govt. of Pakistan, 2000).

2.2.6. Exchange Rate Policy

Pakistan imposes export restrictions on a variety of products, mainly agricultural commodities, whose exports are subject to ad volarem, specific or compound duties, either for revenue reasons or to act as a disincentive to export raw materials (Khan and Mehmood, 1996). There are some products whose export is subject to special procedures based on economic consideration. For example, the export of rice by private sector is subject to registration of contracts with Export Promotion Bureau (EPB) and pre-shipment inspection by internationally recognized inspectors. Similarly, the export of cotton by the private sector is subject to the procedure as may be specified by the Government in the gazette. Exports of food products of animal origin, fruits, vegetables, oilseed products and some other commodities are subject to quality control restrictions. Fertilizer export is permitted only after determining the exportable surplus.

Monetary and exchange rate policies are major components of liberalized trade policies in a country. Pakistan's monetary policy refer to the measures which the State Bank of Pakistan takes in controlling the money and credit supply to bring about the desired changes in the economy. During the early 1990s, the government has introduced market oriented monetary and credit policies to achieve the planned growth, anticipate inflation and bring about expected changes in net foreign assets of the banking system. One of the main problems created in the financial markets has been the lack of autonomy of the SBP. The principal financing entity in the system has often been held captive to the political governments. Under the financial sector reform programme of the government, the SBP was given full authority to conduct the monetary policy of the country in May 1997.

Before 1981, like many other countries, Pakistan's rupee was linked to the US dollar for a long time. It was constant at the rate of Rs. 4.762/US$ up to 1971-72. In May 1972 rupee was devalued by 131% from Rs. 4.762/US$ 4 to Rs. 10.59/US$. Subsequently, when US dollar was devalued against all other currencies the new rate was fixed at Rs. 9.9/US dollars in March 1973. In January 1982, the rupee was de-linked from the US dollar and the government followed a managed floating exchange rate policy. Initially the government planned to peg the value of the rupee to an index, which was a weighted average of currencies of Pakistan's major trading partners. This policy allowed the exchange rate to fluctuate against the US dollar. However, this policy did not help much to improve the negative trade balance. From 1980-81 to 1990-91, the rupee was devalued by more than 125%. Up to May 1998, exchange rate arrangements were very liberal and the country followed a managed floating system. Under this system SBP set the daily exchange rate, which it used to purchase and sell US dollars in business with other authorized banks, and foreign exchange authorized dealers. Considering the competitiveness of the tradable sector and to control inflationary pressures, the SBP was adjusting the exchange rate on a frequent basis for various currencies.

The government took a number of measures to move towards the ultimate goal of having market-determined rates of foreign exchange during 1997-98. All commercial banks and authorized foreign exchange dealers were allowed to determine the undertake transitions of their own exchange rates for various currencies in term of rupee depending on the demand and supply situation in the market. However, the US dollar to rupee exchange rate was still being determined by the SBP. Subsequently, from May 24, 1998, banks and authorized dealers were also permitted to fix their own buying/selling rates for US dollars. To maintain the flexible exchange rate policy and safeguard the competitiveness of the Pakistan's exports, three adjustments were made in the exchange rate during 1997-98. A minor adjustment of Rs. 0.06/ US$ was made on July 11, 1997 and other devaluation of Pakistan's rupee of 8% and 4.2% were made on October 15, 1997 and June 27, 1999, respectively. The rupee dollar exchange rate stood at Rs. 46/US$ at the end of June 1998 depicting a total devaluation of 12.0% during 1997-98 compared to 13.2% in 1996-97 (SBP, 1998).

2.2.7. Agriculture and the Environment

With virtually all available cultivable land and water resources now being used, pressure on the country's natural resource bases is growing and environmental problem have already reached critical level. Soil erosion has caused crop yields to dwindle. Forests are being depleted at alarming rates as land is cleared for fuel wood, for agriculture use, and as fodder/forage for livestock. Ranglands are becoming increasingly degraded irreversibly, as a result of uncontrolled grazing of livestock, industrial pollution and increasing level of salinity resulting from upstream irrigation stress the marine environment. Increased pesticide use has created growing resistance among pests and destroyed natural predators. A depleted and polluted environment impact the poor by increasing health problems and lowering the productivity of the natural resource,s off which they often must live. Alone water-borne diseases account for 60 percent of infant mortality in Pakistan.

There is an ecological principal that the poison we put into the environment comes right back to us in our air, water and food. According to different surveys, pesticide residues have been reported in our water, soil, and food commodities and even in cattle and breast milk. Presently, about 70,000 chemicals being traded, of which as many as 35,000 have been classified by the organization for the economic cooperation and development (OECD) and the United States Environmental Protection Agency (US-EPA), as definitely or potentially harmful to health.

A world health organization (WHO) study revealed that about three million people in the world suffer from pesticides poisoning and 220,000 die annually, majority of the victims belongs to developing countries. Pesticides can cause sterility, reduction in fertility, depression of sperm counts, dermatitis, skin cancer, hypertension, immune system disorder, hormonal system disorder, reproductive system disorder and even blood disintegration. Some studies shows that dichlorophenoxy acetic acid (herbicide) can cause non-Hodgkin's lymphoma, a form of cancer. In India alone, according to conservative estimates, there will be 806,000-cancer patient by 2001, largely due to environment pollution including pesticides.

Pesticides consumption is increasing alarmingly in Pakistan. Such a tremendous use of pesticides not only drains the exchequer, but also presents a growing threat to the people and environment of the country. Roughly, 85 to 90 percent of pesticides applied in agriculture never reach the target organism; instead they become dispersed through the air, water and soil. In Pakistan, the problem of pesticides pollution is more acute because of the large number of compounds with different modes of action and toxic characteristics are sold under various generic trade names. Another problem is the abundance of adulterated or fake pesticides available in the markets. Incompetent law implementation authorities and illiterate farmers further aggravate the situation. All these combined pose a serious threat to our environment.

2.3. Opportunities, Challenges and Priorities for the Future

Like many other developing countries, agriculture sector occupies an important place in the economy of Pakistan. It is the main source of foreign exchange, provides employment to over 44% of the labor force, and is the main source of income in the rural areas, which constitute about 70 percent of the total population. Its share in agriculture is slightly above 25 percent to GDP and this sector also provides linkages through which it can stimulate growth in other sectors. Presently, agriculture sector no longer enjoys the same earlier environment to growth in acreage and yields. This is due to many factors including the withdrawal of subsidies on inputs, development of irrigation water has slowed down and health of soil is deteriorating. Beside this, no new technological breakthroughs have come and resultantly the previous growth rate patterns have become unsustainable while population is still growing at a fast rate. Currently the country has been facing shortage of some food commodities, and the increasing demand had to be met through imports.

Pakistan is blessed with diverse agro-climatic conditions, and one of the best irrigation systems of the world. Considering these conditions various crops may be grown almost around the year. It is possible to grow tropical, sub-tropical and temperate crops in the country. Major crops grown in Pakistan are wheat, cotton, rice, sugarcane, gram, maize, sorghum, millet, rapeseed/mustard and tobacco. Minor crops include pulses, potato, onion, chili and garlic etc. Upland crops occupy an important position in the agricultural sector of Pakistan. The average yields of almost all crops are much lower than the potential and needs considerable improvement in the present yield level of all crops. It is expected that due to the heavy pressure of population, demand for agricultural commodities will increase in near future.

Keeping in view the present global economic scenario and the speed with which Pakistan is opening its product market, there is a widespread concern about the effects of trade liberalization on agriculture. Improving the economy of the agriculture sector, achieving the self-sufficiency in food, improving the farmers' income are the top priorities of the country. Considering the present structure of the agriculture sector, natural resource base, policy environment. trade related infrastructure, political economy etc., the country is gradually moving towards liberalizing trade in agriculture and is taking steps to support the domestic agricultural sector to compete in the international markets. To fully implement the requirements of the UR agreement on agriculture there has long way to go, especially in terms of improving the trade infrastructure, quality of the products, environmental issues and issues related to sanitary and phytosanitary requirements of the agreement. To smoothly proceed towards a more liberalized economic environment, the expected effects of trade liberalization related to various agricultural products needs to be identified.

Nature has been kind to Pakistan. God has endowed the economy with abundant rich and fertile land, labor and human resources. In any agrarian economy, growth prospects depend on these endowments. The agricultural growth in the country compares favorably with other developing countries but the nature of sources of this growth has created doubts about its sustainability. The rapid population growth makes this performance less impressive in terms of per capita growth. Pakistan has been endowed with vast tract of potential cultivable virgin land, perennial rivers, to provide water for irrigation, suitable climate for raising different crops and sturdy peasantry to exploit these resources. Presently, agriculture sector is facing several constraints which effects land productivity in Pakistan. Therefore, to coop with the future challenges and to sustain the agricultural growth rate in the country, Government has established following main priorities to catch the future food and fiber requirements of the country (MINFAL, 2000).

i) Higher growth rate of agriculture than the population growth rate.
ii) Food security and self- reliance in food crops.
iii) Enhancing productivity of wheat, rice, oilseeds, cotton and sugarcane.
iv) and and water development for sustained agricultural growth.
v) Timely supplies of Agricultural inputs and appropriate technologies to the farmers and the end users.
vi) Balance emphasis on all aspects of agricultural production, including livestock, fisheries and forestry.
vii) Improving marketing of agricultural commodities.
viii) Emphasizing agricultural research to generate agricultural technologies including biotechnology for raising productivity per unit of land, water and livestock.
ix) Improving the productivity of small farmers while encouraging the large farmers for utilization of modern technologies.

2.4. Strategies to Achieve the Future Priorities

To realize the potential in agriculture, attain the projected growth rate of 5.0 percent per annum and achieve the targets, set for various crops and inputs for the year 2010, the following action plan is envisaged (Agri. Strategy, 2000). Efforts to convert the cultivable waste, riverine, coastal, marginal and fragile lands to productive lands will be intensified by all the concerned public sector organizations. The trend in converting the fertile lands in to housing schemes and other non- agricultural uses will be discouraged. The idea of corporate farming will be encouraged in the country. Conservation of existing water resources, construction of new reservoirs, participatory water users organizations will be developed on priority basis. Activities of on farm water management and integrated land use will be adopted. These interventions will be disseminated through the electronic media specially T.V and radio.

The available agro-biodiversity will be utilized in breeding program to evolve high yielding varieties and sustainable use limits of selected biological resources will be established in the country. Detailed evaluation of available agro-biodiviristy will be made to select desirable genotype having resistance to various biotech stresses. Laws will also be developed to regulate access to the genetic resources.

Emphasis will be given on production and use of hybrid seeds in the country. Efforts will be made to induct NGO's and private sector to promote the hybrid seed. Appropriate varieties for different ecologies will be identified and quarantine laws for imported seeds will be enforced. Rules for truth in labeling to protect the seed industry and farming community will be promulgated.

Availability of fertilizers, stability of prices and private sector investment will be ensured and encouraged. Use of organic, inorganic and bio sources will be promoted by involving extension department. Fertilizer recommendations will be developed for different cropping zones and cropping systems. Availability of gypsum will be ensured for reclamation of sodic soils and sub-standard tube well water.

Pesticide application will be rationalized by developing and promoting IPM approach by establishing farmers' field schools for farmers education in IPM. Manufacturing of pesticides, research on pesticides application equipment and their quality control will be strengthened. The pesticide Act will be strictly enforced in order to check adulteration and other malpractices in the marketing of agro-chemicals.

Easy availability of institutional credit will be given priority and credit card scheme will be introduced. Formal credit will also be extended to rural non-farm households and women's for income generating activities. Diversification of capital investment in agriculture towards the development of farm infrastructure and value added ventures like dairy, horticulture and other export oriented interventions and income-generating programmes at farm level will be encouraged.

Agro-services, rental centers of farm machinery will be encouraged and community based machinery pools have been tried, if operated successfully it will be replicated. Institutional credit for the purchase of tractors, implements will be ensured and prices of tractor will be reduced. The use of small tractors particularly for the orchard and vegetable production will also be encouraged. Public institutions on farm machinery will be evaluated to improve their capacity.

Wheat production in the new areas of the country, availability of improved seed and use of weedicides will be encouraged. Wheat productivity will be increased through launching wheat maximization programs, improved farm management practices and balanced use of chemical fertilizers.

Transplanting operation of the rice will be mechanized to increase the productivity per unit. Hybrid varieties of rice and mechanical harvesting will be promoted in the rice growing areas. It will save 15 to 20 percent harvest losses.

Efforts will be made to shift to CLCuV resistant varieties. Heat and cold resistant varieties will be developed. Expansion of cotton area in Balochistan and D.I. Khan will be considered. Cotton crop maximization program will be started to educate the farmers about agronomic practices and to increase productivity.

Sugarcane is an insufficient water user, therefore, increase in its area will no be encouraged. All efforts will be made to increase its per unit productivity. For improving sugar recovery, payment of the sugarcane will made on the basis of sucrose contents or varieties having high sucrose will get premium prices. This intervention will popularize the cultivation of high sucrose varieties. Sugarcane crop maximization programm will also be started to educate the farmers about agronomic practices and to increase productivity.

Edible oil sector consisting of cottonseed, canola and sunflower will form the part of edible oil self-reliance strategy. Local production of sunflower hybrid seed and domestic certified canola seed will be encouraged. Some areas of Balochistan and Sind will be used for oilseed cultivation. The loss of cottonseed oil during processing of cottonseed is high; it will be reduced through improving extraction technology.

Horticultural crops, floriculture and agro-based industry will be promoted in the country. Marketing of vegetable and fruits in the remote areas will be improved by providing marketing credit and improving infrastructure. Farmers around the cities will be encouraged to grow flowers, vegetables and fruits. Their specialized markets will be established. Arid land horticulture, nurseries in public sectors and horticultural export will be encouraged.

For the development of livestock sector emphasis will be on quality rather than quantity. The above mentioned target will be achieved by increasing the per unit productivity of animals, ensuring improved feed and fodder availability, improving animal health care services, strengthening livestock extension services and livestock marketing system will also be improved.

In order to improve the fisheries sector, priorities will be given to modernize the fishing fleets; to develop export out let from Gowader and Pasni and in future a shrimp conservation policy will also be followed. Improvement in human resources and information system for fish exporters will be developed. Resource survey and research on stock assessment, migratory pattern and biological studies will be carried out to develop strategies for sustained exploitation. Improved aquaculture techniques like pen culture and cage culture will be introduced through demonstration to fish farmers.

Small farmers will be encouraged to take up small enterprises, e.g. mushroom, honey production, plant nurseries, rural poultry and kitchen gardening. Cut flower industries will be established around the main cities.

Research Institute will be provided more autonomy, funds and a technology transfer institute will be established in each research institute. Practical training will be built into the degree programme and electronic media specially T.V. network will be more extensively used for telecasting special programme. Under intellectual property right, all seeds of local varieties will be patented and plant breeder's rights act will be enacted to protect the rights of breeders and research institutes. The finance division will be approached not to apply cuts on the allocation of funds for agriculture sector.

Priorities of agricultural research system will be restructured. Management information system to effectively manage the research system will be started. Under this human resources will also be developed. Cess fund may be levied on commodities/ inputs to generate research funds. The modality of generating and using funds can be worked out. The detailed strategy about research is spelt out in the National Master Agriculture Research Plan for 1996-2005, prepared by Pakistan Agricultural Research Council.

Chapter 3: CROP PROTECTION AND PESTICIDE USE

Despite, considerable advancements have been made in terms of production of main agricultural crops, the current yields of major crops in Pakistan are less than 25% of the world potential. One of the major constraints to achieving potential yields and quality of crops is the attack of a variety of pests. The pest problem increased with the introduction of high yielding and fertilizer responsive crop varieties, which proved susceptible to various pests. For example, introduction of deltapine cotton in Pakistan has resulted in changing the status of so far very minor pest e.g. *Heliothis* and army worm to serious pests of cotton; resulting in ban on deltapine cultivation. Similarly, cultivation of IRRI-6 is responsible for introduction of rice planthopper and rice blast (Chaudhry, 1981). Wheat rust is becoming a nuisance due to the introduction of Mexican origin varieties. The wild oats and *Phalaris* grass so far weeds are of minor importance have become source of serious infestation in wheat due to import of Mexican seeds in large quantities.

Some plant feeding insects are important, not so much because they directly reduce crop yield and quality, but because they transmit disease organisms. This is particularly the case with crop virus diseases, many of which can only spread from plant to plant by means of suitable insect vectors. In Pakistan, for example, the white fly (*Bemisia tabaci* Genn.) is a notorious vector of the cotton leaf curl virus. The traditional control methods became insufficient to control these pest problems.

In Pakistan, crop protection is largely dependent on the heavy use of pesticides, either due to inefficient alternative control tactics or inadequate knowledge of these tactics to the end users. Since the pesticide business has been privatized in the country, there has been steady increase in the pesticide import and consumption. Now Pakistan is considered the second largest pesticide consuming country among the twelve Asia and Pacific regional countries and occupies a disadvantageous place in terms of safe use of pesticides (Qasmi, 1997).

Pesticides have not solved the pest problems and in addition, increased the cost of production. Pimental (1992) reported that despite the use of 2.5 million tons of pesticides worldwide in 1992, 55% of potential crop production is lost to pests. In monitory terms the loss to crops in Pakistan is estimated around Rs.130 billion annually (Baloch, 1995). In Pakistan, cotton crop alone faces more than 130 pest species, which cause loss of millions of rupees annually (Ahmad, 1995). In sixties, sugarcane *Pyrilla* and sugarcane borers reduced the sugar recovery upto 5% in NWFP. Similarly, stem borers, plant hoppers and leaffolder, also seriously attack rice crop every year (Baloch, 1995). However, the occurrence, population density and distribution of these pests vary depending upon availability of original as well as alternate host plants besides the optimum environmental conditions for their multiplication. Increasing salinity problem and decreasing soil organic contents are also one of the main reasons of reducing the vigor of the crops and increasing their susceptibility to pests and diseases.

3.1. Historical Overview of Crop Protection Problems

At the inception of Pakistan, there was practically no plant protection service in the country, nor were there any means for the farmers to understand and realize the needs and economic soundness of plant protection measures and to obtain their requirements of pesticides and equipment.

The agricultural services although both at the Federal and provinces were making concentrated efforts for the evolution of higher yielding varieties and introducing them, application of fertilizer, production and distribution of improved seeds, better agricultural practices and farm mechanization etc. But no adequate arrangements for prevention and reduction of losses by insect and diseases were made. However in late fifties, due to heavy losses incurred by pest, a realization came to the country and a plan for employing the existing resources for spot spraying against pests and diseases was conceived (Chaudhry, 1981). The incidence of major pests of important crops (where pesticide use is high) and their control measure is discussed as follow:

3.1.1. Major Insect Pests and Disease Incidence 1970-2000

3.1.1.1 Cotton

a) Insects

The pests of cotton fall into two broad types, the sucking pests, white fly, thrips, jassids, aphids and mites which usually come in first, and the bollworms, which have their greatest effect during the boll formation stage. It is estimated that about 20-40% loss is occurring annually due to different pests of cotton (Ahmad, 1999). Following the peaks in 1991-92, yields of cotton in Pakistan have rapidly decreased to less than 500kg/ha, lint, in 1993-94. Compared to the era of eighties when Pakistan achieved a yield of 768kg/ha, the yields are going down and in 1998-99 crop season the yield was 511kg/ha. The main reasons were the lare up of cotton leaf curl virus, white fly, *Helicoverpa armigera* and complete failure of chemical control against major insect pests. Insecticide resistance in white fly and bollworms has increased manifold against pyrethroids and many organophosphatic pesticides (Ahmad, 1995).

In Pakistan, the pink bollworm, *Pectinophora gossyiella* first appeared as pest in 1961 in the southern Punjab and was related to wide-scale cultivation of cotton in the area. For the first time, *H. armigera* was found on cotton in 1967, after aerial application. In 1983, the cotton crop failed in Pakistan because of heavy rains in September, which resulted in high pest infestation. Later on, farmers started applying pesticides indiscriminately on cotton, which resulted in increase of secondary pests. The aphids appeared in 1987, 1988 and 1990. During the same season, *H. armigera* re-appeared and now it has become a regular pest. The tea mite, which was not a cotton pest in Pakistan, was first detected in 1983, became serious problem in 1988 and now appears every year in greater number. Before 1985, white fly appeared sporadically on cotton and it has become persistent pest since 1987 causing quantitative and qualitative loss to cotton (Ahmad, 2000).

The main problem has been the flare up of pests due to favorable climatic conditions. The decline in cotton production is partly related to El-nino effect of weather, which prevailed over this region for the last three years. Due to El-nino effect, the cotton bollworm *H. armigera* appeared as the key pest in the whole region and damaged the cotton crop considerably. In 1992, Cotton Leaf Curl Virus spread by cotton white fly (*Bemisia tabaci* Genn) damaged cotton crop in Pakistan. In 1996, the crop failures in Pakistan were related to white fly damage, which appeared in epidemic form all over the country. In 1997, crop season due to El-nino effect American bollworm appeared in large numbers and farmers became helpless to control this pest (Ahmad, 1999).

The disastrous falls in cotton production (1.9 million bales and 29% loss of total production) in 1993-94 have mainly attributed to the cotton leaf curl virus (CLCuV). This may be the combination of heavy rains and increased insect attacks especially American bollworm (*H. armigera*). The part of the problem has been due to increasing resistance of white fly and American bollworm to insecticides. The extent of the yield declined to 1479 kg/ha in 1993-94 is a clear indication of the importance of pest problems to cotton.

Chemical based control programme has actually increased the seriousness of the problem. They disturbed the agro-ecosystem and killed the non-target and environment friendly organisms such as parasitoids, predators and birds. Disturbance in an agro-ecosystem led the new pest problems through resurgence and resistance processes in the naturally occurring pest populations. Since 1980, minor pests have become major and new pests have appeared on cotton (Table 2). Before 1980, cotton Jassid was the only key pest. The extensive use of pesticides since 1982, further changed the pest complex and cotton bollworms, white fly began to appear as major pests after the resurgence, besides cotton Jassid (Inayatullah, 1997; Ahmad, 2000).

Table 2. Changes in insect pests of cotton

Year 1980	Year 1998
Jassid	Jassid
White fly	White fly
Thrips	Thrips
Spotted Bollworm	Spotted Bollworm
Pink Bollworm	Pink Bollworm
Spider Mites	Spider Mites
	Aphids
	American Bollworm
	Tea-mite

Source: Ahmad, 2000

American bollworms, aphids and tea mites were originally not pests of cotton in Pakistan, but became as a direct result of large scale and indiscriminate use of pesticides. The detail of the damages due to insect pests since 1992-93 is given in Table 3.

Table 3. Production loss due to insect pests

Loss in Production (000 Bales)	Year
250	1992-93
1650	1993-94
2500	1994-95
2000	1995-96
2700	1996-97
2800	1997-98
3050	1998-99

Source: Ahmad, 2000.

The population of red spider mite also increased during this time and became a new pest of cotton. In addition, cotton aphid also appeared in outbreak form, but late in the season. It makes cotton lint black and covered with honeydew on which fungus grows, making the lint unacceptable for marketing (Inayatullah, 1997).

Due to indiscriminate use of pesticides, the pests of cotton flared up late in the season and did considerable loss to the cotton crop. It is evident from the statistics that the production loss due to insect pests increased from 250 thousand bales in 1992-93 to 3,050 thousand bales in 1998-99. Besides direct yield losses, the feeding insects also cause indirect loss by transmitting diseases to crops. For example, white fly is a big source of transmitting cotton leaf curl virus disease in Pakistan since 1993-94.

b) Diseases

Besides cotton leaf curl virus, bacterial blight, boll rot and root rot were the main cotton diseases of Pakistan. Bacterial blight was widespread throughout the country. It has been more or less eliminated due to acid delinting of the seed. Boll rot spreads due to insect injury and high humidity. It was not considered an economic disease because most of the varieties were late maturing and fruit formation did not take place in the month of August. During high rainfall and high humidity the damage may occur upto 150-200 kgs of seed cotton/acre (Khan *et al.*, 1994). The root rot is a localized disease and appears in patches.

Cotton Leaf Curl Virus: The Cotton Leaf Curl Virus was first observed in Pakistan near Multan in 1967 and has been noted occasionally since then. This position of disease persisted till 1987. In 1988 about 60 hectares of cotton near Multan were completely damaged (Ahmad, 2000). Since then the intensity of the disease has been increasing and affected thousands of acres in different districts of Punjab. The detail of the area affected and the loss occurred due to Cotton Leaf Curl Virus is given in Table 4.

As may be seen from the table that losses were so severe that the farmers in many districts gave up cultivation of cotton and the area reduced considerably in these districts. It is now believed that only member of the *Malvaceae* can be hosts to CLCuV particularly Okra, which is widely grown in cotton areas and providing an ideal overwintering species for the virus. With the development of resistant varieties the varietal pattern changed and the most susceptible varieties were replaced by relatively tolerant and resistant varieties.

Table 4. Production loss due to Cotton Leaf Curl Virus in the Punjab (1988-1999)

Year	Affected Area (000 hectares)			Loss in Production (000 bales)
	Partial	Complete	Total	
1988-89		0.06	0.06	0.3
1989-90		0.20	0.20	1.0
1990-91		0.80	0.80	4.0
1991-92	11.3	0.60	14.10	20.0
1992-93	364.0	121.0	485.00	750.0
1993-94	807.0	262.0	889.00	18.80
1994-95	407.0		407.00	221.0
1995-96	882.0		882.00	447.0
1996-97	1823.9	137.4	1761.0	2100.0
1997-98	762.9	19.50	782.4	1118.0
1998-99	457.9		457.9	587.1
1999-00	289.1		289.1	370.5

Source: Ahmad. 2000

Weeds: Around 18 species of weeds are found in cotton fields (Annexure 3.1). *Trianthema monogyna* is the most widely mentioned weed. The range of weed species occurring in cotton is probably much wider than this. There are a number of *Malvaceae* weeds that grow along cotton, where that can play an important role as alternate hosts for cotton leaf curl virus. A delay in weeding can drastically reduce yields and 75% decrease in yield is estimated, after 90 days without weed control situation. Weeds in cotton crop provide a micro-environment with increased shade and higher humidity that assist the multiplication of pests and diseases (Anon, 1995; Ahmad, 2000). Weed free cotton suffered less with disease may be a direct result of lower white fly populations.

c) Pest Control Strategies

The effective pest control measures are vital part of farming. Prior to the introduction of green revolution in early sixties, farmers used to control pests through farming practices and the mechanical r.:moval of pests. Pests were kept under economic damage levels through simple farming practices like crop rotation, trap crops, leave set aside, resistant crop varieties (nonsucculent, stout and hairy), altering the sowing or harvesting time, to manage pest populations. The traditional farmers were growing many crops side by side. This provided a rich and diverse agricultural bio-diversity. A rich bio-diversity helps in controlling insect pests, due to presence of plenty of natural enemies (Poswal and Williamson, 1998). Similarly, presence of limited host plants also checks the widespread of pests. Later on, pesticides became a regular part of plant protection and at present chemical control method is widely in practice.

IPM: The success of pest control lies only on implementation of IPM programmes, which can reduce the usage of insecticide. Pakistan has both early and late maturing varieties. The early maturing varieties need early plant protection measures as late maturing varieties shed all their early fruit, plant protection early in the season is not necessary. It is important to know that periods of growth and fruit production so that pest control programmes are adjusted accordingly in the overall insect and crop management system. These periods not only describe the different phases of plant growth and development, but also confirm to the changing patterns of insect pest problems and provide a basis for pest control decision-making in integrated control system.

i) Breeding of hairy varieties against jassid attack is mandatory in Pakistan. Nectariless cotton provides resistance to bollworms and leafhoppers.
ii) Early planting encouraged attack of thrips and spotted bollworm, while late planting resulted in late maturity and heavy infestation of pink bollworm.
iii) In cotton-wheat and cotton-fallow rotation a pest-free period of almost six months helps to eliminate hibernating and diapausing larvae of bollworms Sunflower, Soybean and spring
iii) Maize help in the buildup of *H. armigera* (Ahmad, 2000). The planting of maize and sorghum around cotton fields also helps in the multiplication of parasitoids and predators.
iv) Infestation of jassid is reduced during hot and dry seasons. High temperatures induce sterility in pink bollworm. Infestation of pink bollworm is reduced at 37-38°C (Ahmad, 2000). In 1990-91 crop season, the infestation of pink bollworm was low because of temperatures (40°C) in July and August.
v) Lucerne helps in conservation of predators to control sucking pests. The most important predators are the green lace wing (*Chrysoperla carnea*), flower bug (*Orius* sp.) and syrphid fly, other predators includes *Geocorus* sp., *Corams* sp., *Rhynocoris* sp., Staphylinid beetles, spiders and birds.
v) Animal grazing after last picking is recommended to avoid carryover and control pink bollworm.

3.1.1.2. Rice

Rice, the third largest crop of Pakistan, is grown under diverse climatic and edaphic conditions. The Punjab is leading rice-growing province famous for producing aromatic Basmati varieties. Rice-Wheat is the major rotation in this area. Besides, berseem, sunflower, peas and watermelon are grown in rotation with rice.

a) Insects

In Pakistan, paddy crop is attacked by 69 insect pests, which cause about 15-17% loss on recurrent basis. The major insect pests that cause significant yield losses are stem borers, leaffolders (LF), plant-hoppers, and leafhopper (Inayatullah *et al.*, 1986; Mahar and Bhatti, 1986; Rehman *et al.*, 1986). Stem borers, leaf and plant hoppers, leaffolder and grasshoppers are most serious and are of regular occurrence. The mealy bugs, rice hispa, etc., occur periodically or as and when conditions are conducive for their population build up and distribution. The abundance of pest species varies from one region to another. For instance, stem borers are predominant in Basmati growing areas of Punjab, plant hoppers in Sindh and grasshoppers in Swat valley of NWFP (Inayatullah *et al.*, 1986). Niaz (1971) reported 10 major species of economic importance, which cause about 25-30% damage.

Since the introduction of high yielding varieties, distinct changes have occurred in the insect pest complex of Pakistan. Several species, which were once considered minor pests, are now considered major pests in Pakistan. Examples are LF and white-backed planthopper (WBPH), stem borers are still a great threat in traditional Basmati growing areas (Kalar tract) in Punjab province. Basmati yield loss caused by yellow stem borer (*Scripophaga incertulas*), white stem borer (*Scripophaga innotata*), pink stem borer (*Sesamia inferens*) and striped stem borer (*Chilo suppressalis*) has been estimated at 20-25% (Afzal *et al.*, 1977; Ahmad *et al.*, 1979; Ahmad, 1984, 1987; Mahar *et al.*, 1986). The LF complex, including *Cnaphalocrocis medinalis* and *Marasmia patnalis*, has become a major pest of rice due to the reduced genetic variability in rice, change in cultural practices like using higher amounts of fertilizers in high-yielding varieties (Dahaliwal *et al.*, 1979). Medium grain (IRRI) rice varieties are more susceptible to WBPH while the Basmati varieties are more susceptible to damage by stem borers. Both types of rice are relatively susceptible to LF.

The Pest Warning and Quality Control of Pesticides Institute has surveyed the Rice Zone (Sheikhupura, Gujranwala and Sialkot Districts) since 1984 for various insect pests and rice blast. The overall data for these regions show that the percentage of fields with borer remained fairly constant at between 15 and 26 percent, from 1984 to 1990 and that hispa generally remained very low at 0.1 to 0.9%, an exception being 1986, when 3% were reported in Sialkot. Populations of WBPH were also low over the same period (0.1 to 1.6%). However, LF population increased from a low level in 1984-87 (maximum 2.9%) to relatively high levels from 1987 to 1990 (8.2, 8.5, 27.3 and 21.8%, respectively). In general, the incidence of borers and plant hopper was greatest in the Sheikhupura District, while LF population were consistently more common in Sheikhupura and Sialkot, but less common in the Gujranwala District.

Stem borers: In Pakistan, the most important and widely distributed species are yellow stem borer, *S. incertulas* (Walker), white stem borer, *S. innotata* (Walker), pink stem borer, *Sesamia inferens* (Walker) and striped stem borer, *Chilo suppressalis* (Walker) (Haque, 1970; Koehlar, 1971; Inayatullah *et al.*, 1989, 1990; Inayatullah and Rehman, 1990). The survival of *S. incertulas* during the year can be divided into three phases; phase-I, the survival of over-wintering larvae in stubbles from November through March; phase-II, survival of all the life stages from April to June. During this period the insect survives on volunteer rice, sprouted rice stubbles and rice nurseries; and phase-III, survival on rice crop from July through October (Inayatullah *et al.*, 1989).

During phase-I, high maximum temperature, low minimum temperature, low relative humidity and low rainfall; during phase-II, high maximum temperature, high minimum temperature, high relative humidity and low rainfall; and during phase-III, low temperature, high relative humidity and high rainfall encouraged the population build up of *S. incertulas*. Generally *S. incertulas* remains active from April to October and hibernates in stubble from November to March.

Analysis of light trap catches data at Rice Research Institute, Kala Shah Kaku from 1976 to 1987 had revealed that number of *S. innotata* adults increased in alternate years since 1977, whereas from 1984 to 1986, the population of *S. incertulas* was higher continuously. Population of *S. incertulas* was higher in those years in which *S. innotata* was not abundant and *vice versa*. Thus the two species co-exist but their higher densities occur in different timings. In fact, the two species have evolved two mechanisms of co-existences; (i) the wet weather in phase-III is suitable for the development of *S. incertulas*. Whereas comparatively dry weather in this phase is suitable for *S. innotata;* (ii) the emergence of the adults of two species at different times of the year helps in avoiding the inter-specific competition. Emergence of *S. innotata* usually starts at the end of March and the first peak is observed in April, whereas *S. incertulas* emergence starts in April and the first peak is observed in May. Similarly, the second peak of *S. innotata* is observed in second week of September where as that of *S. incertulas* is observed at the end of September (Inayatullah *et al.*, 1989).

Pink stem borer, *S. inferens* does not hibernate in rice stubbles and remain active throughout the year. It is a common pest of both rice and wheat in Pakistan but is considered as a minor pest of both the crops. This may be due to its polyphagous nature. Outbreaks in rice usually result from a population spill over from adjacent sugarcane fields or other alternate hosts. Its first peak is found in April and second in September on rice crop.

Leaffolders: The rice leaffolder, *Cnaphalocrocis medinalis* earlier considered as a minor and sporadic pest of rice, appear to have become increasingly important with the spread of high yielding varieties and accompanying changes in cultural practices. Misuse and excessive use of nitrogenous fertilizers have been cited as the cause for high LF populations. Leaffolder is now distributed all over the Pakistan, particularly Kalar tract of Punjab and Sindh. Infestation of LF generally starts in late August and peak population is found from mid September to late *b) Diseases*

Diseases of rice include, bacterial leaf blight, bakanae disease and foot rot, paddy blast, brown leaf spot, narrow brown leaf spot, stem rot, kernel smut and false smut (green smut). Of the six commercial varieties of rice, the two medium grain varieties (IRRI-6 and KS-282) are resistant to foot rot and paddy blast, while the some Basmati varieties (Bas-385, Bas-198) are more susceptible to both diseases.

In most of the Punjab, early maturing Basmati varieties (3 weeks early) mature at the peak of rice blast leading to neck blast and breaking of panicle, damage that is much worse than is found with the later maturing varieties. The early maturing Basmati varieties have been very successful in North Punjab, where it was not previously possible to grow Basmati varieties, and where rice blast is not a problem. Among plant parasitic nematodes, *Hirschmaniella* sp. has been observed on rice but otherwise information is extremely limited.

Disease management: The first aim must be to try to prevent any disease entering the field by removing, possibly by ploughing, any diseased residues of rice or other plant materials. This is an additional argument for careful land preparation before planting rice. Seed should be clear of disease and can be treated inexpensively with a fungicide, such as Benomyl or Topsin. Seed treatment is more effective when applied to pre-germinated or pre-imbibed seed.

Weeds: The most serious weeds of rice are those annual members of the Cyperaceae and Gramineae that are adapted to growing in water, *Cyperus iria, Cyerus difformis, Fimbristylis* spp. *Echinochloa crusgalli* and *Echinochloa colona* (Annexure 3.3). *Sphenoclea zylanica*, broad leaf, and *Marcelia minuta*, fern, are typical, and widely found rice weeds. Khan *et al.* (1987) consider that sedge and grass weeds are responsible for most of the yield losses of rice. This view is supported by the Rice Research Institute, who estimates that grass weeds represent 80 percent of the total weed population, compared with only 15 percent for sedges and 5 percent for broad leaf weeds. The low incidence of broad leaf weeds is not unusual, but the 15% attributed to sedge weeds is not typical of rice growing areas because these weeds are well adapted to waterlogged conditions, and usually represent a higher percentage.

Typha is present but the most widely reported perennial weed of rice in the Punjab is *Cyperus rotundus*, which is rarely if ever found in the classic rice growing areas of South East Asia. Its presence as a weed of rice, together with such species as *Cynodon dactylon* and *Sorghum halepense*, which are well adapted to dry conditions, together with the wide range of non-water adapted annuals, such as *Silybum marianum* and *Stellaria media*, is an indication that water management is not adequate for good weed control (Anon, 1995).

Weed management: Hand weeding is not considered to be a serious option in rice because labour is difficult to find, is expensive, and sometimes more damage can be done by trampling the rice while hand weeding than by the weeds themselves. Emphasis is given to control weeds during land preparation, particularly in submerged condition. The most persistent weeds are grasses, which, in the past, have been difficult to selectively kill, but there are now a number of herbicides, available in the Pakistan, that can selectively remove grass weeds and sedges from rice. Some sedges and broad leaf weeds have been traditionally removed with the phenoxy herbicides, and these can still be effective, but their continual use can result in an increase of grass weeds. A detailed study of weed management and rice yield revealed that Butachlor (Machete), Thiobencarb (Saturn) and Propanil (Stam) gave good results. The cost benefit ratio was dependent on the population of weeds, but all three products were better than hand weeding (Zafar and Sabir, 1989). It is likely that the future development of rice in Pakistan will depend increasingly on the use of herbicides, to compensate for the decreasing availability of good quality water.

3.1.1.3. Sugarcane

a) Insects

Stem borers: Lapidopterous stem borers are serious pests of sugarcane in Pakistan. Carl (1962) reported early stem (Shoot) borer, *Chilo infuscatellus* (Sn.), Top borers, *Scirpophaga (Tryporyza) nivella* (F.) and *S. excerptalis (Tryporyza nivella intacta)*, root borer, *Polyocha (Emmalocerca) depressela* (Swinh), and "pink borer", *Sesamia inferens* (Wlk) from sugarcane in Punjab and NWFP. Of these, first two species are regarded as serious pests. Gurdaspur borer, *Bissetia steniella* (Hampson) has become a serious pest in Punjab (Mohyuddin, 1980), since it damages the cane in July, when the crop is almost mature and difficult to treat by chemical or mechanical means. Losses of approximately 23% of cane weight, 39% of cane juice and 13% of sugar content have been reported by Ayub Agriculture Research Institute (AARI). Overwintering larvae pupate in the stubbles and adults emerge later than other borers in July. *C. infuscatellus* can also be a very destructive pest of sugarcane and attacks the cane during both the early growth stages in spring and after node formation. In particular, it kills the growing point of young plants forming "deadhearts". Overwintering larvae pupate from March and emerge as adult from late March. *S. nivella* and *S. excerptalis* cause similar damage, although unlike *C. infuscatellus*, these species remain active throughout the year and complete four to five generations. Damage is confined to the top part of the cane where the larvae make a ring around the stem and feed on the pith.

The pink (rice) borer, *S. inferens*, has recently caused localized problems on sugarcane in the two rice-growing Districts, but sugarcane is not a preferred host for oviposition (grasses are preferred) and this pests is not generally considered to be important. *P. depressela* although widely distributed is also not considered to be an important pest.

Sucking pests: The "Indian Sugarcane Leafhopper", *Pyrilla perpusilla*, has been reported to be a serious late season pest on sugarcane in the Punjab and NWFP and is capable of significantly reducing sugar yields (to 7-7.5%). However, biological control of this pest seems to be working well in at least some areas. Over wintering nymphs moult to adult in the spring and several generations can occur per annum. In early part of the year, the majority of the nymph may transfer to adjacent wheat fields. It breeds on sugarcane, pearl millet, wheat and maize (Fennah, 1969). In Pakistan, it is a serious pest of sugarcane in NWFP and extensive aerial spray was done to control it (Mohyuddin, 1981).

Another potential sucking pest is the black bug, *Cavelerius [Macropes] excavatus*, which can present a serious problem in some years on ratoon crops. The incidence *of C. excavatus* is increasing year after year due to increasing moisture stress. Where severe problems occur, ratoon crop is not recommend (Anon. 1995). Whitefly and mealy-bugs have been recorded throughout Pakistan attacking sugarcane crop. *Aleurolobus barodensis* Mask. is widely distributed in the Punjab and NWFP and is serious pest in the NWFP probably due to aerial spraying. Localised outbreaks of mealy bug have been reported and severe infestations were found at Khanpur (Mohyuddin, 1981).

Termites (*Termes obesus*) can also be serious in some areas in southern Punjab. For example, in Layyah District, where losses of up to 50% can occur especially in young cane. While the red spider mite, *Tetranychus indicus*, can be a problem in some years when it is particularly dry, even in irrigated areas.

Insect control:

i) Most farmers cannot afford to apply pesticides on sugarcane, although some large farmers and subsidised tenant farmers use granular insecticides such as carbofuran (Furadan^R), diazinon (Diazinon^R) or dimethoate (Basudin^R) to limited extent. These compounds are also thought to improve root growth.

ii) Aerial spraying has been used in the past against *Pyrilla* in the Sindh and NWFP, but in the Punjab sugarcane fields are too fragmented with too many obstructions for this method of application to be effective or safe. Sets may also be treated at planting; formerly organochlorine insecticides were used for this purpose, and sevin dust is now under trial for termite control, but such treatments are only applied by a few large farmers in Barani areas.

iii) Greater emphasis is placed on non-chemical means of control, including the mechanical removal of damaged tops etc., and other cultural methods, although most farmers do not appear to be concerned about the removal or destruction of cane stubble.

iv) The spring planting date has an important effect on the percentage infestation by borers. plantings in late February giving higher yields and a lower percentage of "deadhearts" compared with March planting.

v) The biological control of insect pests by natural enemies generally plays a more important role on sugarcane than most other crops. For example, successful biological control of *P. perpusilla* has been reported by PARC-IIBC (now CABI Bio Science) within the Punjab, NWFP and the Sindh. The nymph and adult parasitoid, *Epiricania (Epipyrops) melanoleuca* appears to be particularly important and is common in the Punjab, although periodic redistribution is necessary, and it has been successfully introduced by CABI in various other regions. The parasitoid lays its eggs on "trash" and can be spread by distributing leaves with parasitiod eggs, although such foliage is commonly used for fodder. Attempts to keep eggs alive for extended periods have so far proved unsuccessful.

vi) Various predators of *Pyrilla* eggs, including Coccinelids and lacewings (*Chrysopa* spp) are also widely distributed. Other parasitoids include the egg parasite, *Tetrastichus pyrillae*, which is less well established but has proved effective in Pakistan through augmentation and redistribution. *Tetrastichus pyrillae* also parasitises eggs of whitefly and *H. armigera*.

vii) The endolarval parasitoid, *Cotesia (Apanteles) flavipes* was first introduced into Pakistan in 1962 and became established on maize borer, *Chilo partellus*. Subsequently, sugarcane borer-adapted strains were introduced in 1983 and it is now widely distributed and is reported to give high levels of parasitism on sugarcane in at least some area with the exception of top borers. Releases of the egg parasitoid *Trichogramma chilonis* have also been shown to be very cost effective against cane borers in large-scale trials in the Sindh, NWFP and the Punjab (Mohyuddin, 1981). This parasitoid is particularly amenable to mass-production under laboratory conditions. Combined releases were found to give the best control against top borer. *Telenomus dignus* removes scales from egg masses allowing *T. chilonis* to parasitise the remaining eggs.

b) Diseases

Red rot caused by *Colletotrichum falcatum* is considered to be the most important disease of sugarcane and is the main focus of plant breeding for resistance. Other commonly prevalent diseases include smut (*Ustilage scitaminea*), sugarcane mosaic virus, Pokkah boeng (*Fusarium moniliforme*), red stripe (*Xanthomonas rubrlieans*) and sugarcane rust (*Pucinia melanocephala*). The importance of smut has delined with the advent of tolerant varieties, disinfection of setts and suitable cultural control (Anon. 1995). In contrast, sugarcane rust has emerged since 1990 as a new disease mainly because BL-162 is susceptible and a varietal selection programme is now in progress. Sugarcane mosaic virus is also more important, since resistance to red rot is not reciprocal, and this virus can reduce yields by approximately 15%.

There is little or no use of fungicides for the treatment of the diseases of sugarcane, the main strategy being the breeding of new varieties with resistance. There is now increasing interest in non-chemical control of diseases, especially the use of mounds and furrow irrigation to keep the cane base dry and away from fungal spores and bacteria in irrigation water.

Weeds: The weeds occur in sugarcane crop are given in annexure 3.4. The population of weeds present in a sugarcane crop at any time depend on the soil, the agronomic history of land use and time of year. The most persistent weeds were the perennial broad leaf, *Convolvulus arvensis*, the perennial grass *Cynodon dactylon*, and the perennial sedge *Cyperrus rotundus*. The importance of these particular weeds lies with their ability to survive the current agronomic practices, especially the herbicides that are most commonly used.

Weeds invade sugarcane fields at planting and ratooning. The annual weeds are easy to control at planting by preparing a seed bed and incorporating a pre-emergence herbicide. But it is difficult to control perennial weeds, especially during the period immediately after cutting the cane, because cultivation is not possible within crop row, and the pre-emergence selective herbicides cannot control weeds that have become established during the previous season.

Weed management: Traditionally, weeds have been controlled by preparing a well-cultivated planting bed, and by mechanical weed removal from the rows. More recently Gesapax combi has been used to control germinating weeds, but this mixture of triazine herbicides cannot control perennial weeds, which is one of the reasons why they are becoming so important. The other reason is that cultivation breaks the rhizomes and, in the case of *Cyperus rotundus*, separates the tubers, but does not kill them.

Weed control becomes more complex when inter-cropping is done. It is difficult to find selective herbicides suitable to both crops, though inter-cropping can reduce weed problems.

3.2. A Critical look at Crop Loss assessment 1970-2000

3.2.1. Reports of Crop Loss: Some Examples of Pre and Post-harvest

3.2.1.1 Insects

It is rather difficult to present statistically correct and scientific data on the losses caused by insect pests and diseases. Many variable and complicated factors are involved; so is the variation of the damages caused by a particular organism or group of organisms on a given crop and in a given area, from year to year. Infestations reduce the yield, lower the quality, increase the cost of production & harvesting and require outlays for equipment and materials for adequate control measures.

According to the recent estimates, the crop losses brought about by the destructive action of insects alone, average annually to Rs.51.0 per acre of agriculture and horticultural land. FAO have estimated that the world is loosing 33 million tons of food grain due to damages caused by insects, fungi and mites in storage (Chaudhry, 1981). Food and Agriculture Commission (1960) placed the losses at 10 to 15% of potential yield of crop and 50 to 100% in severe out-breaks. Chaudhry (1981) reported that losses estimated in major crops are Rs.1437.00 million by insects, Rs.1029.3 million by diseases and Rs.1144.0 million by weeds, totalling to Rs.3610 million per year. The Agricultural Inquiry Committee (1975) recorded that increase in yield can be 10 to 25% due to plant protection measures. In Fifth year plan (1978-83) 20 to 30% losses were estimated. Some of the outstanding examples of havoc created by pests are:

> In the fifties, rice infested with borers produced so many grainless ears, that the crop was left unharvested and allowed grazing. It was established that about one lac (0.1 million) borers were successfully hibernating in the stubbles per acre, and thus were carrying over infestations from season to season. In Hafizabad Tehsil alone, in 1956 and 1955 the intensity of rice borer attack reached a level of 77% thus resulting into a damage amounting to Rs.400 crores. Reduction in yield of Basmati varieties on account of rice stem borers has been estimated at 20-25%. During outbreak years, 70-90% of crop may be damaged and in certain cases crop had to be left un-harvested due to high cost of harvesting than the yield obtained. It is reported that attack of rice stem borers was as high as 80% in late transplanted crop during 1957. However, the incidence of stem borers has been reduced with the introduction of Basmati 385, which is comparatively resistant to stem borers than the traditional variety, Basmati 370.
>
> *Pyrilla* on sugarcane is yet another example of insect capable of inflicting intense damage, if left unchecked. Severe attacks of this pest in Frontier Province have reduced the sugar recovery to as low as 5%. A survey carried out in 1956 revealed that the quantity of grains lost due to rodents in Sialkot District in one year, was enough to feed the population (0.3 million) of Sialkot (Chaudhry, 1981).

a) Cotton

Central Cotton Research Institute, Multan has carried out some studies to estimate the yield losses caused by different pests of cotton. A brief account is given as:

Yield loss due to group of insects: The yield loss due to sucking pests and bollworms were estimated. The results showed that whitefly and jassid reduced the yield by about 10% and bollworms by 57%. Both insects altogether reduced the yield by about 83%.

Yield loss due to Pink Bollworm: Efforts were made to assess the damage of pink bollworm larvae in the farmers' field. Bolls with 4 damaged locules reduced the yield by almost 88%. Three damaged locules reduced the yield by 76%. Two damaged locules reduced the yield by 58% and one locule reduced the yield by 45%. These yield losses were primarily due to loss in weight.

Damage due to Spotted Bollworms on terminal buds: The first attack of spotted bollworms appears on the terminal buds of the cotton plant before fruit formation has taken place. Damage to the terminal bud stimulated the auxiliary buds below the damaged portion and produced monopodia. The plant growth compensated the damage of the terminal bud through monopodia. The control of spotted bollworm at this stage can be avoided.

Simulation of Bollworm damage: In order to obtain indications on the critical level of damage made by bollworms in cotton and capacity of the plant to recover from this damage. heavy injury was simulated by means of weekly manual removal of all fruiting parts from between 40-90 days after planting of cotton. The crop was sprayed at weekly interval to avoid the possible damage of insect pests. The results indicated that late maturing varieties could compensate the attack of bollworms up to 89 days of planting after which economic loss will occur. In case of early maturing varieties like CIM-240 and CIM-109 the defruiting beyond 60 days will affect the yield significantly. For such varieties early plant protection is important.

b) Rice

The extent of losses by pests of rice varies in time and space. The average incidence increased with the stage of crop, from early elongation phase to ripening. Insect pests may cause 5-90% yield losses to rice (Aziz and Shafi, 1963). During an out-break season 70 to 90% of crop may be damaged by rice stem borers and in certain cases crop had to be left unharvested due to high cost of harvesting than the yield obtained (Haq. 1972; Baloch, 1975; Makhdoomi *et. el.*, 1976). Stem borers caused 17% loss in 1935, 80% in 1957, 12% in 1963, 30% in 1970, 12% in 1971 and 5% in 1974 in some areas in Pakistan (Latif, 1956; Ghouri, 1977). Chaudhry (1975) reported that the attack of rice stem borers in late transplanted crop during 1957 was as high as

80% in some parts of the Lahore Division and rendered the harvest of the crop uneconomical. Reduction in yield of Basmati varieties on account of yellow stem borer has been estimated at 20-30%, occasionally, the crop infestation goes up to 90% (Mahar and Hakro, 1984; Mahar *et al.*, 1986; Salim *et al.*, 1991).

White backed planthopper, *Sogatella furcifera* is one of the major insect pests of rice in Pakistan (Mahar *et al.*, 1978; Majid *et al.*, 1979; Salim, 1991). The first appearance of the insect as a major pest of rice in Sindh was recorded in 1976 and caused upto 60% paddy yield losses in certain parts of Sindh province (Mahar *et al.*, 1978). In 1979-80 outbreak of the insect occurred in major rice growing areas of upper Sindh and caused "hopperburn" in various rice fields. In the Punjab where, Basmati rice is grown the insect has long been known to occur casually as a minor pest of rice, however, it appeared in an epidemic form in 1978 in major rice growing areas of the Punjab province. Since then it has been causing considerable yield losses to rice. The insect inflicts more damage on coarse rice varieties than on Basmati rice. However, during certain years when environmental conditions become favorable for its development causes 'hopperburn' even in Basmati fields.

Leaffolder is also inflicting severe losses to paddy crop since its endemic outbreak during 1984 (Zafar, 1991). Inayatullah *et al.* (1986) ranked it as one of the major rice pests. During the 1989-90 crop season the pest multiplied enormously, with severe incidence observed during September. Survey of 2,941 rice fields at 73 locations in the Basmati growing areas indicated that the crop was severely damaged in Sheikhupura, Sialkot and Gujranwala districts. On Basmati 385 and Basmati 370 the average infestation was 16.6% and 12.7%, respectively. In shady areas and late sown crop the infestation of the insect was upto 72% and 40% respectively (Salim *et al.*, 1991). During normal years insect pests cause 15-25% yield losses to Basmati rice in Pakistan.

c) Sugarcane

Irshad *et al.*, (1990) worked out the losses caused by sugarcane borer, *Chilo infucatallus* on the basis of joint bored and dead hearts. Examining 2000 canes studied the relation between the whole cane damage and joints bored. The data shows the joint infestation increases with stalk infestation. It is difficult to sample many fields for joint infestation to calculate loss in sugarcane. The data indicates that 5.2% joints are bored and expected recovery of area is 7.47%. However, recovery of healthy (% joints bored) was 8.02%, indicating the loss of 0.55% in sugar recovery. Therefore, this borer reduce sugar to the extent of 212 kg/ha (av. yield is 38700kg/ha).

Similarly, CABI (1999) reoprted the effect of different levels of borer infestation on sugarcane yield and reported that there is positive correlation of borer infestation and cane yield. With

20% borer infestation the yield reduced more than 30%. Sugar recovery is inversely proportional to the internode damaged by the borers. Reduction in the recovery is significant, 2.84% vs 1.19% in borer infested and healthy cane stalks.

d) Weeds

Data published in Pakistan on crops grown under typical conditions include 47% losses to weeds in spring or autumn sown soybean, 33% loss of Bas-370 and 22% loss of IR-6, varieties of rice ((Khan *et al.*, 1987) and 40% loss of cotton (Brohi and Makhdoom, 1987). These weed loss figures are based on comparison with hand weeded reference plots and assume that these hand weeded plots provide a yield comparable to what would be obtained in the absence of weeds. Often the process of hand weeding damages the crop plants, and by the time the weeds are big enough to remove they may have already had an effect. Both crop damage and early competition can cause loss of yield.

e) Post-harvest losses

Wheat and rice are the two major food grains stored in Pakistan. During storage, insects, mites, rodents, birds and fungal diseases can cause losses of food grains and losses through spillage may occur during handling and transportation. There are a number of reports and statements on the extent of grain losses but research studies, which give reliable estimates, are few. An early report (Anon, 1953) states a loss of 6% for food grains annually in Pakistan. Qureshi (1967) reported a loss of 10-15% by insect and 5-10% by diseases in stored cereals. Haque *et al.* (1969) found that Khapra beetle caused 4-10% loss in store. Little information is given about how the data were collected.

An extensive survey of different parts of Punjab, Sindh and NWFP was made by the University of Agriculture, Faisalabad to study the incidence of insect pest attack on stored cereals and pulses (Qayyum, 1977). An assessment of percentage of damaged grains in the samples was made. Insects like *Trogoderma granarium, Rhizopertha dominica, Tribolium castaneum, Sitophalius oryzae, Callosobruchus* spp., and *Sitotroga cerealella* were found. The results revealed that insect pests attack varied from 1-17% in wheat, 1-15% in rice and 5-7% in gram during 1971-73. Chaudhry (1980) carried out some studies on losses during threshing and storage at farm level, market level and public sector storage and results revealed that highest 8% and 10% losses were found at market level in wheat and rice, respectively.

A detailed study was carried out on storage losses in public sector (Baloch *et al.*, 1986). The results revealed that losses ranged from less than 1% to more than 10%. Some of the low levels of loss were misleading since they related to grain stored at one site only. Whereas, the grains had been previously stored at one or more places in the region. In such cases grains were 2-3 years old and it was estimated that the overall weight loss could be as high as 15%. The national average storage loss is 3.5% for a period of 5 months (Baloch *et al.*, 1986). The risk of incurring high losses increases when proper control measures are not done.

3.3. Trends in Pesticide Use 1970-2000: Volume and Value

As it has been stated earlier, before the introduction of high yielding varieties (HYV) farmers used to control pests through farming practices (such as tillage and rotation) and the mechanical removal of pests. Thereafter, synthetic pesticides became a regular part of plant protection measures. Initially, in the 1950s pesticides were used for the first time to combat the attacks of locusts. In 1954, the government imported formulated pesticides amounting to 254 metric tons (Habib, 1996). This was the beginning of the pesticides business in the country. Until 1980, Plant Protection Department was responsible for pesticide import and their distribution in the country through national agricultural extension network. Most of the pesticide imports were for aerial spraying to control locust, pests of sugarcane, cotton, rice, tobacco and fruit crops. There was subsidy on pesticides and aerial spraying was free of any cost. Thereafter, the government started to charge nominal cost from farmers, which was then extended up to 25% of the total pesticide application cost. The subsidy was totally abolished in 1980 and 1982 in Punjab and Sindh, respectively. The concept of agricultural self-sufficiency was closely linked to the amount of pesticides used.

In 1980, the pesticide business was transferred to private sector and Government of Pakistan allowed them to import manufacture and market pesticides in the country. Since then there has been steady increase in the pesticide import and consumption. The increasing trend in the use of pesticides is evident from the fact that pesticide consumption increased from 665 metric tons in 1980 to 45,680 metric tons in 1999, out of which 27210 metric tons valuing Rs. 7324 million were imported. However, since 1998 there has been some decrease in pesticide consumption. The role of private sector in promoting the production and use of pesticides is tremendous. The private sector also took full advantage of government's pesticide oriented policies. The aggressive media campaigns on TV and radio support the above argument. Private companies provided many incentives to farmers including credits. They undertook extensive campaigning among farmers and motivated them to use pesticides. Their extension services for promoting their products were excellent as compared with the staff of Agriculture Extension Department. One of the key components of dramatic increase in pesticide use in Pakistan is related to very soft import and registration at the time, which allowed the generic compounds registered elsewhere, to be imported without field testing.

Pesticides import, production and their value overtime are given chronologically in table 3.4. 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 (Jabbar and Mallick, 1994). Therefore, the import figure for the years 1981 and 1982 are low, but since then there is a steady increase in the pesticide consumption and import. The pesticide import is greater than local formulations even though private companies were asked to establish formulation plants when pesticide business was privatised. But due to Government's relaxed import policies local production has been reduced since1996.

The data (Table 5) indicate that pesticide use has increased considerably over the years in Pakistan. From 1981-1999 there has been 1162% growth in the consumption of pesticides. However, there is 85% reduction in real value from base year, 1980. Per unit price of pesticides is also decreased drastically since 1993 after the introduction of generics. The dramatic increase in pesticide use has been primarily aimed at cotton pests; whitefly, jassids and bollworms (Poswal and Williamson, 1998). The number of sprays on cotton increased from 1 in 1981-82 to 6-14 in 1997. However, there has been some decrease in 2000. This decrease may be attributed to pesticide decrease on cotton due to impact of IPM strategies being implemented in the region and farmers awareness to IPM techniques particularly use of bio-control agents in recent years. Due to the complexities in cropping system and smallholdings, ground spray has always been preferred. Aerial spraying has been restricted to epidemic outbreaks of pests like locust, sugarcane *Pyrilla* and white backed plant hopper.

Table 5. Pesticide availability for use in Pakistan

Year	Quantity (m.tons)					Nominal Value (million Rs)	*Real Value (million Rs)
	Import finished product)	Locally formulated	Ratio 1:2	Sum of 2 & 3	a.i		
1980	-	-	-	665		39	39
1981	-	-	-	3677	905	213	192
1982	3552	1448	1:0.41	5000	1345	320	275
1983	4875	1713	1:0.35	6588	1757	629	504
1984	6081	3132	1:0.52	9213	2585	2256	1711
1985	8270	4260	1:0.52	12530	3489	2249	1635
1986	8834	5665	1:0.64	14499	4111	2978	2090
1987	8019	6829	1:0.85	14848	4429	3259	2151
1988	6256	6816	1:1.09	13072	4065	2334	1396
1989	6869	7738	1:1.13	14607	4706	3642	2054
1990	4802	9941	1:2.07	14743	5730	4561	2283
1991	6157	14056	1:2.28	20213	5920	5535	2528
1992	6691	16748	1:2.50	23439	5619	6554	2739
1993	6128	14151	1:2.31	20279	4919	5384	2024
1994	10693	14176	1:1.33	24869	6183	5808	1934
1995	20134	23239	1:1.15	43373	7645	7273	2151
1996	24151	19068	1:0.79	43219	7325	9987	2647
1997	24168	13836	1:0.57	38004	11209	8611	2182
1998	22765	18081	1:0.79	40846	10390	6990	1697
1999	27210	18470	1:0.68	45680	11420	7324	1706
2000 (Sept)	12500	28680	1:2.29	41180	10295	-	-

Source: Adopted from Feenstra *et al.* 2000, and Department of Plant Protection, Karachi
* = Value of pesticide deflated by using CPI, treating 1980 as base year.
a i=aetive ingredients

3.3.1. Pesticide Use by Crops, Type of Pesticide and Region

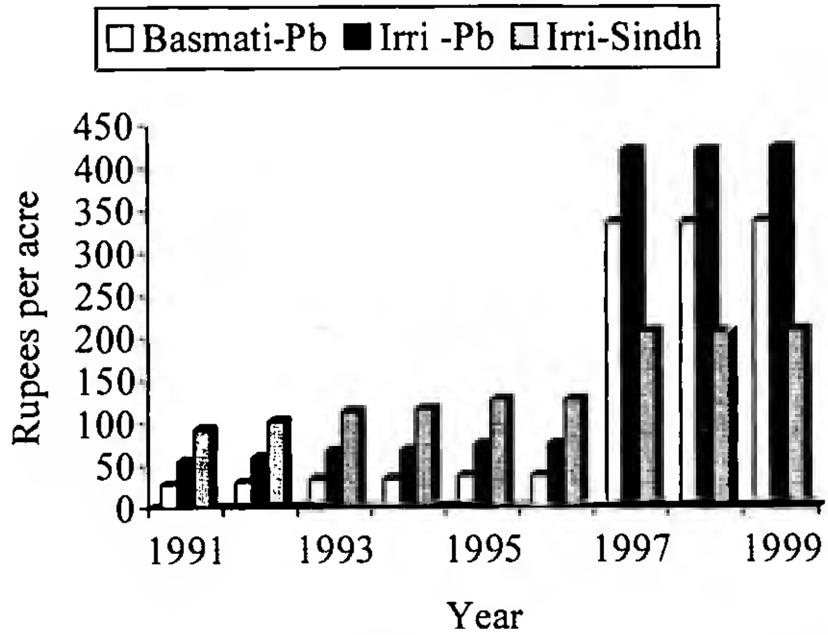
The data indicate that on average the insecticides comprise of 90% of the total pesticides consumption in the country followed by herbicides 7%, fungicides 3% and others (acaricides, fumigants) 0.2% (Figure 3.2). There is constant consumption of insecticides with slightly decline during 1982. In the last three years the similar trend is also observed from the data provided by PAPA companies. However, there is a steady increase in herbicide use. Particularly, herbicide use has been increased in wheat and rice crops, which share 53% and 14 % of the herbicide used, respectively, during 1998 (Source: Ali Akbar).

Of the pesticides used to control pests of various crops, on an average cotton crop shares the highest proportion and almost 54% pesticides are used to control cotton pests followed by 16% on rice, 13 % on sugarcane and 10 % on fruits and vegetables (Figure 3.1a). However, according to PAPA sources, on average 63% of pesticide use is on cotton and 19% on others (Figure 3.1b). The data reveal that there was an abrupt increase after 1981-82. The percent treated area under cotton crop is now declining but steadily increasing on fruits and vegetables (Figure 3.1a). During year 1999-2000, the cotton shares 53% of the treated area while fruits and vegetable share 17%. Similar trend is also observed from Figure 3.1b. Particularly, pesticide use on fruits and vegetables has increased in Balochistan, NWFP and Sindh provinces (Table 6).

Table 6. Share of pesticide use on crops within provinces of Pakistan (1998-1999).

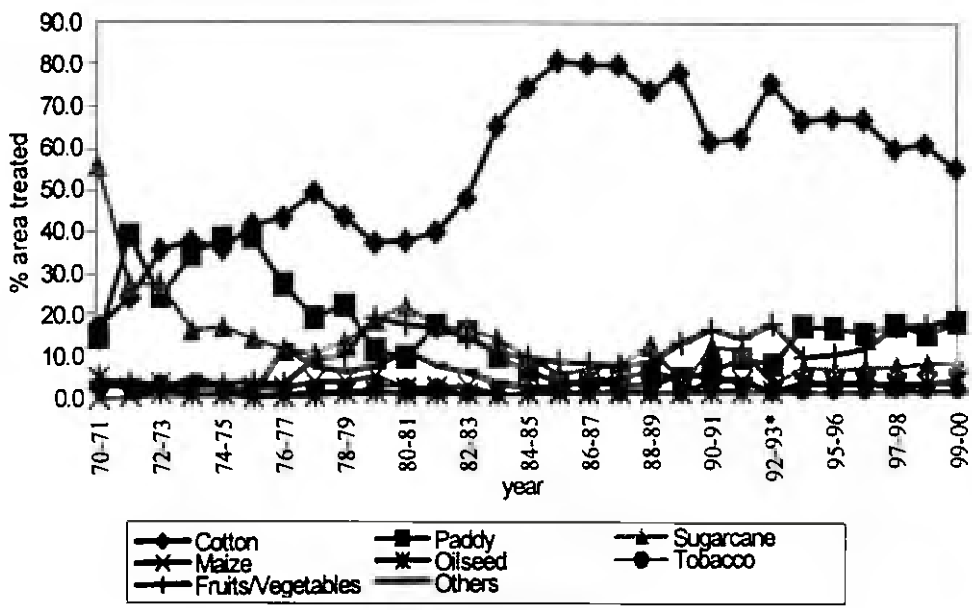
Crop	Percent share			
	Punjab	Sindh	NWFP	Balochistan
Cotton	68	31	0.1	1
Rice	16	7	6	7
Sugarcane	6	12	10	0
Maize	2		11	0
Fruits/vegetables	6	48	55	90
Tobacco	0.1	-	13	1
Oilseeds	2	2	5	1

Source: Agri. Statistics of Pakistan. 1999.



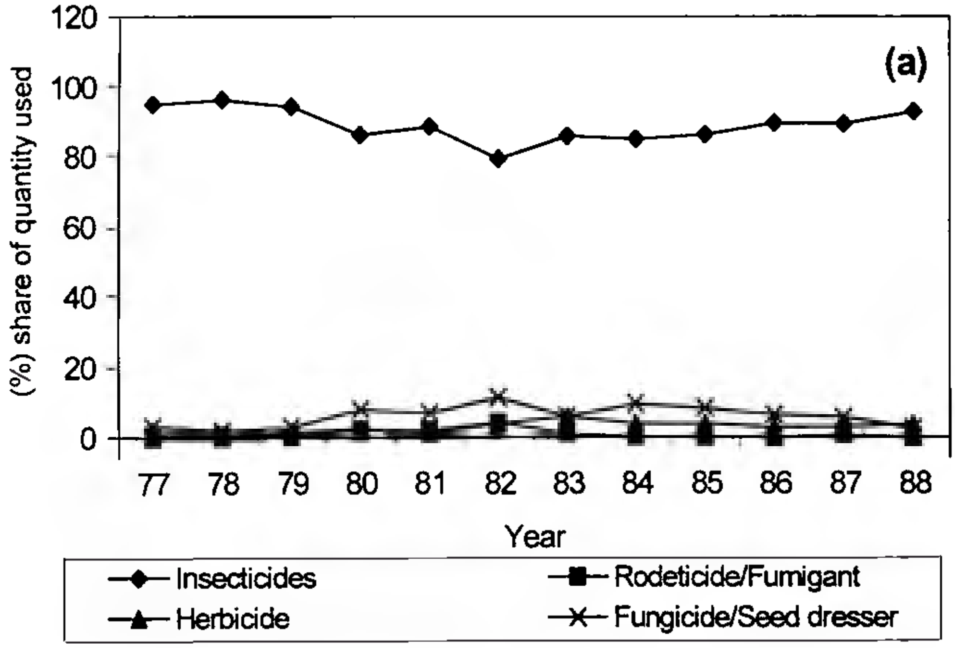
Source: Agri. Statistics of Pakistan

Figure 3.1a: Crop wise percent area treated with pesticides.

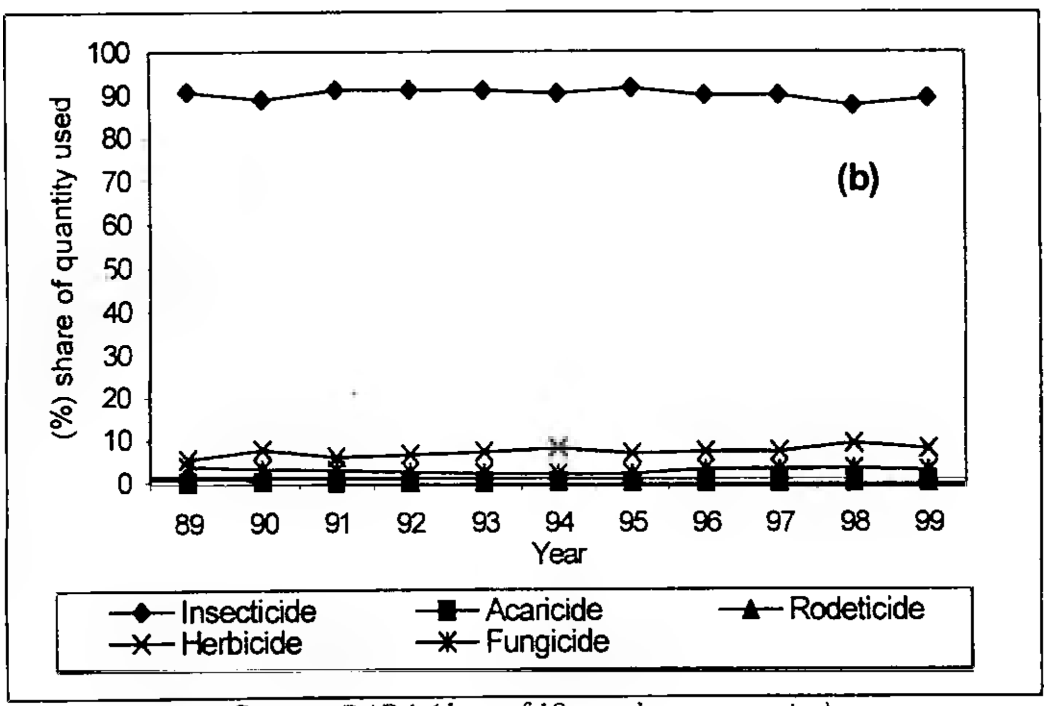


Source: PAPA (data of 18 member companies)

Figure 3.1b: Percent share of pesticide use on various crops.



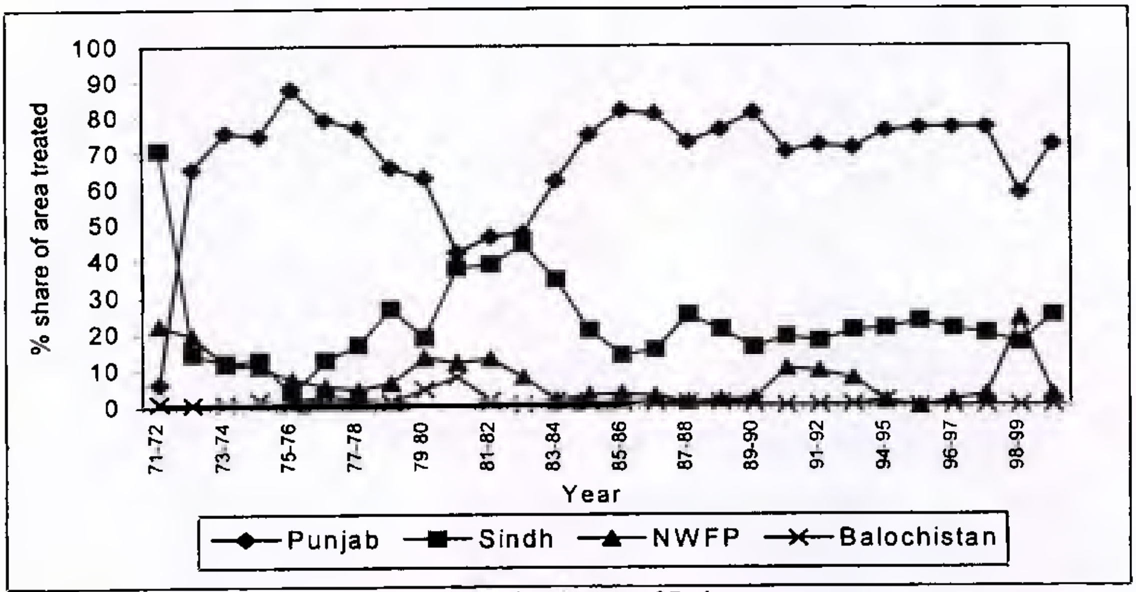
Source: Agri. Statistics of Pakistan



Source: PAPA (data of 18 member companies)

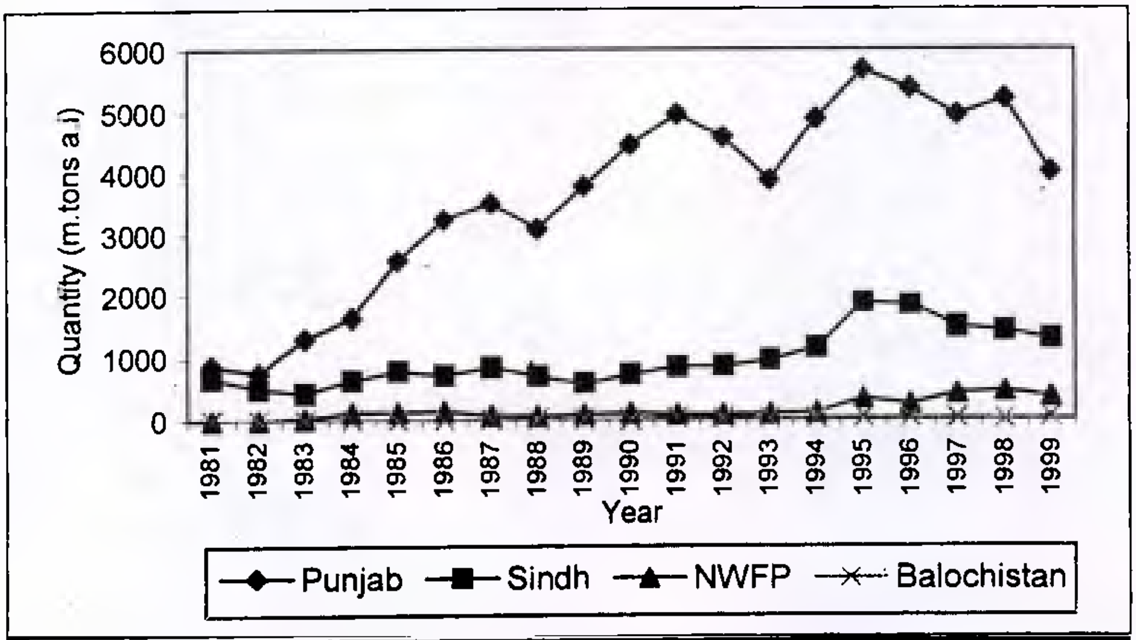
Figure 3.2: Share of category wise pesticide use in Pakistan.

Figure 3.3a reveals that Punjab share the highest proportion of pesticide use in the country and on an average 68% treated area is of this province. According to PAPA sources, on an average, 75% of the pesticide used in the country are in Punjab followed by Sindh 22% (Figure 3.3b). Data show that pesticide use is slightly declining in Punjab and Sindh, because of the use on cotton is declining. However, the pesticide use is increasing in NWFP and Balochistan because of increase on fruits and vegetables.



Source: Agri. Statistics of Pakistan

Figure 3.3a: Province wise share of area treated with pesticides.

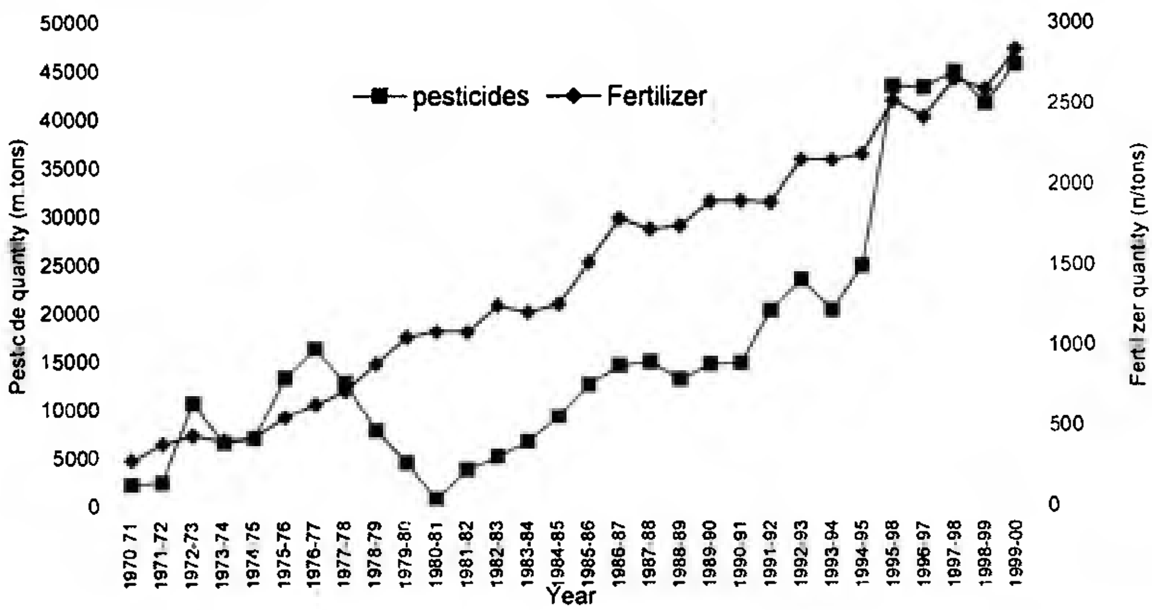


Source: PAPA (data of 18 member companies)

Figure 3.3b: Province wise pesticide use in Pakistan.

3.3.2. Comparison with Development of Fertilizer Use

Chemical fertilizers are the largest chemical products consumed in the country, which is 5.72 million tons per year. Pesticides too have a wide spread use in Pakistan with 45680 million tons (PEPA, 2000). The data indicate that there is a steady increase in the fertilizer consumption and growth increase in fertilizer use is 901%, in comparison with pesticide use (1932%) since 1970-71. However, pesticide use has grown at faster rate (1038%) than fertilizer (162%) since 1980 (Figure 3.4). Pesticide use curve shows a lot fluctuations, according to the severity of the pest problem. However, the use trend in both the inputs is similar for the last five years. According to Economic Survey of Pakistan (1998), the domestic production of various kind of fertilizers was 4022 thousand tons (90% of the chemical produced in the country) as compared to 14 thousand tons of pesticides locally formulated in 1997-98.



Source: Agri. Statistics of Pakistan, and Pakistan Fertilizer related Statistics.

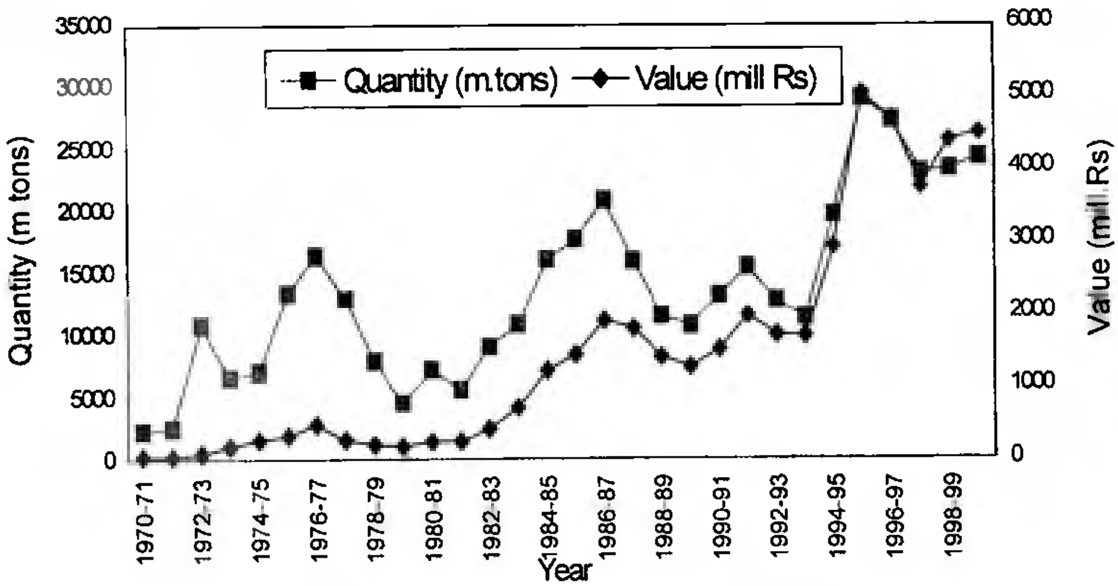
Figure 3.4: Comparison of pesticide and fertilizer use in Pakistan.

3.4. Imports of Active Ingredient and Formulated Products

3.4.1. Assessment of Data

As it has already been stated that pesticide consumption increased dramatically after the pesticide import and production was privatized in 1980. The increasing trend in the import of pesticide is evident from the fact that there is 971% increase in pesticide import since 1970-71 and 239% since pesticide business is shifted to private sector. The import bill of pesticides is also increased manifold.

The data indicate that there is nearly 1900% increase in import bill since 1980-81 (Figure 3.5). The pesticide import was declined in 1980-81. Jabbar and Mallick (1994) reported that it was due to the stocks available with government and private sector was asked to utilize previous stocks. Another decline can be observed after 1989-90. This may attribute due to the 70% local formulation done by the multinational companies in the country (see table 3.4). Later on in 1991-92, due to the government's relaxed import and registration policy, which allowed importing generic pesticides, may also one of the major reasons of increase in import quantities.



Source: Foreign Trade Statistics of Pakistan, Bureau of Statistics

Figure 3.5: Pesticide import by Pakistan (1970-2000).

3.4.2. Illegal Imports: Approximate Volume and Values

Various undocumented statements indicate that illegal import of pesticides is in practice in Pakistan. Particularly, during the regional Pesticide Policy Workshop in Balochistan, the participants brought this matter in discussion (personal communication with Dr. Soomro). But no data are available on the extent of quantity being imported/smuggled to the country. However, (Hasnain, 1999) reported that despite the ban on 21 pesticides, these are still used on limited scale due to smuggling from Afghanistan, Iran, India and other countries.

3.5. Adoption of Integrated Pest Management

As it has already mentioned that no single method is applicable under all the situations, it is therefore essential to adopt integrated approach for an effective and economical pest control.

The Integrated Pest Management (IPM) is the best alternative to pesticides to assure more sustainable and environment friendly control of pests of important crops. Some technologies are already available and have been successfully demonstrated on a large scale to control pests of various crops. In Pakistan, unfortunately these technologies could not be practiced in perpetuation. because of government's pesticide oriented agricultural policies. The farmers are rather ignorant of the basic steps of good plant protection that include the awareness of bionomics of pests and their natural enemies and pest scouting which leads to decision making for choosing proper tactics at proper time. Further, it requires farmer's hard work and a cultural change. The obstacles in implementing IPM and factors, which encourage IPM implementation in Pakistan, are given in Box 3.1 and Box 3.2, respectively.

Box 3.1. Obstacles to IPM implementation

i) Government's pesticide oriented policies. No IPM policy exists in the country.
ii) Lack of political will for IPM rather pesticide use. For example, influence of political personalities to go for aerial spraying to oblige the people of their constituencies to get vote.
iii) Strong private sector involved in pesticide business and their vested interests.
iv) Aggressive media campaigns on radio and TV regarding pesticide use. For detail see Chapter 6.
v) Poor economic conditions of farmers. Private sector enforces pesticide use by exploiting the situation and giving them several incentives including credit (see Chapter 6).
vi) Illiteracy of farmers in general. No knowledge about IPM to them. They were made believe that pesticides are the only solution to their crops.
vii) Farmers' psyche about quick knocks out effects of pesticide, which are preferred over long lasting efforts. Further, pesticides are easy to apply and no hard work is involved and saves their time.
viii) Due to the importance of cotton crop, farmers are not willing to take any risks to lose their crop. Pesticide application ensures desired targets of the farmers. No incentive to farmers for switching over to IPM.
ix) Unawareness of agriculture extension department regarding IPM which involve hard work. They prefer convenience. The extension system is not equipped to handle updated IPM research.
x) Non-availability of comprehensive and adequate IPM technology, particularly for cotton. No information on carry over of natural enemies.
xi) IPM curricula in agricultural universities are almost non-existing. Universities do not produce specialists in IPM to ensure a steady stream of experts for research, education and extension.
xii) Lack of mass rearing facilities, storage and transport of parasites and predators. The small scale rearing facilities will not achieve the purpose of IPM implementation programme and reducing the use of pesticides.
xiii) IPM requires systematic and calculated approach, which is virtually not available. The prevailing situation is that extension department imposes packages of technologies on farmers. Whereas, IPM requires farmers participation.

Box 3.2. Factors encouraging IPM implementation

i) Indiscriminate use of pesticides, which resulted into creation of pesticide associated problems, such as environmental deterioration and health risks.
ii) Awareness of pesticide related risks among various stakeholders.
iii) Development of pesticide resistance in many pests.
iv) Presence of pesticide residues in food beyond MRL.
v) Destruction of natural enemies resulted in imbalance of agro-ecosystems.
vi) Increase in endless import billing of pesticides.
vii) Increased cost of production.

3.6. Discussion and Conclusion

In Pakistan, cotton, rice and sugarcane are the major crops grown on more or less 6.5 million hectares every year. The yields are hampered due to heavy attacks of a number of insect pests, diseases and weeds, which cause considerable yield losses. According to an estimate, in Pakistan, insect pests and diseases cause 30-50% loss to various agricultural commodities either in the fields or in stores. Plant protection measures in Pakistan are largely limited to the use of pesticides and collectively 83% of the pesticides are used to control pests of cotton, rice and sugarcane. According to Qasmi (1997), Pakistan is the second largest pesticide consuming country among the twelve Asia and Pacific regional countries and occupies a disadvantageous place in terms of safe use of pesticides as the bulk of our farmers are illiterate and untrained.

The concept of agricultural self-sufficiency was closely linked to the amount of pesticide used. In fact, increased pesticide consumption has not led to increase in yields in all the cases, particularly in cotton. In most cases, the income of cotton growers has fallen because of more spending on pesticides. An extensive use of pesticides during the eighties has changed the cotton pest complex (Ahmad, 1999). The number of sprays also has increased upto 14 times due to substandard quality of the product that resulted in the development of resistance in key pests of cotton against commonly used pesticides (Inayatullah, 1997). Despite their heavy use, the pest attack is becoming more severe and the effectiveness of pesticides may be hampered due to application of wrong pesticide at wrong time, deterioration of the ingredients due to adulteration and development of resistance in the pests. Besides resistance development, the indiscriminate use of pesticides has also destroyed the bio-control agents in agro-ecosystems. The populations of natural enemies have almost diminished in cotton growing areas and upto 90% population has declined during the last decade (Hasnain, 1999).

As the environmental concern is gaining ground and the ill effects of chemical pesticides have been realized all over the world, it is right time to rectify the situation. No single method alone can control all the pests under all situations. In fact, various alternatives are available that promise a more sustainable and environment friendly control of pests, but never practiced on a sufficiently large scale. The Integrated Pest Management (IPM) is the best alternative to pesticides, which is combination of various control tactics, including biological control, growing resistant varieties, altering the sowing times, crop rotation, clean cultivation of crops and if needed, the selective use of both synthetic or naturally occurring botanical pesticides. The only problem is implementation of IPM because of number of reasons. It is urged that the current menace of pesticide use can only be avoided with farmers' involvement and participation. In view of the growing importance to achieve sustainable productivity, it is difficult to see anything other than IPM, which can provide an acceptable or affordable basis for pest control in the future. There is need to produce farmers as IPM experts rather extend ready-made prescription to them. It would be of utmost importance that government should give explicit recognition to this principle and create a policy environment in which IPM can take sound footing.

Chapter 4: ECONOMIC FACTORS RELATING TO PESTICIDE USE

The knowledge of economic factors related to pesticide use is essential in order to plan and/ or ameliorate any pesticide policy in a country. These economic factors can be divided into price and non-price factors. Information about these factors helps to sharpen the policy directions at national as well as individual level. Price-factors have direct impact on the use of pesticide at farm level. While non-price factors have no direct influence on the profitability of a farm but help in making decisions regarding use of pesticide (Fleischer *et al.*, 1999). Keeping in view the importance of the subject, this chapter provides a fair deal of discussion on the economic factors pertaining to pesticide use in the country. The chapter is divided into five sub-sections. First section deals with the productivity estimates of pesticide use, review of the existing literature available on the subject in Pakistan and shortcoming in the methodologies followed in the studies.

The second and third sub-sections of the chapter examine the relationship of various price factors with the pesticide use in the country over time. Fourth section discusses the non-price factor while last section concludes the chapter.

4.1. Productivity Estimates of Pesticide by Major Crops

In Pakistan, there have been few studies conducted to estimate the productivity of pesticides on cotton crop. The economists working in the agricultural research system were never engaged to study economically optimal level of pesticide use, negative externalities and alternative methods of pest control. However, some studies emerged from postgraduate level research conducted at agricultural universities. At present no institute is involved to gather data systematically and to use cost benefit analyses of pesticide use at regional or national level. The Agricultural Prices Commission of Pakistan (APCom) collects input-output data of major crops at farm level after 5 years interval to construct cost of production tables. These tables are updated every year by simply assuming variation in factor prices and treating factor use levels as constant, a very hard assumption. Moreover, costs of production reports are treated as "confidential" and not easily accessible. Similarly, cross-section data collected periodically is also inaccessible. The crop protection specialists being conducting trials on pesticide efficacy at different pesticide use levels or combinations. They also tried recently to check the efficacy of different pesticides on most damaging pests like white fly.

4.1.1. Review of Existing Studies

Elahi (1998) studied the effect of 33 qualitative and quantitative factors on cotton productivity. Multiple regression function was used to highlight the factors that play significant role in crop production. Quality seed, better fertilizer, better pesticide use and other agronomic practices (moisture condition at sowing, rotations, planting time etc.) have shown significant contribution towards cotton yield. The optimum doses of fertilizer (92 nutrients kg of N+P), irrigation (5), ploughing (4) and plant protection doses (6) were also determined in this study.

Ahmad *et al.* (1996) estimated net income contribution from different pesticide use packages (different mixes and quantities of pesticides). It was concluded that a package with a share of low plant protection cost (13%) in the total cost provided maximum net returns (Rs. 5179/ha) than many other packages with relatively higher plant protection cost (15-18%) and low net returns (Rs. 4062/ha). Cobb-douglas functional form was also used to prove that one- percent increase in plant protection cost had significantly increase the cotton yield by 0.22 percent. The sum of coefficient (1.19) of all inputs shows an increasing return to scale and if plant protection coefficients are excluded, the remaining coefficients value (0.97) implies decreasing return to scale. It was therefore concluded that the pesticide use significantly contributes towards higher productivity.

Imran (1993) used experimental data of pesticide use trials from two different research institutes. The partial budget methods were used to compare marginal returns between 5 pesticide treatment packages. The sensitivity in the prices of inputs and outputs was examined and a most effective and economically feasible package was recommended for extension purposes.

Ahmad (1991) used partial budgeting methods on primary data to identify the most profitable cotton production methods. The results were compared between less than 1.5 ton/ha, 1.5-2.5 ton/ha and above 2.5 ton/ha yield categories. A gap of Rs.17193 and Rs.1880 per ha was found in the net return of high yielding and low yielding farmers. The management factors determined behind this gap were; use of improved varieties, planting time, plant population and fertilizer application methods. Interestingly, there was no mention of the role of pesticides in achieving higher cotton productivity in this study.

Abid (1991) also used partial budgeting methodology to suggest optimal combinations of pesticide use by considering the financial restraints of the farmers. Higher level of doses (550-650ml per acre) was suggested for effective control than recommended levels (450-650ml). Author also emphasized health hazard aspects of pesticide and suggested using pest scouting before applying pesticides.

Iqbal (1991) and Hassan (1991) also used net benefits and Cobb-Douglas production function to prove that the package of improved cotton production technology need to be demonstrated or adopted by the farmers, otherwise full benefits of investment on few technological inputs might not help to realize the fuller yield potential.

Javed (1989) applied linear multiple regression function on cross-section data collected from farmers to estimate the effects of different factors on the yield variability in the cotton crop. The beta values from the number of sprays (2.644), number of ploughings (2.311), interculture (1.553), irrigation (0.723), fertilizer bag (1.320) with negative signs show that pesticide use is the most important variable that makes maximum contribution to reduce the yield gap in cotton crop.

4.1.2. Data and Methodological Problems in Estimation

The review of studies conducted in Pakistan (mentioned above) shows that a pattern is followed either to identify a more economical package of pesticide or to determine the contribution of pesticide use towards crop yield. The analysts mainly tried to develop general conclusions based on cross-section data collected from few villages of a specific locality, while ignoring the agro-climatic and system diversities. Most of the inferences drawn from these studies are of static in nature and no effort was made to address the critical issues of overuse of pesticides and their implications on bio-diversity, environmental hazards and human health problems. Hence, higher benefits cost ratios were estimated by ignoring the external costs of pesticides. The benefits from pesticide are also over-estimated as a result of ignorance to incorporate the changes in productivity of pesticides due to resurgence and resistance processes. Moreover, pesticide role in these studies is highlighted as a yield-increasing factor rather than as a damage control agent.

Most immediate concern that emerges from this review is the non-availability of required data to analyze the use of pesticides as damage control agents and not to treat them as direct productive inputs, which overstate their impact on production (Waibel *et al.*, 1999). The limited availability of data is the result of individualistic approach followed by the research and policy institutions to achieve their specific objectives. There is a strong need to collect relevant data and make it accessible for an economic analyses of pesticide use which would provide a clear reference scenario for rational use of pesticide or to help pesticide use reduction.

The collaborative efforts on the part of cotton research institutes, pest-warning department and social scientists could provide good foundations to execute right strategies to collect relevant information on many critical and dynamic aspects of cotton production.

4.2. Agricultural Output Price Policy and its Impact on Pesticide Use

Agricultural output price policy in Pakistan was initiated in the 1960s when government adopted it as a major policy instrument towards the country's economic development and growth. In continuation to this, government established Agricultural Prices Commission (APCom) in March 1981 with the main objectives to protect farmers from the undue fall of prices during post-harvest period and to raise their income and to stabilise market prices, (Maan and Malik, 1996). The Commission recommends to government support prices of five major crops *viz.* wheat, rice, cotton, sugarcane and maize besides some minor crops on yearly basis.

It is well documented that major share of pesticide in Pakistan are being applied to two principal cash crops namely cotton and rice. Therefore, both crops were taken into consideration while analysing the output price policy in relation with pesticide use in Pakistan. It is observed that support prices of cotton and rice for all major varieties of the crops had been increased gradually up to 1988-89 and risen sharply in the subsequent years, in general (See Figures 4.1 and 4.2).

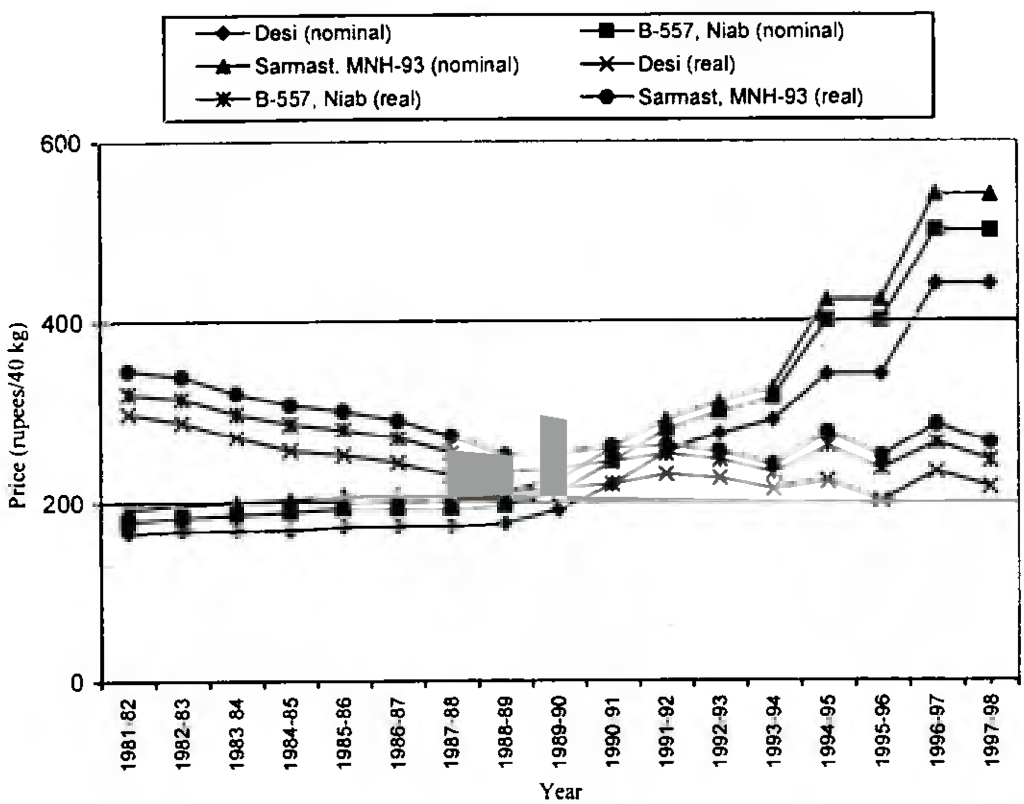


Figure 4.1 Nominal and real support price of seed cotton

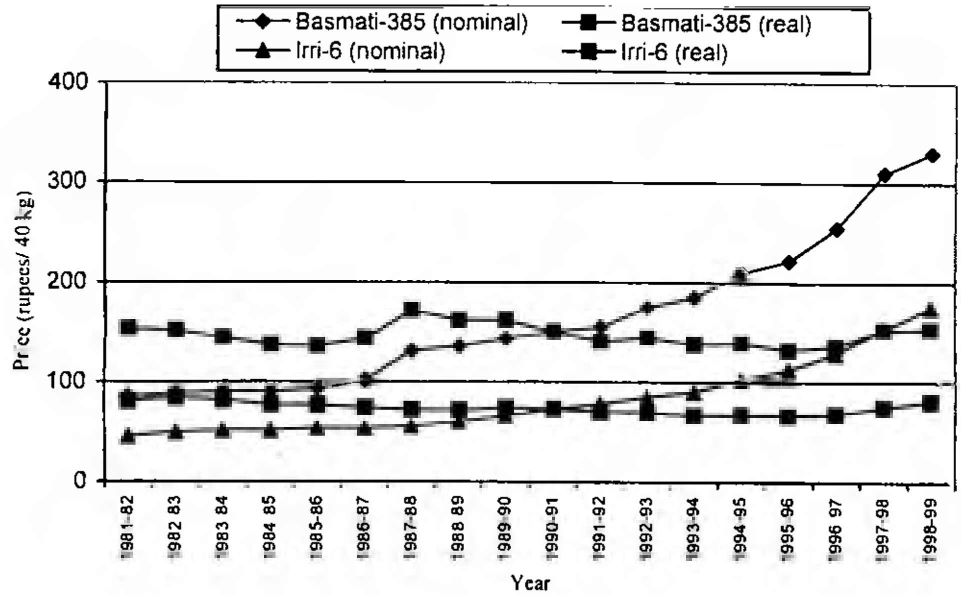


Figure 4.2 Nominal and real support price of paddy rice

The devastating floods of 1988-89 and 1992-93 and declined agricultural growth rate were the main reasons behind augmented agricultural out put prices. The Leaf Curl Virus (LCV) attack on cotton crop during 1992-93 had also made the farmers heavily relying on pesticide use for their better cotton crop leading to higher cost of production. The event is quite evident by looking at the cost of plant protection measures adopted for cotton and rice crops in both the major growing provinces (See Figures 4.3 and 4.4). Consequently out put prices, fixed on the basis of cost of production, had increased sharply after the period of 1992-93 particularly in case of cotton. However, the real support prices of seed cotton and paddy rice in terms of 1990-91 prices declined, reflecting an overall decreasing trend.

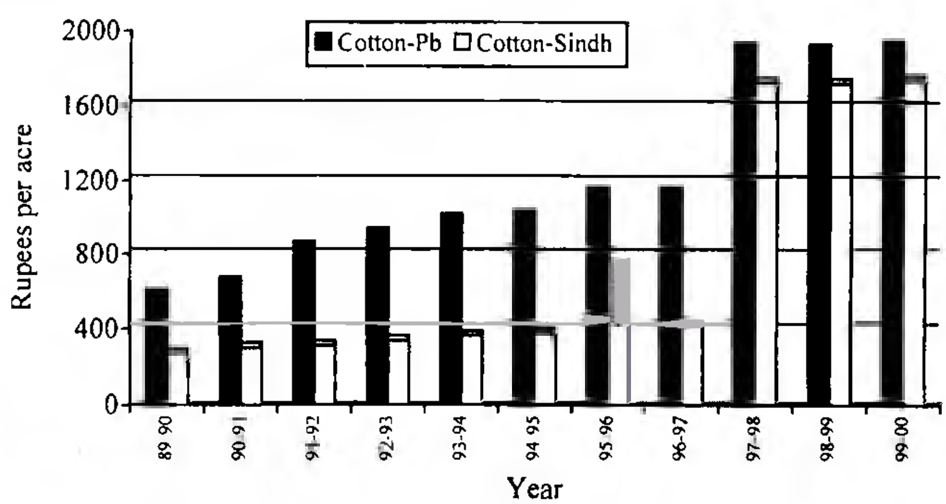


Figure 4.3 Cost of Plant Protection Measures Adopted for Seed Cotton

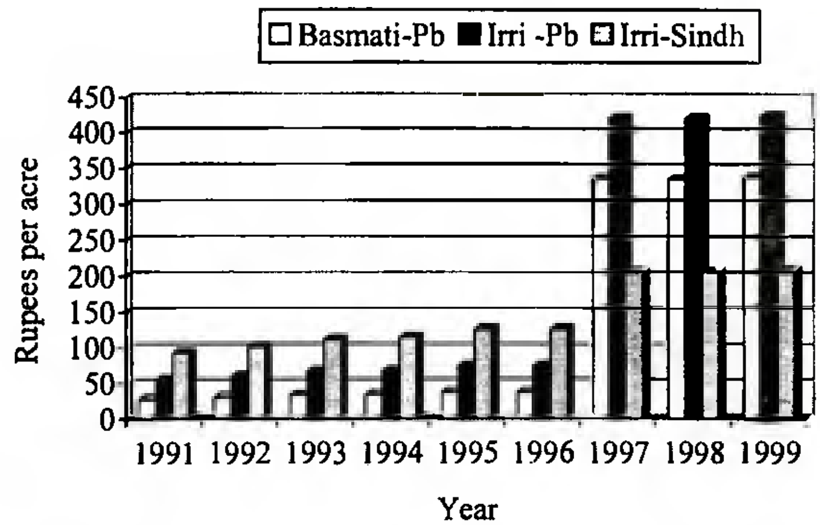


Figure 4.4 **Cost of Plant Protection Measures Adopted for Paddy Rice**

An attempt was also made to calculate the proportion of pesticide cost in total cost of production. The results were not meaningful to incorporate them in the report, as only APCom data was accessible to perform such estimations. The major limitation with the data is that it was collected only at two point of time (in 1990s) and for in-between period only price estimates are updated assuming static input use level, which is very hard assumption and resulted in similar proportion of pesticide cost. The other possible reasons might be, a) proportionate change in all costs, b) farmers are reducing quantity as price increases or substituting with more use of generic pesticides, and c) prices of inputs or quantities are changing proportionately. A through investigation is required to validate the assumptions.

To observe movement of the seed cotton and paddy rice prices in relation with total consumption[1] (i.e. availability) of pesticide in Pakistan, quantity index was calculated. It is pertinent to mention that about 76 percent of all pesticides are being used on cotton crop in Pakistan (Khan, 1998). Therefore, due to the inability of data, total pesticide used in Pakistan was taken as a proxy of total pesticide used on cotton and rice crop[2]. The pesticides quantity index showed an increasing trend following the price path and risen sharply following the year 1992-93 when Leaf Curl Virus (LCV) achieved the level of epidemic (See Figure 4.5). This implies that output prices have positive relationship with pesticide use on the crops.

[1] In Pakistani statistical data books the term "consumption" is being used to describe the total actual amount of pesticides applied to crops in any particular year whereas, in reality, it depicts the total amount of pesticides available in the country in a year. It includes total imports (in finished form) and local formulation. Therefore, actual amount of pesticide sprayed/ used on crops, vegetables and fruits may be on the higher side as illegal import of pesticide from the bordering countries (see Hasnain, 1999) is not included. Acquisition of such information is very important in terms of its accuracy (Ayuthaya, 1999)

[2] It is estimated that on an average 16 % of the total pesticide was used on rice crop.

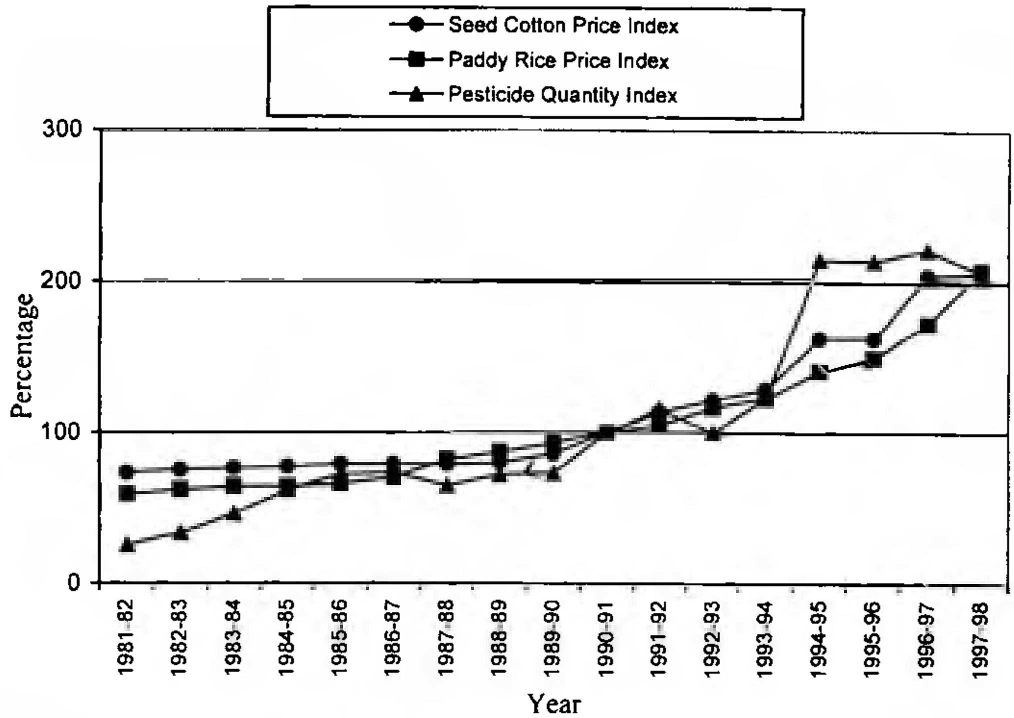


Figure 4.5 Output price trend and total availability of pesticide in Pakistan (based on 1990-91 =100)

4.3. Pesticide Price Trends

4.3.1. Subsidies and Taxes

To protect crops from insects, pests and diseases Government of Pakistan provided plant protection services to farmers free of charge during the initial years of the scheme. Major crops' acreage covered by plant protection measures expanded swiftly from 0.008 million hectares in 1954-55 to nearly 0.526 million hectares in 1959-60. Government kept on providing these free plant protection services to farmers till late sixties. In 1966 government started to recover 25 percent cost from the farmers for ground plant protection measures. However, aerial operations were continued as a free service till 1980.

Under new Agricultural Policy, government completely withdrawn the subsidy on pesticides in February 1980 and handed over the business of agro-chemicals to private sector (Maan and Malik, 1996). Due to strenuous efforts and profit oriented campaign of private sector, pesticides use increased tremendously from 3,677 metric tons in 1981 to 44,872 metric tons in 1997 (GOP, 2000). To achieve the target of wide coverage government provided spraying equipment to farmers on subsidized rate. Import of herbicides was exempted from duty and surcharge by the government in 1992-93 and pesticide import was exempted from the duty as well in the later years (Habib, 1996). To encourage local formulation government also provides concessions and rebates on import of packaging material and other active ingredients.

During 2000-2001[3], government charged 25% duty on import of finished insecticide/fungicide whereas the rate was 10% on technical/active ingredient's import. Other taxes on the sale of pesticide were 15% income tax and 15% General Sales Tax (GST). As far as spraying equipment were concerned, 20% duty was payable on the import of sprayers (Per. Comm., 2001).

The rate of central custom duty on insecticides *viz.*, mosquito coils, mats and the like was 35% ad.val[4] whereas sex pheromone, fungicides, anti sprouting products and plant growth regulators had the duty of 25% ad. Val. However, duty rate for weedicides was 10% ad.val (CBR, 2000).

Other key crop input i.e. fertilizers were generally exempted from the import duty (Per. Comm., 2000). Only urea fertilizer was taxed @ 10% ad.val., subject to the condition that total C&F cost did not exceed US$ 100 per ton[5] (CBR, 2000). Summary of the government's subsidy and customs duty on pesticides and other inputs/ equipment is given in Box 4.1.

Box 4.1 Summary of government's subsidy and customs duty on pesticides and other inputs/equipment

Commodity/Operation	Time Period	Subsidy/Customs Duty
Plant Protection Services (Ground and aerial operations)	till late 1960s	Free of cost
Plant Protection Services o Ground operations o Aerial operations	since 1966	25 % of the total cost charged from the farmers
Herbicide Import	till 1980	Free of cost
Pesticide Import	1992-93	Exempted from the duty and surcharge
Insecticides/ fungicide (finished)	1993	Exempted from the duty and surcharge
Insecticides/ fungicide (technical/active ingredient)	2000-2001	25 % customs duty
Insecticides viz., mosquito coils, mats and the like	2000-2001	10 % customs duty
Sex Pheromone, fungicide, anti sprouting products and plant growth regulators	2000-2001	35 % ad.val[1].
Weedicide	2000-2001	25 % ad. val.
Sprayers	2000-2001	10 % ad. val.
Other Inputs/Equipment	2000-2001	20 % customs duty
Fertilizers	2000-2001	0 % customs duty
Seed (vegetables)[2]	2000-2001	0 % customs duty
Vegetable and other seed processing machinery	2000-2001	10 % customs duty
Import of agricultural machinery, equipment and implements (not manufactured locally) – new or used[3]	2001-2002	0 % customs duty

1 *ad.val* (advalorum) as per value of the bill
2 Bhutta, A. R. (2001) Personal Communication with Deputy Director, Federal Seed Certification and Registration Department, GOP, Islamabad
3 If imported under Corporate Agriculture Farming (Source: Board of Investment, Government of Pakistan, May 2001)

[3] A financial year from July - June
[4] *ad. Val* (advalorum) as per value of the bill.
[5] Vide S.R.O 445 (I)/2000 dated July 01, 2000

4.3.2. Pesticide Prices in Comparison with Output Prices

Pesticides prices increased significantly until recent years. However, it is a common notion among different stakeholders that pesticides prices are decreased substantially after the introduction of generic scheme. In order to validate this notion, the acquisition of time series data pertaining to pesticide prices proved a tedious job due to many reasons. First, various brands of pesticides are abandoned due to closure of business by the formulators or marketing firms. Second, some businesses are handed over to new firms, which resulted in the loss of previous years' data. Third, it is a common practice presently that prices are charged well below the maximum retail prices (MRP) printed on the label. This is due to the competition of generic products with the branded ones hence, exact sale prices of the products are not known. Therefore, to cope with the situation data supplied by the Pakistan Agricultural Pesticides Association (PAPA) pertaining to their sale by value and quantity since 1990 is used to calculate pesticide price index. Figure 4.6 shows that pesticide price index[6] and output (cotton and rice) price index both got an increasing trend. However, pesticide price index lied equal to the cotton price in the beginning and later it started lying below to the cotton price. This may implies that popularity of generic pesticides forced the branded products to be sold at lower prices. This phenomenon is quite evident in the case of Cypermethrin pesticides (See Table 4.2). The price trends reinforced the need of a through investigation about the generic pesticides, their market share and role in lowering pesticides prices.

Table 7. Price comparison of branded and generic pesticides by group

Pesticide	Under Brand Name (Rs/Litre)			Under Generic Name (Rs/Litre)		
	1997	1998	1999	1997	1998	1999
Monocrotophos 40 WSC	480	450	500	220	198	210
Methamidophos 60SL	263	272	325	125	115	112
Cypermethrin 10 EC	840	650	450	272	200	191
Endosulfan 35 EC	237	284	324	240	245	312
Isoproturon 500FW	503	448	450	268	260	270

Source: NFDC, Islamabad

[6] while calculating price index only those pesticide groups which were mainly used for cotton and rice crop.

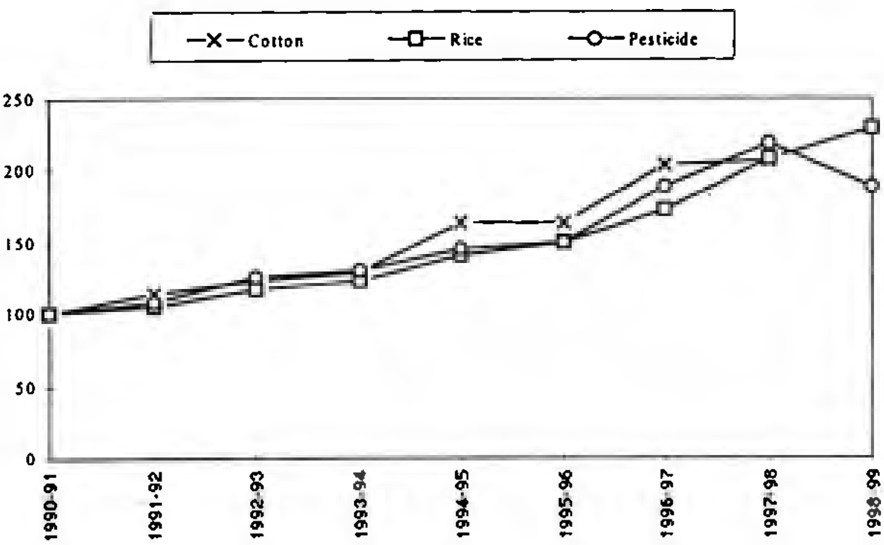


Figure 4.6 Pesticides and output price index (1990-91=100)

4.3.3. Pesticide Prices and Fertilizer Prices

Fertilizer is one of the important crop inputs and plays a major role in attaining maximum crop yield especially after the introduction of high yielding varieties (HYVs). In order to compare fertilizer price trend with the movement of pesticide prices, a graphic analysis has been made (Figure 4.7). Overall, an increasing trend is observed in both the prices (viz. fertilizer and pesticide). The figure also reveals that the pesticide prices lied over the fertilizer prices in general but declined after achieving their maximum in 1997. This may refer to the import of cheaper pesticides under generic scheme. To validate this perception a more comprehensive data pertaining to generic as well as branded products are required.

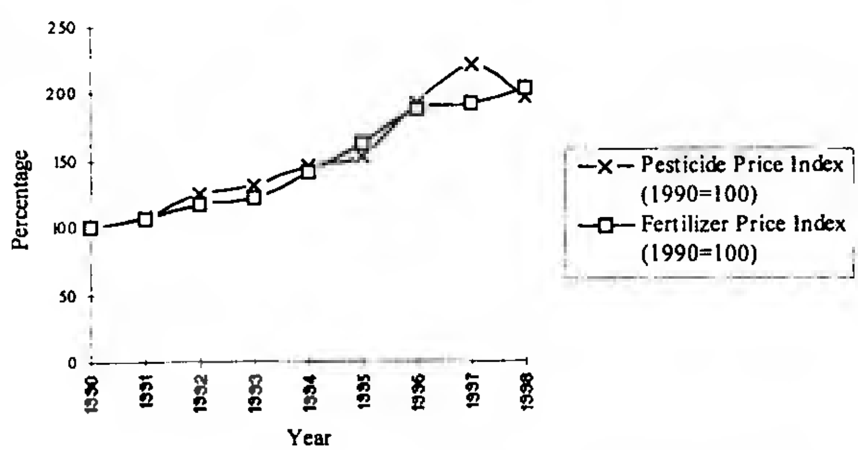


Figure 4.7 Trends In fertilizers and pesticides prices

4.3.4. Pesticide Prices, Labour Cost and Herbicides Use

Availability of agricultural labour force for various farm operations is becoming difficult day by day. Overseas immigration, changing socio-economic structure of the rural poor and rural-urban migration are the main reasons of the shortage of rural labour force resulting increase in the wage rate. The herbicide price index depicted a steady increasing trend while quantity index of herbicide used also increased after dipping down during the year 1991-92 and 1992-93 (Figure 4.8). One of the reasons of increasing price trend of herbicide is the non-availability of wide range of herbicide under generic scheme. Hence, branded products are expensive however, coinciding with the shortage of agricultural labour and effectiveness, herbicides use is increasing on overall basis.

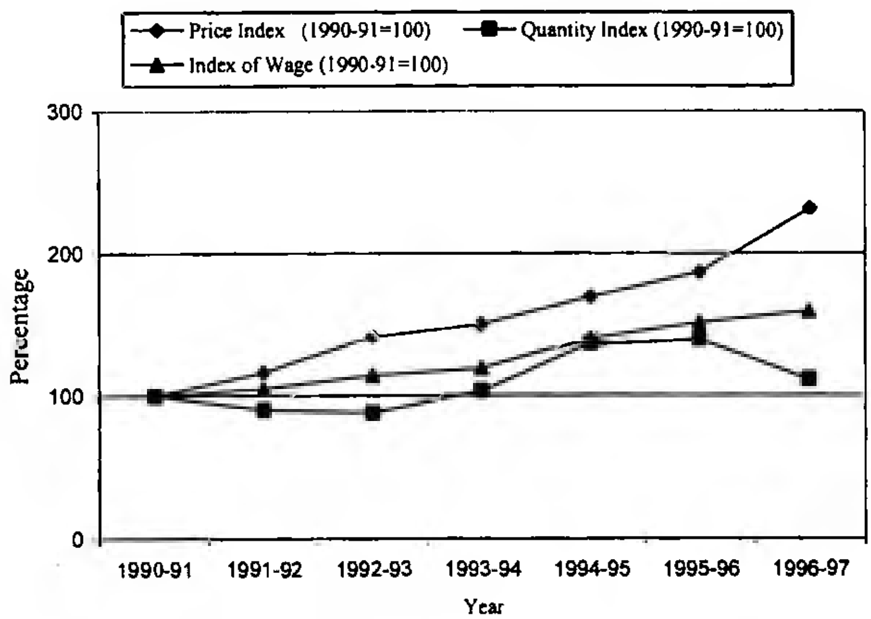


Figure 4.8 Comparison of wage rate of unskilled agricultural labour, quantity of herbicide used and price

4.3.5. Effects of Exchange Rate Movements on Pesticides Prices

Most of the pesticides used in Pakistan are imported from other countries besides the import of active ingredients for local formulation. Therefore, exchange rate of Pak Rupee with US $[7] have an impact on the sale price of pesticide. Overall pesticide prices showed a positive relationship with the movement of exchange rate (Figure 4.9). It is interesting to note that pesticides' price index decreased since 1997 onward despite the increased exchange rate. The total quantity of pesticides consumed also increased from 44.9 thousand tons in 1997 to 45.7

[7] With effect from 8th January 1982, the rupee is floating against the dollar and is linked to a basket of currencies.

thousand tons in 1999 valuing Rs 9904 million to Rs 7324 million respectively. Apparently it looks that more import of cheaper pesticides under generic scheme might be the reason. The paucity of data and lack of co-operation and initiative among different stakeholders did not allow validating this notion. A National Fertilizer Development Corporation (NFDC) publication made a comparison of the prices of generic and branded pesticides and concluded that generic pesticides are quite cheaper than the branded ones (See Table 7).

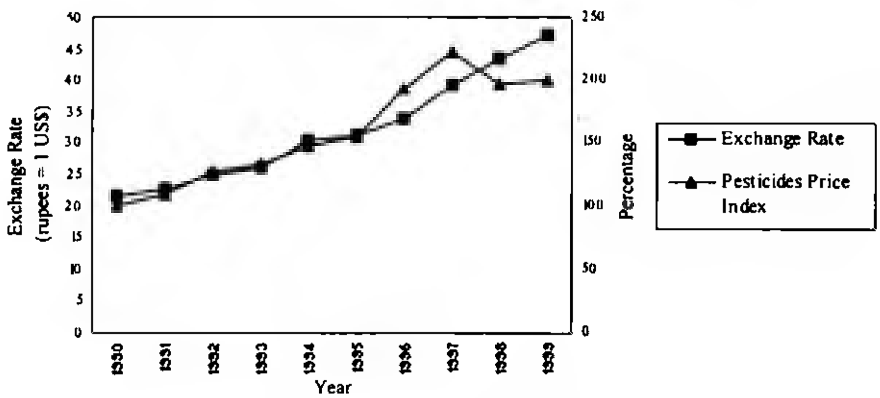


Figure 4.9 Relationship between Exchange Rate and Pesticide Prices

4.3.6. Estimate of Own Price Elasticity of Demand for Pesticides

Estimate of own price elasticity of demand for pesticides is an important indicator of pesticides consumption in relation to its prices but due to the non-availability of time series data pertaining to various pesticide prices and quantity, made the task difficult. However, an attempt has been made by using the aggregate data provided by PAPA. The aggregate quantity of active ingredient (A.I) of each pesticide group was divided to its total sale value in order to calculate retail price of active ingredient per kg. No conclusive results were obtained. Regression analysis was also tried and results are given in Table 8.

Table 8. Regression results

Pesticide Group	Coefficient Value	t-value	R^2
Organophosphate	0.269737	1.159306	0.143835
Carbamate	- 0.05928	- 0.20205	0.005077
Pyrethroids	- 0.44609	- 4.32529	0.700466*
Chlorinated	1.293772	2.815019	0.497624*
Fungicides	0.07499	0.427072	0.022291
Rodenticides	- 0.14949	- 0.20327	0.005868
Herbicides	0.162831	1.162287	0.144468

Only pyrethroid and chlorinated group of pesticides showed some significant 't' values. It is generally understood that under present farming scenario pesticide use in Pakistan, particularly on cotton crop, is linked with calendar months irrespective of intensity of pest attack.

4.4. Non-Price Economic Factors

4.4.1. Agricultural Credit

Capital is one of the factors of production and is required in agricultural production like other business activities. Therefore, agricultural credit with usual characteristics of mobility and flexibility play the role of capital in agriculture. In Pakistan, there are two major sources of agricultural credit, (i) *Institutional* viz., Taccavi loans by the Government of Pakistan, Co-operatives, Agricultural Development Bank of Pakistan (ADBP), and the Commercial Banks (ii) *Non-Institutional* viz., kin, friends, landlords, money lenders etc. (Sajidin, 1983).

Agricultural credit is being provided to farming community for the purposes of seasonal inputs and for development purposes (Siddiqui, 1987). The Commercial Banks and Federal Bank for Co-operatives initially concentrated on lending production loans to farmers. Whereas, ADBP mainly focused upon the medium and long term development loans but later on, ADBP also started lending short-term production loans (Pasha, 1987).

The share of agricultural credit provided by the co-operatives to farmers had always be meager (about 5 percent) in Pakistan (Khan, 1983) and no authentic information is available about the volume of agricultural credit transferred from non-institutional sources to farmers in the country (Sajidin, 1983).

Agricultural Development Bank of Pakistan is the single largest agency among the agricultural credit lending institutions in the country (Matin, 1987). More than 70 percent of the total agricultural credit was supplied by ADBP alone during 1998-99 (GOP, 2000). The bank advances short-term production loans against hypothecation of cotton crop under Tri-Partite Agreement among the *bank*, *cotton growers* and *recommending ginning factory*[8]. The loans against hypothecation of cotton crop are sanctioned during the sowing season of cotton crop. The loan is admissible for the purchase of pesticides @ Rs 1000/- per acre. The maximum amount of the loan to individual grower should not exceed Rs. 30,000/- The loan is payable within the period not exceeding than 12 months (ADBP, 1987).

The data showed that agricultural credit extended against the hypothecation of cotton crop was very less in amount in the beginning and increased drastically after the privatization of

[8] The cotton grower in return bound to tender his cotton to the recommending Cotton Ginning Factory, which has entered into an agreement with the bank.

pesticides business from government sector to private sector. The impact and efficiency of mass communication campaign made by the private sector is quite evident from the Figure 4.10.

Box 4.2 Loans against hypothecation of cotton crop

Processing of cases for Sanctioning of Credit Limit

The Bank advances loans against hypothecation of cotton crop. The Ginning Factories, who wish to enter into Tri-Partite Agreement with the Bank for advancing loans to the cotton growers on their recommendation should request for grant of the limit up to which the loans are to be advanced by the Bank during a crop season.

The request thoroughly examined by the Regional Office of the Bank and forwarded to the General Credit Operations Department, Credit Division, ADBP, Head Office, Islamabad for fixation of limit and approval for entering into an agreement with the firm and grower. The request must reach to the head office by the 7th March every year, so that the loans against hypothecation of cotton crop are sanctioned and disbursed during sowing season of cotton crop which starts from the beginning of April in many areas of the country.

The Head Office in the light of the recommendation of the Regional Managers will allow to the respective Branch to enter into an agreement with the Cotton Ginning Factory.

Permissible Items of Loan

Loan against hypothecation of cotton crop is admissible for the following items:-

S. No.	Item	Amount (per acre)	Limit
1.	Seed	Rs 50/-	Actual cost subject to total amount of loan being limited to 50% of the estimated value of crop but not exceeding Rs. 1450/- per acre.
2.	Fertilizer	Rs 400/-	
3.	Pesticides	Rs 1000/-	

Maximum and Minimum Limit of Loans

Maximum amount of loan that can be paid against hypothecation of cotton crop to anyone individual should not exceed Rs. 30,000/-. This will also apply to joint holdings.

Sale of Produce by the Loanee (Grower)

The applicant, at the time of sanctioning of loan, should be made clear that it will tantamount to breach of terms if disposes off his cotton produce through any agency other than the one mentioned in the hypothecation deed.

Duration and Recovery of Loan

The duration of loans agianst hypothecation of cotton crop should not exceed 12 months. The recoveries should be effected from the loanees on the delivery of the produce to the Factory by them.

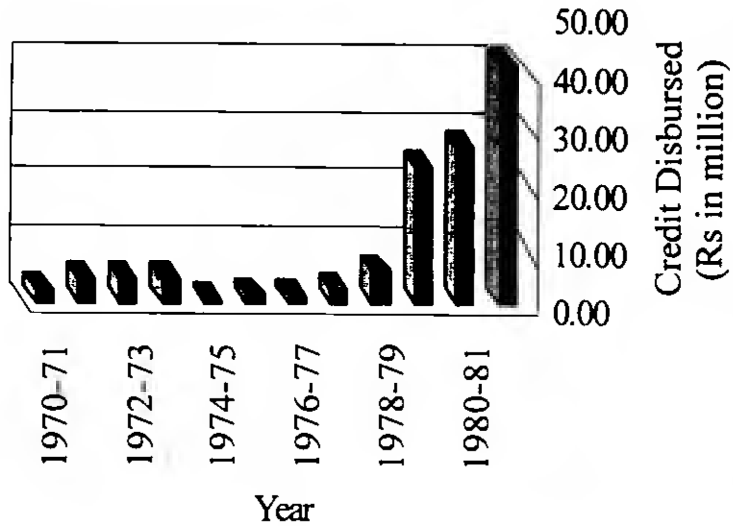


Figure 4.10 Credit disbursed against the hypothecation of cotton crop (1970-71 to 1981-82)

The ADBP also advances short-term production/seasonal loans[9] for the purchase of inputs such as improved seeds, fertilizers, pesticides/insecticides, weedicides etc. besides development loans[10]. The interest rate charged on the loan is 14%, irrespective of the type of commodity (Per. Comm., 2001a). Data pertaining to credit disbursed under hypothecation of cotton crop since 1981-82 onward is not available separately and reflected under production loans extended for the purchase of crop inputs. Therefore, Figure 4.11 shows the total credit disbursed for the purchase of pesticides/insecticides, fertilizer and seed from 1982-83 to 1998-99, irrespective to the mode of disbursement. It was observed that pesticide is the second important crop input after fertilizer and its amount almost followed the same trend as fertilizer. Govemment disbursed more credit to farmers after the incidence of leaf curl virus (LCV) on cotton crop augmenting the sale of pesticide. This shows a direct relationship between the total credit disbursed and pesticide used.

Informal credit also plays an important role in the widespread use of pesticide in Pakistan. Qureshi (1985) observed that some distributing firms obliged the big landowners by enlisting them on their dealership list. Through this practice landowner enjoyed the discount of 15-25% on his purchased pesticide from the firm.

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[9] Production/seasonal loans are advanced for the purchase of fertilizer, pesticide, seed, labour , payment of hired tractor charges and working capital for poultry, dairy, livestock and fisheries.

[10] Development loans are extended for the purchase of tractor, dairy farming, farm equipment, installation of tubewell, poultry farming, orchard land development, fisheries, farm transport, god owns and cold storage etc.

It was further observed that 25 percent of the total sale volume of the liquid pesticide was sold to farmers on credit basis while on cash buying farmer enjoyed 5 percent discount (Qureshi *et al.*, 1989). During the study period, a formal survey was conducted among the cotton growers in Multan, Punjab area. The survey revealed similar information that 71 percent farmers were buying pesticide from retail shops while 29 percent from wholesalers. In an examination of credit sale, 25 percent of those who were buying from the retailer were on credit buyer. Overall, 29 percent were buying pesticide on credit basis. This implies that pesticide availability on credit is one of the main factors of increased pesticide use in the country.

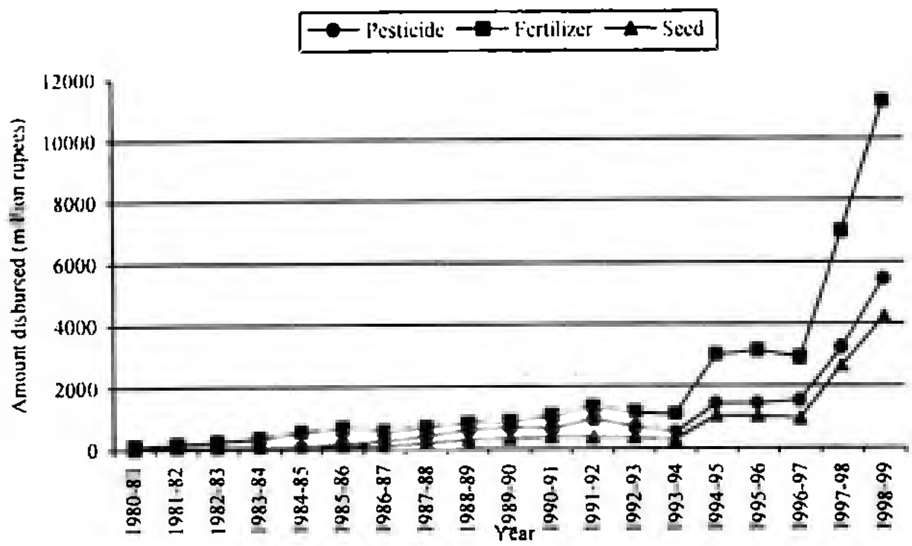

Figure 4.11 **Credit Disbursed for the Purchase of Pesticide and other Crop Inputs in Pakistan, 1982-83 to 1998-99**

4.4.2. Out Break Budgets

Pakistan experienced several outbreaks of locust, leaf curl virus and other insect pest attacks in epidemic form on different crops. Government tackled the situations at emergency basis however no specific budget was earmarked to cope with the outbreaks. Generally, the amount was re-appropriated from the allocated annual budget of agriculture sector (Per. Comm., 2000).

4.4.3. Aerial Spraying

During 1970s government started to give more emphasis on ground plant protection measures and finally, abandoned the free aerial spraying in 1980 under new agricultural policy. However, the aerial services were continued to be available in well-defined areas of Punjab and Sindh provinces at demand and on payment of cost of pesticides. Orchards and paddy fields in Balochistan and sugarcane and orchards in NWFP were also provided with the aerial services

(Maan and Malik, 1996). Figure 4.12 shows the total spray hectares since 1970-71. It observed that maximum area was treated with aerial operations in 1976-77. Thereafter, it gradually declined with little fluctuations and fully abandoned in 1995-96 when no aerial spraying was made. Later on, the aerial spraying was restricted to fruits and vegetables.

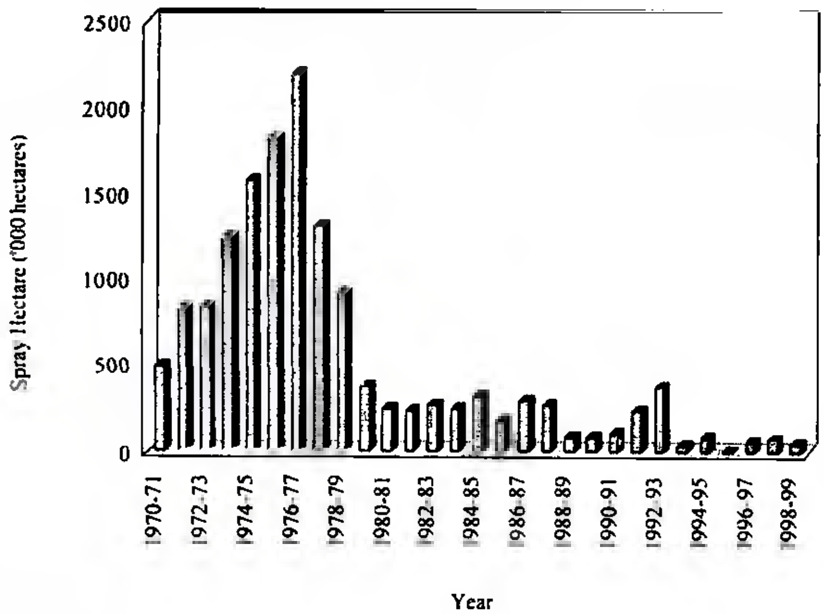

Figure 4.12 Aerial spraying in Pakistan, 1970-71 to 1998-99

4.4.4. Overseas Programmes Encouraging Pesticides Use

Agriculture is one of the major aid receiving sectors of Pakistan's economy. During 1961 to 1988 agriculture sector was ranked fourth and improved its position in the subsequent years by becoming the second largest aid-receiving sector. Within agriculture food crops' share increased from 6 percent to 80 percent between 1991 and 1994. USAID, the World Bank, and Asian Development Bank (ADB) were the big aid donors to the agriculture sector of Pakistan. Among projects *On-Farm Water Management*; *Inputs Production and Supply*; and *Agricultural Research Infrastructure and Institutional Development* were the three most important and large aid receiving groups (Sheikh, 1998).

No direct information is available about the import of pesticides under foreign aid projects however DDT (dichlorodiphenyl trichloroethane) was firstly used in Pakistan under Malaria Eradication Programme initiated with the help of WHO to control mosquito and imported DDT and BHC. A study conducted by Hasnain (1999) also mentioned that some stocks of pesticides were piled up in Pakistan due to excessive, inappropriate and late arrival of donations.

4.4.5. *Export Incentives to Reduce Pesticide Use*

The world is giving a greater environmental consideration to agricultural production and is evolving a range of technologies for the purpose. Under this scenario *organic farming* is one which is getting popularity and the International Federation of Organic Agricultural Movement (IFOAM) is working for the enhancement of biological cycles within the farming system, involving micro-organism, soil flora and fauna, plants and animals (Saber, 1997). Contrary to this, modern agriculture of the era has alarming level of dependency on the use of pesticides.

Endeavors were made to identify any reference regarding export incentives extended to Pakistani farmers by exporters in terms of reduced pesticides use but no authentic source was identified. However, some inferences are available from the developing countries in this regard. Uganda is producing organically grown cotton and Europe's leading Garment Company "GAP" is manufacturing clothes from it. It was observed that consumers are spending $22 billion on purchase of organic products in the world and is the fastest growing sector in the agricultural economy. Demand is expanding for organic products in United States, Japan, and Europe etc. Organic products have export potential in the developing world other than their domestic markets (McGinn, 2000). Pakistan has comparative advantage in production of cotton and rice and can earn more by producing safer commodities than before.

4.5. Conclusions

Impact assessment of any new intervention in the existing production systems is of prime importance to judge its implications to the environment and bio-diversity and benefits to farmers and the society as a whole. The chapter concludes that pesticide use was increased many fold after handing over the business to private sector. Farmers found to rely on pesticides as the major means of pest control, especially after the outbreak of LCV of cotton, at one hand. On the other hand, government policies such as subsidies and taxation, agricultural credit and free aerial spraying encouraged pesticide use to accomplish its objective of enhanced productivity and self sufficiency.

The fullness of analysis is constrained by time and data availability. A serious deficiency of data recording and maintenance at government and private sector level was observed. No futuristic nature of study was conducted so far, using up to date technique or methodology, to assess the qualitative and quantitative factors of pesticide use on the productivity of crops. A time series economic analysis and/or panel data analysis was not possible in order to assess relative efficiency of pesticide use in Pakistan and to propose/ evolve any policy model.

In recent years, the world has shown its concern over the indiscriminate use of pesticide, consequently organic products are getting popularity among the people. Therefore, there is need to take some serious steps toward data management and policy analysis in order to lessen the rely on pesticide use and to keep the country's comparative advantage in tact under globalization.

Chapter 5: PESTICIDE REGULATORY POLICY

In view of insecticide importance to enhance food production, thė Agriculture Inquiry Committee in 1952 recommended to establish a viable plant protection service in the country. During mid fifties chemical pesticides were used for the first time to combat the attacks of locust. Later on aerial spraying was extended to control sugarcane pests in NWFP and fruit pests in Balochistan and NWFP. With the success achieved in controlling sugarcane and fruit pests, the aerial spraying was extended to control cotton and paddy pests in Punjab. Sindh and former East Pakistan (now Bangladesh). Pesticides and other related services (aerial spraying) were initially provided free of cost to the farmers (Habib, 1996). Thereafter, pesticides have been heavily subsidized at different levels to enhance their use in the country. This increase in pesticide use has been source of considerable concem due the emergence of pesticide associated problems. Because of absence of effective regulatory measures, government had to streamline the procedure for the import of effective, safe and cheap insecticides. In April 1963, these tasks were assigned to a committee known as Pesticide and Equipment Standardization Committee headed by Federal Secretary of Food and Agriculture and Provincial Agriculture Secretaries and technical officials of various institutes as members (Haque, 1990). To further streamline the pesticide use in the country following legislation were introduced.

5.1. Pesticide Legislation

No doubt pesticides have benefited the mankind in effectively protecting agricultural and animal production against various pests and helped to control disease-transmitting vector-insects. However, these chemicals posed potentially great hazards to users, consumers, wild life and the environment. The ever increasing application of pesticides and growing public concem about their negative side-effects have made it necessary to set general standards and rules concerning proper use.

Though the use of pesticide in Pakistan was initiated in 1954 with the import of 254 metric tons of formulated pesticides, ironically, pesticide use was legalized 17 years later in 1971. However, pesticide legislation was promulgated well in advance of the launch of FAO's International Code of Conduct on the Distribution and Use of Pesticides, which was adopted in 1985. Policies for regulating the pesticide use in Pakistan were changed from time to time. To legalize the use of pesticides in the country, Agricultural Pesticide Ordinance (now Act) was promulgated in January 1971 and Agricultural Pesticide Rules were framed in 1973. This is a comprehensive law for regulating all imports, manufacture, formulation, marketing, distribution and use of pesticides in the country. Following this, an Agricultural Pesticide Technical Advisory Committee (APTAC) was established to advise the central government on technical matters to the administration of this ordinance. In February 1979, the Government amended the 1971 Pesticide Ordinance, when pesticide business started shifting from public to private sector. The Ordinance was further amended in September 1992 to allow pesticide import under generic names rather brand names and then amended in December 1997 to strengthen the punishment provision for pesticide adulteration.

5.2. Registration of Chemical and Biological Pesticides

Pesticide management system in Pakistan is presented in the form of flow chart (Figure 5.1). The Ministry of Food, Agriculture and Livestock (MINFAL) has the control of pesticide regulation in the country. The Department of Plant Protection in Karachi is responsible for registration and other regulatory aspects of pesticides. Consequence upon the promulgation of the 1971 Pesticide Ordinance and authentication of Pesticides Rules, 1973, Agricultural Pesticides Technical Advisory Committee (APTAC) was set up inter-alia for registration of pesticides. Federal Secretary of MINFAL is the chairman of APTAC. The APTA sub-committee headed by the Plant Protection Advisor and Director General, Department of Plant Protection, is the actual recommending authority for the registration of any pesticide in Pakistan. APTA sub-committee obtains detailed information about the product including name, structural formula, active ingredient, technical grade material, formulated product, flammability, efficacy, toxicological data, residue data, prediction of environmental effects, disposal of surplus pesticides and pesticide container, labeling and direction for use, packaging and methods for analysis. The requisite information is submitted to APTAC for consideration/approval of pesticide registration. Initially, each product is registered for three years and registration may be renewed after three years. Similar procedure is adopted for registration of biological pesticides.

Generally, once a pesticide is registered, its registration is reviewed periodically. During 1980's the issue of internationally banned products was raised in APTAC meetings for de-registering such pesticides in the country. Ultimately, 23 pesticides were de-registered and their import either in technical grade or formulation was banned in 1994. Further, some more pesticides classified as extremely hazardous (1-A category) and highly hazardous (1-B category) by WHO, were recommended for de-registration for use on agricultural crops (Qasmi, 1997). Despite their ban, such pesticides are still used on limited scale due to various reasons, including smuggling from Afghanistan, Iran, India and other countries. Very recently (October 2000), a case of Methyl Parathion 50EC was discussed in a meeting on "Rational Use of Agro-pesticides for Ensuring Environmental Safety" in Department of Plant Protection, Karachi. Despite the fact, Methyl Parathion has been placed on the Prior Informed Consent (PIC) list of FAO/UNEP. The said pesticide was imported (96,000 liters) by a leading national pesticide company in the country, without any consent of the designated national authority. However, Pakistan agrees to the FAO Code of Conduct and the Prior Informed Consent (PIC) and efforts were made to follow the Code of Conduct in the regulatory set-up. In Pakistan, about 17 different products have been placed under PIC list of FAO/UNEP.

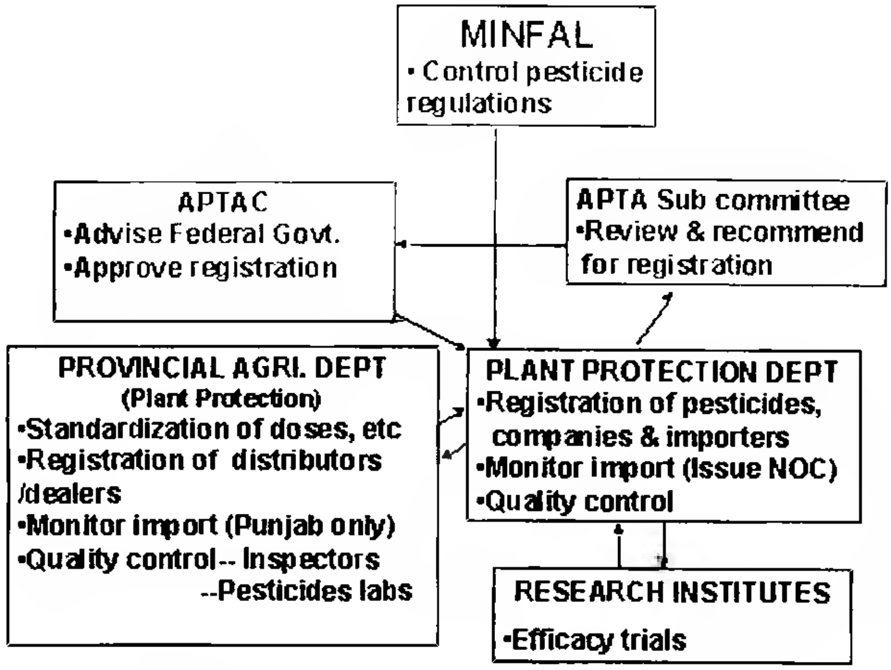

Figure 5.1: Pesticide Management System in Pakistan.

In Pakistan, the registration of pesticides is carried out in three categories.

- Registration under trade name (Form -1)
- Registration under generic scheme not having trade name (Form -16)
- Import permission for pesticides registered in the country of manufacture (Form - 17)

5.2.1. Registration under Trade Name

Application for registration is submitted on Form-I along with relevant samples. After scrutiny of the applications, the samples are sent to government analyst for testing. Under the law (Rule-4) of the Agricultural Pesticides Rules 1973, the application may be sent to laboratory for tests or analysis within one month from the date of receipt of the sample. The samples cleared in the laboratory analysis undergo efficacy evaluation at different Federal and Provincial Research Institutes. The Agricultural Pesticide Rules require that efficacy evaluation trials should be conducted for two crop seasons by at least two agencies. Registration, therefore, takes 2-3 years. The efficacy reports are first evaluated by the Technical committee of the respective Province and then by Provincial Standardization Committee. The efficacy data received from Federal/Provincial Government are examined by the Department of Plant Protection and then placed for the consideration of the APTA Sub-committee and pesticides recommended by the Sub-committee are finally approved by the APTAC headed by the Secretary MINFAL.

5.2.2. Registration under Generic Scheme

Pesticides already registered under trade names can be imported under generic names. Under the provisions of the Agricultural Pesticides (Amendment) Act, 1992 and Amendment made in the Agricultural Pesticides Rules in March 1993, applications are submitted on prescribed Form-16 along with relevant samples. Samples are sent for analysis to the government analyst. Registration is decided/granted on receipt of analysis report.

5.2.3. Import Permission for Pesticides Registered in the Country of Manufacture

Under the provisions of the Agricultural Pesticides (Amendment) Act, 1992 and Amendment made in the Agricultural Pesticides Rules in March 1993, applications are submitted on prescribed Form-17. Import permission is granted on the receipt of complete information and fulfillment of the following requirements.

- Documentary proof of the pesticides registered in the country of manufacture.
- Proof of the use of pesticides in any member country of the OECD or China.
- Documentary proof of the pesticide extensively used on relevant crop and its pests in the country of origin or any OECD member country or China.

According to Pakistan Agricultural Pesticide Association (PAPA) sources, in 1997 the import of pesticides under Form-1, Form-16 and Form-17 was worth Rs 5.8, 1.2 and 3.3 billion. Qasmi (1997) reported 202 active ingredients were registered under regular scheme whereas under generic scheme 14 active ingredients under 139 products were allowed for marketing. The situation has been changed now. In 1999, under the regular registration scheme (Form-1), 189 active ingredients were registered under 349 different trade names with concentration/formulations in the name of particular pesticides marketing companies. But under generic scheme (Form-16), 99 active ingredients were allowed for marketing under 434 brand products (Directorate of Pest Warning and Pesticide Quality Control---personal communication). However, according to Department of Plant Protection (November 2000), so far a total of 498, 792 and 826 different products have been registered or allowed to be imported in the country under Form-1, Form-16 and Form-17, respectively. Over the years, position of pesticide registered or import permission granted is given in figure 5.2. The data revealed that under normal registration procedure (Form-1), the number of products is drastically reduced since 1996. Whereas under Forms-16 &17, the total number of products is increased. Since July 1998, the operation of import permission is restricted to only those pesticides, which are not, registered under Form-1 or Form-16. Only new chemistry products are imported under Form-17 now. Therefore, the number of products under this category has been reduced since 1999. The number of products registered under generic scheme increased gradually since 1998.

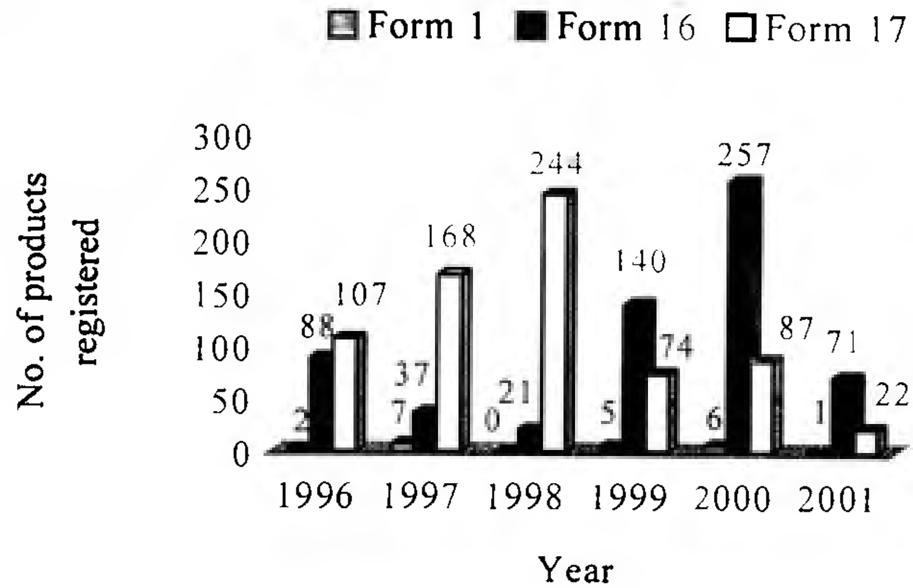

Figure 5.2: Position of pesticide registration/import permission 1996-2001(April)
Source: Department of Plant Protection, Karachi.

5.2.4. Registration Fee

Initially, the registration/renewal fee was Rs.500/ in 1973. This was revised to Rs.1000/ in 1980 and further revision was made to Rs.2500/ in 1990. The registration fee was enhanced from Rs.2500/ to Rs.25000/ per formulation in 1996 and renewal fee was also changed from Rs.2500/ to 5000/. Under Form-17, fee for the issuance of import permission for pesticides registered abroad were levied up to Rs.25000/ in 1998. To strengthen the existing registration facilities, the registration fee may be increased upto 10% or 1% of the actual value of sale may be charged to raise funds for pesticide related research and development work.

5.3. Pesticide Regulations and its Implementation

Legislation and regulation, however, is only as good as its enforcement, which is a major constraints in most of the countries and Pakistan is not an exception. For example, it is clearly stated in the Ordinance that the government may register pesticide, if it is satisfied that *it is not generally detrimental or injurious to vegetation (except weeds), or to human or animal health, even when applied according to direction.* This clearly empowers the registration authority to get all the information from applicant (mentioned in Form-1) regarding the half-life of a pesticide estimated from residues in food, soil, plants, water and health effects evaluated from mammalian toxicity and toxicity to fish, birds, honey bees etc. This is unfortunately not done by the officials concerned, and the registration is mainly done based on physio-chemical properties of a pesticides, and field trials, conducted only to evaluate efficacy or differences in yield of the crop. No samples of the crop are taken to ascertain the maximum residue level under the local climatic conditions. Under such circumstances of evaluation, there is no guarantee of the safety of a pesticide. In order to obtain the necessary data to fix maximum residue limits, crop commodities with known pesticide treatments, should be analyzed. Because of lack of infrastructure in Pakistan for regular monitoring of pesticide residues, and expenses involved for such purpose, pre-harvest period fixed or recommended (safe commodity use), for each pesticide should be enforced or the Applicant Company executing field trials in Pakistan for efficiency and determination of maximum residue limits should bear the expenses for this work.

One of the major reasons of dramatic increase in pesticide use in Pakistan is the soft policy of import and registrations of generic products. Even farmers can directly import pesticide under generic scheme. Such products are imported without field-testing if registered in the country of origin. During 1993 cotton season pesticides worth million of rupees were directly imported by many cotton growers and pesticide dealers under generic systems of registration without knowing any ill effects (Bhambhro, 1995).

Introduction of generic scheme for pesticides no doubt has resulted in sharp reduction in prices, but it has given birth to many complex problems. Multinational companies consider that quality of pesticides under generic scheme is unsatisfactory, right from the port of landing up to delivering to the farmers. Bhambhro (1995) indicated that the diversifying sources of pesticide supply under generic system have increased the chances of sub-standard and adulterated supply of pesticides. Factories are reportedly operating in the country engaged in rebottling, repackaging and labeling of pesticides after adulteration or mixing. The quality of pesticides under generic scheme is satisfactory according to national companies. During our survey to cotton area, farmers have also reported complaints against the ineffectiveness of pesticides. This suggests that not only the products are substandard but the pests have also developed resistance. However, majority of the growers who are illiterate and misled or confused with so many products of the same active ingredient and are ended up with the over use of pesticides (verbal communication with cotton growers). Another issue is that generic products can be sold as ordinary consumer items with no link to original importers and suppliers. This is what happening in most of the cases in Pakistan. One party imports the products in bulk and hands over to other for bottling and distribution (Personal communication with a distributor). According to Mustafa and Shah (1998), this has encouraged unscrupulous entrepreneurs to set up factories for packing, labeling and marketing of spurious products.

To simplify the registration, import and distribution process, if products are already registered in the country of origin, the two years testing can be avoided. This also has some severe implications. Many agencies/companies of exporting countries are providing false documents to help unscrupulous traders who are bringing in spurious products (Mustafa and Shah, 1998). In addition, these products have been tested in entirely different ecological conditions that of Pakistan.

The problem of food and environment contamination will be more aggravated in case of products registered in the country of manufacture and allowed to import without undergoing the registration process (Form-17). Climate and geographical locality can be of prime importance in influencing the extent of environmental effects and there is a danger of uncritical extrapolation of data between temperate and sub-tropical areas. A pesticide in more intense solar radiation may result in photo-decomposition or conversion of the parent compound, and in some cases more toxic products may be formed (Jamali, 1992). The suitability of a pesticide for a particular region must be based on climate, ecological, agronomic, social, economic and environmental conditions and of pest problems. The government of exporting countries never judges the suitability, efficacy, safety or fate of the pesticide under the conditions in the importing countries. Under such circumstances it becomes the responsibility of the government to ensure adequate and effective testing of pesticides along with detailed knowledge of the various anticipated conditions prevailing in the country.

Since the private sector was allowed to import, manufacture and market pesticides in Pakistan, the pesticide consumption increased manifold. Economically handicapped farmers are given several incentives including credit by the private sector. To fulfil the targets fixed by the employers, the sales representatives of pesticide companies also induced farmers via hand sell tactics to increase number of sprays. Reports indicate that in cotton areas, farmers are applying precautionary sprays without observing the pest population (SDPI, 1998).

Although, the subsidies on pesticides have virtually been removed, indirect subsidy is still in practice. The private sector enjoys several subsidies to manufacture, import and market pesticides. There is relaxation on duty and surcharge exemption on import of pesticide raw material, subsidies and loan for factory machines and installations, and free hand for marketing (Hasnain, 1999).

The advertisement of toxic pesticides on the electronic media should be with some code of conduct, duly approved by the government. Zia (1997) has also mentioned that private sector influenced the government policies and took full advantage of its pesticide-oriented policies. The advertisements of their products support this argument. The aggressive media campaigns do not comply with the FAO guidelines for advertising pesticides. The pesticides are promoted as "most effective", "best", "profitable", "total destruction of insects", converter of cotton silver into gold" etc. obviously a violation of the international code of conduct (Habib, 1996).

It is generally agreed that much more is needed in the regulation of pesticides. However, implementing and enforcing regulations will remain a limiting factor. Wiebers, (1993) reported that more than 30% of the Asian counties were unable to enforce restrictions on highly toxic pesticides and about 75% reported inadequate resources for enforcement. Thus, govemment should take responsibility in stopping the projection and promotion of pesticides as the ideal solution of the pest problem. Education of farmers in the safe and effective use of pesticides and in alternative means of pest management should be given equal importance and should be made aware of the costs/benefits of pesticide misuse.

5.4. Legal requirements for Production, Distribution, Storage, Application and Disposal of Pesticides (Standards)

5.4.1. Production

In Pakistan, there is as yet no manufacture of basic or active ingredient locally, except for DDT and BHC, which were manufactured by the Government (banned now). The legal requirements for the manufacturers/formulators are self-explanatory. However, according to SRO 160(1)/96, the formulation plant should have well equipped pesticide analytical system, emission control systems and should follow industrial hygiene precautions. There are 23 local formulating/re-packing pesticide plants in the country, some of which are quite modem and some of which are garage-type' plants. Around 40% of pesticides are locally formulated.

5.4.2. Distribution

Until 1980, pesticide distribution was mainly in the hands of the provincial extension services. although some private companies were allowed to distribute as well. Official figures show that 190 pesticide companies are doing business in the country. However, discussion with Pakistan Agricultural Pesticide Association (PAPA) authorities revealed that there are more than 300 players in pesticide business in the country. Initially all pesticides were imported. After 1980, private-sector was permitted to import, formulate and distribute if they meet the established criteria and was granted proper licenses. Distributors and dealers must be registered with the Provincial Agriculture Department before being allowed to market pesticides in the province. A dealer who sells the pesticides of more than one distributor must be registered separately for each distributor. Registration is granted for 1-3 years and is renewable. Presently, there are around 200, 55, 60, and 67 registered distributors in Punjab, Sindh, NWFP and Balochistan, respectively. Their exact number is not available. Most of the importing pesticide companies do distribution by themselves.

According to SRO 160(1)/96, the authorised distributors should maintain adequate number of qualified staff (10 Agriculture graduates), training facilities, sufficient capital (minimum Rs.1million), adequate storage facility, transportation, packaging and safety measures.

5.4.3. Storage and Use

Storage conditions are ultimately the major deciding factor in prolonging or shortening shelf life of a pesticide. Pesticides stored in stores with proper temperature and humidity with avoidance of direct contact with sunlight will not loose their potencies at a premature stage. Under the Article 11 of Agricultural Pesticide Ordinance 1971, 'No person shall store or use any pesticide save in accordance with rules made under this Ordinance'. Similarly, under section 21of the Ordinance, it is clearly stated that any person who hold stock for sale or advertises for sale an adulterated or sub-standard pesticide shall be guilty of an offence. There is severe punishment and fine for the adulterators. According to Agricultural Pesticide (Amendment) Act, 1997 the punishment for pesticide adulteration was strengthen up to seven years imprisonment and fine more than one million rupees.

The requirements for storage facilities are specified under Sub-Rule 16 of the Agricultural Pesticides Rules 1973. In pursuance of the Sub-Rule 16 of the 1973 Rules SRO 160(1)/96 was notified and specified the storage requirements as under:

- Storage should be away from populated areas.
- Storage should be properly ventilated.
- Should have protected electrical installations.
- Should have fire-fighting equipment.
- Storage should be equipped with protective and safety clothing.
- Should have emergency showers and eyewash facilities.

Requirements relating to pesticide use are stated in Section 18 of the Agricultural Pesticide Rules 1973. 'Persons engaged in spraying pesticides shall use the protective clothing and masks as and when required.' But in reality, very few farmers/workers observe this rule.

5.4.4. Disposal of Pesticides

Under the Section 17 of the Agricultural Pesticides Rules 1973, the requirements regarding empty packages and pesticide remains are not clear and give very gloomy picture. These are stated as:

- The destruction and removal of the empty packages and pesticide remains shall be effected in such a way that sources of water supply is not contaminated.
- The un-cleaned packages shall be destroyed in a way as to preclude the possibility of their being reused for any purpose other than as base material.

However, guidelines required for the disposal of surplus pesticides and pesticide containers, at the time of registration, are given in the law. According to that surplus pesticides cannot be placed in ordinary bins, but has to delivered directly at the local refuse disposal plant. Children and animals should not have access at any time. Empty papers, cardboard or plastic packs be placed in a weatherproof container in the enclosure. Glass containers may be crushed in a sack.

5.5. Environment and Human Health Protection Regulations and Standards

Pakistan follows the WHO's classification of pesticide hazards, which is based primarily on the acute oral and dermal toxicity to rats of technical compounds which is a standard toxicological procedure required for registration of pesticides. In Pakistan, there are no set rules and standards available regarding environmental and health protection from pesticides. However, to ensure the safety of users and environmental protection, data on toxicology, residue studies, prediction of environment effects and guidelines for pesticide disposal are required at the time of pesticide registration. For pesticides, the Agricultural Pesticides Ordinance, 1971 and its Rules, 1973 provide the necessary legal framework for regulating the use of pesticides in Pakistan. Under the Section 40 & 41 of Rules 1973, safety precautions for the health of farmers and workers are given.

The FAO Code requires that governments provide guidance and instructions for the treatment of suspected pesticide poisoning to their basic health workers. But the fact of the matter is that there are no facilities in the villages to cope with such situations. The national legislation has no provision for monitoring the health of farmers involved in handling pesticides. Application practices on farms are often very poor, due to wide spread illiteracy among farmers, inappropriate labeling to meet the illiteracy problem, poor extension, insufficient dealer training, and poor application equipment.

There is no well-defined rules exist in Pakistan regarding the safe residual limits for application of different pesticides to various crops. However, in pursuance of power conferred under clause (e) of sub-section (1) of section 6 of Pakistan Environmental Protection Act, 1997. The Pakistan Environmental Protection Agency with prior approval of the Pakistan Environmental Protection Council made notification in SRO 549 (1)/2000 regarding the National Environmental Quality Standards for Municipal and Liquid Industrial Effluents. According to the notification, the required environmental quality standard for pesticides is 0.15 mg/l in inland water, in sewage treatment and in seawater.

5.6. Monitoring and Enforcement of Regulations and Standards

Under the Act, there is a great emphasis on the purity and efficacy of the product and safety of users. There are various provisions to ensure correct labeling, satisfactory packing, storage and quality control through designated inspectors who can take samples for analysis in the pesticide laboratories. In pursuance of the registration requirements, the directions of use are clearly stated on the label, listing the crop and pest situation for which use is officially registered or approved. The application should be restricted to specific crops for which registration was granted. As it is observed that farmers often use leftover pesticides, recommended for cotton, on other crops, especially vegetables. There is no strict action is taken. This is a big source of food contamination with toxic products.

Under the provision of the Section 15-18 of Agricultural Pesticides Ordinance, 1971 the designated inspector is authorized to enter any premises where pesticides are kept or stored and draw samples of pesticides (divided in three portions/three containers) according to prescribed procedures, for laboratory analysis. The inspector restores one portion of sample or one container, as the case may be, to the person from whom he takes it. The second portion or container is sent to the respective Provincial Government Analyst for test or analysis and the third portion or container is sent to the Federal Department of Plant Protection at Karachi. They perform test themselves or send to designated Federal Government pesticide laboratory (under NARC, Multan). Various pesticide laboratories in Pakistan are presented in Table 9.

Table 9. Pesticide laboratories in Pakistan

Province	Place
Federal	Karachi (under Federal Plant Protection Department) Multan (under National Agricultural Research Centre)
Punjab	Faisalabad, Multan, Kala Shah Kaku (Lahore)
Sindh	Hyderabad, Rohri
NWFP	Tarnab

There is no pesticide-testing laboratory in Balochistan and samples are sent to Federal laboratory, Karachi. If any party has objection to the analysis report, it may request the Advisor and Director, Department of Plant Protection for re-analysis along with necessary fee within thirty days of accusation.

There is general impression that in Pakistan pesticides are sold without adequate measures to regulate the trade for protection of public health and environment. If it is true that pesticide business is not being adequately guarded against unscrupulous traders, it is more out of human level mutilation of the whole regulation system, rather than neglect in the regulatory framework. This aspect assumes greater importance when viewed in the context of the present state of government pesticide laboratories. The number of samples referred to these laboratories is enormous. The process has been unsatisfactory due to lack of enough inspectors and their proper training. There are around 343 inspectors designated by the government and eight pesticide testing laboratories in the country (MINFAL, 1998). The designated inspector is required to draw samples on random basis. For three pesticides labs in Punjab, for instance, the number of samples collected each month is about 750-800. Since these laboratories are not well equipped, under staffed and short of adequate operational budget, the chemical analysis of samples collected is far from reliable and are not timely done. As it takes around 4-6 months for all analysis procedures, the sale of doubtful products continues during analysis process (personal communication with Director, Eco-toxicological Labs, NARC). Government analysts should endeavor to complete analysis within week from the date of receipt of samples. There is a lot dispute in the results due to methodological difference between Provincial labs and Federal labs.

Under the provision of Section 20 of Agricultural Pesticide (Ordinance) Act 1971, any person who has purchased a pesticide (doubt in quality) may apply to a Government Analyst to conduct a test or analysis and Analyst is bound to analyze and issue a report to him. In reality, hardly any farmer has made this request to the Analyst. Most probably the illiterate farmers are ignorant of these rules.

Various reports indicate that most of the pesticides available in the market are adulterated and active ingredient is far less (3%) than the companies claim (50%) (Jabbar and Mallick, 1994). 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 of pesticide adulteration is reportedly accelerated since the introduction of generic scheme in the country. It is often observed that dealers/vendors sell out-dated pesticides and pass them to buyers as valid products (Younus, 1994). Such unethical practices result in failure of pest control, phytotoxicity and augmentation to resistance to pest species.

The government figures show (MINFA, 1993) that 294 cases against 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 one in NWFP were decided by the court. In 43 different cases, punishments were awarded or fines from 500 to 3000 were imposed. Five persons in Punjab were arrested in relation to these cases, and later on acquitted. As of November 1992, 246 cases were pending in Punjab courts. However, the latest figures show that out of 2055 samples drawn, only 164(9%) pesticide samples were found unfit for use in Punjab during 1997-99 (Table 10). The cases were registered with police and court. Similarly, 19 raids were conducted on dealers for selling fake products in Punjab. The official figures reveal that only 4% pesticides were found unfit in 1999 (Table 11). But in reality the position is very tangible. However, no record on the fate of culprits is available. According to Mr. Younus Department of Plant Protection, 90% of the cases involved in pesticide adulteration are liable to punishment (personal communications). The adulterator can be imprisoned up to 7 years together with fine amounting to one million rupees (Agricultural Pesticide Amendment Ordinance, 1997). However, in the field, there are numerous human level distortions that subvert the spirit of the regulatory framework. The implementation is very poor and probably none of culprits involved in adulteration has been punished accordingly.

Table 10. Progress of anti adulteration of pesticide campaign during 1997-99 in Punjab Province.

Activities	Progress		
	1997	1998	1999
No. of dealers checked	2811	5266	5901
No. of sample drawn/sent to labs	575	879	601
Results received	575	879	402
No. of samples declared unfit	83	56	25
	492	823	377
No. of samples declared fit	83	56	25
Cases registered with police/court	83	56	25
Raids conducted		8	11

Source: Department of Pest Warning and Pesticide Quality Control-2000.

Table 11. Position of pesticides quality control samples during 1998-99

Activity	Punjab		Sindh		Total	
	1998	1999	1998	1999	1998	1999
Analyzed	2995	1892	151	1139	3146	3031
Fit	2739	1829	135	1092	2874	2921
Unfit	252	63	16	47	268	110
Unfit (%)	8.41	3.32	10.59	4.12	8.51	3.62

Source: Department of Plant Protection, Karachi

The sources of Directorate of Pest Warning and Pesticide Quality Control revealed that the problem of adulteration and spurious pesticides is generally originating from:

- Import of sub-standard pesticides by the importers from countries like China, Taiwan, Singapore and Belgium.
- Formulation of pesticides using less active ingredients within country.
- Adulteration by the distributors during re-packing.
- Adulteration by the pesticide dealers.
- Preparation of totally spurious material and labeling as pesticides.

In pursuance of Sub-Rules 11(a & b) of the Agricultural Pesticides Rules 1973 and issuance of SRO 160(1) 96, pesticide companies and their authorised distributors are required to maintain the following:

- Technical staff ---10 Agriculture Graduates
- Paid up capital of company---Rs. One million
- Training facilities---10 standardised power and 10 hand.sprayers
- Stores should be properly ventilated, have fire fighting equipment, equipped with protective and safety clothing and emergency shower and eye-wash facilities.
- Re-packing plants, in addition to (iv), should have arrangement for spillage and waste disposal, and have automatic re-filling line.

Almost all the multinational pesticides companies maintain the entire above-mentioned prerequisites for proper handling and to create extensively awareness among the farmers on safe and effective use of pesticides. Since the introduction of generics, when many national players jumped into pesticide business, the maintenance of required technical staff, training equipment and capital is not up to the mark. Even Pakistan Crop Protection Association (PCPA-who is mainly comprising of national companies) requested APTA Sub-committee for reconsideration of the implementation of SRO 160(1)/96 and asked to amend the requirement of hiring the 10 Agriculture Graduates. The current position of technical staff of PCPA member companies revealed that around 60 % of the companies have less than 10 agriculture graduates as technical staff. One of the non-PCPA member company's Chief Executive also told the author that it is very difficult for us to maintain the required number of technical staff and most of the companies are not implementing the SRO 160(1)/96 (personal communication). Similarly, the facilities regarding the workers health and safety at pesticide stores and repackaging plants are not up to mark (except some of multinationals).

Historically, the transportation, storage and distribution system has been imperfect. In some cases, unused pesticides have been in storage for up to 30 years. Under public sector distribution system, it was common to carry over pesticides for two to three years before being used. The situation has improved substantially since the private sector was given responsibility for pesticide business. Basically the distribution system for pesticides is as represented in the following schematic form (Figure 5.3).

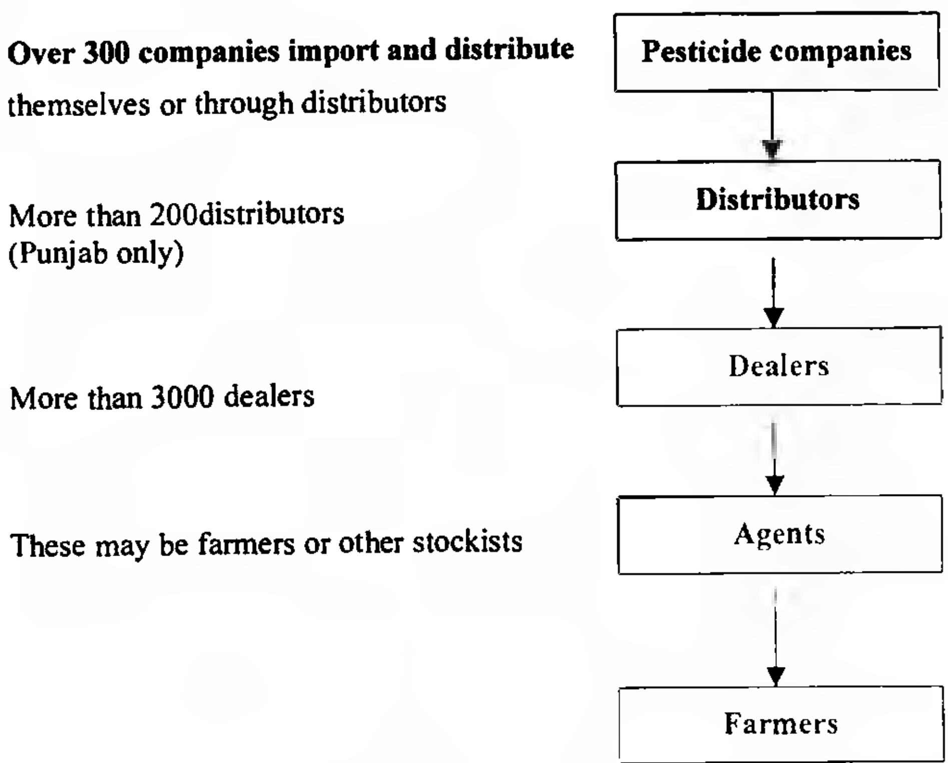

Figure 5.3 Schematic Diagram of Pesticide Marketing System in Pakistan.

Pesticides are mainly marketed through distributors and dealers. Some companies sell pesticides from their own shops, e.g. Naya Sawaira sells Novartis products. Distributors have storage points in strategic locations around the country from which the demand of dealers is met. Most of the farmers get their supplies from dealers. In some cases, agents such as farmers or stockists provide neighbouring farmers with needed supplies. It is reported to be common practice for pesticides to be stored along with other articles, including food items. Also shopkeepers or their employees may sit in the same premises in which pesticide are kept for sale, which enhances the risk of slow poisoning.

According to Pakistan Environment Protection Agency (PEPA), unwanted stocks of obsolete pesticides are around 4687 metric tons in 1700 different stores in the country. However, according to the Department of Plant Protection the quantity is much more (Table 12). These large quantities of out-dated pesticides can present special problems for disposal particularly where suitable disposal technology doses not exist. It is important to safeguard both the environment and general public from such stocks in full compliance with national and international regulations.

Table 12. Position of out-dated pesticides in Pakistan.

Province	Quantity (metric tons)
Punjab	3805
Sindh	2016
NWFP	179
Balochistan	128
Federal (DPP)	178
Total	**6306**

Source: Department of Plant Protection (PPD)-1999.

The pesticides are stored in bulk (drums of 200 litres), in the open under a hot sun in the factory. Most of the containers leak and contaminate soil. After a certain period of storage under such conditions, the pesticides are denatured and may not be suitable for use. The usual disposal practice of the factories is to dig holes in the soil in some places and bury the contents. No enough preventive measure are taken to decompose such poisonous material (Jamali, 1992). These compounds are washed down into the underground water, contaminating the surrounding environment and endangering the lives of human as well as animals.

5.7. Costs of the Regulatory Systems: including Enforcement and Residue Monitoring

As it is mentioned earlier that Department of Plant Protection (PPD) in Karachi is responsible for pesticide registration and other regulatory affairs. Besides enforcement of Agricultural Pesticides Ordinance (Acts) and rules framed thereunder, the PPD entrust with the enforcement of Plant Quarantine Act, 1976 and rules made thereunder, conduct locust survey and their control and arrange aerial pest control facilities. There is no separate budget to run the regulatory system, rather the cost is met from core budget of the department or incurred from various other projects run by the department. The PPD also generate income from various pesticides importing agencies as a registration fee (Rs. 25000 per sample). However, according to the PPD sources, total budget of the department for the year 1999-2000 is around one million (personal communications).

Provincial agricultural departments through notified inspectors do quality control of pesticides. The designated inspectors (mostly Plant Protection Officers and Agriculture Officers), besides their other official responsibilities, randomly draw pesticide samples from various sources for testing in the laboratories. There are around 343 inspectors through out the country and approximately half of them are working in Punjab only where 80% of total pesticide is consumed. There are eight pesticide laboratories in the country, which analyze roughly five thousand samples annually. It is difficult to estimate the exact cost incurred on the pesticide monitoring. However, approximately Rs.25 million is spent on various categories to ensure the quality of pesticides (Table 13). Major cost is on the analysis of pesticides, which reflect the state of their quality. There is no regular monitoring of pesticide residues in food, water and soil done in Pakistan. Rather, few studies were done from times to times in this regard under different projects.

Table 13. Cost of monitoring pesticide quality

Category	(Rs. million)
Salary of inspectors (343)	4.6
Budget of pesticide laboratories (8)	8.4
Cost of pesticide analysis	12.1
Total	**25.1**

5.8. Discussion and Suggestions

An overall view of the existing legislation covering pesticides makes it clear that every aspect of import, manufacture, use and disposal is covered with specific reference to safety. Various Acts and Rules have been instituted over the years as part of development. However, an Act is only as good as its implementation. Imaginative and rational application of the Acts and Rules is a constant exercise in which government, industry, and public must share responsibility and benefits in an equitable manner. Even minimum safety measures require considerable initial and recurring investment from the industry and the enforcement agencies.

There are eight pesticide-testing laboratories under the Act, with a capacity of testing hundreds of samples annually. This is a bottleneck to effective and comprehensive enforcement of quality in pesticides. Quality assurance under the law needs to be given priority. Availability of quality products at all levels would be a cure of many ill effects in the field apart from consumer protection and safety. The existing Acts must ensure increasing emphasis on this aspect of enforcement backed by a high level of testing facilities. Further, harmonized pesticide analysis procedure may be adopted through interchange of random coded samples among the pesticide testing laboratories to maintain the quality control requirements. For this purpose, pesticide laboratories need to be strengthened.

Use of pesticides on non-target crops is also a major concem. Farmers use left-over of pesticides recommended for cotton on fruits and vegetables. There is no legal restriction in this regard. The extent of this issue is not known. There needs to conduct careful study to assess the problem so that recommendation can be made to impose legal restriction on pesticide use.

There is no well-defined set of safe residual limits for the application of different pesticides in Pakistan. The major and permanent pesticide hazard to humans and environment is persistence of pesticide residues in agricultural produce, food and fodder as well as their presence in air, water and soil. There is no large-scale national systematic statute in this area, either to determine correctly the extent of harm through excessive pesticide residues or to punish those who are guilty of neglect in this regard. There is sporadic concem at various levels regarding contamination of foods with pesticides. But little has been done to establish regular national surveys. Despite the fact, very few studies have been conducted from time to time to monitor pesticide residue limits in food. This exercise should be done permanently on regular basis and general public be informed with the results through electronic media. However, no enforcement measures have been done to ensure that residues remain within prescribed safety limits. In depth studies should also be conducted in all regions of the country to assess the impact of pesticides on people, soil, water, food and the environment. For this purpose, Pakistan Environmental Protection Agencies (PEPA) should include pesticide problems in their programmes. Similarly, study should be conducted to assess the impact of obsolete pesticides stocks on the extent of environmental pollution.

Leakage of products can cause localised contamination within storage or sometimes surrounding areas. Recycling, high temperature incineration, small-scale fixed incinerator, cement kiln incinerator and chemical destruction of pesticides, are few options to dispose off pesticides safely. Malik (1989) reported the USAID organised demonstration of pesticide destruction in a cement kiln in D.G. Khan. The issue of old-dated pesticides is very vital and needs the attention of the government and international agencies to co-ordinate a speedy solution. The Govemment recently is expressing concem on the protection of environment and it is therefore the responsibility of PEPA to find a solution to diffuse the time bomb.

Facilities for generating quality registration data (especially toxicological) are very limited in Pakistan. The pesticide industry has not invested in these research and development efforts adequately. Some government institutions are the mainstay, which have their own limitation due non-availability of operational funds. These capabilities need to be augmented by generating cess funds from pesticide industry.

Hundreds of different products have been registered so far in the country. The inventory of natural enemy friendly pesticides should be prepared for the guidance of extension workers and farmers so that injudicious use of pesticide can be restricted.

The purpose of legislation and enforcement measures is not to replace professional practices but augment them suitably. In future, it is expected that industry itself should maintain high professional norms and also accept its social responsibility. Government legislative machinery should guide and direct such progress to achieve national goals with least environmental hazard. There is worldwide dedication to chemical safety and environmental protection. Enforcement of the Acts and development of quality assurance and research development facilities of high level are a concurrent need today.

Chapter 6: RESEARCH AND EXTENSION

Research and extension have a key role to play in reducing health and environmental impacts of pesticides. The research system can help to develop low toxic pesticide products, improve application techniques, and promote alternative forms of pest control. This could lead to evolve high productive and more sustainable farming systems. Research needs to be more directed towards those endeavors that would contribute to the optimization of pesticide use. Similarly, gross root level extension system of the country could help to promote targeted use of toxic inputs like pesticides by providing advice, information and training to farmers. By raising right kind of awareness the benefits of lower pesticide use for profitability as well as the environment, advice, education and skill transfer have the potential to reduce pesticide use.

This chapter reviews the roles that public, private and NGOs play in agricultural research and extension. The overwhelming role of private sector in crop protection is analyzed in comparison with public sector extension. Particular attention is paid to the state of linkages within the research-extension-farmer-continum. This chapter further highlights the role of different research establishments at each province and provides important insight about the state of overlapping in their research activities. Variability in experimental methodology and sampling techniques used in plant protection research is analyzed. It is also pointed out how far the term "IPM" has been miss-understood or practiced at different research organizations. The limitations of farmer training in terms of farmer field days or personal contacts are also elaborated. The concepts of season long participatory training in IPM and simple recommendations by extension officials were compared in relation to their efficacy. Importance of the research and extension system to work jointly for coming to same conclusions is also highlighted. Economic Threshold Levels (ETL) and scanty rather holistic implementation of IPM are the other important topics covered both in research and extension sections.

A. EXTENSION

6.1. Public Sector Extension System

Agriculture extension in Pakistan is the responsibility of department of agriculture in the public sector. It is primarily a provincial subject. Before 1961, agriculture was under one umbrella for all its activities like education, engineering, research and extension. With the increase of workload, a separate agricultural extension service was created in 1962 in order to ensure better efficiency and enhanced agricultural production. It aimed at motivating farmers to adopt modern agricultural technologies but despite its expansion, its concept approach and methodology underwent little change and lacked sound underlying philosophy, well defined objectives and effective programming. The department has a hierarchical organizational structure with personnel working at field level (group of villages below the Tehsil), district, division and regional or provincial level. Its organizational structure is highly centralized as Director of Agriculture Extension has a pivotal position with respect to staff management and scheduling of extension activities, etc.

The agriculture extension system of Punjab and Sindh with special reference to cotton growing area is discussed as under :-

6.1.1. Punjab Agriculture Extension

6.1.1.1 Current Structure

The organogram extension service in the Punjab Agriculture Department has been modified from time to time. The staffing structure established in 1959 was changed in 1974-75 by appointing a Director General (Extension) to supervise all the activities of administrative as well as technical staff. In 1982-83 the establishment pattern underwent further changes with provision of extra technical staff both at supervisory and field levels. The underlying philosophy was to enhance the level of contact between the farmers and extension personnel. Presently, there are 3,263 professionals and over 2,600 ministerial/support staff members on its strength.

6.1.1.2 Current Extension Approach

A modified version of Training and Visit (T&V) System is operative in Punjab province. The system in principle, envisions a direct and effective transfer of available technical recommendations through a close linkage between research, extension service and farmers (Ghaffar, 2000). The main purpose is to bridge the gap between the modern technology evolved at the research farms and that practiced by majority of the traditional farmers through massive transfer of technology (Boner and Baxter, 1984). The T&V system aims at building a professional extension service capable of assisting farmers in raising production and increasing income and providing appropriate support for agricultural development (Sahibzada, 2000).

Although the T&V system has produced better results than the traditional extension system, net impact on agricultural production and the cost effectiveness of the system as a whole has been questioned in some of the evaluations. In some cases, the linkage between adaptive research under T&V system is weak (National Agri. Commission Report, 1987). The extension staff in the existing system is preachers of knowledge with no involvement in input supply and output management.

6.1.1.3 Front Line Extension Agent

The focal point in the current agriculture extension system is the Agriculture Officer who is a professional and a true extension agent and considered as first line worker instead of Field Assistant. The Agriculture Officer is a fresh graduate possessing B.Sc. (Hons) or M.Sc. (Hons) degree in Agriculture. There is no pre-service training for Agriculture Officer though in-service training and refresher courses are organized usually for a variety of campaigns required for introduction of improved inputs, IPM and cultural practices. Most of them learn through trial and error.

The Agriculture Officer is given targets to achieve with limited resources and facilities. His office is usually a very small and inadequately equipped with audio visual aids for farmers. He does not have enough space and furniture to hold meeting of a group of farmers in his office. His touring is limited by lack of means of transportation and operational budget.

However, in Cotton Zone touring of field staff of Agri. Extension has been streamlined to a greater extent. Staff mobility has been improved by providing motorcycles to Field Assistants and Agriculture Officers and vehicles to supervisory, research and training staff. The motorcycles have been provided on ownership and self operating basis. The cost of motorcycles is paid by Field Assistants and Agriculture Officers with interest free installments. No budget for POL (fuel charges) and maintenance has been allocated for official use in rainfed areas.

Contrary to the traditional practice of individual contacts, the Agriculture Officer in the current system in Punjab, contacts group of farmers with pre-notified schedules depending on crops, e.g. thrice in wheat and four to five times in cotton seasons. The role of Field Assistant has been minimized and restricted to the extent that he informs farmers for village level training/group meeting one day ahead of the schedule.

6.1.1.4 Coordination with other Counterparts

A number of front line extension agents including Agriculture Officers, Extra Assistant Directors of Agriculture and Deputy Directors (Agriculture Extension) interviewed informally were of the views that the Agriculture Officer operates in a territorial jurisdiction which overlaps with circles of functionaries of other departments with whom coordination for integrated action is necessary and desirable. Even their headquarters are at different locations. As a result there is no or little joint planning, implementation and touring etc. The Agriculture Officer and Veterinary Officer are two functionaries working in different aspects of agriculture –one for crop husbandry and the other for animal husbandry. One promotes more food and cash crop production and the other more livestock and its products in almost the same area. They hardly have ever thought to advise the farmers to grow food or cash crops as well as fodder on area of his holding in accordance with his needs. They are in competition rather than collaboration supplementing and complementing each other's efforts. The other wings of Agriculture Department (Water Management, Agri. Engineering. Soil Conservation) and allied agencies (Seed Corporation, ADBP, Agri. Cooperatives) work in isolation. Hence, all those aspects requiring integrated efforts are not conceived. There is no supporting services right at hand to provide the matter for which the farmers are motivated. There is hardly any administrative coordination with the input supplying agencies and agencies providing loans to the farmers.

The Agriculture Officer has very little support from the Senior Subject Matter Specialists (SMS) who are available at the divisional or regional level. These specialists are also not adequate, both in number and in specializations, to cater to the varying and changing needs of the farming community. There exist only 8 Subject Matter Specialists of Plant Protection versus 472 front line extension agents in the Punjab Province. There is no forum for exchange of notes on various issues between the specialists and the field workers. The extension education process is, by and large, more of a one-way traffic rather than the desired two-way communication. The Agriculture Officer disseminates the information meant for the farmers but only occasionally transmits the information about experiences and reactions of the farmers to the scientists for want of built-in system. He gets the information in some form from the scientists for the farmers through the set channel but the reverse process is not efficiently carried out for want of required means and formats.

6.1.1.5 Gender Restriction

The Agriculture Officer has gender restriction in his working area. The female, who comprises nearly 50% and do important activities within the household, has not only been ignored in aspects of home economics but also in activities of agricultural nature. There is rarely a female extension worker to advise the women folk on agriculture related household activities. They neither have the clear mandate to interact with women nor the culture allows it to happen. Meanwhile, although women are graduating in agriculture. They hardly take extension jobs as the record shows that there is only a single female Agriculture Officer in whole Punjab Province who is currently working at provincial headquarter and mainly doing desk work. The male Agricultural Officers do not have access to them due to the socio-cultural environment of Pakistan society, Hence half the population, and rather more important in same crucial aspects of family livelihood. are outside the ambit of extension educational system.

6.1.1.6 Focus of Extension

In the past the Punjab agricultural extension focused more of its attention on the needs of big farmers. However, in the current system, the emphasis is being shifted to the small farmers by imparting trainings through organized homogenous groups. The small farmers are in majority though controlling less than half of the total land. They have been found hard working, intensive cultivators and better utilisers of improved inputs, though much below the prescribed dosages, inspite of their relatively poor accessibility to the sources (Khan, 1986). They are mostly illiterate, conservative and tradition bound but they have an open mind to accept improved inputs and practices provided they are afforded the opportunities to avail them easily with favourable terms and conditions as evident from increase in production of last year wheat (1999) and two last consecutive cotton (1998-99).

6.1.1.7 Coverage of Farming Population

The internal effectiveness of any extension system is generally assessed through examining the type of farmers reached by the extension services and coverage of the farming population. The Punjab Economic Research Institute (PERI) conducted in depth survey in 1984 to evaluate Extension's T&V system in the Punjab. It was found that the system had only modest success. However, Hussain *et al.* (1994) could find little evidence that T&V had improved the quality of extension advice. Extension contact was highly skewed towards large farmers. Two major problems specific to Pakistan were identified. First, implementation of T&V was lacking. For example, the survey found that 20 percent of contact farmers did not know that they were contact farmers, and hence the information flow never went beyond them. Second, messages were inappropriate to farmers' circumstances, and ignored the rational and often location-specific tradeoffs that farmers often make. For instance, messages about wheat continue to assume that wheat will be planted on time, whereas farmers often rationally delay wheat planting as a result of interactions in double-cropping systems.

The current scenario regarding coverage of farming population remains almost the same as reported in PERI survey, 1984. The front line extension agent is supposed to cover nearly 60-64 villages or a group of 6-8 Union Councils or 6,500-8,500 farm families or 70,000 to 80,000 acres of cultivated area.

6.1.2. Adaptive Research in Punjab

Playing a pivotal role in the Training and Visit (T&V) extension system, Adaptive Research develops farmers' problem oriented site specific crop production technology packages through repeated experimentation at Adaptive Research Farms and farmers' fields keeping in view local agro-climatic and socio-economic conditions. It is supposed to bridge up gap between research findings and farmers achievements and also maintains an effective linkage between research and extension.

Site specific technology package at Adaptive Research Farms are transferred to farmers through training messages, crop production plans, refresher courses, seminars/workshops, farmer days, visit to farmers' fields, inspection of adaptive research trials/exhibitions/demonstration plots, and electronic and print media, etc. Wheat cultivation in cotton fields by using zero tillage drill is one of the technologies developed on the basis of adaptive research that has been successfully disseminated to the farmers.

Crop production plans are reviewed and developed periodically in close coordination with National Coordinated Commodity Programmes of Pakistan Agricultural Research Council (PARC), Islamabad and Provincial Research Institutes. However, SMSs hardly get any opportunity of exposure to new knowledge and skill because of inadequate in-service training programmes and library facilities.

6.1.3. Crop Protection Curricula

Punjab Agriculture Extension System dominated by the extension and research staff after identifying the constraints of cotton crop has developed the curricula for Field Assistants and farmers with special emphasis on Integrated Pest Management (IPM). The Central Cotton Research Institute (CCRI) located in Multan and Sakrand cotton belt area has also developed IPM strategies for various cotton pests which are being transferred to different clients including agricultural extension field staff and farmers. These include cultural, biological, chemical control, use of sex pheromones and advocating strict pest scouting.

As a result of pest scouting, the number of sprays have been reduced from 10-12 to 4-6 by the cotton growers over the year (Ijaz, 2000). However, a detailed study is required to know various aspects of IPM technology uptake and its impact on crop production and environment protection.

6.1.4. Use of Economic Thresholds

Dr. Stern and his associates from University of California introduced the term "economic threshold" in 1959 (Hashmi *et al.*, 1987). The term refers to the relation between the population density of the pest and the profitability of the control. Economic threshold indicates certain levels of population at the time when it is necessary to determine whether chemical control measures are to be applied or not.

The available information in Pakistan mostly relates to insect pests and is comparatively scant about weeds and diseases. The synthesised information advocated by the pesticide companies and Plant Protection experts on threshold levels of various insect pests of cotton is presented in table-14. These threshold levels are part of the extension curricula and the extension agents instruct the farmers to follow them to schedule chemical treatment of their crops accordingly.

Table 14. Threshold levels of various insect pests of cotton

Name of Pest	Criteria by stage	Threshold Levels
Sucking Pests:		
1. White fly *(Bemesia tabaci)*	Adults/ nymphs	5/leaf
2. Jassid *(Amrasca devastans)*	Adults/ nymphs	1/leaf
3.Thrips *(Thrips tabaci)*	Adults/ nymphs	8-10/leaf
4.Aphids *(Aphis gossypii)*	Adults/ nymphs	15/leaf
5.Mites	Adults/ nymphs	10-15/leaf
Bollworms:		
1. Pink bollworm *(Pectinophora gossypiella))*	Moths sex traps	5 moths per night per sex trap for 3 consecutive nights 1-20 acres: 1 trap/5 acres 21-100 acres: 1 trap/10 acres 100 acres plus: 10 trap for first 100 acres and 1 trap/5 acres for the remaining area. 50% traps in the middle of the field and 50% traps in the periphery.
	Damage	or 1st Aug. to 15th Aug. 15 % damage of flowers, buds or bolls. 16th Aug. to 31st Aug. 10% damage of flowers, buds or bolls. After 1st Sep. 5% damage of flowers, buds or bolls.
2. Spotted bollworm *(Earias insulana)*	Larvae	5/25 plants
	Damage	or 1st Aug. to 15th Aug. 15 % damage of flowers, buds or bolls. 16th Aug. to 31st Aug. 10% damage of flowers, buds or bolls. After 1st Sep. 5% damage of flowers, buds or bolls.
3. American bollworm *(Helicaverpa armigera)*	Eggs or larvae	5 eggs on 25 plants or 5 small larvae (5mm)/25 plants
	Damage	or 1st Aug. to 15th Aug. 15 % damage of flowers, buds or bolls. 16th Aug. to 31st Aug. 10% damage of flowers, buds or bolls. After 1st Sep. 5% damage of flowers, buds or bolls
4. Army worm *(Spodoptera litura)*	Nymphs	Whenever it appears. Localized treatment where found.

Source - Integrated Pest Management Institute, PARC, Islamabad.
- Directorate of Pest Warning & Quality Control of Pesticides Punjab, Multan
- Pakistan Agricultural Pesticides Association (PAPA), Karachi.

The above threshold levels indicate that this criterion is situation oriented, hence quite inconsistent and even unstable. Levels are not fixed in time and space for a given pest or a certain crop. Usually, the level varies from region to region, from year to year, with fluctuations of the value of the crop and the cost of treatments and with the stage of the development of the plants (Hashmi *et al.*, 1987). However, most of the Plant Protection experts in the Adaptive Research believe that this practice should continue as in their opinion it aims at minimising the use of pesticides to cut the cost of control operations and save the environment from unnecessary poisons and pollution. Whereas, IPM experts believe that use of pesticides is not the only way to control pests nor it is the bestway. Indiscriminate spraying tends to eliminate natural predators and parasites, which normally keep the insect pest population down. Besides, use of pesticides is hazardous to human and animal and environment. Indeed, a more effective and economical solution is to practice the IPM. While calculating economic threshold levels, population of predators and parasites should also be taken into consideration.

6.1.5. Expenditure on Agriculture Extension, Punjab

Regular Annual Budget (1999-2000)

Tasks	**Establishment**	**Operational**
	Amount (Million Rs.)	
Extension Services	271.4	45.3
Plant Protection & Locust Control	234.8	4.9
Total:	**506.2**	**50.2**

Additional Budget **through on-going schemes**

Name of Scheme	**Amount (Million Rs.)**
Wheat Productivity Enhancement Programme	19.934
Cotton Productivity Enhancement Programme	12.460
Research on Fruit Crop in Punjab	27.167
Grant of Scholarship to the Trainee Field Assistants at ATI, Rahim Yar Khan	0.160
Upgrading of Cotton Research facilities in the Punjab.	12.260
Total:	**71.981**

6.1.6. Information Support

Dissemination of information about extension operations is important within the extension system for the training and motivating of staff and as input for policy decisions. Externally, it builds up understanding and support for extension's objectives and achievements (Benor *et al.*. 1984). Directorate of Agriculture Information (DAI), Punjab has been supporting agriculture extension system in information dissemination quite effectively since, 1960s.

6.1.7. Expenditures on Information Support

The Directorate of Information, Punjab has necessary facilities for audio visual recording and cassettes multiplication at Lahore, Punjab. The DAI telecasts the paid telops 3 to 4 times a week costing Rs.85,000 for each telop, broadcasts paid radio programmes daily and publishes paid advertisements carrying messages in various newspapers. The DAI also publishes its fortnightly magazine "Zarat Nama" regularly and crop booklets, the number of these ranges from 150,000 to 500,000. For all these information support programmes, Rs.55 million operational budget was allocated during 1999-2000. Information support activities are carefully planned, implemented and monitored. However, there is still a room for improvement. Suitable verified success stories from field staff, farmer reaction to extension beside general data on technologies generated, monitoring and evaluation results disseminated through print and electronic media could make the information support more effective and useful.

6.1.8. Agriculture Extension under Punjab Cooperatives Department

Parallel to the Punjab Government Agriculture Extension, there exists another small entity "Pak-German Institute of Cooperative Agriculture" at Chock 5 Faiz, Multan under umbrella of Punjab Cooperatives Department. The Institute was established under an agreement between the Government of Pakistan and the Government of Federal Republic of Germany in 1959 aiming at demonstrating improved methods of agriculture and offering training facilities to the farmers and their sons/wards in different trades to generate their income through self-employment. This Institute is almost running the same Field Assistant (FA) course as being run by the in-service training institutes of Punjab Agriculture Extension Department like Rahim Yar Khan, Sargodha and Dahgal.

6.2. Sindh Agriculture Extension

The traditional agriculture extension system is still in place in Sindh Province. The Director General (Extension) Sindh operates the extension service with 1763 professionals excluding administrative staff under six directorates i.e. Extension, Coordination, Plant Protection, Training, Information and Marketing. The staff position is almost similar to that in Punjab i.e. one Deputy Director at district level, an Assistant Director at the sub-divisional level (about three per district) who would supervise 7 Agriculture Officers, each of whom is responsible for 6 Field Assistants. In Sindh F.A. is the front line extension worker. Sindh Agriculture Extension lacks sufficient staff with transport to pay regular visits to farmers and also lack in practical training facilities and office accommodation to provide farmers with adequate services.

Sindh Agriculture Extension Department has two Agricultural Training Institutes; one at Jackabad and other at Sakrand for two years pre-service training courses to Field Assistants and Stock Assistants. A class of Female Field Assistants has also been enrolled at ATI, Sakrand since 1996 and during the last decade, 2,756 students have successfully completed their training.

The ATI, Sakrand has excellent on-campus training and boarding facilities. The curriculum was revised in 1981, and its instructors were given training during 1981-83 either abroad, or locally under an ad-hoc training programme. However, nearly all those who received teachers training left for positions with better incentives in terms of pay and perquisites or transferred at other field stations. As a result, the training of FAs suffered. (World Bank Report No.6300 PAK 1987). Currently, the faculty members are following the old 'Chalk and Talk' teaching method. A very rare practical training to the students is imparted in ATI. With rapid technological advancement and changing requirements, the ATI curriculum needs further updating with more focus on practical training.

EXPENDITURES

Table 15. Budget of Agriculture Extension, Sindh Province 1991-92 to 1998-99 (in million)

Year	Development				Non-Development			
	Estt.	O&M	Total	Proportion	Estt.	O&M	Total	Proportion
1991-92	20.998	102.353	123.351	17:83	90.238	11.075	101.314	89:11
1992-93	20.018	108.847	128.864	16:84	89.909	16.600	106.505	84:16
1993-94	35.039	79.083	114.122	31:69	100.634	23.491	123.856	81:19
1994-95	0.350	0.461	0.811	43:57	166.939	21.501	188.440	89:11
1995-96	0.638	1.723	2.361	27:73	184.795	17.349	202.144	91:09
1996-97	0.292	0.305	0.597	49:51	199.275	16.623	215.899	92:08
1997-98	0.402	0.198	0.600	67:33	208.462	16.48	224.942	93:07
1998-99	-	3.968	3.968	00:100	205.983	11.151	217.134	95:05

The main stumbling block impeding the progress is insufficient operational and maintenance budget (5-9%), which requires Government of Sindh's special attention. The Agriculture Extension, Sindh needs to launch separate development schemes to generate more funds.

6.3. Private Sector Extension System

Currently fertilizer, pesticide, agricultural machinery and part of seed industry are in private sector. They share in agricultural extension services with public sector particularly in areas where they have good chance of enhancing their own business profits. Their own self interest provides them the necessary incentive or propulsion to reach out even to the remote locations. Government of Pakistan as a matter of policy is encouraging the private sector to contribute in agriculture development. Thus the private sector especially the multinational pesticide companies carry out various field activities along with aggressive pesticides marketing campaigns, backed up by very convincing publicity campaigns through electronic and print media. The following are the major extension activities of the pesticide companies in the cotton growing areas of Punjab and Sindh.

6.3.1. High Profile Farmers Meetings

Almost all the multinational pesticide companies organize a seminar at tehsil level before start of the cotton season, which is normally participated by 150 to 200 farmers who are usually innovators, early adopters, progressive, vocal and big landlords. Such meetings are generally chaired by some very influential persons who are either from local administration or political set up.

6.3.2. Village level Meetings/Field Advisory Service

Private sector's extension programme aims at reaching all sorts of farmers (small and large; urban and rural; owners and tenants; and illiterate and literate) and make them aware and enhance their understanding on the benefits of adoption of package of production technology with special focus on use of pesticides. A number of village level meetings which are followed by continuous advisory services to the farmers are rendered by the multinational pesticide companies, for instance, 40-50 meetings/village by Novartis and 30-40 meetings/village by the F.M.C. during cotton crop season in cotton belt of Punjab. About 20 to 40 farmers participate in each meeting. Field advisory service is provided throughout the crop season in which Sales Officer meet big and progressive farmers whereas the field staff (task force) visit medium and small farmers.

6.3.3. Demonstrations and Field Days

Private sector runs a quite aggressive programme of on-farm demonstration to display the effect of their recommended practices with particular reference to their products. During informal discussions and observations, it was revealed that the Novartis alone conducts 90-100 farmer field days and same number of demonstration trials in each district as compared to 17 demonstration trials and field days per district by the public sector (Annual Report Vehari District 1999-2000). In addition to these, the private sector also organizes a number of exhibitions to promote their products.

The activities are undertaken by country wide strategically based group of well trained and qualified, motivated, highly mobile young sales officers and task force who are fully equipped to serve the company and to promote their products.

6.3.4. Expenditures

Private sector spends a huge amount of money on marketing campaigns and field extension activities. According to an estimate more than 155 million rupees were spent by the 18 pesticide companies for cotton during January to December, 1999 (PAPA, 1999).

The Novartis and FMC both the multinationals spent an amount of Rs.35.0 and Rs.21.5 million respectively, on marketing campaigns (electronic and print media) for cotton, during 2000 whereas for field extension activities, in each district, Rs.2.0 million and Rs.1.5 million were spent by Novartis and FMC, respectively. As a matter of policy the pesticide companies spend 1-2% of the total sale on marketing campaigns and other extension activities. A comparative statement of the field activities and expenditures of private and public sectors at village and district level is given in table-16.

Table 16. Comparative statement of the field activities and expenditures on cotton during 2000.

Private Sector				Public Sector
Activities at District Level		Novartis	FMC	Agri.Ext.Punjab (Distt. Vehari)
1.	**High Profile Meetings/ Distt.**	1	1	-
	Participants/meeting	150-200	150-200	-
2.	Village Level Meetings/Farm Advisory Service/ Village	40-50	30-40	2 to 3
	Participants/meeting	30-40	20-35	10-25
3.	Demonstration Plots/Distt.	90-100	30-40	17
4.	Field Days/District.	90-100	30-40	17
5.	Mobility of Extension Workers	Vehicle	Vehicle	Motorbike
6.	Expenditures:			
	6.1 Marketing Campaigns (Print media & electronics) for Punjab and Sindh.	40.0 Million	20.0 Million	-
	6.2 Field extension activities/District	2.0 Million	1.5 Million	1.7 Million for all crops including 0.8 million for cotton crop protection

6.4. Non-Government Organization Sector Extension System

The NGO sector in Pakistan has grown rapidly in the last two decades. Even the modest estimate about the number of NGOs would indicate that there are at least 10,000 NGOs in the country, at least 5000 of them are active. (Mufti, 2000). The large number are single-community or village-based groups run by volunteers, with a minimal administrative structure, and usually welfare-oriented, though there are increasing trends towards building of the organization and developing more professional expertise and capacity to reach out to a larger number of beneficiaries. Among these are the various advocacy groups and organizations working towards conscientization and mobilization. A very small number of NGOs are actively involved in agriculture extension activities in the country.

In the cotton growing areas of Punjab, National Rural Support Programme (NRSP) and Punjab Rural Support Programme (PRSP) are the leading NGOs contributing significantly in the field of agricultural extension. Both the NGOs follow the common strategy to harness people's potential to help themselves.

6.4.1. National Rural Support Programme (NRSP)

National Rural Support Programme (NRSP) has been functioning in Punjab since 1993 with the main focus on human resource development and rural credit disbursement. In addition to disbursement of credit worth Rs. 65 million for agri inputs and livestock improvement during 1999-2000. The NRSP is also carrying out various extension activities in the five model Union Councils (UCs) in cotton growing areas. During Kharif 2000, NRSP planned to increase an average yield of cotton from 1.5 ton/ha. to 2.0 ton/ha. in the model union council located at Raja Pur District Lodhran, Multan Division with various agricultural interventions:-

By reviewing the NRSP's interventions in their selected model UC, it was revealed that technical personnel involved in implementation of these activities are either unaware of the concept of Integrated Pest Management (IPM) or have poor coordination with research and extension departments. This needs a detailed study to find out the impact of their interventions and also to know the means to make these efforts more productive. In Sindh the NRSP started its activities in Hyderabad in June, 2000. So far, NRSP has constituted 5 field units, 45 community organizations, organized 6 training courses and trained 60 activists. Held 6 veterinary camps. The NRSP disbursed credit amounting Rs.1.0 million for livestock improvement and Rs.0.2 million for agricultural inputs from June to November, 2000. It is too early to comment on impact of NRSP's extension activities in Sindh.

The NRSP got endowment fund of Rs.500 million from Government of Pakistan during the year. 1992-93, which is its main source of funding. NRSP earned an amount of Rs.104 million on account of interest from its endowment during 1998-99. Other funding sources include the UNDP/donor agencies.

6.4.2. Punjab Rural Support Programme (PRSP)

Punjab Rural Support Programme initiated its operations in Multan Division in August 1998. Majority of rural population of Multan comprises of small farmers and tenants. Division of land, generation after generation, is making sustainable agriculture difficult for farmers having small land holdings and poor yields. PRSP, like NRSP also focuses on human resource development and credit disbursement for income generation activities, as credit is the top priority of the resource poor farmers.

6.4.3. Credit Disbursement and Income Generation

During the year, 1999-2000, 3,097 loans worth Rs.48.6 million were disbursed to the members of community organisations. 10% of the total credit was disbursed for agricultural inputs mainly seed, fertilisers and pesticides. Participatory monitoring exercise revealed that credit availability considerably increased the income of the borrowers. Those availing the credit for agriculture escaped the hostile exploitation of local moneylenders who charged as high as 100 to 200% interest rate on borrowed goods and money. Secondly, by utilising the credit extended by Punjab Rural Support Programme (PRSP), these farmers were able to purchase the agricultural inputs of their own choice which was not possible in case the agricultural inputs were bought from the dealers on credit. Once the resource constraint was removed due to credit availability, these small farmers used quality agri. inputs in optimal quantity and at proper time, consequently harvested better crop yield and earned higher profits.

Credit extended by PRSP, Multan for agric. inputs helps the poor farmers to escape the hostile exploitation of agric. input dealers who charge heavy interest/profit on borrowed agri. inputs. This is apparent from the comparison given in Table 17 in which the credit and cash prices of an average spray programme have been compared.

Table 17. Comparison of credit and cash prices of Agric. inputs

Pesticide group	Average cash price (Rs.)/Litre	Average credit price (Rs.)/Litre.
Methameidophos	174	283
Endosulfan	330	466
Acetamiprid	415	650
Cypermethrin	337	500
Fenpropethrin	495	625
Chlorophriofos	405	612
Total	**2,156**	**3,135**

Source: PRSP Annual Report, Multan Region, 1998-99

On credit sum of Rs.2156, the borrower has to pay Rs.215 as service charge, if credit is availed from PRSP for six months while the dealer charges an extra profit of Rs.980 on the borrowed agri. inputs of the same amount i.e. 2,156. The result is that all the profit earned from the crop goes to the dealer if agri. inputs are bought on credit from the dealer.

6.4.4. Extension Linkage Development

The most important role of an NGO is to serve as a bridge between farming community and service providing agencies, to facilitate the process of service delivery especially to the resource poor farmers. NRSP and PRSP are accomplishing this role by developing linkages with all concerned agencies. Both NRSP and PRSP in close collaboration with Agriculture Extension and Research Department are carrying out the following activities:

i. Selection of Union Councils (UCs) to develop as model UCs and development of an integrated plan of operations to work on different interventions for each crop.
ii. Development of training curricula for crop management and livestock improvement.
iii. Activists/farmers training based on participatory approach rather than 'chalk and talk' method.
iv. Lay out of demonstration trials on farmers' fields.
v. On-station and on-farm visits.
vi. Organization of workshops/seminars/farmers days.

Contrary to the Pesticide Industry, the NGOs could play a vital role in minimizing the use of pesticides and maximizing the crop productivity in the country if they keep on complementing and supplementing of Government extension department efforts and serve humanity with sincerity, dedication and commitment (Sahibzada, 2000). In the cotton growing areas, there is a great potential to promote, motivate and strengthen the other existing viable local NGOs also, such as Farmers Development Organization, Basti Muluk, District. Lodhran; Dehat Dost Tanzeem (Village Friends Association), Mianchunu; Yasir Welfare Society, Khanewal; Awaz Foundation, Multan; Kissan Sang, Chak No. 390/WB, Lodhran; Kissan Itthad, Chak 368/WB, Lodhran in the Punjab and the 'Bahan Beli' in Sindh.

It has been observed that very few farmers interact with researchers either in their own or initiations taken by some research workers. This situation is not conducive to agricultural development. Similar situation prevails regarding farmers' interaction with extension agents particularly in Sindh province. However, more farmers' interaction with extension agents in Punjab has been observed especially during the last three years. Generally a substantial proportion of extension agents do not get a chance to interact with researchers.

Attempts are being made by the Government of Punjab to develop or strengthen the research-extension-farmers linkage through Cotton Production Committee (CPC). The provincial Minister for Agriculture convenes regular periodical meetings with all the actors at Central Cotton Research Institute (CCRI), Multan and reviewed the progress and find out the possible measures to encounter any problem or threat to the cotton crop in Punjab. However, a detailed study is needed to know the impact of CPC efforts since its inception.

6.5. Concluding Observations on Extension

The current agricultural extension system in public sector is a modified version of Training and Visit (T&V) system in which Agricultural Officer is the front line extension agent instead of Field Assistant. Contrary to the traditional T&V system, instead of individual contacts, the extension agent contacts group of farmers with pre-notified schedule. The extension agent operates in a territorial jurisdiction, which overlaps with circles of functionaries of other departments with whom coordination for integrated action is necessary and desirable.

There is rarely a female extension worker in the public sector who could advise the women folk who comprises nearly 50% of the population as the male extension agents neither have the clear mandate to interact with women nor the Pakistani culture allows it to happen. Hence half population is outside the ambit of extension educational system. Even under the reorganized, strengthened and time bound extension system of Punjab, only a minority of farmers in the villages is covered and very little change or improvement in the quality of extension has been observed. The traditional Agriculture Extension System is still in place in Sindh with major focus on big and influential farmers.

The extension agents hardly get any opportunity of exposure to new knowledge and skill because of inadequate in-service training programmes and library facilities. The agri. educational institutions from where the FAs, AOs, AROs, ROs and SMSs, etc. receive their pre-service training provide little practical training, as 'Chalk and Talk' method of teaching is the norm. The textbooks are out-dated and very little training is provided in analytical thinking, problem solving, extension methods, effective communications, rural sociology and farm management. There is a dire need to update the curricula.

The agriculture extension information material developed in the extension system, is still based on general recommendations instead of site specific. Information has become routine rather than need based. Limited use of mass media is hindering effectiveness especially reaching women and other resource poor and illiterate farmers.

Though agricultural research and extension systems in different provinces of Pakistan have realised the importance of improving linkages between their organisations, but so far they are unable to develop frequent researcher's interactions with extension agents and farmers to promote effective flow of knowledge and feedback. Extension and farmers have practically no direct role in research decision making, determining research priorities and contributing research ideas. At present, researchers and extension agents in Pakistan are generally ignorant of each other activities. A continuing problem is the lack of suitable measures to objectively assess the strength of the links between research and extension. Malik (1990) reported the annual interaction rate was less than one per researcher, which referred a very low level of communication between researchers and extension agents. Both the actors act in isolation of each other.

It has been observed that very few farmers interact with researchers either in their own or initiations taken by some research workers. This situation is not conducive to agricultural development. Similar situation prevails regarding farmers' interaction with extension agents particularly in Sindh province. However, more farmers' interaction with extension agents in Punjab has been observed especially during the last three years. Generally a substantial proportion of extension agents do not get a chance to interact with researchers.

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Irrational use of pesticides particularly in cotton and vegetables has increased enormously in Pakistan due to quite aggressive pesticide companies campaigns, backed up by very convincing media publicity. Eco-friendly technologies like IPM need to be promoted and strengthened through extension activities.

The role and function of agricultural extension services need to be modified with the aim at promoting self-reliance in rural communities through developing community based organizations and NGOs. It is necessary to sharpen the effectiveness of agricultural extension system by exploring ways of integrating positive characteristics of private sector or NGO operations into public sector management and by bringing participatory approach into real practice.

B. RESEARCH

6.6. Structure of Government Pest and Pesticide Related Agriculture Research

Both National (Central) and Provincial institutions are involved in plant protection research.

6.6.1. National Institutions

6.6.1.2 Pakistan Agricultural Research Council (PARC)/National Agricultural Research Centre (NARC) Islamabad

PARC is the apex body, which prepares master research plans for the country. NARC has several research institutes including Integrated Pest Management Institute (IPMI) and Crops Disease Research Institute (CDRI).

Major activities related with pest management are screening of varieties and insecticides of different crops. Work on mass rearing of *Trichogramma chilonis* and *Chrysoperla* sp. has been initiated. In spite of the establishment of the IPM Institute, pest management activities are continued in various section of different crops such as sugarcane, maize, rice, sunflower, millet, vegetables etc. and these correlate with the activities of the provincial research departments. There is a need to centralize the plant protection activities under IPM Institute.

6.2.1.2 Atomic Energy Commission

There are three agriculture research centers run by Atomic Energy Commision, located in Punjab, Sindh and NWFP.

i. Nuclear Institute of Food and Agriculture, Peshawar, NWFP

Activities of the Entomology Division were mainly focused on the integrated control of insect pests of apple, tobacco, sugarcane, sugarbeet, maize and stored grain pests grain pests using radiation techniques.

Pheromone traps are being used to monitor fruit flies infestation in orchards of guava, peach etc. Studies on IPM of chickpea pod borer based on mutant resistant and cultural practices such as de-branching are in progress. In the termite project, radiotracers dyes are being used to detect nesting system. Screening of different chemical against termites is also being carried out.

ii. Nuclear Institute of Agriculture and Biology, Faisalabad, Punjab

Current major research activities are on cotton host plant resistance and evaluation of new insecticides against major insect pests, impact of insecticides versus no control measures on insect pests population and yield, effect of sowing date and plant density on insect pests population, studies on various aspects of mass rearing of T. chilonis. IPM trial against cotton bollworms is being carried out based on time of planting and releases of egg parasitoid. Monitoring of bollworm population is being done by utilizing sex pheromone traps.

iii. Nuclear Institute of Agriculture Tandojam, Sindh

In Sindh, activities are mostly focused on biological control of sugarcane borers, fruit fly management, management of rice, maize, oil seed crop pests based on varietal resistance, cultural control etc. Similar activities are carried out in provincial research institutions and in most of the cases the results contradict.

6.2.1.3 Pakistan Science Foundation

Pakistan Science Foundation provides funds to the projects on plant protection from various research institutions.

6.2.1.4 Central Cotton Research Committee (CCRC)

Central Cotton Research Committee has cotton research institutes at Multan and Sakrand and research stations at Bahawalpur, Ghotki, Mir Pur Khas and Nasirabad. Major activities of these institutes/stations are the screening of plant varieties and insecticides for major pests of cotton. Studies related with IPM such as host plant preference, ecology, alternate host plants of major insect pests, yield losses due to pests, cultural control. Use of semio-chemicals etc. have been carried out in a more specialized manners.

Studies on various aspects of important insect pests of cotton were carried out. These include agro ecosystem, population dynamics of pests and their natural enemies, economic threshold level of major insect pests, pest-scouting system, yield losses due to sucking pests and bollworm. Economics of spraying, simulation of bollworms damage, effect of insecticides on cotton plant growth and fructification, evaluation of different plant characters tolerant to bollworms infestation. Monitoring of pesticides resistance in insects and development of strategies for the control of major insect pests leading to integrated pest control are major areas of research.

6.2.1.5 National Institute of Biology and Genetic Engineering, Faisalabad

In collaboration with International Insecticide Resistance Committee (IRAC), NIBGE work is mostly focused on resistant monitoring in the insects to insecticides.

6.6.2. Provincial Institutions

6.6.2.1 Punjab

In Punjab, there are two major provincial departments working mainly on entomological aspects. Entomology Section and Plant Protection Institute both are located in the Ayub Agriculture Research Institute Faisalabad. The entomological section is mainly concerned with research work to develop effective and economically feasible system of pest management. Major activities of the section are the screening of insecticides against insect pests of various field and orchard crops, evaluation of plant varieties for their resistance to insect pests, ecological and population dynamic studies of major insect pests, development of alternative control measures such as cultural, biological, mechanical and semio-chemicals. Work on tools of Integrated Pest Management is also initiated.

The activities of the Plant Protection Institute are divided in to three categories. Pesticide Division ensures the quality control of the pesticides, proper utilization of plant protection materials and evaluation of pest control operations and implementation of the rules and regulations of the pesticide act. Pest Management Division is responsible for determination of tolerance, residues and economic dosage of pesticides, pest survey and warning services, study the population dynamics of major pests of important crops and to develop alternate techniques such as cultural, mechanical and biological for the control of major pests. Pest Control Training Division imparts practical in-service training for the nominee of Agriculture Extension and Research Departments.

Besides, these two major departments, plant protection activities are also being carried out in various institutes such as Vegetable Research Institute, Horticulture Research Institute, Rice Research Institute, Sugarcane Research Institute, Oilseed Research Institute, etc.

Punjab Agriculture Research Board, Lahore sets research priorities and is responsible for coordination among various institutes within the province. It provides funds for research to different research institutes, for example.

i. Rice research Institute, Kala shah Kaku
ii. Barani Agriculture Research Institute Chakwal.
iii. Cotton Research Institute Multan
iv. Oilseed Research Institute Faisalabad.

During 1992-93, IPM Centre was established at Faisalabad under ARP 11 project. Major work is done on sugarcane, cotton and rice.

Studies of Economic injury levels of various insect pests were reported and based on the same numbers as were reported by other institutions in other agro- ecological zones of the country. Moreover, their correlation with natural enemies has never been made. In fact, natural enemies have never been given their due consideration in IPM.

6.2.1.2 Sindh

In Sindh, plant protection activities are being carried out in Agriculture Research Institute, Integrated Pest Management Institute, Horticulture Research Institute, Rice Research Institute, and Wheat Research Institute etc. The major focus of activities is the screening of plant varieties and insecticides against the major insect pests.

The activities of the Integrated Pest Management Institute involved screening of varieties, insecticides and implementation of the already proven technologies such as using egg parasitoids for the control of sugarcane and cotton pests and evaluation of other novel material such as neem, Bt etc.

Integrated Pest Management Institute was established in 1992-93 under ARP-II project. The major objective was to develop IPM technologies for the farmers. The major goals of the project were to coordinate with the staff of all the research institutions, extension personals and the farmers to produce most sustainable productive agriculture ecosystem, develop strong liaison with plant protection workers, coordination with national and international institutions.

This institute had very little capabilities to accomplish the above-mentioned goals and objectives due to the misunderstanding of the concept and practice of IPM. To achieve all the above-mentioned targets, it is imperative that good team of taxonomists, ecologists and IPM oriented entomologists are available. Besides these, it also requires a highest level of cooperation/coordination between research and extension departments, which was lacking. The current research programs of IPM Institute are highly biased and most work is done in the area of wheat breeding/resistance research. Several research projects have been labeled IPM research but there is little work carried out in the priority areas except for cotton.

6.2.1.3 NWFP

At the time of the establishment of the Pakistan in 1947, research and extension in the NWFP were conducted by the provincial department of Agriculture in a well-coordinated manner under a single Director of Agriculture. Later on two separate Directorates of Agriculture Research an extension were established. However, with the passage of time the linkages and interaction between the two departments became very week resulting in low efficiency of transfer of new technology from the research centres to the farmers. In 1987, the provincial research system was merged with the NWFP Agriculture University resulted in dual administration of agriculture research by the Vice Chancellor and the Secretary, Department of Agriculture, NWFP.

The government of Pakistan became conscious to the environmental hazards of the pesticides and IPM was the critical issue in the policy and planning. In 1991-98 the ARP II was implemented and IPM was the integral part. Following projects were implemented in this perspective;

i) Expanded programme on the control of termites.
ii) Expanded programme on control of fruit fly.
iii) IPM of sugarcane borers.
iv) IPM of sugar beet pests.

The following research institutes and centres are involved in research activities. Research activities were mostly based on the screening of new plant varieties and insecticides against insect pests. Research work has been done on insect pests of fruits, vegetables and cereal crops;

i) Entomology Section at Agriculture Research Institute, Peshawar
ii) Potato Research Center, Abbottabad
iii) Entomology Section at Agriculture Research Institute, DI Khan
iv) Entomology Section at Agriculture Research Institute, Mardan
v) Entomology Section at Agriculture Research Station, North Mingora, Swat
vi) Agriculture Research Station, Dhodial, Manshera
vii) Agriculture Research Station, CADP, Chitral
viii) Cereal Crops Research Institute, Pirsabak, Nowshera
ix) Barani Agriculture Research Station Kohat
x) Entomology Section in FATA Project at ARI-Tarnab (Peshawar)

6.2.1.4 Balochistan

Major activities are focussed on the management of fruits and vegetables pests with particular reference to apple, almond and grapes in case of fruits and cabbage, tomato, okra, onion etc. Research on plant protection is done in entomology and plant pathology sections at Agriculture Research Institute, Quetta. Main emphasis of the activities is on the screening of insecticides against various insect pests. Some work on cultural control aspects were also carried out.

In Balochistan, deciduous fruits are the major cash crop. However, the present production system with heavy reliance on pesticides is doomed to collapse sooner or later. Due to a number of factors, pesticide applications are increasing continuously. Thus putting extra pressure on an already extremely vulnerable ecosystem, besides increasing risks for human health.

Under FAO project work has been done on IPM and pest control in apple orchards in Balochistan. A report was compiled on the pesticides, its hazards and its alternatives. Few IPM recommendations were also suggested for the least use of pesticides. Balochistan has great potential with regard to IPM. One of the strongholds of fruit producing Balochistan is that it is blessed with the almost absence of economically important diseases. Furthermore, the orchards are fairly isolated thus a unique island situation exists suitable for the implementation of ecological based control measures such as sterile male technique or confusion technique.

Unfortunately, there are some important draw-backs hampering the implementation of the IPM:

i. Majority of the orchards are sold to pre-harvest contractors and they make decisions regarding plant protection. As their main interest is based on getting higher yield and therefore, inclined to spraying of highly toxic chemicals.
ii. A lot of cheap, highly toxic, broad spectrum pesticides of dubious quality are smuggled in from abroad. The price difference between the selective and those smuggled from abroad and broad spectrum local products is so big that farmer prefer to buy the cheaper outdated, highly toxic and broad spectrum pesticides which make the situation more worse.

6.6.3. Inter-Governmental Organizations

6.6.3.1 CABI Regional Bioscience Centre, Rawalpindi

Main focus of work from 1957-1979 has been on exploring the natural enemies of both for insect pests and weeds. During 1980 and early 90s, the emphasis was to provide services for the implementation of IPM. Since mid 90s, the work has more focused on Farmer Field School approach along with traditional research on IPM and its implementation in the farmer's fields. Biological control based IPM activities are being carried out in all the provinces of Pakistan. Various technologies such as mass rearing of *T. chilonis* have been disseminated to the various institution and departments and this technology is being widely used throughout the country.

Presently, this centre has strong IPM programs on deciduous fruits, vegetables, maize, sugarcane, and cotton throughout the country where holistic approaches in IPM are adopted.

6.6.4. Universities

There are four agriculture universities, two agriculture colleges, university departments and faculties in the country. Students in these universities are doing research at master and doctorate levels.

- University of Agriculture, Faisalabad
- NWFP Agriculture University, Peshawar

- Sindh Agriculture University, TandoJam
- University of Arid Agriculture, Rawalpindi
- Agriculture College, Quetta
- Agriculture College, Multan
- Faculty of Agriculture, Gomal University, DI Khan
- Nematology Institute, Karachi University

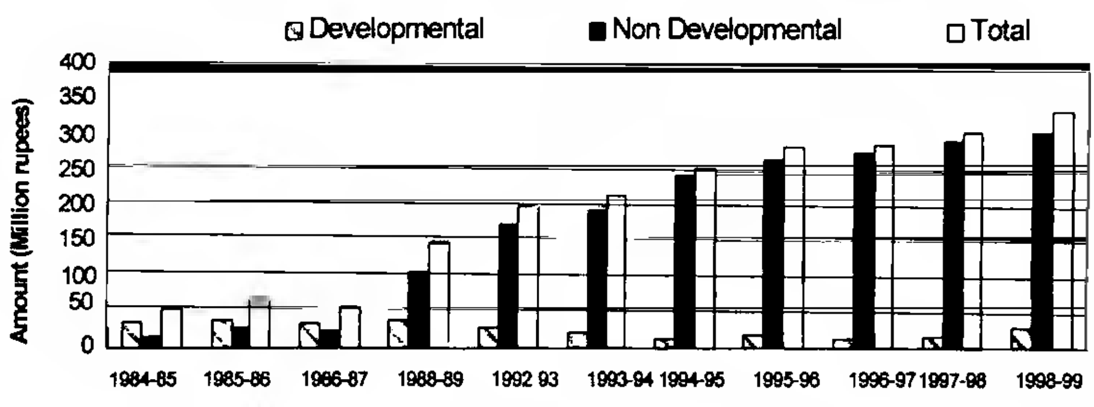
6.7. Costs of the Government Systems and Estimates of Expenditures on Pesticide Related Research vs IPM Research including Biological Control

Cost estimates of various research institutes over the years had rarely been available particularly the split up for various sections working on plant protection. Therefore, it was not possible to split expenditures on pesticide related research from expenditure on IPM research including biological control. However, estimated budget of CABI Regional Bioscience Centre was available and has been used as expenditure on IPM research including biological control.

6.7.1. Punjab

The total amount spent on agriculture research kept on increasing from Rs 54.03 million to Rs 337.4 million (20 fold increase) since 1984-85 but amount spent on development (research and development) rather declined over the years (1.3 fold) (Figure 6.1). From 50-70% of the budget had been used for development in 80s but since early 90s only 5% of the budget is spent on development.

Figure 6.1 Amount spent on agriculture research in Punjab



Budget for entomology section shows similar trends, total budget has increased by 25 fold (from Rs 0.26 million to Rs 6.6 million) since early 70s compared to only 5 fold increase in developmental budget (Figure 6.2). In early 70s about 35% of the budget had been spent on development but since early 90s only 5% of the budget is spent on development.

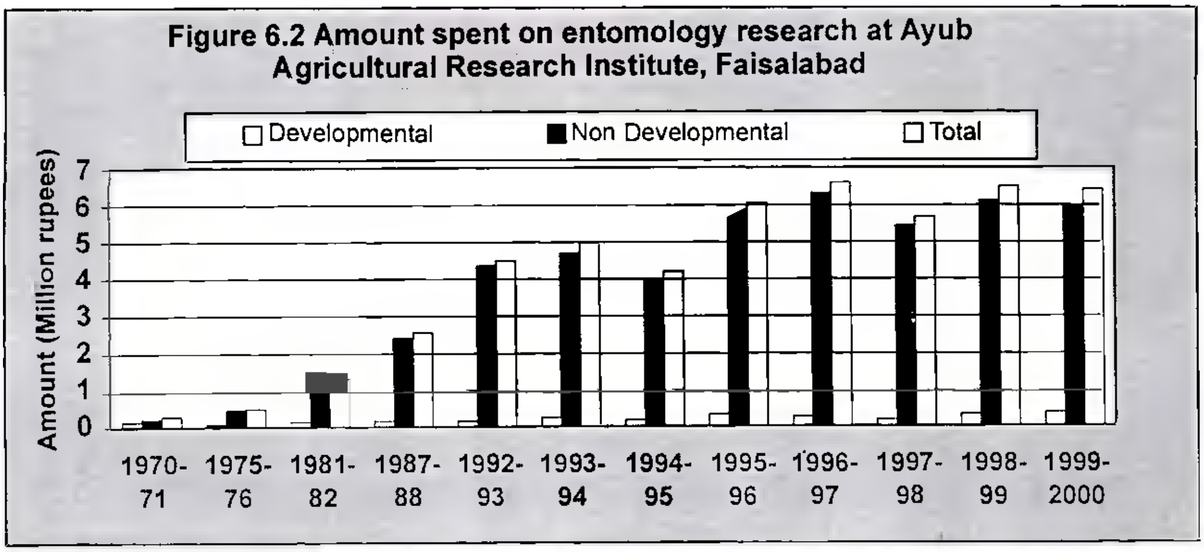
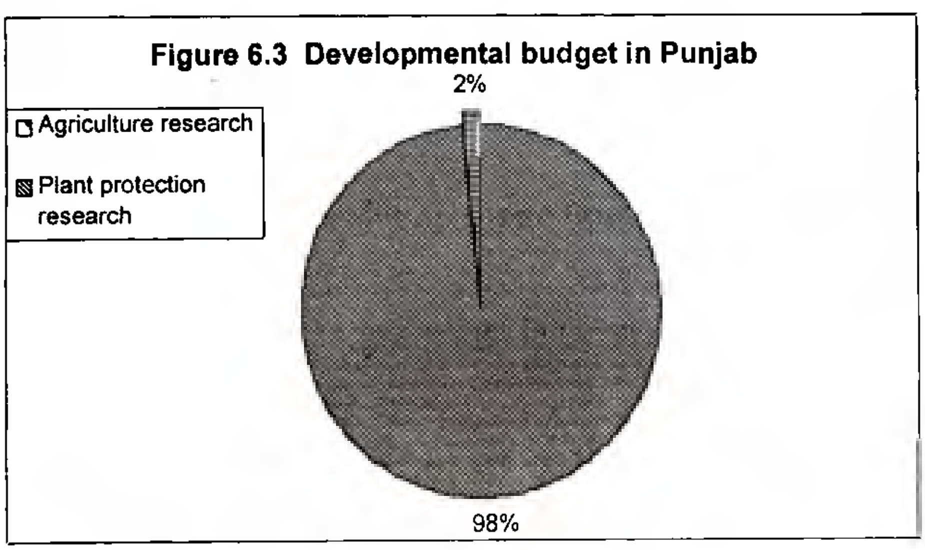


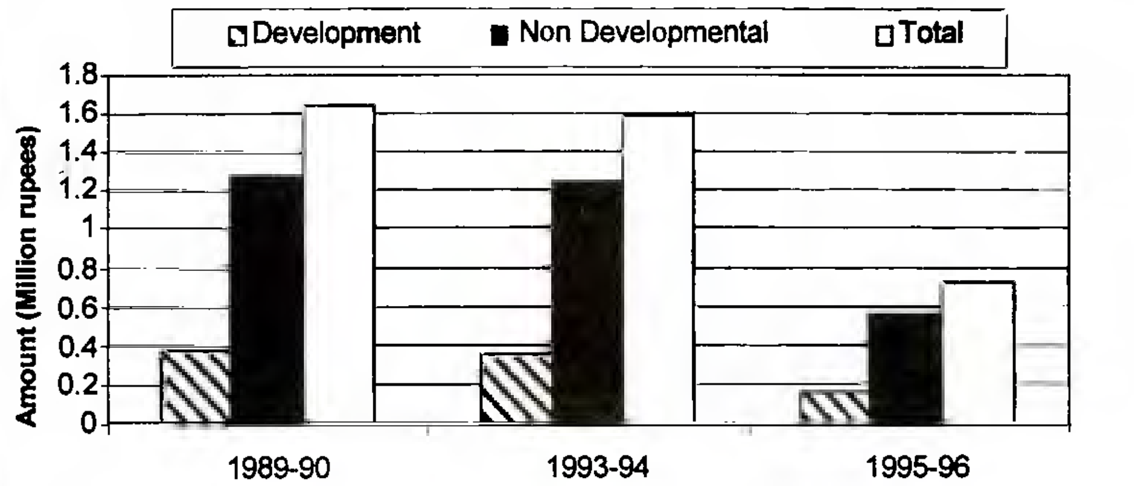
Figure 6.3 shows the comparison between the amount spent on agriculture research and plant protection research during 1996-99. A total of Rs 935 million were spent on agriculture research compared to Rs 31 million spent on plant protection research, which shows 30 fold difference. Only 2% of the development budget was spent on plant protection (Figure 6.3).



6.7.2. Balochistan

Budget for Entomology section at Agriculture Research Institute, Quetta (Figure 6.4).

Figure 6.4 Amount spent on entomology research in Balochistan



6.7.3. NWFP

In 1996-97, a total of Rs 152.176 million were spent on IPM research, of which only Rs 25.102 million (16.5%) were used for development purpose (Figure 6.5). Budget for agriculture research institute, DI Khan had only Rs 415,000 for development during 1996-97 (0.32% of the total budget) (Figure 6.6).

Figure 6.5 Amount spent on IPM research in NWFP

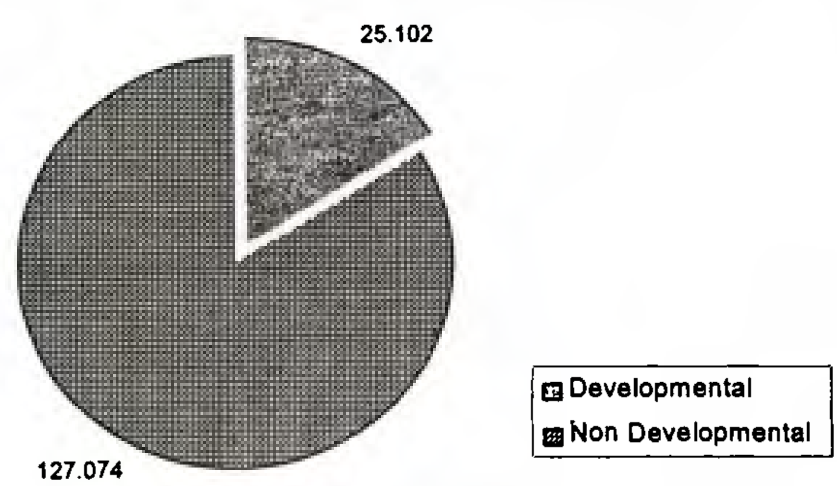
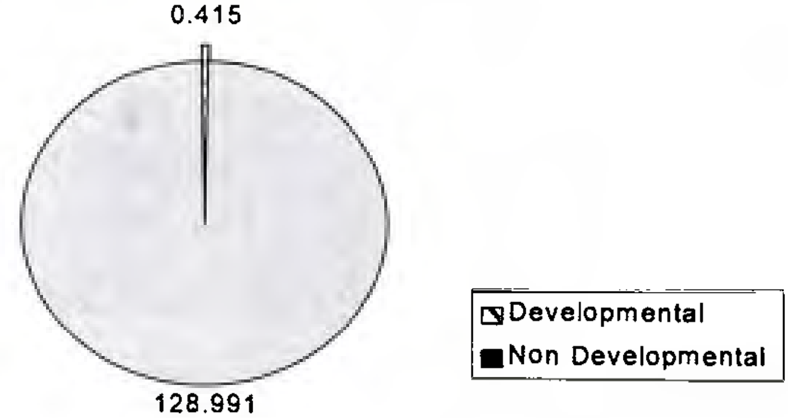


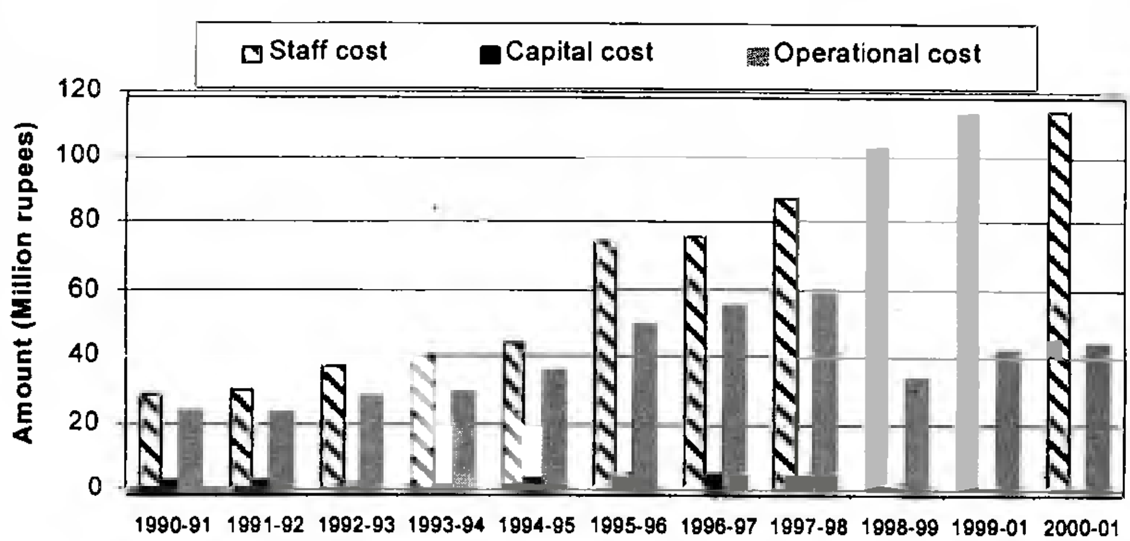
Figure 6.6 Budget for Agriculture Research Institute Dera Ismial Khan, NWFP



6.7.4. NARC

Staff cost has increased 4 fold since early 90s while capital cost (amount spent on equipment etc) has decreased 4 fold (Figure 6.7). Although the amount for operation (development) has increased 1.8 times since early 90s, the percent to total budget has decreased from 43.2% to 27.6%. Figure 6.8 shows a comparison between budget spent on plant protection (both CDRI and IPMI) and total NARC budget. Plant protection budget has increased from about Rs one million in 1989-90 to Rs 10.4 million in 2000-01. Total NARC budget has also increased from Rs 48 million to Rs 157 million.

Figure 6.7 Trends in staff, capital and operational costs in NARC



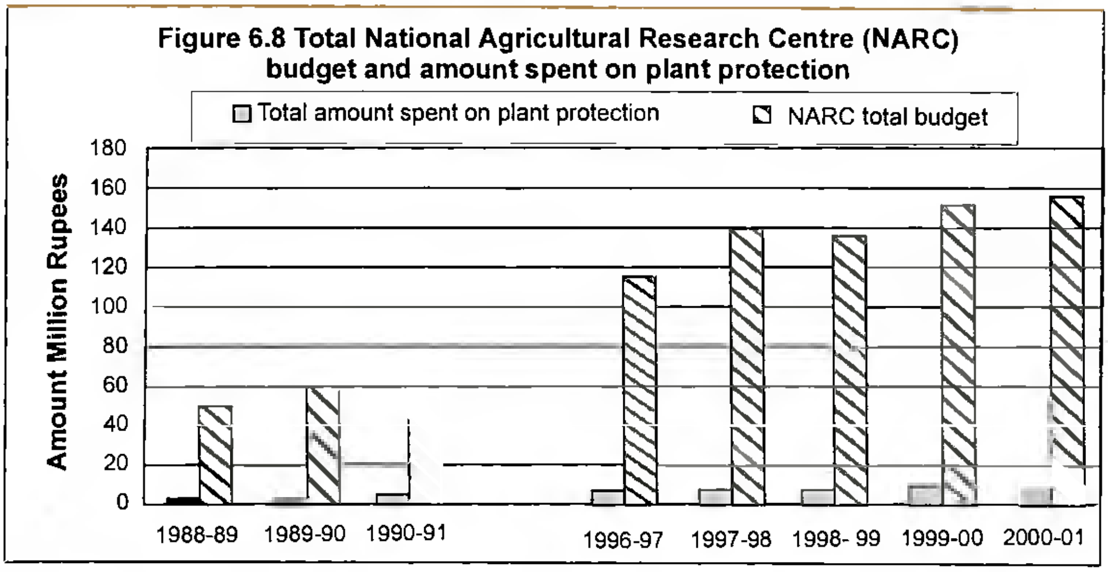
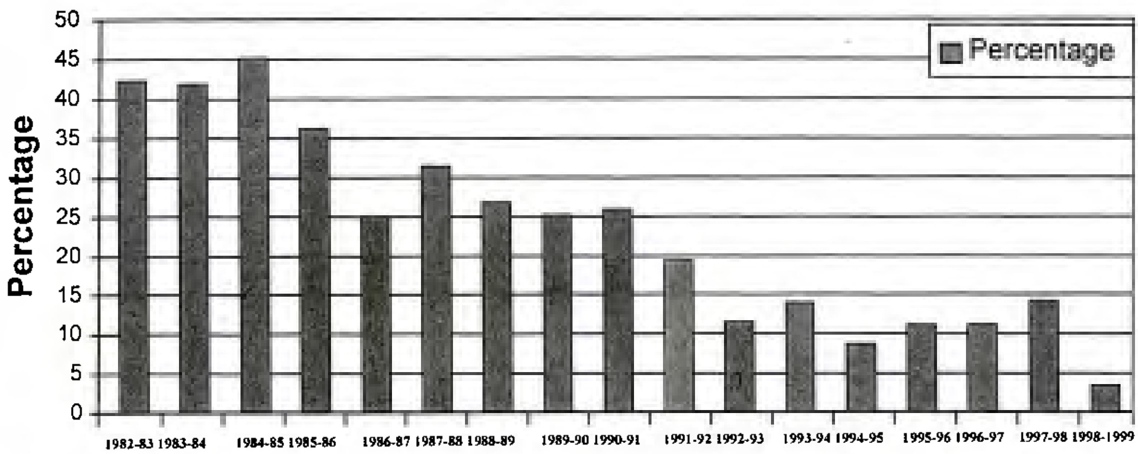


Figure 6.9 illustrates the trends in amount allocated for development in CDRI, Islamabad over the years. About 40% budget had been allocated for development in early 80s which about 20% in early 90. More recently less than 5% of the total budget is available for development purpose.

Figure 6.10 Trends in allocation to developmental budget in CDRI



6.8. Role of NGOs in Pest and Pesticide Related Research

Several non-governmental organisations in the country are involved in the research and development of agriculture and plant protection. Although their role in research not very significant (spending about Rs 2-5 millions annually) but is worth mentioning.

i. Agha Khan Rural Support Programme support research on vegetable and fruits Integrated Pest Mamagement (IPM) in Chitral.

ii. Christian Relief Service (an International NGO) provided support to farmer participatory research on cotton through local community based organisations (CBOs) in Khanewal area.
iii. OXFAM provides support to farmer participatory research on neem-based products for pest control in Sindh
iv. CARITAS Lahore provides support to farmer participatory research in cotton, cereals, vegetables, etc.
v. Pakistan Policy Research Institute, Islamabad is involved in agriculture research.
vi. Several NGOs, for example, Punjab Rural Support Programme (PRSP) and Sarhad Rural Support Programme (SRSP), have been engaged in agriculture development. These NGOs have 'Scout Farmers' with the theme 'to help the poorest of the poor'. These scout farmers are trained in maintenance of spray machinery and safe use of pesticide. The NGOs contribute to improved and sustainable agriculture through their field teams using tools such as demonstration plots and farmer field days.

6.9. Role of Private Sector in Pest and Pesticide Related Research (including Resistance Monitoring)

6.9.1. Pesticide Manufacturers and Distributors

Research and development wings of private sector (mostly multinational pesticide companies) are mainly involved in evaluation of new chemicals. The agrochemical industry collectively spend over a billion of US$ to support its research and development function. In recent years, increasing cost of R & D has forced some big names in chemical industry either to merge with others or be bought over by bigger companies.

In Pakistan, the pesticide companies are spending about 10% of their total budget in research and development. Recent focus is around the following aspects;

i) Changing trends in pests (which type of insects are becoming serious)
ii) Pest specific research, for example seed treatment (to increase seed treatment from 2% to 8% of total pesticide use)
iii) Package development (water soluble sachets for ready use- to reduce human contact)
iv) Use of safeners (particularly in herbicides to avoid injury to crop/plants)
v) Promote ridge sowing (equipment are provided free of cost) which not only save water but also facilitates plant protection practices
vi) Research on previously unsolved issues

The research and development setup usually consists of Research and Development Head supported by senior research and Development Officers. Several Research and Development Officers are recruited who work at field level and have contacts with government agriculture research institutions.

Novartis Pakistan Limited has established laboratory at Multan doing research on pesticide resistance monitoring in *Helicoverpa armigera* and whitefly. Moreover, effects of pesticide application on population of natural enemies are studied in field.

6.9.2. Progressive Growers

Several progressive growers in the country are engaged in agriculture research and development. For example, Mr Jehangir Khan Tareen and Bukhari have developed farms on scientific basis and are also doing research on:

i. Use of pheromone traps for monitoring and control of insect pests of cotton and sugarcane
ii. Mango fruit fly and mango midge
iii. Mortality of overwintering *Helicoverpa armigera*

In Pakistan, there are 12 *Trichogramma chilonis* mass rearing facilities, mostly established in the private sector supported by sugar industry, for example Habib, Faran, Alnoor, Kamalia Sugar Mills, etc. Several growers, for example 'Vitova Insectaries', has developed private laboratories for the production of *Trichogramma* cards on commercial scale.

6.9.3. Pesticide resistance monitoring laboratory at Faisalabad

Through consortia with International Resistance Action Committee (IRAC), several private pesticide manufacturer and suppliers fund a programme on pesticide resistance monitoring in key pests of cotton, particularly *Helicoverpa armigera* and whitefly.

6.10. Available Non-Chemical Technologies

The philosophy of IPM is to integrate all available pest control strategies in such a manner that one technology compliments the effect of the others. IPM is an approach, a philosophy of ecosystem oriented agricultural crop management. Research on IPM management and decision management tools or, in other words, holistic approach is required. Moreover, the Economic Threshold Levels (ETL) needs to be re-determined, considering not only pest's population levels but other factors like population levels of natural enemies, crop health, plant compensation, etc. Such important parts of IPM should be incorporated in research institute's mandates.

6.10.1. Regulatory Methods

Plant quarantine (Viral diseases with root stocks and in seeds)

6.10.2. Cultural Control

1. Use of resistant varieties (Rust resistant wheat varieties)
2. Crop rotation (Nematode control in potato)
3. Tillage of soil (Destroy fruit fly pupae)
4. Variation in time of planting or harvesting (Canola can escape aphid)
5. Pruning and thinning (Cherry tip borer in apple)
6. Sanitation (Collection and destruction of infested fruits reduce fruit fly)
7. Planting of trap crops (Maize stem borer control)

6.10.3. Mechanical Methods

1. Hand destruction (Cabbage caterpillar larvae in cabbage/cauliflower)
2. Exclusion by screen, barriers (Locust control)
3. Trapping, suction devices, collecting machines (Grasshoppers)

6.10.4. Physical Methods

1. Temperature (heat, cold, humidity)
2. Energy- light traps etc (Moths of various lepidopterous species)
3. Sound (Birds)

6.10.5. Biological Methods

1. Conservation of natural enemies (*Stethorus punctum* for two spotted spider mite)
2. Re-distribution of natural enemies (Aphid parasitoids, *Cotesia* sp. for maize stem borer)
3. Augmentation of natural enemies (*Trichogramma chilonis* for sugarcane
4. borers)
5. Introduction of natural enemies

6.10.6. Genetic Methods

Propagation and release of sterile or genetically incompatible insect (Fruit fly)

6.10.6. Semi-Chemicals

1. Attractants
2. Repellents

6.11. Research-Extension Linkages: Uptake of IPM vs Pesticides Based Technologies

Extension Department works on the principle of direct and effective transfer of available technical recommendations through close linkages between research, extension and farmers. However, the nature of collaboration between research and extension systems varies in different provinces.

6.11.1. Dissemination of Technologies

New technology developed at the research institutions are usually disseminated to the extension departments through the following possible routs:

i. Progress reports.
ii. Brochures.
iii. Short exposure visits of the extensionists to the research institutions.
iv. Short training courses organized for the extensionists by various research institutions.
v. Field days organized at the demonstration plots established by the research institutions.
vi. Training institutes.
vii. Conferences and Workshops.
viii. Adaptive Research:
ix. Production of campaign material.

6.11.2. Research-Extension Linkages in Punjab

In Punjab, the major function/objective of current extension system is the testing of research findings of various research institutions through adaptive research under local conditions and amended if required. Besides, research farms, demonstration plots are established on farmer's land where the technology package for a particular crop is implemented under direct supervision of the extension department.

For the awareness of the general farmer's communities, progressive farmers of the area are invited at the farms once at the time of the sowing of the plot and secondly at the harvest time where salient features of the technology package are briefed to the farmers by the experts from the research organizations.

Adaptive research component of the extension department is the real backbone for majority of the extension activities. It bridges up gap between research institutions and the farmers. The main objectives of the adaptive research are:

i. Identify farmer's problems.
ii. Demonstrate and evaluate the research findings of research institutions.
iii. Develop area specific production technology.
iv. Transfer of this technology to the farmers through extension staff thus maintaining an effective linkage between research and extension.

Another important component of the research, extension and farmers linkages is the private sectors (Pesticides & Fertilizer Companies). In most of the cases, research on pesticide screening and evaluation is carried out in close collaboration with the field staff of these multinationals and results are usually biased. Being business oriented organizations; these companies usually promote manipulated messages due to the availability of the efficient infrastructure. In some cases, conflicting messages are promoted which create confusion for the farmers regarding their crop management. Furthermore, there is strong danger of duplication, where many different types of field extensionists interact with the same farmers.

6.11.3. Research-Extension linkages in Sindh

In Sindh, linkages between research and extension departments are almost negligible and chances of coordination have been very rare. One of the possible reason could be the none-existence of adaptive research component and therefore, testing of new technology under site specific conditions are not possible. The knowledge being generated at the research institutions, conceived correctly or in-correctly by the extensionists and conveyed to the farmers on a generalize basis without considering the agro-climatic factors and which has shattered the confidence of the farmer's community to a great extent. Due to the non-existence of the coordination system, influence of private sector is very dominating.

6.11.4. Research-Extension Linkages in NWFP

According to the research guidelines/mandate of Agriculture Department, NWFP, the linkages between research and extension departments are defined as:

i. Conducting adaptive research trials on farmer's fields for transfer of technology and to determine the various constraints affecting yield potential in collaboration with the extension staff and with emphasis on sustainability and minimum interference with the environment.
ii. Providing advisory services to extension staff, farmers, farmer's associations, private entrepreneurs and agro-based industry including the production and distribution of extension and advisory materials.
iii. Organize short in-service training/refresher courses/field days for staff of research, extension, development projects and farmers for the transfer of technology and production management.

However, in-spite of very clear-cut mandate, the links between research and extension are very week. Therefore, the existing technology is not passed on effectively to the farmers.

In mid eighties and early nineties, there were different setups under which research and extension activities were being carried out:

6.11.4.1 University System

In this system a university is given land on which to conduct research and train students. An outreach section is attached, which has the task of keeping in contact with the surrounding areas and thereby ensure communication between researchers and the farmers. University is mandated to research and outreach was mandated to conduct farming systems research with farmers. University has its own various setups for conducting research and extension. However, the interaction between this system and the extension department is sporadic and ad hoc, inspite of the fact that the university actually training the future staff of the extension department. There is a lack of well-organized exchange of information between research and the extension. Unfortunately, outreach is not in a position to organize this exchange of information.

6.11.4.2 Research

Research is well established with clear mandate. However, adaptive research section with a strong on-farm component, the mandate is less clear. There is uncertainty, whether this is supposed to be done by outreach. Interestingly, extensionists have never been considered as potential partners in conducting on-farm research. This reflects the understanding of extension being solely an affair of transfer of technology. For example, in case of fruits and vegetables research, communication with the extension department is sporadic and ad-hoc. Farmers training are an integral part of the research system.

6.11.4.3 Outreach

Outreach concentrate on informal networking among the various agencies. Mandate of outreach appears to be ill defined and there is a lot of confusion as to how it is distinguished from extension. On the one hand outreach is supposed to conduct on-farm trials and make the linkages between researchers and the farmers. However, at the moment outreach department is virtually not much effective because of the lack of resources such as man power and other facilities and than there is a danger of duplication with extension department.

6.11.4.3 The Extension System

It includes the three main agencies: Extension Department, griculture Training Institute and Fruit and Vegetable Development Board (FVDB). These three agencies are not under University. FVDB is an autonomous body and directly under the Secretary Agriculture, Agri. Extension Department is also under Secretary Agriculture and the Agri. Training Institute is with in the Extension Department.

FVDB has been made responsible for extension activities in horticulture sector but the task is poorly understood. Extension department mandate seems to closely follow the general understanding of extension being just "transfer of technology" With the passage of time more and more things have been taken away from extension and put into the hands of other agencies. There is no clear concept of how the extensionists should interact with researchers in their area.

Training institute is responsible for training the field staff of the extension department. Training of inservice field staff and the farmers also takes place in research institutions.

Instead of improving the linkages between the researchers and the various extension agencies, there appear to be lot of duplication of the activities. Everybody seems to invest efforts in directly training farmers. Both the FVDB and the Extension Department, demonstrate same types of target populations. Both the research department and the training institute have programs for in-service training extension field staff. Generally, there is very poor coordination among various agencies concerning the interactions, which should finally take place with the farmers.

This has led to the situation where a great deal of duplication is inevitable, where people of various agencies approach the same farmers with more or less the same issue but with somewhat different solution. It all comes together on farmer's fields and the farmers are left to try to make sense out of it all and integrate the sometimes conflicting signals they are getting.

During 1998, it was proposed that adaptive trials should require the participation of research in order to provide the appropriate research discipline and to link up the trials with the station based research. Extension staff is required to supervise the widely scattered plots. Carrying out the exercise jointly would have the added advantage of developing a spirit of cooperation amongst the two departments.

According to the current proposal of the Agriculture Extension Task Force, the extension system in each division would include a minimum number of seven Senior Subject Matter Specialists (SMS) whose responsibilities would be to maintain links with their counterparts in the research system and passing on this information to the extension field staff. The communication of research knowledge would take place in the following three ways:

i. Communication of the latest research results: Each section of the research station will keep its corresponding SMS informed about the latest research development.
ii. There will be a system of on call advice. The SMS would be able to call on his corresponding section in the research station for advice and accompanying of research SMS to the field from time to time.
iii. Production of advisory material.

6.11.5. Research-Extension Linkages in Balochistan

The current linkages between research and extension are almost negligible. During the discussion with the officials of the extension department, it was informed that practically there is very little interaction with the research department. During late eighties, adaptive research activities were initiated under a foreign funded project. However, after the termination of the physical phase of the project, the adaptive research component was continued on papers as non-developed activities and some of the adaptive research farms were also maintained but in realities there was no such activities.

Due to poor interaction, documentation and background information on technical subjects are sparsely available to the extension workers to pass on to the farmers. This lack of interaction especially hampers the activities of the young extensionists who lack practical experience. It is believed that most of the recommendations given by the extensionists are based on personal experience. As a result, extensionists are recommending and selling highly toxic pesticides with out realizing their impacts. This also resulted in limited training activities undertaken by the extension department because of lack of resources and knowledge.

6.12. Discussion and Conclusion on Research Systems

In the NWFP, over all condition of agriculture research is comparatively better as compared with the Punjab and Sindh. Various institutes have been involved in specialized research activities and there have been very little overlapping of these activities. For example Sugar Crops Research Institute, Mardan is specifically working on Entomological problems of sugarcane and sugar beet, Cereal Crops Research Institute, Pirsabak is working on cereal crops, Agriculture Research Institute, Tarnab is working on field crops as well as on vegetables. However, still there are several research issues such as screening of similar plant varieties and insecticides against similar insect pests, which overlap in one way or the other in different research institutions. Similarly, major focus of activities of Nuclear Institute of Food and Agriculture Peshawar and Agriculture Research Institute, Dera Ismail Khan is on fruit flies management.

In case of Punjab, the situation is worse, different institutes/departments are engaged in almost similar activities but ironically yielding some how different results. This is particularly true in case of insecticide screening and varietal susceptibility. Entomology Section and Plant Protection Institute of Ayub Agriculture Research Centre are working on more or less same issues of pest management, screening of insecticides with major focus on cotton. The same activities are being carried out in more specialized way by the Central Cotton Research Institute. In Sindh, similar nature of activities is being carried out with variable results in the provincial agriculture departments and Atomic Energy Agriculture Centre, Tandojam.

In Agriculture Universities of NWFP and Punjab, work on IPM of various crops such as rice, cotton, fruits and vegetables have been carried out and some are still in progress. Almost similar results have been achieved in different projects, which were achieved in different research institutions both at provincial and national levels. Another important issue is the experimental methodology/sampling techniques, which are highly variable for identical studies in different institutions. No standard methodology was available.

The philosophy of IPM is to integrate all available options for controlling pest population for sustainable productivity with no adverse effect on human being, animals and environment. In most of the cases, the term IPM has been mis-understood and there is a little understanding of the meaning and implication of the IPM. IPM is an approach of eco-system oriented agriculture crop management. It is not a discipline but it's an operational philosophy. It is not based on having fields devoid of insect life, on the contrary, IPM aims at increasing the complexity and diversity of the insects and animal life with in an agro-ecosystem to encourage its sustainability. It requires highly trained entomologists, pathologists, plant physiologists, agronomists, soil scientist, good managers and strong linkages with extension departments.

Most of the institutes/departments have no clear cut IPM mandate and in most of the cases the program was initiated with out realizing its requirements such as trained manpower facilities and research priorities. Present IPM research revolves around the development of IPM tools. Research on IPM management and decision management tools or, in other words, holistic approach is required. Moreover, The Economic Threshold Levels (ETL) needs to be re-determined, considering not only pest's population levels but other factors like population levels of natural enemies, crop health, plant compensation, etc.

As for as training component is concemed, it has been very week particularly in case of provincial agriculture sector. Major training activities have been the on job short term training mostly related with utilization of pesticides, pest control, safe use of pesticide etc. Farmer training is limited to farmer field days or personal contacts. Concept of season long training is lacking. Mostly farmers complained that recommendations given by different officials of the agriculture departments usually vary which further deteriorate the situation.

PARC in collaboration with CABI Bioscience conducted few short-term training on IPM for the staff of the provincial research departments. During 1997, CABI conducted a season long Training of Trainers and Farmer Field School under ADB funded project. Under this training program all the Agriculture Officers/EADA of the Extension Department in District Vehari were trained. This program had a very deep impact on the extensionists and the farmers and created a lot of interest in different sectors. Based on the same experience the extension department Punjab revised their activity plans.

Several non-governmental organisation have been supporting research particularly farmer participatory research. Such support is vital, especially in the scenario when the government institutions lack operational funds. Although multinational pesticide companies do invest in research and development but all their efforts are product-based (pesticides).

The total budget for the research institutions has been increasing but the operational budget for actual research and development has been decreasing ever since. Research and extension systems need to invest heavily in understanding their target clients- all those involved in agriculture in the province- as well as the resources upon which they depend, that is the environment in which they work. The environment includes the agro-ecological systems of the area. The reason is clear: the problems and the potentials of the clients have to be thoroughly understood if the priorities for research and extension are going to be correctly identified. Equally important is the need for the research and extension systems to come to the same conclusions as to the needs and potential. If not, research will be implementing work that extension has no interest in utilizing while extension will want to carry out activities for which research can provide no back up. In order to ensure that research and extension comes to the same conclusions, this investigatory work needs to be implemented jointly.

Chapter 7: EXTERNALITIES OF PESTICIDE USE

Pesticides role is well accepted for generating a benefit in the form of crop damage avoided. The crop protection strategy in Pakistan is almost entirely based on pesticide use whereas, development of IPM based technologies is in its initial phases of scrutiny as well as implementation. This technology is still inconclusive, almost all over the world, because of its information intensive characteristics, higher initial costs of experimentation, precision of data required on complex and highly variable biological agents and demanding nature of collaboration among farms of a particular region.

Beside rapid increase in pesticide use especially in the dominant sub-sector of Pakistan's cotton, no detailed studies have been undertaken to evaluate the productivity of pesticides or their effects on the natural biological resource base. Unplanned use of chemicals resulted in environmental pollution and un-economical returns on the costly investments. The pressure to maximize outputs is enormous on low income and resource poor small farms. They have, therefore, little regard for degradation of natural resources, health risks and future productivity. Although pesticide have cost but the farmers are mainly concerned about the private cost of pesticide they pay to achieve desirable outputs and are least concerned about the undesirable outputs produced during production processes.

There is a strong need to familiarise farmers as well as policy makers about how much costs of pesticides are paid at market level and how much indirect costs are not even accounted for the undesirable outputs. The society usually pays the price of these forced outputs as the market price ignores the environmental and health impacts. The external costs are not paid for the impairment of health among pesticide users, reduction in biological diversity, ground water contamination, residues in food items, and so on. These costs are required to be internalised by making all stakeholders to take them into consideration. This section of the study highlights: first, the social costs of pesticide use which are born by others and not by the manufacturers or applicators; secondly, to suggest appropriate guidelines for regulating the safe use of pesticides.

The results synthesised in this chapter include occupational poisoning, food residues, drinking water contamination, pest resistance, loss of bio-diversity, cost of prevention & abatement measures and the cost of awareness campaign. The results are based on the lab analyses of blood and food constituents and the secondary data collected from research and extension system, the cross-section information gathered at field level from pesticide dealers, manufacturers, labourers and market intermediaries.

7.1. Health: Incidence and Expected Value of Damages

7.1.1. Occupational Poisoning

The safety measures used by different occupational groups involved in pesticide packing, distribution and applications are less appropriate. The receptivity towards the flow of information about the pesticide risks to health is particularly very low at almost all levels. Data compiled in this study would provide basis to understand the severity of pesticide poisoning at different occupational levels. This can serve as a starting point on which future rigorous studies may improve upon. The wide range of estimates used to estimate the external costs has much scope for improvêment provided data on important aspects are regularly monitored and documented.

7.1.1.1 Beliefs and Behavior of Pesticide Applicators

Studies on health damages question about the consideration of occupational poisoning as a true externality. Pearce and Tinch (1998) argued that if the farmer is more informed about the effects of pesticide, the less likely that any health damage is external. Beliefs and behavior of the farmers were assessed in this study through inquiring them on numbers of statements about their consciousness towards pesticide associated health hazards. It was considered that personal beliefs of farmers shape up their attitude, which further plays an important role to perform a particular behaviour. The response of 27 sample farmers regarding five belief statements covering different aspects of health risk of pesticide on cotton growers was analysed (Table 18).

Table 18. Beliefs of Sample Farmers Towards Pesticide Associated Risks

Statements	N	Mean	SD
Touch to pesticide is dangerous for health	27	1.5	2.0
Inhaling pesticide is dangerous for health	27	1.6	2.1
Due to increased use of pesticide health problems are increased	27	1.3	2.1
Give priority to better crop production than health	27	0.8	2.2
Using pesticide causes health risk to spray operator	27	1.3	1.9

Farmer responses were taken on 6-point scale, which include 3 points towards bad and 3 points towards good direction form the neutral 0 point. The result spells the contrasting attitude of farmers towards health related aspects of pesticide use. They were quite good in their understanding about the health hazard of pesticide use in terms of touching and inhaling during spray. In clear contrast they also give more preference to crop production than health. The level of agreement towards this health hazard dimension was also quite high as compared to other health cognise dimensions. This attitudinal dimension would help to understand the farmer's negligence in observing precautions during spraying.

The results about the precautionary measures used by farmers during spraying are presented in Table 19. Compatibility among farmers' belief and their behaviour in taking mandatory precautionary measures during cotton spraying was analysed. Only half of the farmers claimed that they use precautionary measure during pesticide spray. The measures used most frequently include avoid eating/drinking during spray, covering body and washing hand/face after finishing spray. More than one quarter of the farmers has not shown much consciousness in observing even these basic precautions. Use of eyeglasses, gloves, boots and masks was either non-observed or to a very limited extent.

Table 19. Percent farmers using precautionary measures during pesticide spray

Precautionary Measures	Districts of Cotton Zone				All	
	Lodhran		Multan			
	Yes	No	Yes	No	Yes	No
Observe precautionary measure while spraying pesticides	41	59	70	30	52	48
While spraying pesticides use gloves	-	100	-	100	100	-
While spraying use mask to cover nose & mouth	12	88	30	70	19	81
While spraying pesticide use eye glasses	12	88	20	80	15	85
While spraying pesticide cover head	41	59	40	60	41	59
While spraying pesticide use boots	12	88	20	80	15	85
While spray pesticides cover body	76	24	100	-	85	15
Avoid smoking while spraying pesticides	59	41	20	80	44	56
Avoid eating while spraying pesticide	71	29	50	50	63	37
Avoid drinking while spraying pesticide	57	43	100	-	67	33
Spray in wind direction	50	50	70	30	58	42
Wash hand and mouth after applying spray	94	6	90	10	93	7

The results also show wide disparity in the use of these precautions between two districts. Relative difference in the flow of information about precautions, taken during spraying, could be the possible reasons behind this difference. The shallow understanding about the hazardous effects of inhaling pesticide and non-compatibility of the precautions recommended under harsh climatic environment were the major causes behind non-observance of standard precautionary measures. Farmers mainly perceive that use of butter and lemon pickle in the diet, which is taken before spray, could help to avoid harmful affects of pesticides during spraying, even while observing less prescribed precautions.

Farmers were also asked if they have got any formal training about pesticide handling and spraying. Results shows that only small proportion (10%) of farmers has got such training in Lodharn district, whereas more farmers (30%) got these training in Multan district. (Table 20). The higher proportion of farmers who got training about spraying in Multan district explain the difference behind practicing better precautionary measures.

Table 20. Percent farmers got training in pesticide handling and spraying

Got training	Lodhran	Multan	All
Yes	12	30	19
No	88	70	81

Farmers' behavior about pesticide storage practices and disposal of empty containers were explored in the sample survey. Figure 7.1 shows that about one fourth of the sample farmers were storing pesticide either in the living rooms of human being or animals. However, majority of the farmers has constructed separate store for keeping pesticide at safe places.

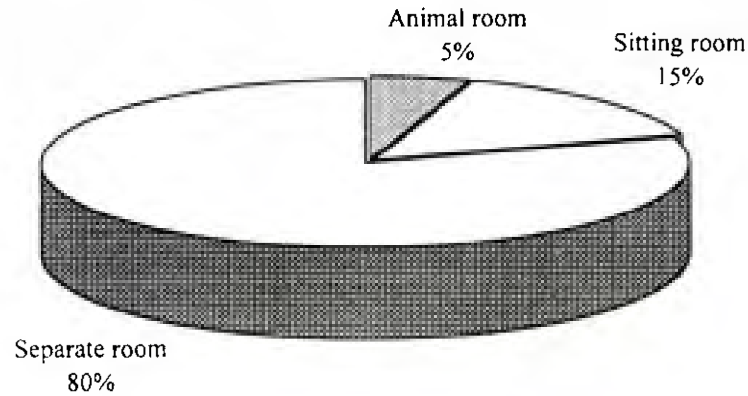


Figure 7.1 Pesticide storage places at farmers in the cotton zone

Farmers overwhelmingly throw away or sell pesticide containers. These could be easily found lying near farms or in the fields. About 10 to 40% farmers disposed them off properly either through burning or burying. Majority of the farmers who dumped empty containers properly belonged to Multan area. There are farmers who were re-using empty containers at home (Figure 7.2).

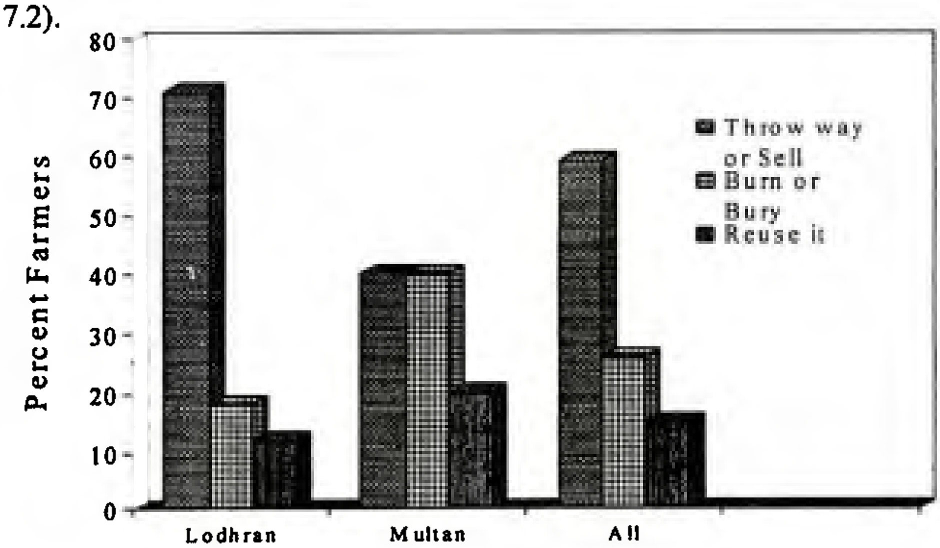


Figure 7.2 Methods of disposal used for empty containers of pesticide in the cotton zone

7.1.1.2 Sickness Incidence of Pesticide Applicators

As analysed above, farmer's behaviour is not in conformity with their beliefs, which they promulgate while involved in pesticide handling and spraying. Their limited response in terms of protective measures undertaken precisely reveals this notion which shows their restricted understanding of the pathways by which pesticide contamination can occur.

The evidence from hospitals and survey results shows the happening of quite a large number of acute poisoning cases in the cotton zone (Table 19). The result shows that about every second household has reported pesticide-related sickness. On large farms, where more persons involved in spraying, more than 1 person got sick.

Table 21. Farm level incidence of pesticide poisoning in the cotton zone

Poisoning of Pesticide Applicators	Incidence level
Percent households experience any sickness during last spraying season	63%
Number of persons per household got sick (Range)	1-4 (1) persons
Main symptoms of sickness	Vomiting, Dizziness, breathing difficulty
Average duration of sickness (days)	2-60 (10) days
Work days lost due to sickness during last crop season (no)	2-90 (13) days
Treatment source	Village Doctors /hospitals
Health treatment cost due to pesticide sickness (Rs/year)	Rs. 100-3000 (1062)
Persons hospitalize (no/households)*	1 per 100 households
Persons died with poisoning*	1 per 8000 households
Health recovery status and work efficiency after sickness	48% partly
Suicidal deaths	1 per 400 households

Note: Figures in parentheses are averages
* Estimates based on data collected from local hospitals

Vomiting (25%), dizziness/breathing (12%) and mix of many symptoms (63%) difficulties were the major symptoms of sickness (Figure 7.3). It takes about 10 days to recover from the sickness. Work loss of 13 days is estimated as few more days consumed in recovering fully to involve in farming activities. For minor ailments doctors at village level or nearby road/town were consulted and case of acute poisoning local doctor refers cases to the city hospitals (Figure 7.4). At least 2 persons per village or from 200 households hospitalised, due to the nature of acute poisoning. A fraction of .025 persons per village of 200 households or 1 person per 8000 households could not recovered from ailment and died as a result of acute poisoning.

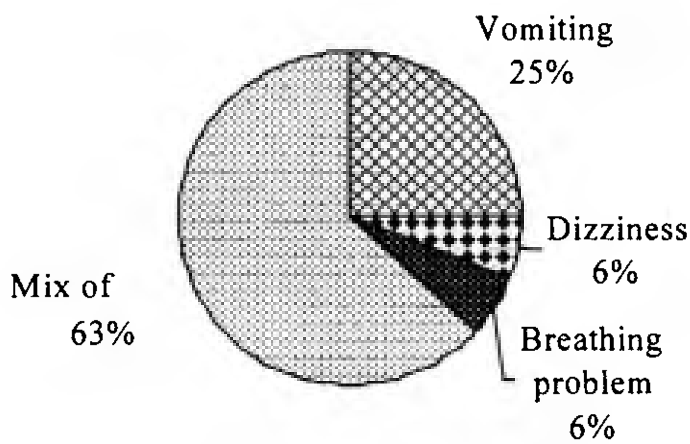


Figure 7.3 Major symptoms of poisoning to Pesticide

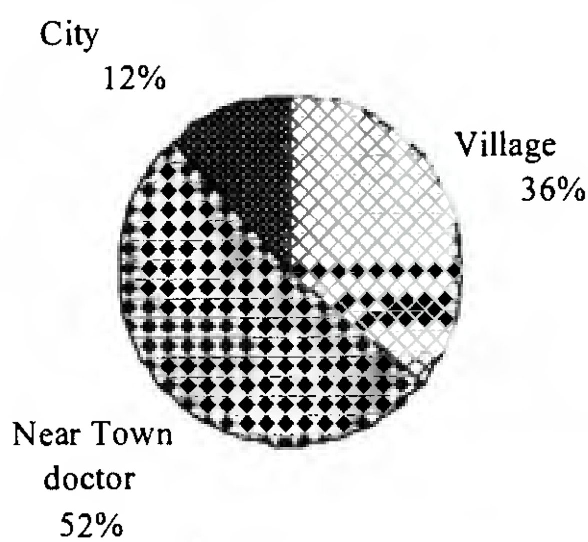


Figure 7.4 Source of treatment for pesticide associated

The recovery from pesticide sickness is not always hundred percent. About 48 percent respondents told that the sick person was partly recovered (Table 21). Figure 7.5 shows that partly recovered persons become less active (41%), more susceptible to poisoning and tend to avoid working with pesticides (6%). The temporary or permanent loss of the farm labor force is an externality to the chemicals used to avert yield losses.

Pesticides are now being used in suicidal deaths at an alarming rate. About 8-10 suicidal deaths with in a radius of 20 villages reported by the doctors working in local clinics or small hospitals. Farmers of 6 villages also reported 11 such deaths in last five years. Both sources confirm almost similar rate (1 person per two villages or 400 households) of suicidal deaths. Beside, under reporting of suicidal deaths, the rise in such cases is amicably acknowledged in popular articles published in daily newspapers. Easy access to the pesticide as a lethal poison make it convenient to commit suicide and need to be corrected through introducing appropriate users legislation.

Many of the poisoning cases, arise either through inappropriate use of the chemicals or through failure to observe basic safety requirements. The farmers perceptions that the new stream of pesticides are not as effective as the old one also contribute towards non-observance of proper safety measures. They confuse pest resistance to the inefficacy of the chemicals and presume that if these are not killing insects, how could they harm to the applicators. The results from clinical tests, about pesticide hazards to human health, need to be effectively communicated through all-important mediums. The pathways that induce poisoning required to be hinted vigorously in these information-sharing campaigns.

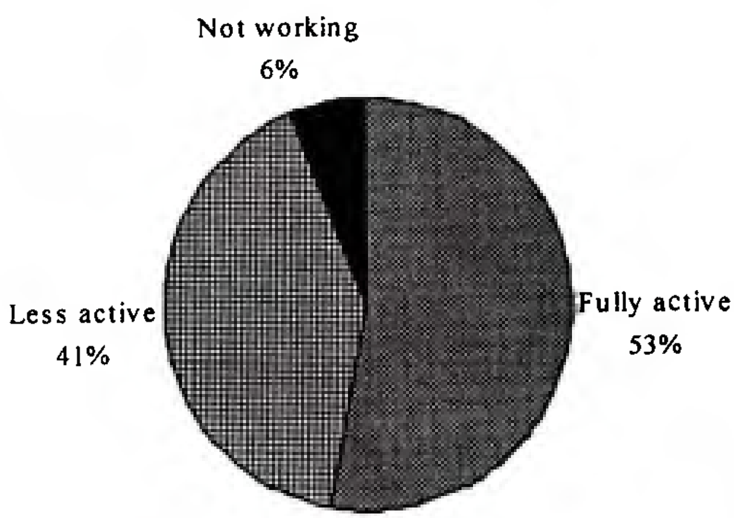


Figure 7.5 Affect of sickness on work efficiency

7.1.1.3 Externality of Pesticide-Associated Poisoning to Applicators

Higher incidence of pesticide associated poisoning to pesticide applicators resulted into enormous work losses, treatment costs and fatalities (Table 22). The results inferred from sample survey, clinics, and resource persons data were extrapolated for 9 major cotton growing districts of the cotton zone. About 1.08 million persons subjected to pesticide associated sickness; among these 24000 affected acutely and were hospitalised; about 271 fatalities happened per season, and 0.24 million days were lost due to minor and acute illnesses. In case of accidental deaths a loss of 2.96 million days is estimated by assuming 30 years of loss per fatality.

Substantial losses of Rs. 24 million in terms of treatment, 18 million for work loss during ailments and 224 million for accidental deaths is estimated. It is difficult to assign value to a loss of human life, which varies in different societies according to their own value systems. For instance loss of human life in USA is valued as 2 million dollars per person. A conservative estimate for losses to human lives in this study were made in terms of working days loss, which is valued with average wages, paid to unskilled farm labour. Total health externality of pesticide applicators was estimated as Rs. 267 million, leaving aside the partial recovery and long-term consequences to the effected individuals.

Table 22. Externalities of pesticide associated poisoning to pesticide applicators

Externality Elements[a]	
Persons reported sick per season (millions)	1.08
Persons hospitalize during last cotton production season (millions)	0.02
Treatment cost (Rs. million)	24.00
Work loss of poisoned persons (man days in millions)	0.24
Cost of work loss[b] (Rs. million)	18.3
Accidental deaths by poisoning (no)	271.00
Potential work loss for accidental deaths (million days)	2.96
Cost f accidental deaths[c] (Rs. millions)	224.40
Suicidal deaths per years (no)	1084.00
Total Externality(Rs. million)	266.7

a Estimated for 2.17 million HH of 9 major cotton growing districts
b Estimated for monthly wages (Rs. 2300) paid to permanent hired labor
c Estimated for Rs. 2300 monthly wages for a loss of 30 years of productive life per fatality

7.1.1.4 Health Hazards for Women Cotton Pickers

Chronic pesticide poisoning can be measured either by ChE levels in the blood or the pesticide residues in blood, fatty tissues and maternal milk. The pesticides have three routes of entry in the human i.e., skin, lungs and the gut by absorption, inhalation or ingestion respectively. Adverse health effects of pesticides relate to chronic or acute poisoning in humans. Chronic poisoning arises from continual long-term low level exposure. Chronic effects can cause cancer, adverse reproductive outcomes, immune functions peripheral, neuropathies, neurobehavioral disorders and allergic sensitization reactions, particularly of skin (Repetto and Baliga, 1996). The organophosphorous compounds seem likely to continue to be the most important type of insecticides used in the developing countries and demand for them will probably be more than double over the next 10 years. OP inhibits AChE, the enzyme responsible for the break down of the neurotransmitter AChE. The WHO recognizes the ChE bio-monitoring as a preventive measure against organophosphate exposure and there is a good co-relation between exposure and ChE reduction. (Khan *et al.*, 1996 and Carlock *et al.*, 1999). OP poisoning form more than one third of the total poisoning cases. There is no regular program for monitoring the health of the workers involved in handling the pesticides (Inayatullah and Haseeb, 1996).

Cotton picking is a labor intensive job and overwhelmingly performed by the women folk, who either belong to the farm families or to the land less households of the same or nearby villages. Labor is also transported from long distances where it is in short supply. Female laborers from all age groups were involved in cotton picking, starting from the ages of 6 to 8 years. A high percentage of cotton pickers belong to the rural land less households, which are generally the poorest strata of the population. Mostly they are illiterate and heavily dependent on wage earnings from cotton-picking activity. On an average they spend 8 hours per day and pick 50 to 100 kg of cotton. The total quantity picked per season per worker ranges between 1500 to 2000 kilograms for less than Rs. 3000 of total wage earnings per season, as wages paid to them are quite low (Shafiq *et al.*, 1993).

Beside low wages, long working hours and hard job, the women pickers are also exposed to toxic chemicals sprayed heavily on the cotton crop. Cotton picking season starts in the middle of October and extends up to end December. With the influx of cotton pests, like white fly and American bollworm, farmers tend to use pesticide even during cotton-picking period, which causes further miseries to the cotton pickers. The low level of awareness among male or farm workers plays a significant role in human poisoning. The information provided to them is either ignored or ill conceived. Jabbar and Mohsin (1992) reported that 68% females pickers were not aware of the side effects of pesticide poisoning and 95% were not taking any precautionary measures, while 86% of the males had full awareness and 82% were taking precautionary measures.

Masud and Baig (1991) reported in a study conducted in Multan area that out of a total of 88 female cotton pickers only one was out of danger and 74% had blood ChE inhibition between 12.5-50%. 25% were in dangerous condition with ChE inhibition between 50-87.5%. Masud and Parveen (1998) reported results from pesticide residues monitoring studies conducted during 1990's. It was indicated that blood samples of cotton pickers in Multan District in 1992 showed 22 samples out of 25 (88%) contained pesticide residues. The different pesticides were cypermethrin, methamedophos, profenofos, endosulfan, cyhalothrin, dimethoate, monocrotophos, gamma-BHC, deltamithrin, DDT, DDD and DDE, chlorpyrifos, fenpropathrin and alpha-methrin. Similar studies in 1993 showed that out of 50 samples, 41 (82%) were found to contain traces of pesticide residues. In 11 of 15 (73%) samples of human milk, residues of pesticides were found in 1992. In 1993, 18 samples out of 25 (72%) came out positive.

a) Women Cotton Picker Study, 2000

A detailed study was conducted in Multan and Bahawalpur Divisions, of major cotton growing belt, to assess the level of poisoning among cotton pickers (Tahir, 2001). The blood samples (5 cc each) of about eighty women were collected, from 40 pickers and the same number of non-pickers, at two points of times– prior to the start of sprays and during cotton picking season. The sample women belonged to the 8 villages of Lodharan district and 4 villages from Bahawalpur district. Blood samples were collected in pre-season i.e. before the spray from 26th June to 5th July and post-season i.e. after the exposure to female cotton picker from 10th Oct. to 21st Oct. 2000. The additional information, from women cotton pickers, was collected through a structured questionnaire. Women responses were collected specifically on precaution observed during cotton picking, pesticide handling, incidence of poisoning, work loss, involvement in farming, picking hours/duration and wages paid.

Quantitative blood cholinesterase activity was determined by the calorimetric method induplicate (Knedel and Bottger, 1967) with the help of diagnostic kit supplied by Diagnostic Merck KG aA. The analysis was done on Perkin Elmer lamda 3 Double Beam UV-visible, Model R100A Spectrophotometer at wavelength 405 nm.

b) Results from Blood Sample Analysis

The ChE level was found to be in normal range (80-100%) in non-picker and picker groups during pre-season when analysed qualitatively. In the blood samples before exposure to pesticide, the average activity of ChE in non-pickers was non-significantly different (5.35 kU/l) with the average activity of female cotton pickers (5.26 kU/l) as given in Table 21. These values are in the normal range (2.0-6.7 kU/l) but are closer to the maximum of the range. Percent activity of ChE in cotton pickers before exposure to pesticide varied from 45-100%. The 71% female pickers were in normal range (88-100%) followed by 15% in mild (76-87%), 7% in moderate (65-75%), 5% in considerable (51-61%) and 2% in hazardous (00-50%) as shown in Table 23. Acute clinical poisoning is likely to appear when the ChE activity inhibited to 50% or more and hazard level at 30% inhibition (WHO, 1982). In this study 50% inhibition of ChE in blood were found in 1 female cotton pickers followed by 30% inhibition in 4 females. This indicates that about 2% female pickers are in the range of acute poisoning before the exposure to pesticide.

Table 23. Average Cholinesterase enzyme activities (kU/l) in female pickers during pre spray and post spray season during 2000 in Punjab, Pakistan

Surveys	Female groups	
	Non-pickers	Pickers
Pre-season	5.36 (4.17-6.82)	5.26 (2.39-7.57)
Post-season	4.80 (2.23-6.65)	2.81 (0.90-5.57)

Normal range kU/l 2.0-6.7 for women.

Due to environmental contamination the average activity (4.80 kU/l) of ChE in non-picker blood, collected after exposure to pesticides (post-season) were found to be significantly different with the average activity (2.81 kU/l) of female cotton pickers (Table23). These values also lie within the normal range. However, the percentage activities of ChE in cotton pickers after exposure varied from 18-100% individually. ChE activity in blood samples of 10% female pickers was in normal range (88-100%) followed by 16% in mild (76-87%), 13% in moderate (65-75%), 19% in considerable (51-61%) and 42% in hazardous (00-50%) (Table 23). Inhibition of ChE in blood was found 50% in 42% individuals followed by 30% inhibition in 19% females. The common symptoms like headache, vomiting, nausea, dizziness, blisters, skin peeling, itching, sneezing, muscular pain, stomach cramps and fever were observed in majority of cotton pickers.

Thirty five pickers during post season survey, complained a variety of symptoms like headache, nausea, vomiting, skin irritation general weakness, fever, dizziness, stomach pain and blisters. Some (46%) women had cuts on hands and their skin was broken. Other (11%) females with low ChE activity (0-50%) had reported headache, vomiting nausea, itching, fever, stomach cramps and muscular pain. Four of them refused to give blood due to high fever. Another 6 pickers who had 51-64% ChE, complained headache nausea, vomiting, dizziness and muscular pain. Eight of them had mild ChE level i.e. 76-87% activity complained only headache, vomiting and nausea.

Table 24. Female's pickers (%) group on the basis of hazards during pre-spray and post-spray season during 2000

Surveys	Percent Activity of ChE				
	Normal (88-100)	Mild (76-87)	Moderate (65-75)	Considerable (51-64)	Hazards (00-50)
Pre-season	71	15	7	5	2
Post-season	10	16	13	1	42

Female cotton pickers categorized into three groups on the basis of their %ChE activity i.e. 70-100 Normal, 50-70 hazardous and 0-50 severe. It was observed that after spray the percent activity of ChE was decreased and 42% females were in acute range, 19% in hazards and 39% in normal range (Figure 7.6). Females (100%) suffered from headache, vomiting and nausea were in hazards level, while 67% were in severe level who suffered from vomiting and 15 % females had problem like stomach cramps were in hazard level. Pickers (54%) had skin problem like skin peeling, itching and 38% had blisters and skin burning was in hazardous level. On the other hand, 33% complained itching and burning of skin and 17% had blisters and skin peeling problem were in severe level.

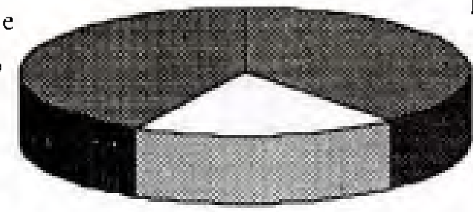


Figure 7.6 Status of women cotton pickers suffering determined by acetycholinesterase (AChE) Analyses

c) Survey results about precautions observed and incidence of sickness

Most of the pickers use no caution (such as gloves, shoes and face covering) during picking (Table 25). Women pick cotton even when they become pregnant or breast-feeding–as for all these poor women cotton pickers, this serve as a primary source of earning. The pickers work morning till evening in hot and humid climate. They ate (90%) and drank (100%) in the fields along with their children. Only few women reported that they wash hands and face just after finishing the job of cotton picking. No precaution is followed to wash clothes separately, which they wear during picking.

Table 25. Precautions observed by women cotton pickers by acetycholinesterase (AChE) levels

Precautions during cotton picking		Percent
Wear gloves	No	100
Cover face	No	100
Wear shoes	Yes	100
Eat during break time	Yes	90
	No	10
Drink water	Yes	100
Wash hand/face after picking cotton	Yes	87
	No	13
Wash hand when get back home	Yes	100
Wash clothes used during cotton picking with other clothes	Yes	100
Pick cotton during pregnancy	Yes	100
Practice breast feeding while picking	Yes	100
Children stay with while picking	Yes	100

During picking cotton crop was still contaminated with pesticide residues and female pickers were found to eat and drink in the field without washing their hands. The residues of pesticides or some of it may find their way into the hands of cotton pickers, who are unfamiliar with the potential risks and necessary safety measures. Mostly (87%) experienced sickness during this season (Table 26). They complained of nausea (100%), vomiting (90%), headache (100%), skin irritation (42%), blisters (23%) and gastroenteritis problems (10%) during picking, muscular pain (45%) and dizziness (29%). Pickers reported 9 days of sickness per season with the loss of 5 days when they could not work. The work loss in monetary terms estimated about Rs. 400 per worker per season, which is a serious blow to their already meager earning levels.

Table 26. Incidence of Sickness among women cotton pickers by Acetycholinesterase (AchE) levels

Poisoning of cotton pickers	**Results**
Experienced sickness (%)	
Yes	87
No	13
Average duration of sickness (days)	9
Workdays loss (no)	5
Treatment cost per season (Rs)	47
Deaths from poisoning reported at village during last 5 years (%)	
Nil	74
One	3
Two	16
Three	6
Suicidal deaths at village during last 5 years (%)	
Nil	61
Two	29
Three	10

Pickers use home remedies (such as sugarcane, candy, lemon juice, honey, pickle, herbal tea) for minor intoxication. The local doctor is called in case the symptoms of illness either persist or converted into nervousness or unconsciousness. Only 3% women pickers brought to district hospitals due to the serious nature of poisoning. The suffering women visit doctors 2-3 times that cost them on an average Rs. 47. The effects of pesticide use on human health further highlighted with the information collected from cotton pickers about accidental and suicidal death incidence (Table 24). Nearly one fourth of the women reported 1-3 deaths from pesticide poisoning. However, quite a large proportion of the cotton pickers reported 2-3 suicidal death incidences.

d) Health Externalities of Women Cotton Pickers

About 2.6 million women pick cotton from the 9 major cotton-growing districts of the study area. Health hazards to women cotton pickers show that about 2.2 million women got sick from their exposure to pesticide used on cotton crop (Table 27). Although, money spent by this low-income strata on health treatment is not very substantial (Rs. 47/season/women), but still colossal economic losses of Rs. 105 million is estimated in this account. Five days work loss of 2.23 million-picker accumulated into 11 million days of work loss, which is translated as Rs. 660 million externality to this lowest income strata of the economy. In this way an externality of Rs. 765 million rupees is estimated for women involved to pick cotton from heavily pesticide applied cotton fields.

Table 27. Externality of poisoning to Women Cotton Pickers in the cotton zone

Health externality components[a]	Externality
Women reported sick during one picking season (million)	2.23
Treatment cost (Rs. million)	105
Work loss (million days)	11
Work loss (Rs. Million)	660
Total Externality (Rs. millions)	765

a estimated for 5127 thousands tons of cotton picked by 2.6 million women in 9 cotton growing districts of cotton zone

7.1.2 Industrial Workers Contact with Pesticide

The complexion in the pesticide filling has changed with the advent of generics in the pesticide market. Individual entrepreneurs rather than big companies like multinationals were installing pesticide-packing plants in large number. The availability of low cost locally manufactured plants contributed towards this changed impetus. The safety element is a big question mark for these newly installed 25 plants, only in Multan. The big plants run by multinational were found operating under much better and safe conditions. The owners of the two new filling plants and the labor working on such plants were interviewed to explore facts behind industrial workers contact with pesticides. A wide gap was found in the claims, about the precautionary measures taken and the working conditions of the owners and the laborers working on these plants.

Owners express great satisfaction with the safety measures taken in the form of observing long breaks after short intervals, good hygiene/bath/wash facilities, provision of gloves and masks, provision of pedestal fans to save labor from emissions, medical care and treatment facilities to the workers. The owners further said that the workers do not eagerly use the masks and gloves provided during filling process. However, workers took an exception to the owners claims and indicated that on majority of the plants work load is very high, wages are low, gloves and masks are provided in limited numbers, wages are not paid during sickness and companies mainly hire the services of dispensers instead of qualified doctors. Proper clothing is also not provided to the labor, except aprons for few workers who mainly work at the most vulnerable points.

A difference was found in the length of intervals (30 to 90 minutes) and total working hours per day (6 to 8) told by the workers and owners of the filling plants. The owners expressed that if a worker is exposed to pesticide, he is being asked to take rest or break for few days, but it is the labor who insists on working instead of going on leave. The workers were of the view that since they are not compensated for sickness period, therefore they couldn't afford to loose their earnings. This happened mainly because the labor is engaged through contractors on daily wages, rather than their deployment on seasonal basis.

Both automatic and manual plants are used for filling. The government is looking forward for the complete substitution of manual plants for the automatic ones. Although workers are convinced about fewer omissions from the automatic plants but they informed that only few automatic plants are functioning and filling is mainly accomplished manually. Also one fourth of the powdered pesticides are filled manually, as they could not be filled on automatic plants. Workers and the plant owners' views were found similar about the role that properly ventilated buildings can play in lessening the workers exposure to pesticide.

The working conditions are mainly unsuitable at most of the plants, except two big old plants in Multan City, which cause poisoning among laborers. Nearby areas of these plants also affected with the omissions from filling plants. The plant owners accepted 1-2 acute poisoning cases during last season along with some minor ailments to other workers. Nearly one thousand laborers usually work on 25 plants with an average volume of 300,000 liters to 900, 000 liters fillings per plant per season. About 50% labor fell sick up to a minor extent and 2-3% experienced acute sickens and referred to hospitals during a season (Table 28). Medical treatment cost is quite high, ranging between 10-20 thousands for acutely poisoned patients. Treatment cost for other minor poisoning cases is in hundreds, which the dispensers charged from companies under contractual arrangements. The minor ailments of the workers cost Rs 4-8 thousands to the owners of plants per season. On an average 6 days working loss is estimated for the 15% of the labor force, which got sick more severely. Dispensers practicing at village level mainly prescribe the rest to the sick laborers.

Table 28. Incidence of pesticide poisoning to industrial workers contact with pesticides

Industrial workers health hazards[a]	Externality
Labor experienced sickness	50%
Acute poisoning cases	3%
Workdays loss (15%)	6 days
Treatment cost for minor poisoning/person	Rs. 200
Treatment cost for acute poisoning/person	Rs. 15000

a Estimated for 1000 laborers working at 25 plants in Multan city

There is a need to strictly implement the legislation regarding control on the emissions from plants and imposition of complete ban on manual filling practices. The regulation need to be passed to construct proper ventilated buildings with approved designs. The severity of poisoning to this most exposed class of workers, required to be regularly monitored through establishing blood-testing labs.

7.1.2.1 Externalities of Industrial Workers Poisoning

Out of 1000 labor force working at 25 pesticide plants, 500 were reported sick by inhaling pesticide emissions (Table 29). The treatment cost for ailments accounted as 0.1 million for minor ailments and 0.45 million for acute poisoning cases. The work loss of worth 0.09 million was bom by the poor laborers, exposed to higher toxicity on one hand and on another hand not compensated during sickness period. The total extemalities of 0.64 million needs to be checked/intemalized through implementing/devising appropriate regulations to promote safe working environment at filling plants.

Table 29. Externalities of industrial workers contact with pesticides

External Costs of Industrial Workers Poisoning[a]	Externality
Labor reported sick (no)	500
Treatment cost for minor ailment (Rs. Millions)	0.1
Treatment cost for acute ailment (Rs. millions)	0.45
Work loss (days)	450
Work loss (Rs. million)	0.09
Total Externality (Rs. millions)	0.64

a Estimated for 1000 laborers working at 25 plants in Multan city

7.1.2.2 Contact with Pesticide at Distribution, Storage and Disposal

The lion share of pesticides is now packed and distributed by the large number of small distributors. No uniform standards are followed in using quality-packing materials, which results into the emission of noxious fumes from packing. Sub-standard material is being used to save cost of packing, which is estimated to an extent of 10-15%. Nearly 3 rupees are saved for using low quality bottles of 1 liter and Rs. 6 for a low quality cartoon used for the packing of 10 bottles. Profiting behaviour of pesticide firms, at the expense of human health, could be well understood if these saving might be stretched to large business volumes of many entrepreneurs. However, large multinationals as well as some quality conscious generic companies still use quality material. The distributors at retail level informed that nearly 40 out of 175 (22%) companies surrounding Multan area, use quality-packing material.

Spillage of chemicals is happening as a result of breakage during transportation and storage. The chances of spillage increase many folds if pesticides are stored or transported in many piles or in big heaps, as low quality material could not sustain the heavy loads. The damaged bottles are not handled appropriately, as it take many days to return these to the distribution points. Several acute poisoning accidents have been reported in Pakistan during loading and unloading of pesticides with improper clothing. In one such case 7 workers died in Multan during 1972.

The pesticide retail shops are the best places to sensitise severity of pesticide emissions, due to breakage or the use of sub-standard material. Shops full with all sorts of pesticide, without separate storage arrangement, are not a rare phenomenon. The salesmen, attendants and even farmers sit, work, eat/drink under highly contaminated environment almost year-round. The maximum precaution if observed, by the minority retailers, is the installation of exhaust fans. At many places pesticide shops are located near grocery stores or fruits and vegetable markets, and serves as a source of contamination of foodstuffs.

Although, no acute poisoning case was reported at retail level, except minor ailments, yet the workers long exposure to toxic chemicals need to be investigated. Poisoning at this level need to be further detected through analysing the blood samples of workforce involved. Pesticide required being stored separately and displayed symbolically–without chemicals at sale points.

7.1.3 Pesticide Residues in Food Chain

7.1.3.1 Fruits and Vegetables

The studies to detect pesticide residues in fruits and vegetables were started since early 80's. The results from these studies are summarised in Table 30. The initial studies were conducted by National Institute of Health (NIH) during 1981-84, in which 159 samples of fruits and vegetables were analysed and it was found that nearly 30% samples were contaminated, of which only 3% were above Maximum Residues Limit (MRL) level. Masud and Hasan (1992) analysed 59 samples of different fruits and vegetables from Karachi wholesale market and stated that out of 250 samples screened, 93 (37.2%) were contaminated with a variety of pesticides in which 45 (18%) were exceeding maximum residue limits. Similarly, during 190-91, 254 samples of fruits and vegetables of five districts of NWFP were analysed and 102 (40%) samples were found contaminated in which 33 (13%) samples were found exceeding MRLs (TARI, 1993). Out of 50 samples being analysed from Quetta and Pashin districts of Balochistan, about 19 (38%) were found contaminated in which 1 (1%) were exceeding FAO/WHO MRL values (Masud and Hasan, 1995). Overall 1059 samples of fruits and vegetables analyzed during last two decades, of which 422 (40%) have been found contaminated with pesticides residues and 71 (1%) samples were exceeding maximum permissible limits being set by FAO/WHO Codex Alimentarus Commission.

Table 30. Summary of studies on pesticide residues in fruits and vegetables in Pakistan

Location	Year	Samples			Reference
		Total	% Contaminated	Exceeding MRLs	
Karachi	1982-83	141	09 (6%)	02 (22%)	Masud, *et al.* 1983
Islamabad	1981-84	48	48 (100%)	BHC, dieldrin	NIH. 1984
Karachi	1988-90	250	93 (37%)	45 (48%)	Masud, 1992
NWFP	1990-91	154	54 (35%)	22 (41%)	TARI 1993, Masud 1995
Islamabad	-do-	96	48 (50%)	11 (23%)	Masud, & Hasan. 1995
Gadoon		5	Nil	Nil	Masud, 1991
Quetta	1992	50	19 (39%)	01 (5%)	Masud, & Hasan. 1995
Islamabad	1996	13	5 (38%)		Tahir, (2001)
Faisalabad	1982-97	298	108 (36%)		Thesis, UAF, table 4
Total		1059	422 (40%)	71 (17%)	

These reviews show that most of the studies were conducted in Karachi, Islamabad and NWFP markets. The Multan area was ignored where the major chunk of the pesticide is used not only on cotton crop but also on fruits and vegetables. The present study was therefore mainly confined to conduct pesticide residue analyses for vegetables produced in the Multan division and some fruits from Balochistan province were also included for such analyses. Perkin Elmer Autosystem Gas Chromatograph equipped with Electron Capture Detector (ECD-Ni^{63}) and Capillary Column (25 M. methyl silicone, 0.53 mm, I.D. 2 .ou film thickness) was used to analyze the vegetable and fruit samples collected for this study. The MRL values determined by joint FAO/WHO Codex Alimentarius Commission were used as reference values in this study (Appendix 7.1).

7.1.3.2 Results from Residues Analyses of Vegetables and Fruits, 2000

The samples of four vegetables viz. okra (*Hibiscus esculentus*), brinjal (*Solanum melongena*), gourd (*Citrullus vulgaris*) and bitter gourd (*Momordica charantia*) were taken (1 Kg each) from different locations (four direction) around Multan city in duplicate. Six samples of apple (*Malus pumila*) varieties either Gold delicious or Mashhadi were collected from the out skirts of Quetta City.

A total of 48 vegetable samples, comprising 12 for each vegetable, were analyzed for the residues of 14 commonly used pesticides. All the vegetable samples were found contaminated, out of which 63% samples found exceeding MRLs. Relatively more sample of vegetables under gourd category were found with exceeding MRLs (Figure 7.7). The pesticides exceeding their MRLs values were carbofuran, dichlorvos, methyl-parathion, fenitrothion and azinphos-methyl. While the pyrethroids deltamethrin and cypermethrin were not detected in any samples.

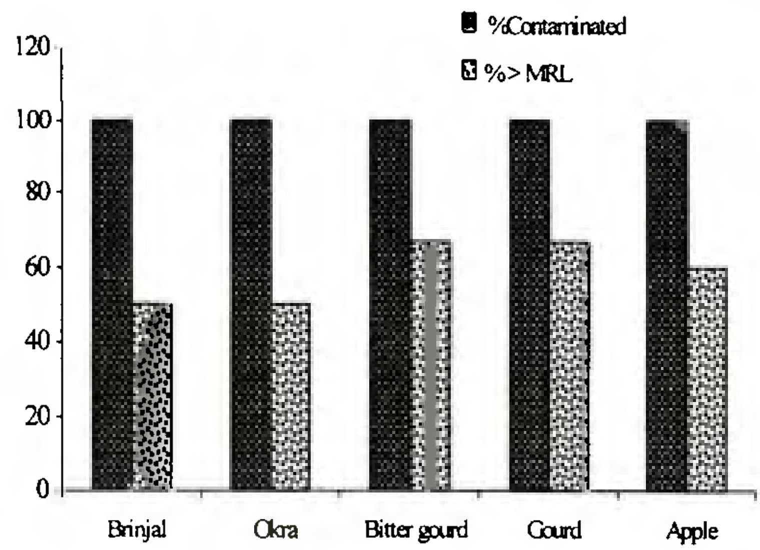


Figure 7.7 Status of pesticide residues in vegetables and fruits during 2000

The apple samples were analyzed for the residues of six pesticides namely methamidophos, diamethoate, carbofuran, methyl-parathion, malathion and azinphos-methyl. All 5 samples were found contaminated with the residues of 4-5 chemicals. About three (60%) samples were found with excess MRL values of Carbofuran. The residues of Methamidophos were also found in almost all samples but its MRL values were not available for comparison.

7.1.3.3 Externality of Pesticide use on Vegetable and Fruit Crops

This study was conducted especially in the cotton growing area of Multan region to estimate the cost of indiscriminant use of pesticide on vegetable crops. The vegetable samples were collected from village level markets while ascertaining their supplies from the same region. Both producers and consumers were found ignorant about the persistence of pesticide residues in the vegetable outputs. The crux of the matter is that the chemicals specified for cotton crops were also used to produce vegetable and fruits crops. The mandatory precautions to use chemicals safely, certain days before vegetables harvesting or picking, were rarely observed. Oppositely, farmers were found performing harvesting and spraying operations simultaneously. This ignorance on the part of farmers mainly resulted in accruing large number of vegetable samples above MRLs in the cotton growing areas of the Punjab (Figure 7.7).

In Punjab, nearly 0.12 million-hectare area is allocated to vegetable crops. The cotton zone contribute 28 % in total vegetables production of the province by allocating 0.04 million ha (30%) area (Government of Pakistan, 1998). Official statistics show that total vegetable supplies from the cotton growing area were around 57 thousand tones. The chemical residue analyses in this study was confined to kharif vegetable crops only, where more than one half (58%) of the samples were found above MRL levels. Presence of higher chemical residue levels in all vegetables suggests throwing them away as these are not suitable for human consumption. The externality of pesticide use on vegetable crop was estimated through using data from alternative sources (Table 31). The vegetable production figures were taken from agricultural statistical books. Half of the total vegetable production was assumed to be produced during Kharif season, as data on vegetables is not documented in correspondence to the production seasons.

Table 31. Pesticide use externality for vegetable production in the cotton zone of Punjab

Sr. No.	Particulars	Results
Vegetable Crops		
1	Total quantity of kharif and rabi vegetables produced (000 tons)	56
2	Total quantity of kharif vegetables produced (000 tons)	23
3	Total share of vegetables subjected to residues analyses (000 tons)	18.4
4	Weighted average value of sampled vegetables (Rs/ton)	7689
5	Weighted percent vegetable output above MRL levels (%)	51
6	Quantity need to be thrown away due to high MRL values (000 tons)	9.4
7	Potential cost of pesticide use on vegetables (Rs. million/season)	72.3
Apple Orchard		
1	Total quantity of apple produced from Balochistan (000 tons)	483
2	Percent apple output above MRL levels (%)	60
3	Quantity need to be discarded (000 tons)	290
4	Potential cost of pesticide use on apple orchards (Rs. million/season)	145.0

Similarly, crop wise statistics of individual vegetable crops is also not available. These deficiencies were done with collecting data from major vegetable markets of Multan district. Information collected from vegetable markets comprises: (a) total period of vegetable supplies; (2) quantity of vegetables supplied; and (c) price variability during whole supply period. Resource persons from different markets of Multan city were contacted to collect required information.

The pesticide use externality on vegetable crops was estimated by implying pesticide residues analyses results to the quantity of sample vegetables produced in the study zone. Four vegetables were subjected to residue analyses, which hold 83% of the vegetables (18.4 thousand tons), produced in the region (Figure 7.8). Brinjal (37%) and okra (47%) were the major vegetables cultivated in the cotton zones of the Punjab. Other sample vegetable like Bitter gourd (5%) and Tinda Gourd (1%) has nominal share in the total vegetable production of the area.

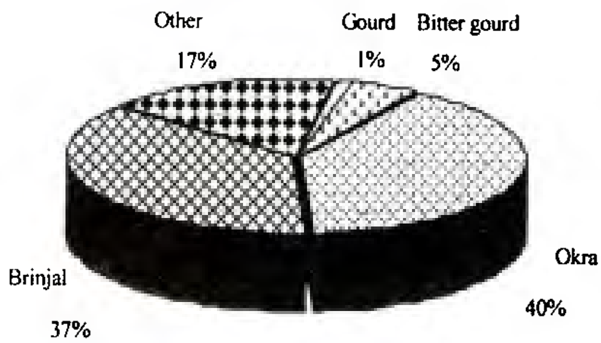


Figure 7.8 Area allocation to different Kharif vegetables in the study zone

Weighted average price of sampled vegetables was estimated in stepwise progression; firstly, weighted value of individual vegetables were estimated by multiplying seasonal prices variability to the respective seasonal variation in supplies; secondly, total quantity of individual vegetables were estimated along with their weighted prices; thirdly, production and value of all vegetables were summed up; and (d) finally, total weighted value of the sampled vegetable was divided by their total production to obtain weighted average price of sampled vegetables.

Weighted percentage (51%) of vegetable above MRL levels was calculated by multiplying the percent area under sample vegetable to respective percentage of samples found above MRL levels (Figure 7.7). The 51% of the vegetable that found un-suitable for human consumption accumulated into 9.4 thousands tones of kharif vegetables that should either be thrown away or abandoned for human consumption. This could result into an economic loss of Rs. 72.3 million if pesticide use on vegetable may not be regularized.

Similarly, from the total 483 thousand tones of apple production, 290 thousand tones is required to be prohibited from entering into the market channels, as 60% of the apple samples were found above MRL levels. In the absence of any regulatory measures, the potential loss to the apple produce would be 145 million rupees, in case this colossal quantum of apple fruit is turned off from consumption.

A well-equipped network of residue monitoring system in fruit and vegetable items is required to be established on priority basis. Creation of an effective integration among research, extension and residues monitoring departments is another important consideration in this respect. There is an urgent need to develop more applied techniques to promote safe use of chemicals by the fruits and vegetable growers. The scope of analyses is required to be expanded to all vegetables and fruits produced all over the country.

7.1.4 Irrigation and Drinking Water Resources

The status of pesticides residues in water from different areas of Pakistan has been summarised in Table 32. Total 107 water samples have been analysed so far, in which 31 (29%) samples were found contaminated. Most of these studies were conducted around early 1990's.

Table 32. Summary of pesticide residues in water in Pakistan

Location	Samples		Pesticides detected	Reference
	Total	Contaminated		
Samundri	10	7 (70%)	Monocrotophos, cyhalothrin, endrin	Ali and Jabbar, 1991
Karachi	79	10 (13%)	DDT, DDE, -BHC, aldrin and dieldrin	Parveen and Masud, 1988
Lahore	03	02 (67%)	Monocrotophos, cyhalothrin, cypermethrin	TARI., 1993
Mardan	12	12 (100%)	Dichlorvos, mevinphos, dimethoate, methyl-parathion, fenitrothion, chropyrifos, endosulfan and profenphos	Ahad, *et al.* 2000
Gadoon Amazai	03	0	Analyzed for diazinon methamidophos, benomyl & heptachlor.	Masud and Parveen, 1991
Total	**107**	**31 (29%)**		

The results show that water contamination levels were quite variable but mostly within the FAO/WHO safety limits. The results from the latest study, conducted in the Mardan areas of the cotton zone, revealed alarmingly high contamination rate (100%) along with considerable proportion of samples (33%) found above MRL levels. Out of the 14 pesticides tested 11 were present as residues in which 6 pesticides (carbofuran, dichlorvos, phosphamidon, esfenvalerate, lindane and α-endosulfan) were exceeding their individual MRLs of 0.1 μg/litter. These residue analyses in water indicate that if chemical use is continued at the same level it would not be long before our water supplies will be unfit for consumption and their accumulation in ground water overtime may lead to serious disaster.

7.1.4.1 Externality of pesticide use on Drinking Water Resources

Pesticide use extemality on drinking water resources is based on the water residue analyses of 12 samples representing 12 different villages or locations of the cotton zone. The results were expanded to total number of villages and their residents affected with drinking water contamination (Table 33). It was assumed that households could fetch water from 67% of the villages or locations where water is still suitable for drinking purposes. A minimum of two labor hours was assumed to be used to fetch water from an average distance of 2-5 kms. A potential loss of 0.18 million days is estimated with a shadow cost of Rs. 14.3 million to the farming community of the cotton zone of the Punjab.

Table 33. Pesticide use externality for drinking water contamination in the cotton zone of Punjab

Sr. No.	Particulars	Results
1	Total number of villages in 9 districts of the cotton zone	10845
2	Sites/villages where water was found above MRL (%)	33
3	Number of villages with unsuitable drinking water	3578
4	Total number of households affected (number in 000)	716
5	Total labor days[a] to haul suitable water from 2-5 km radius (days in 000)	179
6	Opportunity cost for the haulage of drinking water (Rs. millions)	14.3

a 2 labor hours per household were assumed to be used to fetch water from different distances

7.1.4.2 Pesticide Residues in Cotton Seeds, Oil, Lint and Cattle Feed

The widespread use of pesticides has resulted not only in the contamination of various crops but also their residues in food products and cottonseed oil. The levels of pesticide residues in cotton seeds, oil, lint and cattle feed in Pakistan is summarised in Table 34. About 639 samples of all these commodities have been analysed out of which 352 (55%) samples were found contaminated with different pesticides.

Table 34. Summary of pesticide residues in cottonseed oil, lint and cattle feed in Pakistan.

Commodity	Year	Samples			References
		Total	Contaminated	Exceeding MRLs	
Cottonseed	1986	70	47 (67%)	15 (31%)	TARI. 1993; Parveen, *et al.* 1996
-do-	1987	80	49 (61%)	16 (33%)	-do-
-d0-	1988	100	88 (58%)	51 (58%)	-do-
Lint	1986-88	250	89 (36%)		Masud and Parveen, 1998 & 1999
Cattle feed		79	36 (46%)		Parveen and Masud, 1987
C.S. Oil	1992	35	25 (71%)		Masud and Parveen, 1999
	1993	25	18 (72%)		-do
Edible Oils	1990				Waheed, 1991
Total		639	352 (55%)		

The results from previous studies show that out of total 250 cotton seed samples 184 samples (74%) were found contaminated with a variety of pesticides and 75 samples (41%) contained pesticides above MRLs. From 250 cotton lint samples about 89 samples (36%) were contaminated with a range of organochlorine, organophosphorus and synthetic pyrethroids. Seventy-nine randomly collected cattle feed samples were screened and 36 (46%) of the samples were found contaminated with different pesticides or their metabolites. Similarly, about sixty cottonseed crude oil samples were analysed for pesticide residues and 43 samples were found to contain residues of single or multiple pesticides.

7.1.4.3 Results from Cottonseed Oil and Cottonseed Cake, 2000

Six samples each of cottonseed oil and cottonseed cake were collected from three different dealers in Multan Division. For both the commodities, 100% samples in all sites were found contaminated in which 67% samples exceeded MRLs (Appendix 7.2 & 7.3). In case of cottonseed cake samples diazinon and methyl-parathion while cottonseed oil samples methyl-parathion exceeded MRLs.

7.1.4.4 Externality of pesticide use on Cottonseed Oil and Cottonseed Cake

Pakistan heavily relies on the imports (79%) of edible oil and only 29% are locally produced. Share of cottonseed oil in total domestic production is about 71% and traditional and non-traditional oilseed crops (mustard, sunflower, soybean etc.) contribute remaining 29%. Quite high percentages (67%) of cottonseed oil sample were found contaminated at above MRLs. Data on cottonseed oil and cottonseed cake production from Statistical books was used to account for the pesticide use externality on these important ingredients of human and animal consumption. The externality for these constituents was estimated for respective quantities found above MRL levels. About 327 tones of edible oil and 2, 146 thousand tones of oilseed cake produced in the Punjab need to be abandoned for consumption purposes (Table 35). The economic value of this externality was accounted to be Rs. 7.23 million for cottonseed oil and Rs. 16.1 for the oilseed cake.

Table 35. Pesticide use externality on cottonseed oil and cottonseed cake in the cotton zone of Punjab

Sr. No.	Particulars	Results
Cottonseed oil		
1	Total cotton oilseeds production (000 tons)	3640
2	Total edible oil production from cotton seeds (000 tons)	436
3	Share of Punjab in edible oil production from cotton seeds (000 tons)	327
4	Quantity of oil need to be abandoned duè to high MRLs (000 tons)	219
5	Average value of processed cotton seed oil[a] (Rs/ton)	33000
6	Potential cost of contamination of cotton seed oil (Rs. millions)	7.23
Cottonseed Cake		
1	Total cotton seedcake production from Punjab (000 tons)	3203
2	Quantity of seedcake need to be abandoned due to high MRLs (000 tons)	2146
3	Average value of cotton seed cake (Rs/ton)	7500
4	Potential cost of contamination of cotton seed cake (Rs. millions)	16.1

a = Price of raw cotton seed oil

7.1.5 Pesticide Residues in Animal Milk

Masud *et al.* (1991) analysed milk samples from Gadoon Amazai, NWFP for the residues of methamidophos, benomyl, heptachlor and diazinone and found no residues of any pesticide. However, Parveen and Masud (1988) had reported the presence of organochlorine pesticides in cattle milk samples collected from Cattle Colony in Karachi. This discrepancy in the results of two studies may be due to the fact that organochlorine compound are persistent and bioaccumulative in nature and the occurrence of their residues in fatty substances are quite likely. Moreover, due to the rapid metabolism of organophosphorus compounds in cattle body, 41% of the fed pesticide is retained by various body organs and muscles, 50% is excreted in urine, 7% in feces and only 2 % goes in milk (NIAB, 1987).

7.1.5.1 Results from Milk Analyses, 2000

A total of 18 milk samples, collected from different villages in Lodhran and Bahawalpur districts, were analysed for the residues of six organophosphorus insecticides. No residues of any insecticide were detected in any sample. This might be due to the collection of samples during post cotton production season. Similar analyses during pesticide spraying period on cotton crop might give different results, when majority of the farmers use weeds from cotton crop for animal feeding. Future studies need to be conducted by giving due consideration to alternative sources of animal feeding by different farm size categories.

7.1.6 Soil Analyses

In the past organochlorine insecticides like DDT and BHC were extensively used in both agriculture and public health sectors. Previous studies were, therefore mainly confined to determine residues of DDT in the topsoil of various croplands of the country (Table 34). The results from these studies shows those persistent organochlorine pesticides leached down in the soil and even after stopping their usage years ago, were present in the root zone. The pyrethroids with a shorter half-life were detected even 10 months after the last sprays.

Table 36. Summary of pesticide residues in soil of various agro-ecological zones of Pakistan

Location	Pesticides detected	Range, ppm	Reference
Kala Shah Kaku	DDT and its metabolites especially DDE	0.6	Mumtaz, *et al.* 1983; Baig, 1985
Multan	-do-	1.3 – 5	-do-
NWFP	-do-	0.2 – 0.5	-do-
Bhalwal	-do-	0.2 – 0.5	-do-
Samundri	Monocrotophos, profenofos fenvalerate, dimethoate, cyhalothrin, cypermethrin aldrin, dieldrin, endrin, p,p'-DDD, p,p'-DDE & p,p'-DDT	Traces -0.64	Ali and Jabbar, 1991
Gadoon Amazai	Analyzed for diazinon methamidophos, benomyl & heptachlor.	Nil	Masud and Parveen, 1991

7.1.6.1 Results from Soil Analyses, 2000

Twenty four composite soil samples from two depths (1-6 inches and 6-12 inches) and six locations in duplicate were collected from the cotton zone of Punjab. All soil samples at both depths were found contaminated with pesticides residues (Appendix 7.4). The residues of most of the pesticides were slightly higher in the top layer as compared to the lower one. Concentration and frequency of fenvalerate, lindane and azinphos-methyl were found higher in lower layer than the top one. The presence of Lindane residues in lower layers was mainly due to its past applications in the area, while that of fenvalerate was due to the previous year application and that of azinphos-methyl due to current year application.

7.2 Production-related Externalities, Incidence and Cost of Damage

7.2.1. Resistance and Resurgence

Almost all the insect species are capable of developing some type of tolerance to a pesticide. Pest resistance is now recognized as a serious deterrent, in many operational controls, where pesticides are applied as a single control component or integrated with other measures. It is believed that pesticide resistant populations exist even before application of pesticides but they are rare. Resistance may appear due to natural selection, site insensitivity or some other means of survival in the presence of pesticides. Biological factors responsible for increased resistance include: (i) large initial populations, (ii) short life cycle, (iii) more than one stage of the pest in contact with pesticide, (iv) poor hygiene, (v) many harborages and (vi) continual reinfestation. Chemical factors are: (i) ineffective pesticide, (ii) insufficient treatment, (iii) treatment too infrequent, (iv) total reliance on chemical control and (v) no post-treatment assessment. Literally, hundreds of species of insects, plant pathogens, rodents and weeds have become resistant to chemical pesticides and it is a global phenomenon (Anon., 1986).

7.2.1.1 Pesticide Use Levels

Consumption of pesticides in Pakistan has increased from 14,742 ton in 1989-90 to 44,872 ton in 1998. Almost three-fold increase in pesticide consumption is observed at the expense of disproportionate improvements in the yield of cotton crop, which has consumed lion's share of pesticides (Figure 7.9).

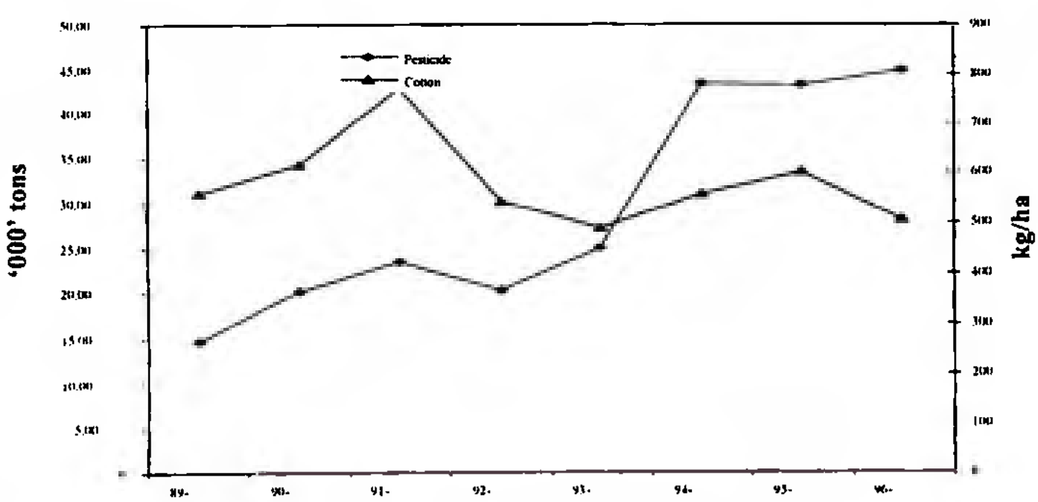


Figure 7.9 Pesticide consumption and cotton

The higher yield levels attained during early 90's were not sustained during remaining part of this decade, despite massive pesticide applications. A sharp increase in the pesticide consumption after 1994 has resulted into static or declining cotton yield. Ahmed, (1999) reported a considerable increases in the number of sprays, which further highlight above mentioned enhanced pesticide use (Figure 7.10).

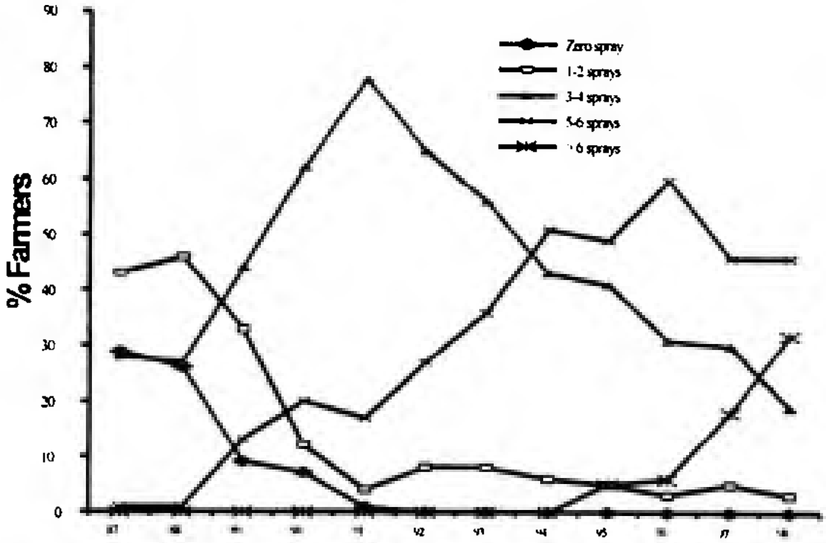


Figure 7.10 Percent cotton growers using different number of sprays over time

Percent farmers using zero or a minimal level of 2-4 sprays declined considerably by 1991-92. Cotton grower's restriction to four sprays per season attained its peak during 1991 and then switched over to higher number of 5 or 6 sprays. Farmers who were mainly performing six sprays during 1996 moved further towards 7 to 11 sprays during later years.

The increase in number of sprays was probably not for yield improvements, but to avoid crop damages–mainly accruing due to the flare of pests and resistance problems. The flare of some particular pests (such as *Bemisia tabaci, Helicoverpa armigera* and *Amrasca devastans*) happened with regular intervals, which provoked excessive and indiscriminate use of pesticide. Farmers in Lodhran district had used 8 spray as a result of white fly flare-up during 1997, whereas, under normal circumstances they use 5-6 sprays. Farmers mainly relate such occurrences to changes in weather conditions, quality of pesticides and pests flare-up. The role of pest resistance is a least contemplated factor on the part of farmers, whereas field entomologists have not yet fully endorsed the results from pest resistance studies, which according to them are conducted at a limited scale.

7.2.1.2 Incidence of Pest Resistance

Prior to nineties, little work on resistance was done in Pakistan on sound scientific lines. Irshad, (1999) has classified a comprehensive review on pest resistance problems in Pakistan. He improved upon his predecessors Matin and Jabbar, (1988) and Jabbar, (1988), who reported preliminary information on pest resistance issues. Results from private pesticide companies, who established Insecticide Resistance Action Committee (IRAC) on Cotton in 1990, are not available. Review of existing studies conducted to explore pest resistance problems had identified 7 insect species resistant to a wide variety of pesticides. Among these, 4 insects attack crops during pre-harvest stages while 3 are problem for stored grains. The resistance problems in other minor pests could also be found, as so for and so on research work on resistance problems is mainly confined to major pests.

Ahmad *et al.* (1995, 1997, 1998a, b, and 1999a, b, c) have conducted work on resistance of cotton pests to different groups of insecticides during consecutive years. They found *Amrasca devastans* (Cicadellidae: Hemiptera), *Bemsia tabaci*, (Aleyrodidae:Hemiptera) and *Helicoverpa armigera*, (Noctuidae:Lepidoptera) of cotton insects resistant to different pesticides. The resistant strains of A. *devestans* have been collected from southern Punjab, *B. tabaci* from central and southern Punjab and *H. armigera* from southern Punjab, lower Sindh, Kaghan and Muzzafarabad. *A.devastans* has shown resistance against 8 different pyrethroid insecticides, *B. tabaci* to 17 insecticides of OP, carbamate and pyrethroid origin and *H. armigera* to 18 insecticides of OP, carbamate and pyrethroid group.

According to Khan (1967), aerial and ground spraying with endrin in July 1961 in Mardan and Malakand (NWFP) gave very low mortality of this pest. Experimentation with varying doses of endrin and laboratory trials in cages with bioassay tests indicated that *Pyrilla* had developed resistance against hydrocarbon group of insecticides, and this was also conformed by Zuberi, (1967).

Alam *et al.* (1991) had conformed resistance in grain borer (*Rhyzopertha dominica*), rice weevil (*Sitophilus oryzae*) and red floor beetle (*Tribolium castaneum*). In grain storage *Rhyzopertha dominica* has developed resistance to 3 insecticides (OP) from Karachi and Sargodha, *Sitophilus oryzae* against 3 insecticides (OP) in many parts of Pakistan and *Tribolium castaneum* to 8 different insecticides allover Pakistan. *R. dominica, S. oryzae, T. castaneum* and *Trogoderma granarium* are also resistant to fumigant, phospine throughout Pakistan.

A fungus *Phytopthera infestens* is also resistant to metalaxyl. Some unconfirmed/unpublished reports of resistance are also circulating for *Plutella xylostella* on vegetables, whiteflies on sugarcane and citrus, *Spodoptera* on vegetables. *Cydia pomonella* on apple, and mites and aphids on orchards, cotton and vegetables.

7.2.1.3 Effects of Pest Resistance on Pesticide use levels

In majority of resistant insect pests, the Resistance Factor (RF) is quite high and it is not possible to control these resistant species with lower doses. RF has been recorded in *H. armigera* as high as 720 to monocrotofos, 177 to bathroid, 106 to zetcaypermethrin in *A. devestans* and 2000 to cyfluthrin in *B. tabaci.* With such a high RF it is impossible to control these pests with the prevalent insecticides. In *Tribolium castaneum* the highest RF was found to be 250 to malathion, 138 to fenitrothin and 91 to actellic. Almost similar conditions prevail for other insecticides and other storage pests. In the grain storage the most alarming case is of resistance to phosphine, because alternative fumigants are not available. Therefore in the grain storage it is also difficult to kill these insects through conventional methods.

Resistance has mainly been recorded against insecticides in Pakistan and not in other pesticides but insignificant work has been conducted on other pesticides. It is not a different situation as elsewhere in the world resistance problem is also mainly been investigated to insecticides. Development of pesticide resistance in plant pathogens and weeds has not yet been researched in Pakistan. Farmer's attitude and behavior towards alternative plant protection measures is investigated to relate these to the emergence of pesticide resistance in pests.

7.2.1.4 Beliefs and Behavior in Pesticide use on Cotton Crop

Farmers' attitude was assessed on the same scale mentioned above in section 7.1.1.1: (a) to know their intentions in protecting cotton crop from pests; (b) to understand their beliefs on pesticide hazards; and (c) to explore their understanding of effects of pesticide use on beneficial insects and pests resurgence issues. The response of 27 sample farmers regarding six belief statements covering different dimensions of pesticide use were analysed (Table 37). The results about these attitudinal dimensions of farmers would help to understand the farmer's adherence to chemical poised crop protection strategies.

Table 37. Beliefs of sample farmers towards the protection of cotton crop from pests

Statements	N	Mean	SD
Use pesticide to get more production	27	2.6	0.7
Use of pesticide to reduces the risk of crop failure	27	2.4	0.8
Use of pesticide is the only solution to save crop from pest	27	2.2	1.1
Excessive use of pesticides causes resurgence of pests	27	1.7	2.1
Use of pesticide is destroying natural enemies	27	1.4	1.9
Over doze of pesticide is more effective	27	0.3	2.5

The results clearly explain how resolutely farmers think pesticides as an important option to protect cotton crop from the pests. Use of pesticide is thought to be the single most important criterion to have better crop productivity and to minimise risk of crop failure. Farmers were found according less weight to the secondary effects of pesticides, i.e., resurgence of pests and loss of natural enemies. Their level of agreement was also low on these natural outcomes of relying excessively on chemicals for achieving better or secured crop productivity. Farmers accorded low weight to use over dozes of pesticide for effective pest control. Low efficacy of higher doses of pesticide, mainly during the years of pest flares, might have made farmers to realise this important understanding, which could be used further to impart knowledge about resurgence or resistance problems in pests for the promotion of alternative fewer chemicals based pest management strategies.

The results about the pest management knowledge and behaviour are presented in Figure 7.11. Use of chemical method of pest control is overwhelmingly higher, followed by cultural methods. Biological and IPM methods of pest control are at infancy stage and discrepancy in the state of their knowledge and use was also found higher among few knowledgeable farmers.

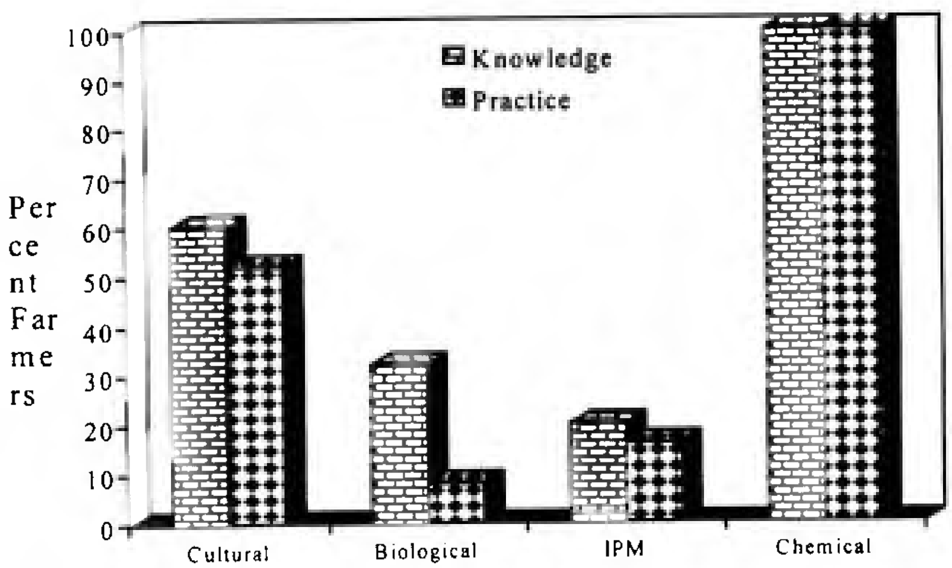


Figure 7.11 Farmers' pest management knowledge and behavior

In response to an open ended question about what method is preferred for controlling pests, majority of the farmers (81%) showed their preference for chemical methods. About 11% farmers have indicated that they practice early sowing to minimise chemical use and remaining 8% has used some sort of similar kind of end objective. When farmers were asked to explain reason behind the selection of specific pest control methods, majority of them have indicated that they are not very clear about other alternatives and hence think that application of chemicals is the best way of controlling pests. About 95 farmers were asked to quantify the role of pesticide in protecting cotton crop from pests. About one half of the farmers (45%) recognised that pesticides play 100% role in crop protection, and one fourth of them think in terms 80-90% role. Very few farmers think that pesticides contribute less than 50% towards appropriate crop protection.

This absolute reliance on chemical methods is now converging towards the creation of resistance in pests. As a consequence, chemical use has increased with little or no significant effects on crop productivity and rising costs of plant protection. A panic is created among farmers with the influx of more number of pests at some critical stages (August and September months) of crop growth. This happens almost every year even under normal circumstances. The intensity of such panacea increased many folds during the flare up pests that resulted into more sprays by applying mixes of many chemicals with relatively higher doses.

7.2.1.5 Externality of Pest Resistance

Increased pesticide resistance in pest population resulted into additional applications of pesticides to maintain expected crop yields. This becomes more obvious during pest flare-ups, which cause serious set back to the cotton crop. Cross-section data collected from farmers show that about 3 such setback to cotton crop were reported during last decade, mainly as a result of severe pest attack (1997 & 1998) and Cotton Leaf Curl Virus problem in 1993. In most recent pest flares, white fly and American bollworm inflicted major damages to the cotton crop.

Cross-section data further shows that yields obtained at severely affected farms, during these years, were not more than 1.2 ton/ha. However, average yield obtained during 1997 and 1998 was nearly 1.8 ton/ha. Whereas, about 2.3 tones per ha yield is generally obtained during normal years like 1999. This shows 28% decrease in cotton production as a result of inefficacy of chemicals to protect crop from major pests, which have developed pest resistance over time. The official statistics also show 23% decrease in yield per unit area during two consecutive kharif seasons (1997 and 1998) of pest flare than subsequent year (1999) or during preceding years.

Farmers use more pesticide to reduce the impact of pesticide resistance during pests flare-ups years. The average number of sprays as reported by farmers is 5 in number under normal pest problem situation. With the flare of resistant pests like white fly, the average number of sprays increased to 8. Yield loss due to pest resistance is accounted as Rs. 8648 per ha at a price of Rs. 700 per 40 kg of seed cotton (Table 38). Similarly a loss of Rs. 2491 per ha is estimated for 3 extra sprays to overcome problems of resistance in pests. The cumulative effect is about Rs. 11000 per ha which had increased many fold (Rs. 5667 millions) when extrapolated to 1.7 million ha of cotton grown in 9 major cotton growing districts of the Punjab.

Table 38. Externality of pest resistance in terms of pest flare-ups in the cotton zone

Pest Resistance	Externality
Pest flare ups experienced during last 10 years (no)	3
Cost of 3 extra sprays (Rs/ha)	2491
Cost of 28% yield loss (Rs/ha)	8648
Externality for 1.7 million ha of cotton area in 9 districts (Rs. million)	18891
Adjusted externality per annum-multiplied by 3 & divided by 10 (Rs. million)	5667

7.2.2. Domestic Animal's Poisoning

The pesticide poisoning to humans is relatively an established complexion as compared to animals. The difference in believes and behavior of farmers, about the safe use of pesticides, and consequential poisoning of human is well reflected in the analyses presented above. Domestic animals are poisoned through different mechanism of pesticide use on crops. The common sources of animal poisoning are: (a) feeding fodder sprayed with chemicals; (b) chemicals residues in the cotton seed cake; and (c) chemicals residues in the wheat straw. Animal succumbed to acute poisoning if fed accidentally with poisoned fodder. To large farmers, animal poisoning is not that acute, as to the small farmers or land less households. Large farmers can grow separate fodder crops on ample land resources available to them, which reduce the chances of forage inherent animal poisoning. On the other hand, farmers with meager (60%) or no land resources (5%) heavily rely on cutting weeds from standing crops, which exposed their animals to higher poisoning frequency.

Higher incidences of pesticide hazards are realized, as the bulk of animal forage comes from the heavily sprayed cotton fields. The chances of animal poisoning is enhanced manifold, as land-less farmers are not completely restricted to cut weeds/fodder from standing crops, and any misconception regarding the number of days before pesticide was applied could cause havoc to the animals. The vulnerability of land-less class to such overlooking is high, as many odorless chemicals are now being used, which make it difficult to assume when the field was sprayed, until and unless the farm owner is consulted in a priori.

Information on incidence of pesticide associated sickness to animals was gathered from 27 farmers and 2 farm level veterinary clinics from Multan district of the cotton zone. The male farmers were interviewed to collect animal sickness/mortality incidents of large ruminants. Information on the extinction of beehives with the advent of pesticide use was also specifically asked. Information on poisoning of small ruminants and poultry birds was collected from 35 women cotton pickers. Beside, survey information, the clinical tests were conducted on Cotton Seed Cake (CSC), which is the main constituent of milking animal feed. The milk samples were also collected for clinical analyses to confer the pesticide residue presence in animal milk.

7.2.2.1 Pesticide Associated Animal Poisoning

Farm level survey results show that out of total 27 male farmers, 9 (33%) have reported animal sickness from feeding poisoned fodder (Table 7.18). As conceived above more proportion of small farmers (50%) reported animal sickness as compared with the large farmers (25%). Major consequences of poisoning on animal health include loss in milk productivity (40%), loss in vigor (36%) and mortality (18%).

Data from veterinary clinics show that nearly 200 poisoned animals are treated from 15 villages per season, out of which 80 animals (40%) have experienced adverse kind of poisoning. Information collected from farmers show that at village level, out of 6 animals affected by poisoning, 1.5 (26%) died, incurring a financial loss of Rs. 16000 for large and Rs. 1200 for small ruminants (Table 39). The difference in poisoning incidence, reported by farmers and veterinary clinic, shows that mainly severe cases were accounted for at farm level. Similar losses were reported for household poultry (32%) and sheep goat (23%) kept as domesticated animals.

Table 39. Pesticide associated animal production loss in the cotton zone

Poisoning of animals	**Incidence level**
Large ruminants	
Small farmers reported animal sickness	50%
Large farmers reported animal sickness	25%
Total animals affected with pesticides per village (no)	5.9
Milk animals affected with pesticides per village (no)	2.3 (38%)
Milk production loss	5 kg (12 days)
Decrease in the value of animals as a result of loss in vigor	30%
Animal mortality per village	1.5 (26%)
Financial loss for animal mortality (Rs/animal)	Rs. 16000
Treatment cost (Rs/animal)	Rs. 250-300
Animal fully recovered (%)	43%
Small ruminants/poultry birds	
Women reported sheep/goat sickness	23%
Sheep goat productivity loss	3%
Sheep/goat vigor loss	20%
Sheep goat treatment cost	Rs. 160
Women reported poultry birds poisoning	32%
Birds vigor loss reported	58%
Birds mortality reported	42%
Treatment cost per affected flock	Rs. 60

Quite higher ratios (38%) of milk animals were accounted for in the total number of animal affected by poisoning. Milk yields of sick animals decrease drastically for first few days and regains foregoing level with in a period of 10-15 days. Farmers on average reported a 5-kg per day milk loss of poisoned animals for 15 days. Quite surprisingly, milk from affected animals is either consumed at home or sold to village milkman. Lab analysis of milk from affected animals suggested to be carried out to create awareness or to formulate necessary regulations for prohibiting its consumption for specific time period.

The treatment cost of large ruminants estimated @ Rs. 250-300 per animal. One half of the farmers get their animal treated from veterinary doctors and remaining relies on self-medication (13%) and treatment from veterinary compounders (37%). The severity of animal poisoning is well reflected from high proportion (57%) of partial recovery of the affected animals. This could further imply to the inadequacy of the treatment services available at farm level. The farmers further report about 30% decrease in the value of partially recovered animals. The small ruminants mainly get treated from local veterinary compounders. The cost of treatment of small ruminants is Rs. 160 and for birds flock is Rs. 60.

a) Externality of Animal Poisoning

Externality of animal poisoning incidences, reported by villages folk and local veterinary doctors, accumulated to Rs. 1304 million, when aggregated for the total strength of small and large ruminants and poultry birds present in the study zone (Table 340. This higher externality need to be interpreted cautiously, as some of the costs are externalities when poisoning of the animals of other farmers or landless peoples are concerned. In case if own animals were affected by pesticide poisoning, this might happened as a result of an information deficit on the ill-effects of pesticides. Owned animals got poisoned due to Mortality and loss of vigor in animals and birds account for the major components of this externality. Higher expenses were incurred on treatment cost of small ruminants and poultry birds. The externality for milking animals is only estimated for the reduction in milk yield of the poisoned animals for a specified time, whereas externality of milk which is being consumed could also be included, if the scientific evidence support that toxicity in such milk is higher than MRL levels.

Table 40. Externality of domestic animals and poultry birds poisoning in the cotton zone of Punjab

Externality estimates	Cost in Rs. millions
Large ruminants[a]	
Animal loss due to mortality	260
Milk loss during poisoning period	1.5
Treatment cost of poisoned animals	11.3
Permanent loss in animal vigor after poisoning	42.7
Total externality	315.5
Small ruminants[b]	
Treatment cost	268
Vigor loss	402
Total	670
Poultry birds[b]	
Mortality	189
Treatment	130
Total	319
Grand Total	1304.5

a Estimates based on 521 dry (Buff) 1444 milk (Buff), 337dry (cows), 749milk (cows) in 000 in the study zone
b Estimates based on 1714 (sheep), 5563 (goat) and 6416 (poultry birds) in 000 in the study zone

7.2.3 Honeybee poisoning

Increased pesticide uses have severely affected the wild honeybee colonies of the area and deprived farming communities to get direct and indirect benefits to agriculture. The responses collected from resource persons of the 7 villages shows 87% reduction in the bee colonies. The remaining 13% colonies are hardly surviving and seriously weakened because of pesticide exposure. Farmers were of the view that every third tree of their village was having a bee colony during pre-pesticide use period.

About half to one kilograms of honey was collected from each bee colony that was accumulated to nearly 3 kg of honey per household per village. About 0.6 tone of honey production was estimated per village during pre-pesticide use era (Table 41). The direct annual loss of Rs. 9.91 million is estimated for 5661 tones of loss in honey at a price of Rs. 0.1 million per tone of raw honey.

Table 41. Estimated wild honeybee losses due to pesticide exposure in the cotton zone of Punjab

Sr. No.	Particulars	Results
1	Total number of villages in 9 districts of the cotton zone	10845.0
2	Estimated honey production per village prior to pesticide use (Tons)	0.6
3	Total honey production in the area prior to pesticide use (Tons)	6507.0
4	Loss of potential honey production (Tons)	5661.0
5	Farm-gate price of raw honey (Rs. million/Ton)	0.1
6	Potential monetary loss of honey (Rs. Millions)	56.6

In addition to direct losses caused by the damage to bees and honey production, other crops might also be affected because of the lack of pollination. For instance, sunflower is being planted after cotton in some specific pockets of the cotton zone. This crop is in promotional stage to replace late wheat planting or area left fallow. Efforts made to bring sizeable area under sunflower to bridge the domestic production and consumption has not succeeded. Year to year fluctuation in both area allocation and yields for sunflower crops are very high. For instance, area allocation to sunflower reduced from 7487 ha (1991-92) to 3723 (1992-93) in Multan district and from 10117 ha (1996-97) to 1700 ha (1997-98) in Lodhran district. About 50% loss in sunflower yield occurred in 1988 during the flowering and seed setting stages (Shafiq *et al.*, 1993). The main contributing factor was determined as poor seed formation in the sunflower heads. Rise in temperature at seed setting stages and poor quality of hybrid seed is mainly cited to explain such yields fluctuations whereas low population of pollinators could also contribute towards poor seed setting. Although, no scientific evidence is available from Pakistan, to directly relate sunflower yield losses to depletion in pollinators' population, however, Piemetal *et al.* (1993) analysed honeybees related pollination losses around 10% of pollinated crops. Assuming a conservative 10% loss in sunflower production would result in net annual loss of Rs. 6.55 million in 9 districts of the cotton zone (Table 42). However, these losses need to be further examined through conducting research on pollination aspects of sunflower production.

Table 42. Estimated yield losses of sunflower crop due to poor pollination in cotton zone of Punjab

Sr. No.	Particulars	Results
1	Total production of sunflower from 9 cotton districts (Ttns)	52371
2	Production loss[a] due to poor pollination (tons)	5237
3	Price (Rs/ton)	12500
4	Potential monetary loss in sunflower production (Rs. million)	6.55

a =10% pollination losses assumed from the analyses of Picmetal *et al.* (1993)

Research need to be carried out through shifting bee colonies to sunflower producing pockets for investigating the augmentation in yields due to enhanced natural pollination. Studies about the role of effective pollination on the yields of other crops like cotton, melon and maize also need to be carried out. Although, using bees to enhance cotton and melon pollination is difficult at present because of the intensive use of pesticide on these crops however, it could be tested at sites where the implementation of IPM approach to protect cotton crop from pests is in progress.

7.3. Environmental Externalities, Incidence and Expected value of Damages

7.3.1. Wild Life and Birds

The direct toxic effects of pesticides on wildlife and birds have not been studied in Pakistan. The studies conducted during 1st half of the 20th century (Whistler, 1916, 1922, 1930; Currie, 1916; Lindsay-Smith, 1914; Ali, 1941;) mainly indicated existence of species their taxonomy, habitat, reproduction, and description of food habits. The insectivores or birds beneficial to agriculture were identified in studies conducted by Hussain and Bhalla (1937), Khan *et al.* (1980), Beg *et al.* (1982), Quayoom *et al.* (1982) and Hussain *et al.* (1989).

It has now been well recognized that the birds are good indicators of the health of the countryside, which has not been researched in the cotton growing ecology of Pakistan. The results from studies by Rayment *et al.* (1998) show that 10% of all birds on arable lands are killed annually by pesticides. Despite overuse of pesticide on cotton crop during last two decades, no work has been undertaken to determine; (a) the dynamics in the insect eating bird species and (b) the hazards of the pesticides to them.

For this study 6 resource persons from the same number of villages were contacted to collect their responses about the loss of birds fauna with increased use of pesticide. Farmers indicated great reduction in the species like Dove, Tiliar and soom chari. They said that a 50% reduction in the number of these species is noticed during pesticide use era. It was difficult to assign some economic value to the significant damages directly inflicted to these birds or role of these birds to control pests, particularly when the role of insectivores reduced under higher pest populations. The simplistic estimates were difficult to be made without knowing bird population before pesticide use, real reduction in bird population and the way the pesticides harm these birds.

7.3.2. Loss in Biodiversity

The largest concern is now also accorded to the use of pesticide that relates to their impact on biodiversity. Pearce and Tinch, (1998) indicate that yet this is the subject about which least appears to be known. For instance pollinator damage is relatively better understood than depletion in soil fauna due to over use of pesticides. The idea of biodiversity and its economic value has not been addressed adequately in the literature. The analysis of biodiversity externalities from the standpoint of economic analyses is also unsatisfactory and need rigorous analyses.

Farmers were inquired in this study to understand their know how about biodiversity losses and the value they assigned to such losses in terms of enhanced cost of pesticide use (Table 43). The analysis shows that farmers were aware about this pesticide externality and expressed quantitatively that about 48% cost of pesticide could be reduced if previous natural balance is restored. Assuming a 48% reduction in pesticide use, as a result of loss in biodiversity, resulting in net annual loss of Rs. 3381 million from 9 districts of the cotton zone. However, this economic loss need to be further examined through conducting research that could link pesticide application to biodiversity.

Table 43. Externalities of loss in biodiversity for the cotton crop of Punjab

Sr. No.	Particulars	Values
1	Use of pesticide destroying natural enemies[a]	1.4
2	Reduction in cost of pesticide if natural balance regained (%)	48%
3	Average cost of pesticide use for last two years[a] (Rs/ha)	4151
4	Cotton area in nine districts of the cotton zone (000 ha)	1697
5	Potential cost of disturbance in natural balance for 9 districts (Rs. millions)	3381

a= mean value of 7 points scale from good to bad (+3 +2 +1 0 –1 –2 –3)
b= estimates based on the normal level of 5 sprays

7.4. Cost of Abatement Measures for Environmental and Health Externalities

There is no regular pesticide residue-monitoring program in the country. Plant protection Department at Karachi, working under Ministry of Food Agriculture and Livestock (MINFAL), is responsible for registeration and the provincial agricultural departments take care of other regulatory aspects of pesticides. Currently pesticide-monitoring research is handled at 4 federal and *10* provincial institutes. Most of these institutes are mainly concerned with quality control of pesticides or with the efficacy trials of pesticide in developing pest control packages. The review presented in relation to residues analyses of food chain and water show that different institutions without any consistent and clear methodology, conducted some occasional studies (See section 7.2). The studies conducted in the cotton zone are few and far between.

Pesticide residue analysis in this study was specifically conducted in the cotton zone of Punjab to examine health hazards to farm workers and residues in food chain, water, soil and animal milk and their feed constituents. The results discussed in earlier sections of this chapter show rather alarming situation in terms of health hazards among farm workers and residues levels that found above MRL in many food products and natural resources. These findings suggest expansion of such token analyses on continuos basis as well as at a larger scale. It would help in further understanding of the residue situation, which could be used for regulating its use through taking appropriate crop management practices and introducing specific pesticide regulatory measures.

Table 44 shows the potential external costs of monitoring human health hazards and residues in food chain, soil, water and animal feeding resources in the cotton zone of the Punjab. About 80-270 samples in different categories of environmental, human and food chain were estimated to be collected from sample districts, which accumulated as 1220 samples from 9 districts, with a potential operational cost of Rs. 4.84 millions that would be incurred in the collection and analyses of these sample.

Table 44. Externalities for abatement measures for environmental and health externalities in the cotton zone of Punjab

Sr. No.	Particulars	Total samples	Potential cost[a] Rs. millions
	Residues monitoring		
1	Field labor (spray men, pickers)	160	0.08
2	Industrial workers (Manual & Automatic plants)	120	0.06
3	5 Vegetables, melon and mango fruit outputs	210	1.05
4	Surface and underground water	100	0.5
5	*Cottonseed, lint and cattle feed*	80	0.4
6	Milk	160	0.8
7	Soil	270	1.35
8	Wheat grain + straw	120	0.6
	Total	1220	4.84

a = Operational cost to collect and analyse blood sample is estimated as Rs. 500 and sample of all other outputs as Rs. 50000 per sample

The water cleanup process requires water survey to target the contaminated water for cleanup, which cost very high and it is considered more feasible to use abatement measures than to take the course of purifying it after contamination. In this study water lifting/hauling costs from neighboring localities, where water is still suitable for drinking purposes is assumed to be bome by the farming community in the short-run (See section 7.2). This was assumed by considering the unwillingness of community or poor state of the economy, to afford to purify water from the contaminated land aquifer.

The clothing used by workers during pesticide spray, cotton picking, pesticide packing and distributions was usually of ordinary standards, except by multinationals. Most of these clothing consists of old clothes which farmers wear during working hours. Farmers don't take special care even to wash these clothes separately. The implication of this irrational behavior appeared in terms of poisoning, health damages and works loss, which is already accounted for in the occupational poisoning section of this chapter.

7.5. Public Awareness Relating to Externalities of Pesticide Use and Cost of Awareness Campaigns

The provincial extension departments working at field levels are launching season long campaigns to promote critical aspects of improved crop management. Extension strategy for cotton crop include more than 50 components like; land preparation, sowing time, sowing methods, improved varieties, biological cultural pest control, pest scouting and using Economic Threshold Levels (ETL) for pesticide prescription, irrigation scheduling and regulating fertiliser use. The use of age old/static ETL standards by extension agents have helped farmers to at least understand the utility of using pesticide in relation to pest population dynamics. The special emphasis during recent years in Punjab to delay 1st spray through seed dressing and pest scouting had started paying its dividends in the form of reducing number of sprays from more than 8 to 4 or 5, on larger cotton growing area (See section 7.3). The electronic and print media is also being used for mass education on regular themes about general crop management and special debates/messages held/displayed on sporadic production problems.

The private companies allocate considerable amount of financial resources to launch media campaigns, demonstration plots, high profile meetings and farmers meetings. Their efforts are mainly confined to promote their products, whereas some multinationals do some symbolic research cum demonstrations to highlight pesticide efficacy aspects, mainly to prove the superiority of their products. Multinationals conduct about 90-100 farmers field days and same number of demonstration trials as compared to 17 field days and trials by public sector extension in each cotton-growing district of Punjab (See chapter 6). There is no match in the expenditure of pesticide companies on the promotional aspects of pesticide use and public sector expenditure to streamline the pesticide use in relation to other vital aspects of cotton production management. The expenses of only two multinationals (Novartis and FMC) are 3.5 million rupees per season against 7.2 million of public sector extension for cotton crop protection. The effectiveness of public sector extension could be well judged from such insignificant amount and their mandate to cover/demonstrate more than 50 components of improved cotton crop management.

Among 5000 active NGOs who works in the country, only few are involved in the agricultural extension activities. The National Rural Support Program (NRSP) and Punjab Rural Support Program (PRSP) are the two leading NGOs contributing in the field of agriculture by disbursing loans to buy livestock and agricultural inputs. These NGOs indirectly contribute towards farmer's welfare through empowering them to buy inputs of their own choice which is less possible if bought from input dealers on credit. The impact of this financial empowerment in reducing the pesticide use has to be analysed as yet. However their Human Resource Development activities to train farmers in improved crop management in some selected tehsils could be considered as prospective intervention towards improved plant protection endeavors, whereas their staff at present don't have required know how to proceed in this direction (see chapter 6). Their budgetary allocations are merely 0.1 million per region to cover 2-3 districts for implementing 4-5 training courses.

The actual expenses and estimated external cost of awareness campaigns is indicated in Table 45. It is difficult to segregate the budgetary allocation for plant protection measures from total operational budget allocations of public extension system, pesticide companies and NGOs. However, preliminary/rough estimation is made to indicate as to what proportion expenses are made to regulate the pesticide use by different agencies. The expenditures incurred by pesticide companies are not included as an externality, because they do so to promote pesticide use, and the impact of their activities were already estimated in terms of pest resistance, health damages and residues in food chain. The NGOs have small budgetary allocation to impart training among farmers, which would further be reduced when only 5% is being assumed to be spent on topics related to plant protection only. The total Rs. 55 million budget allocation to electronic and print media was first distributed among 4 major crops (wheat, cotton, rice, and sugarcane) and then further curtailed by assuming 50% use for topics on the pest management aspects of cotton crop. The externality of field level extension system was deduced from the district level total budgetary allocations and expenses that incurred to run extension campaigns on cotton plant protection only. One district approximately receives Rs. 1.7 million for all crops and Rs. 0.80 million is spent on cotton plant protection. About Rs. 14:12 external cost of inculcating safe or rational use of pesticide is estimated for extension services provided by using different mediums.

Table 45. Externalities of awareness campaigns on pesticide use for the cotton crop of Punjab

Sr. No.	Particulars	Total Expenses	Estimated Externality for cotton (Rs. million)
1.	Public field level extension in 9 cotton districts	15.3	7.2
2.	Information support through electronic & print media	55.0	6.9
3.	Pesticide companies	7.75	0
4.	NGOs	0.45	0.02
5.	Total externality	-	14.12

Externalities of pesticide use in socio-economic terms are not as understood as their toxic effects in the forms of water pollution, human health problems, environmental pollution, pest resistance and loss of bio-diversity. Even hazardous impacts of pesticides are not uniformly understood at research, extension and farm levels. The giant task ahead is to fully sensitize all stakeholders to promote safe use of pesticide, through improving understanding on the external/social costs of overuse/misuse of pesticides. The estimates on external costs of pesticides need to be reinforced and shared with the community by using all possible means of communication. This could be accomplished by displaying special programs on electronic mass media, initiating special field level extension campaigns, printing and distribution of special pamphlets, training of resource persons by NGO's and involving private sector in communication. This needs to be performed to reverse the prevailing serious repercussions of misuse of pesticide, which would involve additional efforts, along with considerable financial implications, as externalities in terms of particular awareness campaigns.

7.6. Concluding Observations

The quantitative extent of adverse impacts of pesticide on human health, natural resources, food chain, production losses and domestic animal poisoning shows substantial costs on society. The cost estimates presented in this chapter provided strong evidence, which shows significant impacts of pesticides on society and strongly support the precautionary approaches to the use of pesticide in agriculture. There is a an urgent need to familiarize farmers as well as policy makers about how much costs of pesticides are paid at market level and how much indirect costs are not even accounted for the undesirable outputs. Unplanned use of chemicals resulted in environmental pollution and un-economical returns on the costly investments. The reduced reliance on crop protection products seems inevitable for sustainable and healthy crop production. The basic structure of the external costs of pesticide use, established in this study, help draw important conclusion to introduce economic instrument for regulating the pesticide use. Imposition of cess fund on import of pesticides and raw materials is recommended for utilization of proceeds, e.g. on health care, residue monitoring, research & extension. Similar other steps to discourage cheap availability of pesticide to users and strict enforcement of specific regulatory measures are also suggested. Substantial increases in the allocation of financial resources to promote IPM methods in crop protection need immediate attention at planning and policy levels.

Chapter 8: COSTS OF PESTICIDE USE

The externality assessed in the previous chapter arises from the routine and legal use of pesticides. The quantitative extent of adverse impacts of pesticide on human health, natural resources, food chain, production losses and domestic animal poisoning shows substantial costs on society. These estimates are to be used further to distinguish benefits of pesticide in terms of direct returns and indirect environmental and economic costs. The purpose of these analyses was to assess if the negative externalities are very high, pesticide use should be rationalized in order to avoid high cost to the national economy.

It was presumed that social cost is not currently included in the prices of pesticides and as a consequence current level of pesticide use are excessive. This is particularly relevant when the indirect costs to society are explicitly considered. Pimental *et al.* (1992) has made a notable attempt to make a comprehensive estimate of the total external cost of pesticide use. They estimate the external cost of pesticide use to be some $8 billion per annum for the USA.

A second attempt was made by Steiner *et al.* (1995) and estimated $1.3 billion to $3.6 billion for externalities to USA economy. Two to three time less externality was estimated in this study than Pimental study, as they covered some of the categories identified by their predecessors. Waibel *et al.* (1998) estimated external cost from unintended negative side effects of pesticide use amounting to at least 252 million DM/year to old Federal State of Germany. This external cost was amounting to 23% of the respective private cost paid by the producers.

The present study conducted in the cotton growing belt of Pakistan provide additional evidence which shows significant impacts of pesticides on society and strongly support the precautionary approaches to the use of pesticide in agriculture. The reduced reliance on crop protection products seems inevitable for sustainable and healthy crop production. The basic structure of the external costs of pesticide use established in this study help to draw important conclusion to introduce economic instrument for regulating the pesticide use.

8.1. Methodological Consideration for Economic Evaluation of Externalities of Pesticide Use

Heavy reliance on pesticide for plant protection causes additional costs to the society. These costs are in contrary to the private costs paid by producers of the agricultural commodities. The external costs are categorized as actual and potential costs in terms of damage costs or damage abatement costs respectively. Examples of potential costs are the establishment of pesticide residue laboratories, residue monitoring programs and training programs on the safe use of pesticides. Loss of bio-diversity, pest resistance, fatalities (animal, human, honey bee as pollinator, and birds) are the instances of actual cost born by the society. The assessment of the actual and potential external costs was required to specifically design the corrective measures in accordance to the pesticide use level and its relative impact on health, pest resistance and environment.

The external effects of pesticide use in this study were estimated through identification, quantification and monetarisation of impacts. The study was confined to the evaluation of those effects, which are relatively well documented through monitoring data or case studies.

Different economic evaluation techniques like market price and contingent evaluation approached were used to calculate valuable results. The natural scientists, toxicologists and economists worked in close collaboration to produce scientific evidence on pesticide externalities, through implementing specialized studies in the representative cotton-growing region of the Punjab. The scientific evidence based on lab analyses was accumulated on health hazards to women cotton pickers, contamination of food products (vegetables, fruits, edible oil and animal milk) and natural resources (soil and water).

Formal survey and case study methodologies were used to collect evidence on pesticide applicator poisoning, health hazards to domestic animals, loss of biodiversity, production losses due to pest resistance, loss in wild honeybee colonies and production loss due to reduction in pollinators. Pesticide-associated poisoning in animals and human was further substantiated through collecting evidence from local veterinary clinics and human health dispensaries/hospitals. Both the farmer surveys and scientific studies provided sufficient base to estimate external cost of pesticide in monetary terms. Data from national statistics was used to aggregate findings of case studies and selective scientific studies. The external costs were estimated in the following areas in terms of damage costs and damage abatement costs (Table 46).

Table 46. Damage costs and damage abatement costs estimated in different areas

Externality area/category	Damage Cost	Damage abatement cost
1. Human Health		
Occupational poisoning		
Pesticide applicators	Fatalities, treatment cost,	Blood samples monitoring cost, awareness campaigns, workdays loss
Women cotton pickers	Treatment cost	Blood samples monitoring cost, awareness campaigns, workdays loss
Industrial workers, Distribution, Storage and Disposal	Acute/minor ailment cost, Treatment cost, environmental degradation	Blood samples monitoring cost, awareness campaigns, implementation of safety regulations, workdays loss
Pesticide residues		
Kharif vegetables	Potential externality for rejected outputs	Residue monitoring, implementation of regulations
Irrigation and drinking water	Contamination of underground water resources	Residue monitoring, opportunity cost to get clean water
Cottonseed-oil and cottonseed-cake	Rejection of contaminated cottonseed oil and cake	Residue monitoring, awareness cost
2.Production Externalities		
Pest resistance	Yield loss	Research and extension, more pesticide use cost
Domestic animal poisoning	Production loss, mortality and treatment cost	Separate fodder crops, awareness cost
Wild honeybee loss	Loss of honey and yield loss due to pollinator loss	Research to prove and prevent honey bee losses
3.Environmental Externalities		
Wildlife and birds	Loss of useful insects and birds fauna	Ecosystem analyses to restore natural balance
Loss in bio-diversity	Stagnating or declining productivity	Ecosystem analyses to restore natural balance, increased pesticide use
4. Health/Environmental Monitoring	Health and environmental damages	Establishment of regular residue monitoring system
5. Public awareness Campaigns	Complexity to develop general recommendations	Campaigns on safe and judicious use of pesticides

The evidence on known (i.e. workdays loss, treatment cost, human and animal fatalities and pollination losses etc.), probable (i.e. rejection of contaminated products like fruits, vegetables, cottonseed oil drinking water, loss of wild birds and beneficial insects etc.) and possible (i.e. monitoring costs and analyses, costs on extension media etc.) external costs of pesticide use was collected from the sample locations of two major cotton growing divisions, namely Multan and Bahawalpur. The results from different samples (described in chapert 7) were aggregated for the 9 districts of these divisions. Expansion of external cost was confined to the sample divisions, because: (a) these represent intensively managed 80% of the total cotton growing areas of the whole Punjab; (b) cotton-wheat rotation is the predominant cropping system, unlike many mixed systems practiced at peripheral areas; (c) intensity of pesticide use was higher in these specialized cotton growing regions as compared with the rest of the 20% cotton which is planted in the diversified agro-ecologies; and (d) it was easy to convince the managers at research, extension and policy levels by showing correspondence among sample results and their aggregation for the representative cotton growing regions of the Punjab.

8.2. Summary of Costs of Pesticide Use

Table 47 shows the composition of the estimated costs of pesticides on annual bases. The side effects of pesticide on human health, food products and environment are valued through applying standard environmental economics procedures, and are summarized in Table 46. The cost of current level of pesticide use shows conservative estimates for the observed external effects. The environmental and social cost to the nation amount to 11941 million rupees per year for the 9 districts of the major cotton-growing region of the Punjab. Other costs, e.g. caused by chronic health effects, publicly funded research and financing to pest scouting department for pesticides further increased this amount. The bulk of the cost is caused by production losses due to resistance development in cotton pests and damages to domestic animals, followed by damage to human health, loss of bio-diversity and monitoring costs of residues in food chain. The costs of monitoring through residue analysis and implementation of pesticide use regulations belong to the damage prevention costs.

Table 47 External cost of pesticide use in the major cotton growing areas of the Pakistan's Punjab

Types of External Cost	Effects Identified	Value
1. Human Health		
Occupational poisoning		
Pesticide applicators	Fatalities, treatment cost, workdays loss	266.7
Women cotton pickers	Treatment cost, workdays loss	765.0
Industrial workers	Acute/minor ailment cost	0.64
Distribution, storage & disposal	Environmental/health problems	NQ[a]
Pesticide residues		
Kharif vegetables	Potential externality for rejected outputs	72.3
Drinking water	Opportunity cost of labor to get clean water	14.3
Cottonseed-oil & cottonseed-cake	Potential externality for rejected cottonseed oil and cake	23.3
2. Production Externalities		
Pest resistance	Yield loss and more pesticide use cost	5667.0
Domestic animal poisoning	Production loss, mortality and treatment cost	1304.5
Wild honeybee and sunflower production losses	Loss of honey and yield loss due to pollinator loss	63.2
3.Environmental Externalities		
Wildlife and birds	Loss of useful insects and birds fauna with increased use of pesticide	NQ
Loss in bio-diversity	Increased dependence on pesticide use to get stagnating or declining productivity	3745
4. Health/Environmental Monitoring	Cost of toxicity analyses	4.8
5.Public awareness Campaigns	Cost of public extension media and NGOs	14.1
Total		**11,941**

a NQ= Effects are estimated, but yet not quantifiable

Figure 8.1 shows the structure of external costs to different components of agricultural production systems. About 49% external cost can be attributed to the pest resistance problems, while 29% to loss in bio-diversity and nearly 20% accourred to human and animal health damages. The damage prevention cost on residue monitoring and public awareness is less than 2%. This shows the meagre spending on damage prevention strategies against the damages caused by production losses, excessive pesticide use, human health and animal fatalities. The estimates for each category of damages are preliminary, and could be further improved by strictly implementing the individual or willingness to pay (WTP) intentions of the society. External cost estimates about the resistance problems and loss in biodiversity account for sporadic damages and regular extra costs, respectively. As a result, national economy paying the huge price of costly imported pesticides.

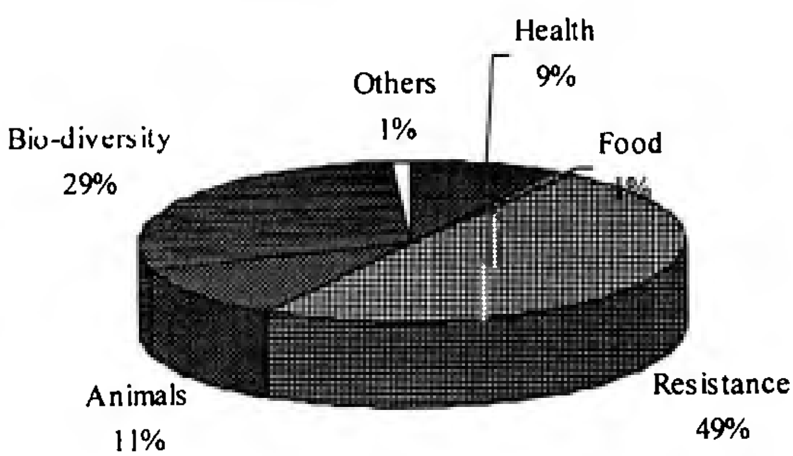


Figure 8.1 Percent share of different external costs in total pesticide use externality

8.3. The True Price of Pesticide

The benefit cost analyses of pesticide use was expressed in a standard benefit-cost ratio (Table 48). Potential yield gains of pest control were estimated by calculating 27% yield loss of cotton due to insect pests and assuming 50% effectiveness of insecticide control under farmer conditions. Production loss estimates are based on the results presented in the annual reports (1992-1999) of Central Cotton Research Institute, Multan. About 272 kg per ha increase in the yield of seed-cotton was estimated with pesticide use. This increase was estimated for average 1741 kg per hectare actual seed-cotton yield from 1990-2000, over last 10 years period. The actual gross benefit of pesticide control was calculated Rs. 8069 million by multiplying prices of seed-cotton (Rs. 17.5/kg) and then with the total cotton area of 9 districts (1.7 million ha). In order to calculate benefit cost ratio, the private costs of pesticides were added to the producer rent yielding the gross value added from this input factor. Dividing the latter by the private plus the external costs resulted into a benefit-cost ratio of about 0.43. This shows that benefit cost ratio of 1.14 reduced significantly when external cost was added in the total cost.

Table 48. Benefit-cost ratio of pesticides in the cotton zone of Pakistan's Punjab

Total costs per year	18611 million rupees
Pesticide costs (chemical + spray)	7044 million rupees
External costs	11567 million rupees
Benefit	8069 million rupees
Benefit-cost ratio without external cost	1.14
Benefit-cost ratio with external cost	0.43

On average pesticide use in cotton is marginally profitable only when external costs are not included in the analyses. Judging, however form the significant extent of externalities suggests that in cotton pesticides are overused and that effective measures be undertaken to reduce their use to a level which is in line with the objectives of sustainable development. This is not only for the benefit of the farmer, the cotton industry in Pakistan but for the Pakistan society as a whole. From a strictly cost benefit approach, it appears that pesticide use is not beneficial. However, the ratio of external costs to the private cost of pesticide use is quite high (1.64), which shows other tradeoffs involving environmental quality, irreversible damages to agro-ecosystem and human health problems. Society pays about twelve thousand million rupees as environmental and public health costs. It is concluded that although pesticide use has some positive contribution to economic welfare, but current levels could still be (and for reasons outside the benefit-cost ratio likely are) above its social optimum.

8.4. Concluding Observations

The analysis of the composition of external costs from pesticides however, shows that the risk minimisation strategy is not successful in preventing damage to human health and natural resources. This most likely further fuels the demand of society for tighter regulations, which increases the social costs of damage prevention and mitigation. The externality of pesticide use estimated in this study provides a starting point on which the following studies can improve upon. The complete cost/benefit analyses performed by considering private and external costs would help to rightly perceive the true cost of pesticide and to reduce the perceived profitability of pesticide. The adverse implications of pesticide use on health, production resources and environment required to be corrected by improved government policies. The direct and indirect benefits and costs of implementation of a policy to reduce pesticide need to be considered in promulgating future safe pesticide use strategies. Clearly, it is essential that the environmental and social costs and benefits of pesticide use be considered when future pest control programmes are being developed and evaluated.

Chapter 9: RECOMMENDATIONS AND FRAMEWORK FOR ACTION

9.1. Consensus on Recommendations

The findings of the study were presented and discussed in the Policy Workshop held on May 1-2, 2001 at Bhurban, Pakistan. The stakeholders from different national institutions such as policy, planning and development, environment, research, extension, NGOs and industry participated in the deliberations (see Appendix 9.1). The resource persons from Global IPM Facility, FAO Regional Office Bankok, Regional Cotton IPM Programme in Asia, European Union (EU), Asian Development Bank (ADB) also participated. The consensus was built on the following recommendations during the final session of the workshop.

i. Government of Pakistan should review mechanisms for strengthening the enforcement of existing legislation in pesticide for import, registration, formulation, distribution, advertising, usage and disposal. Legislation should be amended in cases where human health and the environment are endangered to an un-necessarily high degree.

ii. Pesticide taxes should be considered as an instrument of IPM policy. Financing of control and monitoring may be assured by a targeted cess on pesticide products. Government of Pakistan should be giving increased emphasis to create a favourable incentive system including the use of economic instruments in reducing uneconomic pesticide use and promotion of market mechanisms for the production of food and fibre with reduced pesticide use and safety measures or risk reduction.

iii. The true costs including external costs of pesticides must be made explicit to everybody for the benefit of the Pakistani people and the Pakistani economy. Hiding such information will cause unnecessary risks for the Pakistani people and endanger the international competitiveness of Pakistan's future export markets

iv. Government of Pakistan should create an enabling environment for transforming the existing pesticide market into a market for crop protection information. In this regard the role of extension staff and NGOs in farm level extension work has to be strengthened. Government of Pakistan should set targets for environmental quality and human health related to pesticides. Targets should be developed in co-operation with different ministries (e.g. Agric., Environment, Health) and followed by the establishment of national monitoring and surveillance system.

v. Government of Pakistan should support Capacity Building in Economic analyses of Pesticide use and assessment of externalities. IPM may be taken as a Farming System approach rather than a commodity approach. Instead of having a centralised research system, IPM research should agree on a common ecological framework in support of local decision making. Newly established National IPM Programme (Nat-IPM) may be strengthened.

9.2. Implication of Recommendations on the National Economy

The above recommendations are the culmination of a year-long pesticide policy project of the National IPM Programme, Government of Pakistan (MINFAL) supported by FAO and UNDP. They are intended to make Pakistan's agricultural intensification more sustainable by achieving economic use of pesticides from the point of view of Pakistan's economy and society. They were also formulated in full awareness of stunning changes taking place in international trade. Globalization accompanied by international regulation pose opportunities and threats for Pakistan's agricultural economy. Accelerating urbanisation, Pakistan's favoured access to growing international demand by Asian consumers, and the diversification of demand in OECD countries (e.g. for imported fruits, flowers, processed or specialised foods and fibre products) are quickly expanding Pakistan's opportunities to capture new and lucrative markets.

At the same time, national regulatory agencies in importing countries are imposing stricter standards on allowable product quality and lower tolerances for residue levels of pesticides in agricultural products. The European Union announced in June 2000 new, lower maximum residue levels that go into effect for all imported commodities in July 2001. From this stricter basis in government regulations, which are protected by WTO, more and more food processing companies and food retailers are developing new product lines that demand even stricter standards of production, including organic foods and fibres, and products that are certified as being produced with minimum environmental impact and improved sustainability of agricultural resources. For example, two large multinational clothing retailers, The Gap and Patagonia, advertise proudly that their trousers are made entirely from organically grown and certified cotton.

New molecular and analytical technologies used to enforce these public and private safeguards guarantee that any pesticide residues remaining in Pakistan's exported goods shall be detected. A host of other, mostly smaller, countries trying to export similar products to traditional trading partners means that any science-based decision to refuse exports will instantly permit a competitor from another country to seize that market. The opportunities for export driven growth to nourish the domestic economy are too important for any country to risk by maintaining outdated, pesticide-dependent crop protection systems. It is essential that Pakistan build on its fine IPM research tradition to move on to an IPM implementation programme within an enabling policy framework. These recommendations and the accompanying action plans should provide practical guidance for this crucial initiative.

9.3. Framework for Action

The recommendations were deliberated in sub-groups to prepare a list of actions, responsibilities and time frame for implementation. The outcome from different groups was further discussed with the house in the final session and action plan that follows was prepared and submitted to the Government of Pakistan. The framework for action is being vigorously pursued at all levels and various time bound actions are already being implemented at different levels. The newly established National IPM Programme (see appendix 9.2) has taken on itself to approach various Government Departments responsible for policy change for following through the desired actions. The Planning Commission on its part has allocated an attractive amount of financial resource for IPM Programme at the National level for the next ten-year investment plan.

Frame work for action

Issues	Actions	Responsibilities	Time frame
1. Review of Registration Procedure • Form 1 • Form 16 • Form 17	Constitute a review committee and formulate TORs '	MINFAL, in collaboration with scientists from federal and provincial governments, economists, policy makers, representatives of PAPA/ PCPA and NGOs	By 30th May
2. Enforcement of Legislation	o Strengthening of existing analytical laboratories and setting up of new labs. o Training of analytical manpower for labs o Update analytical standards acceptable and recognized internationally o Accreditations of labs. o Increase monitoring frequency on compliance with legislation, e.g. formulation worker safety	PPD along with respective provincial Agric. Dept, Ministries of Labor and Environment.	One Year
3. Enforcement of existing pesticide regulation system. Increase in pesticides registration/renewal fees need to be considered	Conduct study in relation to regulatory cost by compiling data from all regulatory departments	MINFAL (PPD), National IPM Policy Component, PAPA/PCPA	6 months
4. Policy on local formulation / basic manufacturing of pesticides	Assess the impact of existing policy	Nat-IPM policy component, CBR, PAPA/PCPA, MINFAL	6 months
5. Imposition of cess fund on import of pesticides and raw materials	o Proposal on cess fund to be put up to ECC of Cabinet for approval o Justification to be prepared for untilization of proceeds, e.g. health care, residue monitoring, research & extension	MINFAL and Nat-IPM	3 months
6. Stronger partnership of research, extension and farmers to implement joint IPM activities.	Make IPM more clients oriented through coordination between provincial, federal research institutes and NGOs	National IPM Programme (Nat-IPM), federal and provincial research institutes and NGOs	1 Year
7. Assessment of technical content of past and present IPM work.	Applied IPM research for market oriented horticultural farmers within Farming System Approach	National IPM Programme (Nat-IPM), federal and provincial research institutes and NGOs	6 Months

Issues	Actions	Responsibilities	Time frame
8. TOF/FFS Approach as participatory season long training programme for implementation of IPM.	Promotion and adoption of this approach	National IPM Programme (Nat-IPM) and provincial extension departments and NGOs	6 Months
9. Large scale implementation of IPM programme	Strengthening extension services at village level	Provincial extension departments, NGOs and National IPM Programme (Nat-IPM)	1 Year
10. National programme for monitoring of pesticides residues and health and environmental hazards.	Strengthening provincial and federal capacities to carry out such programmes	MINFAL through PPD in collaboration with Ministry of Health, EPB, PARC, provincial Environmental Protection Agencies (EPAs) and other provincial research institutes.	6 Months for launch
11. Lack of awareness of environmental and health hazards	o Establish awareness programme to educate general public o Establish training programme for dealers o Include the topic in education system at school and university level	MINFAL to liase with private sector UGC and education Boards	Immediately
12. Gender and pesticides use	Undertake a gender analysis concerning pesticide use	IPM Programme with the help of Provincial Agric. Dept.	Six Month (30th Oct)
13. Disposal and updating inventory of obsolete pesticides	Make arrangements in collaboration with donors.	MINFAL	Six Month (30th Oct.)
14. Incentives for producing organic agricultural commodities	Creation of a set-up to certify organic status of the commodity according to international standards. Provide incentives for production and marketing	Federal and Provincial Governments.	Start from next fiscal year (long term)

Hints for TORs:

- Through review of registration procedure
- Impact analysis of product imported under Form 16 and 17
- Short listing of products at registration level
- Clear definition of renewal of the products including registration
- Registration of Bio-products including de-registration and insect growth regulators

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APPENDICES

Chapter 1

Appendix 1.1 **Summary Format**

Executive Summary

1. **Introduction (Dr. M.H. Soomro)**

   A. Background to the study
   B. Objectives of the study

2. **Development of the Agriculture Sector in Pakistan (Dr. M. Azeem Khan)**

   A. Historical overview of agricultural development
   B. Overview of agricultural policy

      1. Crop intensification
      2. Food policy
      3. Agriculture and poverty alleviation
      4. Agriculture industry linkages
      5. Agriculture trade policy
      6. Agriculture and the environment

   C. Opportunities and Challenges for the future

3. **Crop protection and Pesticide Use (Dr. A. Rehman)**

   A. Historical overview of crop protection problems

      1. Major pest and disease incidence 1970-2000
      2. A critical look at crop loss assessment 1970-2000

         a. Reports of crop loss: some examples pre and post harvest
         b. Critical assessment: methodology, reference to presence of natural enemies and other agro-ecological factors

   B. Trends in pesticide use 1970-2000: volume and value

      1. By crop, type of pesticide, region
      2. Assessment of data: what data are missing?
      3. Comparison with development of fertilizer use

   C. Imports and exports of active ingredients and formulated product

      1. Assessment of data
      2. Illegal imports and exports: approximate volume and values

D. Adoption of Integrated Pest Management

1. Obstacles to IPM implementation
2. Factors encouraging IPM implementation

4. Economic Factors relating to Pesticide Use

A. Productivity estimates of pesticides by major crop (**Dr. M. Azeem Khan**)

1. Existing studies
2. Data and metrological problems in estimation

B. Agricultural output price policy 1970-2000 and impact on pesticide use (**Dr. A. H. Qureshi**)

C. Pesticide price trends (**Dr. A. H. Qureshi**)

1. Subsidies and taxes (direct. and indirect: tax and duty exemptions, government distribution and storage)
2. The share of generic pesticides in total consumption and ii-nplications for faringate pesticide prices.
3. Pesticide prices in comparison with output prices (taking indicative insecticides, fun-icides, herbicides)
4. In comparison with fertilisers and labour costs (herbicide use)
5. Effects of exchange rate movements
6. Estimates of own price elasticity of demand for pesticides

D. Non-price economic factors (**Dr. A. H. Qureshi**)

1. Acricultural credit
2. Outbreak budgets
3. Aerial spraying (Balochistan)
4. Overseas aid programs encouraging pesticide use eralm aid programi-nes, World Bank loans (some exa p
5. Export incentives to reduce pesticide use- i-ejec+,ed export coi-ni-nod't'es (fruit and vegetables), contract farmiiig with

5. Regulatory Policy (Dr. A. Rehman)

A. Registration of chemical and biological pesticides
B. Legal requirements for production, storage, distribution, application and disposal of pesticides (standards)
C. Environmental and health protection regulations and standards
D. Monitoring and enforcement of regulations and standards
E. Costs of the regulatory system: including enforcement and residue monitoring

6. Research and extension

A. Extension (**Dr. Ashraf Sahibzada**)

1. Public sector extension system
   a. Structure and approach of government extension system
   b. Crop protection training curricula

c. Use of economic thresholds: method for calculating thresholds, method of implantation, critical assessment
d. Expenditures on agricultural extension
e. Coverage of farming population
f. Integrated pest management methods and approach
g. Problems and constraints

2. Private sector
a. Investment of pesticide industry in marketing campaigns
b. Investment of pesticide industry in farmer training expenditures, approach, coverage

3. Activities of non-government organizations in extension

B. Research **(Dr. Ashraf Poswal)**

1. Structure of government pest and pesticide-related Agricultural research
2. Costs of the government system and estimates of expenditures on pesticide related research vs. IPM research including biological control
3. Role of non-government organizations in pest and pesticide related research
4. Role of private sector in pest and pesticide related research (including resistance monitoring)
5. Available non-chemical technologies

C. Research-extension linkages: uptake of IPM vs pesticide-based technologies **(Dr. Ashraf Sahibzida with assistance from Dr. Ashraf Poswal)**

7. Externalities of Pesticide Use (Dr. M. Azeem Khan)

A. Health: incidence, expected value of damages

1. Occupational poisoning
a. Farmers and farm workers contact with pesticides
b. Industrial workers contact with pesticides in formulation
c. Distribution, storage and disposal including accidental spillage
2. Pesticides for household use, including improper use of agricultural pesticides in the household
3. Accidental poisoning (for example villagers in contact with pesticides from runoff, containers, pesticide contaminated clothing)
4. Food residues
5. Drinking water
6. Suicide cases

B. Production-related externalities

1. Resistance and resurgence
2. Farm animals and fish
3. Honey bees

C. Other Environmental Externalities: incidence, expected value of damages

1. Wildlife and birds (WWF and IUCN reports)
2. Biodiversity

D. Costs of government and private sector prevention and abatement measures for environmental and health externalities

1. Residue monitoring (food and water)
2. Water purification
3. Protective clothing and equipment

E. Public awareness relating to externalities of pesticide u awareness campaigns

I. Government efforts to increase awareness
2. Activities of NGOs to increase awareness
3. Media
4. Private sector including safe-use training

8. Costs of Pesticide Use (Dr. M. Azeem Khan)

A. Explanation of methodology
B. Summary of costs of pesticide use
C. The True Price of Pesticides?

9. Conclusions and Recommendations (Dr. M.H. Soomro)

Appendix 1.2

Pesticide Policy Workshop: "Building Consensus for Action"

Discussion Points on Fiscal and Economic Policy Aspects

Jonathan R. Pincus
SOAS, University of London

One of the main objectives of this study of Policy and Strategy for Rational Use of Pesticides in Pakistan is to estimate the relative efficiency of pesticide use on the country's major crops and to propose measures to achieve greater technical and allocative efficiency. Fiscal and economic policy aspects are therefore of central importance, Sub-topics that fall under this general heading include productivity estimates of pesticide use, agricultural pricing policy, agricultural taxation, input supply and non-price factors affecting pesticide use such as the availability of agricultural credit and government expenditures on aerial spraying and outbreak budgets.

These comments briefly address each of these sub-topics as discussed in the project's draft report. Chapter 4 of this draft brings us a good deal closer to a clear understanding of these issues. I will focus on parts of this chapter that could be supplemented on the basis of further analysis of existing data,

It should be noted at the outset that an important constraint on efforts to carry out a comprehensive analysis of these issues is the absence of relevant microeconomic data on farm productivity, input use, input and output prices. This problem is described in detail in the draft report. There are few existing studies of farm level productivity in Pakistan, and even these tend to omit pesticides as an explanatory variable (see, for example, Ashok Perikh *et al.* 1995). Moreover, there appears to be no regular panel survey of Pakistani farmers. The Agricultural Prices Commission, for example, does not update data on factor use, and in any case does not release cost of production reports to the public or to research agencies.

Without access to these basic data it is impossible to model the impact of pesticide policy change in the framework of a general equilibrium analysis. This is not an unusual situation in developing countries, where we must usually rely on the judicious use of partial equilibrium models to explore the potential impact of agricultural policy change.

However, the Pakistani situation is in some ways more serious than other counties in the relevant comparison group. I would therefore propose that one recommendation of this project should be that the government consider financing an annual national sample survey of farmers in the major agricultural regions. The costs of the survey could be minimized by the use of a small sample (of 1,000 or so farmers) clustered by region and stratified by farm size. Given the importance of these issues, this would be money well spent: savings to the government and to farmers achieved through improved design of agricultural pricing, taxation and input policies would be many times greater than the cost of collecting and analyzing the data. The existence of publicly available panel data would also help the national agricultural research agencies to refine their research agendas in a way that would focus existing efforts on problems of central importance to farmers.

Productivity Estimates

As noted in the draft report, there are few existing studies of farm productivity in Pakistan. Work carried out to date has also for the most part relied on the analysis of partial budgets. In the absence of experimental controls on production conditions (soils, water, farm size, etc.), partial budgets provide no information on the important interaction effects between the various factors of production. These studies are therefore largely irrelevant to the task of estimating the marginal productivity of pesticide use.

One notable exception however, is Muhammad Shafiq and Tahir, Rehman's recent study of 120 farms in the cotton-wheat area of southern Punjab (Shafiq and Rehman 2000). This study uses data envelopment analysis (DEA) to consider the technical and allocative efficiency of cotton production on these farms (*Ibid.*, 323). DEA is an extension of linear programming that measures the extent to which productivity on the farms in the sample differs from the most efficient farms. This method thus produces estimates of the amount by which input use could be reduced on inefficient farms that would enable them to achieve efficiency levels equal to those on the most efficient farms.

Shafiq and Rehman conclude that the least efficient farms in their sample spent more than 70% more on pesticides than other farms achieving similar yields *Ibid.*, 328). Although the study is based on a small sample, this constitutes clear evidence of pesticide overuse in cotton.

However, more evidence is needed before we are able to generalize these results to the larger population of Pakistan cotton producers. The easiest way to achieve this given the data constraints described above would be to estimate individual supply functions for the major crops (for example, cotton, wheat, rice and sugarcane). Time series data on crop-production are available for the major crops in the government's annual Economic Survey[1]. Using these index numbers as the dependent variable, supply functions could be estimated in the standard forms including an index of output prices, cultivated area, water availability, fertilizer use, Labour use and pesticide use on the right-hand side of the equations.

[1] Economic Survey, Islamabad: Government of Pakistan, Finance Division, Economic Advisor's Wing, various issues.

The main obstacle to estimating these functions is the absence of crop-specific data on input use, including labour, fertilizer and pesticides. However, to the extent that information is available on the relative input-intensity of these crops, crop-wise annual estimates could be constructed using national data on labour, fertilizer and pesticide consumption.

The immediate task would therefore be to obtain these estimates of input use intensity and to construct index numbers for crop-specific input use for the major crops. Should these estimates be unavailable, we could construct an index of agricultural output and use this as the dependent variable. The problem with this method is that the index itself must in some way contain information on the output prices of individual crops. Prices in this case would form part of the dependent variable and could therefore not be used to explain changes in output in the individual crops.

Agricultural Pricing Policy

The draft report provides useful information on the relationship between support prices for cotton and rice and pesticide consumption. It is clear from the data presented that, as expected, pesticide use has accelerated with the rapid rise in agricultural support prices in the 1990s. This in part reflects an increase in cotton area associated with price increases, but also the likelihood that higher output prices have encouraged more intensive use per hectare of pesticides on cotton and rice fields. The area under cotton appears to have peaked in FY 1996/97 at 3,149,000 hectares, and has since fallen back slightly (Government of Pakistan 2000, 24). Higher output prices, in combination with recurrent pest problems associated with overuse of pesticides, have thus encouraged ever-higher levels of pesticide use per hectare.

Prices of the main agricultural commodities increased at faster rates than general price inflation during the 1990s (see table), Output prices have also increased more rapidly than input prices, including fertilizer, pesticides and power. Unfortunately, the supply response to these shifts in relative prices has been disappointing. This in part reflects inefficient use of agricultural inputs resulting from artificially cheap input prices and insufficient training of farmers relating to the efficient and effective responses to pest problems at the farm level.

Cotton and Rice Prices as Compared to Consumer Prices

Year	CPI	Cotton	Rice
1991-92	110.58	106.04	110.4
1992-93	121.45	119.2	122.28
1993-94	135.14	168.2	130-94
1994-95	152.73	207.62	141.25
1995-96	169.21	210.57	167.12
1996-97	189.18	242.89	185.5
1997-98	203.96	245.84	197.08
1998-99	215.68	261.55	239.88

The report should draw attention to these issues through the supply functions described in the previous section and through more detailed reporting on the farmers terms of trade: that is, the relationship between prices received and prices paid by farmers. This information would help make the case that true pricing of pesticides would not constitute an undue burden on farmers, and would have an insignificant effect on farmers' incomes.

Input Pricing and Supply

The draft report provides a good deal of useful information the relative price changes of fertilizers and pesticides. These figures need to be deflated by rural producer prices and combined with other prices paid and received by farmers in the farmers' terms of trade index. Rural wages for women should be deflated by the rural consumer price index to gauge changes in the price of weeding labour vis-a-vis herbicide prices.

The estimates of the own price elasticity of various pesticides as presented in the report are compromised by the absence of farm-gate prices. To remedy this problem, these prices should be deflated by the producer price index and aggregated (since the data on pesticides by class are probably less reliable than the aggregate data). These regressions should be carried out in logs. If the equations still result in positive coefficients the exercise should be abandoned, as it is extremely unlikely that higher prices increase demand for chemicals.

Aside from the relative prices of inputs, more information is required on the mode of input supply: are pesticides sold on the open market, or is a significant proportion of the total delivered through cooperatives, the extension system or through suppliers linked to agricultural lenders?

Agricultural Taxation

Agricultural activities in Pakistan account for 25 percent of GDP, and therefore represent an important source of revenues for the federal and provincial governments. Unfortunately, the present system of agricultural taxation has introduced significant economic distortions and has failed to provide a sound revenue basis (World Bank 1999, 10). For example, in FY 1997/98 the land revenue tax collected less then 0.3% of agricultural GDP due to tax loopholes, evasion and overly generous exemptions.

Given the skewed distribution of landholdings in Pakistan, under-taxation of agriculture cannot be justified on equity grounds. Several remedies have been proposed, including more effective collection of land taxes and an agricultural income tax. The implementation of policies that contribute to a more effective and equitable agricultural tax system are crucial to economic recovery in Pakistan.

Input taxes, including pesticide taxes, should be an important component of a revised system of agricultural taxation. At present, pesticides are not taxed, as neither GST nor import duties are applied to them. The report should provide more detail on tax policy with regards to pesticides, and should highlight the benefits of pesticide taxes, including case of collection (compared to land and income taxes) and the positive equity implications (given that large farmers are more intensives users of pesticides).

Non-Price Factors

More detailed information is needed on non-price factors. The rapid increase in credit provided to farmers for the purchase of pesticides since 1997 is striking. It is not clear from the report, however, how these funds are disbursed (in cash or in kind; through retailers or cooperatives) and whether credit is delivered at market rates or with an implicit subsidy, This information is crucial for an understanding of the role of credit in encouraging pesticide use.

Similarly, the existence of outbreak budgets typically encourages both pesticide use and over-reporting of pest populations. Detailed information on the total value of outbreak budgets, and changes in the size of these budgets in recent years (at the federal and provincial levels) is essential. More information is also needed on the mechanisms through which these funds are delivered.

The report provides useful data on aerial praying. However, in addition to the area covered by these programs the report should also include the total cost of these activities.

Conclusion

The report on economic factors relating to pesticide use represents a real contribution to our understanding of the economic foundations of pesticide policy in Pakistan. The main constraint on the team, and on policy makers, is the near absence of relevant data, particularly panel data for the main crops and regions. Given this constraint, the team has done an admirable job of collecting and analyzing information on this extremely important topic. These comments have included suggestions for several additions and amendments to strengthen the report and clarify the main issues.

What has begun to emerge from this exercise is evidence that pesticides are currently overused on the major crops, and that ample scope exists for policy changes that would both improve the efficiency of the system and contribute to greater equity among producers and consumers.

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Appendix 1.3

Pesticide Policy Workshop: Building Consensus for Action

Discussion Points on Agricultural Extension

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The analysis of agricultural extension forms a major building block in a country study on pesticide policy. Extension information whether it is being provided by private or public agents is likely to influence behaviour of clients. Clients are the farmers and large as well as small farmers can be users of extension information because this is often free of charge, non-rival and non-exclusive in nature. Information can be distorted for several reasons and such distortions can lead farmers to take misguided decisions, which can result in income loss for the farmer and in costs for the society. So, the analysis of agricultural extension within the context of pest management and pesticide use is to assess specific components within the extension system that may encourage or discourage pesticide use levels which are uneconomical for the farmer and sub-optimal from the point of view of society at large or in this case the Pakistani people.

The report on the Extension System in Agriculture in Pakistan highlights some of the important issues which set-up the general information environment in crop protection in Pakistan. The situation of agricultural extension provides some indications for distortions that are likely to lead to inefficiency in crop protection, pesticide overuse and the existence negative externalities.

The report analyses the situation in two provinces, namely in the Punjab and in Sindh. It then deals with the role and the functioning of the private sector in agricultural extension and explores the role of NGOs.

The analysis for the Punjab nicely illustrates the procedures and the design of the still popular T&V extension approach. The report indirectly supports the growing evidence that T&V as a huge public sector investment has questionable rate of return. In fact, a recent ex-post World Bank study of the formerly highly praised Kenya T&V system showed that the rate of return is actually more likely to be zero, down from over 1 00 % of the ex-ante analysis. It is now being recognised that the total investment of about 1 billion $ world-wide in T&V has not met the high expectations which were raised when the 'great idea' of Daniel Benor had captured the agricultural investment portfolio of the World Bank. The report of Dr. Sahibzada illustrates impressively the limitations that even a large-scale extension approach like T&V is facing with regards to reaching a large number of farmers. The ratio of I extension agent per 6500 to 8500 farmers shows very clearly that extension hardly is and probably never was an instrument to foster equity among the farming sector but would rather always favour the more well-to-do farmers. The example of the Punjab where of the extension system emphasis is on cotton illustrates this case.

The report also describes the situation in the province of Sindh, which does not follow the T&V approach. The general operational difficulties, which the extension system is being faced, indicate that the provision of unbiased crop protection information is likely to be sub-optimal.

The most striking part of the report is to clearly demonstrate the overwhelming influence of the private sector especially in crop protection. The amount of investment in marketing and promotion by pesticide companies appears to exceed the operational budget of the entire agricultural extension service although some clarification is needed in this regard for the specific provincial situation. Pesticide companies (see table 3 of the report) are conducting 5 times more farmer meetings as compared to the government extension service. Also their extension efforts are more focussed on crops and areas where a market for pesticides exists. The dramatic increase in pesticide use in cotton over the last ten years shows the success of this marketing strategy for the companies. However, as will be stressed in the discussion of Dr. Pincus later on this success is probably at the expense of the Pakistan economy because of rising evidence of uneconomical pesticide use and an intolerable level of externalities.

In the last part on agricultural extension the report summarises the role of NGOs in Pakistan's agriculture. It can be concluded from the analysis that NGOs in Pakistan so far have not taken up the case of pesticide over- and misuse to be one of their targets. After all "a very small number of NGOs are actively involved in agricultural extension". It is the two latter issues that deserve more attention in further discussions and analysis.

Firstly, the case of private sector extension in crop protection raises the important question what public sector strategy would be effective and efficient if pesticide use levels are to be brought in line with the social optimum level of pesticides in an economy. Secondly, given the dominance of private sector marketing, who out of its profit motive provides highly selective information, which must be complementary to pesticides sales the government faces the question how it could create an enabling environment to encourage more NGOs to become engaged in sustainable agricultural practises.

The report also briefly discusses other distortions beyond the provision of information that however, nevertheless can pre-condition farmers' pesticide use decisions. On the issue of credit there are clear incentives to encourage pesticide use when comparing credit and cash prices of pesticides. Finally, the linkages within the "Research Extension-Farmer-Continuum" are faced with serious procedural limitations as interaction and participation was found to be poor.

The following issues, which emerge from the analysis of the report on agricultural extension may help to clarify some important issues and hopefully facilitate the discussion on an effective and efficient extension strategy. In the following, I list five points which I want delve into briefly:

Reference System: it needs to be clarified what the reference system in evaluating the performance of the public extension system actually is. In analysing extension investments one must be very careful in defining such a baseline as the latter largely determines the substance of the critique one can put forward. Also, one needs to specify what evaluation procedures were put in place to assess the effectiveness of extension. In other words, it needs to be made explicit what the purpose of the public extension system really is in view of the dominance of the private sector in this field. For example, if the true (although not readily revealed) purpose of extension is more political rather than economic the assessment will have to be different.

Incentive System: due to the dominance of the private sector in pesticide-based crop protection especially in cotton it would be interesting to learn more about the incentive system in place. In other words, what incentive do government extension agents have to promote alternatives to chemical pesticides. This is especially of interest in cotton, e.g. in the Punjab where crop protection is likely to dominate the contents of extension messages.

The role public sector crop protection and the relationship to NGOs: the role of crop protection within the agricultural extension system needs to be re-assessed. Does it, as is the case in many countries, merely assume the role of a "firebrigade" or is it charged with promoting sustainable crop management system. Once this role is better defined effective linkages with local NGOs who work with farmers directly could be established. A extension agent specialised in crop protection could assume the role of a facilitator carry out training for NGO workers with training, contribute information material and establish linkages to other relevant institutions. This could lead to situation where a pesticide market will be turned into crop protection market.

Research-Extension Linkages: in the report a rather pessimistic picture is given as regards the relationship between research and extension. The well-known situation from other countries is being repeated in Pakistan: research does not listen and is ignorant of the real problem! Here, the basics of an incentive system that encourages collaboration need to be developed. For example, the salary scale of researchers could be tied to the number of extension contacts or research funding could be favoured if extension and farmers are part of the research project.

5. **Training activities:** With regards to training in crop protection and IPM the following needs to be known;

- An inventory of the training capacity, which exists in terms of human capital and infrastructure on a provincial level.
- Pre-conditions for the implementation of participatory approaches to crop protection extension.
- An assessment of the target areas where public sector training is likely to be competitive with the efforts of the private sector will.
- Impact assessment of training right from the beginning

Appendix 1.4

Pesticide Policy Workshop: "Building Consensus for Action"

Discussion Points on Economic Evaluation of Externalities

Gerd Fleischer
IPM Policy Analyst, World Bank

The basic economic concept for evaluating pesticide extemalities is derived from welfare economics. Decentralised decision making about production and consumption of goods and services by markets is only economically efficient if certain conditions are met. Costs and benefits from the private decision maker's point of view may differ from those when evaluating them for the national economy as a whole.

In the case of pesticide use, the occurrence of extemalities leads to non-optimal input use levels unless the costs of negative effects imposed on others and the society in general are incorporated by price mechanisms or other instruments in the private user's decision making. When negative extemalities are significant, pesticide use levels should be reduced in order to avoid unnecessary high costs for the national economy. The economic evaluation of extemalities therefore is important to provide an estimate about the amount by which pesticide overuse should be reduced.

The economic evaluation of pesticide extemalities includes three steps whereby close interaction between natural scientists, toxicologists and economists is needed. Firstly, a cause-effect relationship between pesticide use and the observed negative impact on human health and the environment has to be established. There has to be scientific evidence from laboratory research, controlled case studies or epidemiological data. Secondly, effects have to be quantified. However, in many cases there is a lack of adequate monitoring and surveillance capacity for keeping track of contamination of environmental resources and other damage. The paper of Azeem deals with the third step, i.e. the evaluation of the available body of evidence from literature and field surveys conducted in the course of this project, and its assessment in monetary terms. Studies in other countries have shown that external costs of pesticide use can be expected in the following areas:

Area	Damage costs	Damage abatement/prevention costs
Human health	Suffering from chronic illness Fatalities due to acute and chronic poisoning	Medical treatment Labour productivity loss (labour days) Safety gear Production loss (food residues)
Environment	irreversible loss of biodiversity, groundwater quality	Increased factor costs (drinking water)
Agricultural production		Crop yield loss (pests and loss of pollinators) increased pest control costs due to resistance and loss of beneficial organisms Loss of animal production (livestock fish, honey, wildlife resources)
Government program		Monitoring and surveillance of environmental quality and health impacts Enforcement of regulations Awareness campaigns

For most effects, Azeem uses the indirect evaluation approach, mostly through market prices for production and factor cost impacts. Given the current data situation in Pakistan, this approach can be considered as suitable. The author integrates the available case study material supplied by the NARC team with national statistics and results from literature sources. He aims at presenting a preliminary figure for the likely costs in a specific area and remains generally within the limits of "conservative estimates" for the observed external effects. The estimation of some effects goes beyond the scope of this project and should be undertaken by subsequent research.

The evaluation of Azeem shows that there are two effects, which presently are most important for the national economy. The first area is the impact of pesticides on human health. Case study material from the cotton zone suggests that the number of fatalities is actually higher than one would expect from the extrapolation of data from the World Health Organisation (WHO). Azeem's data reveal that there is one fatal case in each 8000 rural households per year in the cotton zone due to accidental pesticide poisoning. This probably means a comparatively high number of deaths due to pesticide exposure in Pakistan. Equally, the number of non-lethal acute poisoning cases appears to be high in the cotton zone.[1]

[1] The extrapolation from WHO data suggests 300 fatalities and 15,000 acute poisoning cases per year at the given level of pesticide use. Azeem estimates 271 fatal cases in the 9 most intensive cotton zones alone.

Pesticide residues in food and drinking water are a source for acute and chronic poisoning of humans. The laboratory analyses of Khan and Hayat (2000) have demonstrated that a high share of items traded at the markets is contaminated with pesticide residues. Azeem calculated the costs for discarding food items with pesticide residues in excess of the toxicological maximum residue limits (MRL). These hypothetical costs amount to Rs 240.6 million for vegetables, apples, cotton seed oil and cake only. However, this figure represents a preliminary estimate for the external costs for the above mentioned commodities as the items are actually exchanged on the market. Actual health impacts from consumption of pesticide-contaminated food are not yet known.

It can be expected that an appropriate representative monitoring system for food items and drinking water may reduce the risk of negative human health impacts and its associated costs. Azeem calculated the costs of a surveillance scheme at Rs 4.23 million per year for food and water, and Rs 1.26 million for occupational health hazards. However, data from a monitoring system have to be used for actual policy decisions that contribute to a reduction of pesticide residues in food and water. It is therefore likely that the establishment of a monitoring system will increase the overall external costs at least in the short term.

From a strict standpoint of economic efficiency one could argue that the labourers would have internalised the health risk of the work in a pesticide-contaminated work environment by accepting the work conditions. However, the information status of the women about pesticide-related health impacts is low. Furthermore, the mostly landless labourers have little alternatives to working in cotton harvesting.

The second area where high costs for the national economy occur is the impact of pest resistance and the degradation of the agro-ecosystem on crop production. Crop loss and increased pest infestation due to resistance, resurgence and emergence of secondary pests in cotton production alone cause costs of Rs I 1,000 per hectare according to the data of Azeem. About 80 % of the costs is caused by production loss, the remaining by additional pest control costs. For the 9 most important cotton zones of Punjab, this would add up to Rs 5,667 million per year. Even if we assume that only half of the cost increase was caused by the effects of pesticide spraying in prior years, it would mean that the national economy faces a loss which is about equal to the monetary amount of cotton insecticdes in the region. Policy makers should pay special attention to this development as pest resistance is presumably in most cases irreversible. Cotton pest resistance and resurgence therefore endangers the competitive position of Pakistan cotton production on the world market.

Among the other negative impacts of pesticide use on agricultural production, the data of Azeem show an important effect of pesticides on honeybees and on domestic animals. Especially the effect of the loss of pollinators has often been overlooked. More case studies should be conducted to confirm the prevalence of poisoning cases. The same holds true for the effects of pesticides on natural enemies where farmers' experiences indicate a large potential for cost savings in pest control. For the latter, joint field studies between plant protection specialists and economists should be launched. There are other potential effects of pesticide on agricultural productivity which have not yet been well understood, e.g. the damage of pesticides to soil organisms.

Data on effects of pesticide use on biodiversity are not yet conclusive enough for supporting an in-depth economic evaluation. This was to be expected as there is a complex ii-iteraction between pesticides and the ecosystem whereby direct effects on species through intoxication and indirect effects through the food chain occur. There is a potentially important role of wildlife and biodiversity conservation in tourism and recreation that still has to be evaluated.

Conclusions

The study results suggest that in Pakistan two areas where externalities occur need urgent attention. Firstly, human health externalities are economically important as pesticides infringe on the productive capacity of the most disadvantaged sections of the rural population. The case study results in the cotton area show that there is a high number of fatalities and also a high incidence of acute poisoning, both for pesticide applicators and female cotton pickers. Improving the situation will need the implementation of a variety of instruments. Secondly, the cotton sector appears to be a victim of an overemphasis on insecticides for pest control that has led to path dependency on chemical use and production loss. There is a high amount of externalities caused by widespread unsustainable high use patterns. As it is difficult for individual farmers to switch the technology path on their own, the "public bad" of pesticide dependency has to be reduced through a concerted effort of government authorities, research, extension and farmer communities.

The data presented by Azeem show convincingly that the social costs of pesticides are significantly higher than the current market costs signal to the users. This causes an under investment in alternatives, both by private companies, government-funded research and extension services, and the farmers themselves. The amount of external costs demonstrated in the paper suggest that from a purely economic point of view the current use level of pesticides in the country should be reduced and alternative pest control measures should be introduced and promoted. The study results are therefore highly relevant for designing appropriate pesticide policies.

There are some issues that go beyond the scope of the present paper but are nevertheless important for future research. Firstly, more case studies on the impact of pesticides on agricultural production (e.g. pollination, losses of domestic animals) should be conducted to confirm the preliminary findings of Azeem. This would allow the careful extrapolation of the case study results to larger areas. Secondly, more research has to be done in the area of the impact on biodiversity. A contingent evaluation study for the value of biodiversity is suggested.

Appendix 1.5

Pesticide Policy Workshop: "Building Consensus for Action"

Discussion Points on Scientific Basis for Pesticide Externalities

Dr. Gerd Walter-Echols
FAO-EU, Bankok

This discussion covers the following sections of Chapter 7:

I. Health: Incidence, Expected Value of Damage

Occupational Poisoning
Beliefs and behaviour of pesticide applicators
Sickness incidence of pesticide applicators
Health hazards for women cotton pickers
Industrial workers contact with pesticides
Contact with pesticides at distribution, storage and disposal

2. Pesticide Residues in the Food Chain

Fruits and vegetables
Irrigation and drinking water resources
Pesticide residues in cottonseeds, oil, lint and cattle feed
Pesticide residues in animal milk
Soil analysis

The study demonstrates the efforts and labor necessary to collect convincing evidence of pesticide side effects. It gives another example, that pesticides are not handled judiciously under the prevalent conditions of a developing country. Even though farmers claim to cover bodies while spraying (more explanation needed), don't eat or drink during work and wash their hands and mouth afterwards (normal after any work?), careless handling of pesticides is widespread at any point of the pesticide chain from manufacturer to application and disposal.

Occupational Poisoning

Spray operators appear to suffer from pesticide poisoning in considerable numbers. Even though the described symptoms of "vomiting, dizziness and breathing difficulties" could also be attributed to other causes and were not compared to a control group of non-applicators, the picture described makes it very plausible to connect these symptoms with the beliefs and practices of pesticide users. The figure of 63% of households having experienced a possibly pesticide-related sickness is alarming. The slow recoveries (10 days per sickness) may indicate organo-phosphate exposure.

While the study of pesticide applicators relied largely on circumstantial evidence, the study of women cotton pickers linked beliefs and practices with the hard evidence of reduced ChE levels in the blood. The more than 20-fold difference in the group with more than 50% ChE inhibition between women pickers and non-pickers can only be attributed to pesticide exposure. The fact, that 67 % of this group experienced vomiting symptoms, provides further evidence.

Externality Category	Effects	Mio. Rs.
1. Health		
Occupational poisoning		
Pesticide applicators (? Number)	Workdays lost [10], treatment costs [1060 Rs]	
Women cotton pickers (? Number)	Suffering, workdays lost [5/7], treatment costs [47 Rs], deaths?	
industrial workers (~1,000 workers)	Workdays lost, treatment costs	
distribution, storage and disposal	-	

Very surprising was the large gender difference in awareness of pesticide side-effects: 68% of women were not aware of pesticide side-effects, as compared to 14% among males! This figure linked with the apparently widespread belief that local remedies such as the use of butter, sugar cane, candy, lemon juice, honey, herbal tea or lemon pickle will prevent poisoning, point to a dangerous combination. The low average treatment cost of 47 Rs among the women pickers compared to 1060 Rs among the pesticide applicators may point to the fact, that the poorest people are allowed to suffer the most.

The circumstantial evidence of pesticide poisoning could have been made even stronger by the list of products in use, particularly the proportion of Class 1 pesticides (e.g. Methy-Parathion) among them.

The section does not make any estimates of the costs involved. Since the number of possibly affected households was not given, the magnitude of the occupational health effects could not be estimated. However, it can be assumed, that this affects a large proportion of the population in the cotton growing area, where ¾ of all pesticides are used, amounting to a sizable external cost factor. This cost can only be reduced by (1) safer pesticides, (2) alternative practices (e.g. IPM) and (3) health education, which will discredit local remedies and increases cautious handling of pesticides.

Pesticide Residues

Even though ¾ of the pesticides are used on cotton and only 17% on vegetables and fruits, the amount of pesticides used per unit of land is most likely several times higher in horticultural crops than in cotton. This may explain the surprisingly high percentage of vegetables and fruit that were found to have residues above MRL. The common observation, that waiting periods are not observed, and the types of pesticides in use, backs up the evidence. Even though the number of samples was limited, the problem is nevertheless quite apparent and needs to be addressed, particularly if exports are involved.

The 33% of water sources with residues above MRL were surprising. These may have been shallow wells with surface water of generally poor water quality and hygiene.

The contamination of cottonseed oil and cake may have resulted from the same late-season pesticide applications that caused the poisoning symptoms among the women cotton pickers. Even though samples were only collected from 3 sites, the products represent the average contamination of a substantial primary source of cottonseeds, which were collected over a large area. Therefore, even the few samples have already significance.

The lack of residues in milk is not surprising, since organo-chlorine compounds – which were traditionally the source for milk contamination – had been phased out, and farm animals have not so much time to accumulate residues in their relatively short life span. Human milk samples, however, could reveal a different picture.

Externality Category	Effects	Mio. Rs.
1. Health		
Pesticide Residues		
Fruits and vegetables	Rejected vegetables (51%)	72.3
	Rejected apples (60%)	145.0
Irrigation and drinking water	Labor days to get clean water (33% of wells)	14.3
cotton seeds, oil, lint and cattle feed	Rejected cottonseed oil (67%)	7.2
	Rejected cottonseed cake	16.1
Pesticide residues in animal milk	-	
Soil analysis	-	

Externality costs were estimated on the basis of a hypothetical condemnation and destruction of that produce with exceeding MRL. This has not happened. Therefore these costs did not actually occur because of an absence of regulatory measures and enforcement. The same may hold true for the hypothetical labor to get non-contaminated water; in reality, the contaminated wells were not condemned and continued to serve as a water source.

Even if the destruction of the contaminated food is not yet a real external cost, the lack of consumer evidence and the resulting purchase of more expensive "clean" food from elsewhere may already be occurring.

Direct health effects of the detected residues are not known and are difficult to estimate, since the exposures are most likely still in the no-effect range for most of the population (safety factor within the MRL).

Options for Action

Policy/Enforcement

Farmers may have residues, but do they have residue-related problems? Who is willing to make them a problem? Applicators and women pickers have health problems, but who cares about it? If nobody cares why should the farmer/industry care? How can the government/society show, that it cares?

Research

Is the current level of information/understanding not yet enough to take action? What is it that cannot be done without more research? What can be done better with more research? Would the call for more research not just postpone action?

Education

Who needs to be educated? Is education enough to affect changes? For example, would education be more effective with a simultaneous show of enforcement and prosecution of offenders? How would an investment in more education compare to the potential reduction of external costs? How does this compare to alternative measures?

Definition:

External Effects – also known as externalities, spillovers and neighborhood effects – are the discrepancies between private and social costs, or private and social benefits, respectively. The key aspect of externalities is interdependence without compensation. Some individual of firm benefits without paying, or causes others to have higher costs without compensation.

A Field Practitioner's Guide to Economic Evaluation of IPM
Pesticide Policy Project, Publication Series No. 9

Appendix 2.1: Overtime Procurement/Support Price of the Major Agricultural Commodities. **(Rs/40Kg)**

Years	Wheat	Paddy 385	Paddy Irri- 6	Sugarcane Punjab	Phutti Desi
1985-86	80.00	93.00	53.00	11.79	173.50
1986-87	80.00	102.00	53.00	11.79	173.50
1987-88	82.50	130.00	55.00	11.79	173.50
1988-89	85.00	135.00	60.00	12.59	176.50
1989-90	96.00	143.50	66.00	13.75	191.50
1990-91	112.00	150.00	73.00	15.25	220.00
1991-92	124.00	155.00	78.00	16.75	255.00
1992-93	130.00	175.00	85.00	17.50	275.00
1993-94	160.00	185.00	90.00	18.00	290.00
1994-95	160.0	210.90	102.60	20.50	340.00
1995-96	173.00	222.00	112.00	21.50	340.00
1996-97	240.00	255.30	128.80	24.00	440.00
1997-98	240.00	310.00	153.00	35.00	440.00
1998-99	265.00	330.00	175.00	35.00	---------

Appendix 3.1
Weeds of Cotton in Pakistan.

Amaranthus viridis	*Convolvulus arvensis*
Corchorus tridens	*Cynodon dactylon*
Cyperus rotundus	*Desmostachya bipinnata*
Echinochloa colona	*Euphorbia prostrata*
Euphorbia helioscopia	*Euphorbia hirta*
Heliotropium euroium	*Portulaca oleracea*
Portulaca quadrifida	*Setaria spp*
Solanum xanthocarpum	*Sorgum halepense*
Trianthema mongyna	*Tribulus terrestris*

Source: ARP-II report on IPM, 1995.

Appendix 3.2
Registered insecticides to control insect pests of rice in Pakistan.

S. No.	Registered Insecticides	Common Name	Target insect pests	Company
1.	Agree (50 WP)	Bacilus thuringiensis	Lepidopteran	Novartis
2.	Condor (7.5 FS)	Bacilus thuringiensis kurstaki	Lepidopteran	Agrevo
3.	MVP bioinsecticide	Bacilus thuringiensis kurstaki	Lepidopteran	National Pesticide
4.	Larvo-Bt	Bacilus thuringiensis	Lepidopteran	National Pesticide
5.	Bactospine (1600 WP)	Bacilus thuringiensis	Lepidopteran	Pakistan Agrochemicals
6.	Thuricide (1600 WP)	Bacilus thuringiensis	Lepidoptera	Agrevo
7.	Sumthion (98 ULV, 50 EC)	Fenitriothion	Lepidopteran	Granulars (Pvt). Ltd.
8.	Malathion (95, ULV, 57 EC, 50 WDP)	Malathion	Broad spectrum	Cynamild
9.	Sumibas (75 EC, 4D)	Fenitrothion + BMC	Homopteran	Agril Chem & Dyestuff
10.	Mipcin (50 WP)	MIPC	Homopteran	Nichemin Corporation
11.	Deltanet (400 EC)	Furathiocard	Homopteran	Novartis
12.	Padan (10 G and 4G)	Cartao hydrochloride	Broad spectrum	Nichemin Corporation
13.	Nuvacron (40 SCW)	Monocrotophos	Broad spectrum	Novartis
14.	Azodrin (40 WSC)	Monocrotophos	Broad spectrum	Pakistan Burm Shell
15.	Karate (2.5 EC, 2 ED & 0.8 ULV)	Lembda Cyhalothrin	Broad spectrum	ICI Pakistan
16.	Rogor (40 EC & 65 ULV)	Dimethoate	Broad spectrum	Alintco Pvt. Ltd.
17.	Sevin (85 SPO)	Carbaryl	Broad spectrum	Rhone-Poulenc Pakistan
18.	Sevidol (4 + 4 GO)	Carbaryl + BHC	Broad spectrum	Rhone-Poulenc Pakistan
19.	Orthane (40 EC, 75 SP & 5 G)	Acephate	Broad spectrum	R. B. Avari & Co.
20.	Lannate (90 WSP & 29 LU)	Methomyl	Broad spectrum	Du Pont Far East.
21.	Curatter (3 G)	Carbofuran	Broad spectrum	Chemdyes Pakistan
22.	Diafuran (3 G)	Carbofuran	Broad spectrum	Nichemin Corporation
23.	Furadan (3 G & 10 G)	Carbofuran	Broad spectrum	FMC Pakistan
24.	Birlane (24 EC & 10 EC)	Chlorfenvinohos	Broad spectrum	Cynamid Pakistan
25.	Basudin (14 G, 10 G & 5 G)	Diazinon	Broad spectrum	Novartis
26.	Diazinon (14 G, 10G, 5G)	Diazinon	Broad spectrum	EPAID CO.
27.	Miral (2G)	Isazofos	Broad spectrum	Novartis
28.	Cidial (5G)	Phenthoate	Broad spectrum	GHR Pvt. Ltd.
29.	Evisect (5G)	Thiocyclam hydrogenoxalate	Broad spectrum	Agrevo

Appendix 3.3
Weeds of rice

Alternathera sessilis	*Amaranthus graecizans*
Amaranthus viridus	*Ammania auriculata*
Ammania multiflora	*Chenopodium murale*
Cornopus didymus	*Cynodon dactylon*
Cyperus difformis	*Cyperus iria*
Cyperus rotundus	*Dactyloctenium eagyptium*
Dichanthium annulatum	*Digitaria ciliaris*
Eachinochloa colona	*Echinochlod crus-galli*
Eclipta prostrata	*Eichhornia crassipes*
Eragrostis poaenoides	*Euphorbia indica*
Fimbristylis ferruginea	*Fimbristylis quinquangularis*
Ipomoea aquatica	*Justica peploides*
Lemna gibba	*Malva microcarpa*
Marcelia minuta	*Medicago polymorpha*
Oxalis corniculata	*Paspalum disticum*
Paspalum paspaloides	*Phyla nodiflora*
Polygonum barbatum	*Ranunculus muricatus*
Sagittaria trifolia	*Scirpus littoralis*
Scirpus maritimus	*Scirpus roylei*
Setaria pumila	*Silybum marianum*
Sorghum halepense	*Stellaria media*
Sphenoclea zylanica	*Typha domingensis*
Xanthium strumarium	

Adapted from Gorsi *et al.* (1991) and Khan *et al.* (1987)

Appendix 3.4
Weeds of sugarcane.

Achyranthes aspera	*Amaranthus blitum*
Amaranthus polygamus	*Amaranthus viridis*
Anagallis arvensis	*Asphodelius tenuifolius*
Brachiaria remosa	*Capsella bursa pectoris*
Chenopodium album	*Circium arvense*
Cleome viscosa	*Convolvulus arvensis*
Convolvulus pluricaulis	*Corchorus didymus*
Corchorus olitorius	*Corchorus tricularis*
Corchorus tridens	*Coronopus didymus*
Cressa asiatica	*Cynodon dactylon*
Cyperus rotundus	*Dactyloctenium aegyptium*
Desmostachya bipinnata	*Dicanthium annulatum*
Digera arvensis	*Digera latemifolius*
Digitaria sanguinalis	*Echinochloa crus-galli*
Echinochloa colona	*Eleusine indica*
Eragrostis diarrehna	*Eragrostis pilosa*
Erigeron bonariensis	*Euphorbia helioscopia*
Euphorbia hypericifolia	*Euphorbia pilulifera*
Euphorbia prostrata	*Fumaria indica*
Launaea nudicaulis	*Lipi nodiflora*
Medicago denticulata	*Melilotus indica*
Phylanthus nitruri	*Poa annua*
Polygonum plebeium	*Portulacca oleracea*
Rumex dentatus	*Senebiera didyma*
Sesania aegyptica	*Sesbania aculator*
Striga sp	*Solanum nigrum*
Sorghum halepense	*Taraxacum officinale*
*Trianthema monogyna**	*Trianthema pentandra*
Tribulus terrestris	*Xanthium strumarium*

Adopted from: Rahim *et al.* (1987) and ARP-II IPM report, 1995.

Appendix 4.1
Nominal and Real Price of Seed Cotton (*Phutti*)

(Rupees per 40kg)

Year	CPI	Nominal Price		Sarmast. MNH-93	Real Price		Sarmast, MNH-93
		Desi	B-557, Niab		Desi	B-557, Niab	
1981-82	55.61	166	178	192	298.50	320.08	345.25
1982-83	58.21	168	183	197	288.62	314.38	338.44
1983-84	62.45	169	186	200	271.42	297.84	320.26
1984-85	65.99	169	189	203	256.87	286.42	307.63
1985-86	68.86	173	193	207	251.96	280.28	300.61
1986-87	71.34	173	193	207	243.21	270.54	290.17
1987-88	75.83	173	193	207	228.81	254.52	272.98
1988-89	83.71	176	196	210	210.85	234.15	250.87
1989-90	88.76	191	211	225	215.74	237.71	253.49
1990-91	100.00	220	245	260	220.00	245.00	260.00
1991-92	110.58	255	280	290	230.60	253.21	262.25
1992-93	121.45	275	300	310	226.43	247.02	255.25
1993-94	135.14	290	315	325	214.59	233.09	240.49
1994-95	152.73	340	400	423	222.62	261.90	276.96
1995-96	169.21	340	400	423	200.93	236.39	249.99
1996-97	189.18	440	500	540	232.58	264.30	285.44
1997-98	203.96	440	500	540	215.73	245.15	264.76
	215.68						

Nominal prices deflated by CPI (1990-91=100)

The CPI for 1981-82 to 1989-90 has been converted from 1980-81 =100 base using splicing method.

Source: Economic Survey 1998-99 (Statistical Supplement), and APCom

Appendix 4.2
Nominal and Real Price of Paddy Rice

(Rupees per 40 kg)

Year	Nominal Price		Real Price	
	Basmati-385	Irri-6	Basmati-385	Irri-6
1981-82	85	45	152.85	80.92
1982-83	88	49	151.18	84.18
1983-84	90	51	144.12	81.67
1984-85	90	51	136.39	77.29
1985-86	93	53	135.06	76.97
1986-87	102	53	142.98	74.29
1987-88	130	55	171.44	72.53
1988-89	135	60	161.28	71.68
1989-90	143	66	161.67	74.36
1990-91	150	73	150.00	73.00
1991-92	155	78	140.17	70.54
1992-93	175	85	144.09	69.99
1993-94	185	90	136.90	66.60
1994-95	210	102	138.09	67.18
1995-96	222	112	131.20	66.19
1996-97	255	128	134.95	68.08
1997-98	310	153	151.99	75.01
1998-99	330	175	153.00	81.14

Nominal prices deflated by using CPI (1990-91=100)
Source: APCom, GOP

Appendix 4.3 Cost of Plant Protection Measures Adopted for Cotton Seed

(rupees per acre)

Year	Cotton (Punjab)	Cotton (Sindh)
89-90	580.56	263.49
90-91	649.46	296.01
91-92	845.96	307.39
92-93	915.16	334.67
93-94	994.32	360.27
94-95	1007.88	369.28
95-96	1136.00	417.15
96-97	1136.00	417.15
97-98	1907.07	1726.92
98-99	1907.07	1726.92
99-00	1918.63	1737.88

Source: APCom, GOP

Appendix 4.4 Cost of Plant Protection Measures Adopted for Paddy Rice

(rupees per acre)

Year	Basmati (Punjab)	Irri (Punjab)	Irri (Sindh)
1991	27.43	54.39	92.6
1992	29.93	59.36	101.73
1993	33.40	66.22	112.35
1994	33.86	67.12	115.16
1995	37.40	74.08	126.41
1996	37.40	74.08	126.41
1997	334.89	420.45	206.05
1998	334.89	420.45	206.05
1999	337.19	423.38	207.67

Source: APCom, GOP

Appendix 4.5 Price Index* of Seed Cotton and Paddy Rice (1990-91=100)

Year	Seed Cotton	Paddy Rice
1981-82	73	59
1982-83	75	62
1983-84	76	64
1984-85	77	64
1985-86	79	66
1986-87	79	70
1987-88	79	82
1988-89	80	87
1989-90	86	93
1990-91	100	100
1991-92	114	105
1992-93	122	117
1993-94	129	123
1994-95	163	141
1995-96	163	150
1996-97	204	173
1997-98	206	208
1998-99		228

* *Laspeyres Price Index*

Appendix 4.6 Availability of Pesticide in Pakistan

Year	Quantity (tonnes)	3 years moving average
1971-72	2438	#N/A
1972-73	10484	#N/A
1973-74	6474	6465
1974-75	6928	7962
1975-76	13258	8887
1976-77	16226	12137
1977-78	12754	14079
1978-79	7727	12236
1979-80	4419	8300
1980-81	665	4270
1981-82	3677	2920
1982-83	5000	3114
1983-84	6588	5088
1984-85	9213	6934
1985-86	12530	9444
1986-87	14499	12081
1987-88	14848	13959
1988-89	13072	14140
1989-90	14607	14176
1990-91	14743	14141
1991-92	20213	16521
1992-93	23367	19441
1993-94	20279	21286
1994-95	24869	22838
1995-96	43373	29507
1996-97	43219	37154
1997-98	44872	43821
1998-99	41576	43222
1999-00	45680	44043

Source: Agricultural Statistics of Pakistan (various issues)

Appendix 4.7 Price Index of Pesticide and Fertilizer

Year	Pesticide Price Index* (1990=100)	Fertilizer Price Index (1990=100)
1990	100	100
1991	108	107
1992	126	118
1993	132	122
1994	147	142
1995	153	162
1996	192	188
1997	222	193
1998	197	204

Source: Only PAPA sale data was used to calculate *Laspeyres* index.
Fertilizer data was taken from NFDC, Islamabad.

Appendix 4.8 Real Wage Rate of Unskilled Agricultural Labour and Herbicide Price and Quantity Index

Year	Real Wage Rate*	Price Index (1990-91=100)	Quantity Index** (1990-91=100)
1990-91	37.1	100	100
1991-92	35.3	116	90
1992-93	34.9	141	88
1993-94	32.7	150	103
1994-95	34.1	169	136
1995-96	33.1	186	139

* Deflated by CPI (base year = 1990-91)
** *Laspeyres* quantity index

Appendix 4.9 Comparison of Exchange Rate and Pesticide Price Index

Year	Exchange Rate	Pesticide Price Index
1990	21	100
1991	22	108
1992	25	126
1993	26	132
1994	30	147
1995	31	153
1996	34	192
1997	39	222
1998	43	197
1999	47	199

Source: Economic Survey 1998-99 - Statistical Supplement)

Appendix 4.10 Credit Disbursed Against Hypothecation of Cotton Crop (1970-71 to 1981-82)

(Rs million)

Year	Amount
1970-71	2.35
1971-72	3.98
1972-73	3.93
1973-74	3.93
1974-75	0.61
1975-76	1.35
1976-77	1.06
1977-78	2.20
1978-79	5.67
1979-80	23.48
1980-81	27.02
1981-82	41.34

Source: ADBP Annual Report (various issues)

Appendix 4.11 Credit Disbursed for the Purchase of Pesticide and other Crop Inputs (1970-71 to 1981-82)

(Rs million)

Year	Credit Disbursed for Pesticides	Fertilizer	Seed
1980-81	27	111	24
1981-82	41	187	54
1982-83	22	260	57
1983-84	45	354	73
1984-85	95	562	111
1985-86	202	690	130
1986-87	280	579	129
1987-88	445	711	218
1988-89	620	848	320
1989-90	718	879	351
1990-91	669	1061	392
1991-92	967	1348	372
1992-93	701	1171	383
1993-94	528	1094	293
1994-95	1438	3031	1067
1995-96	1445	3161	1045
1996-97	1539	2946	954
1997-98	3269	6980	2661
1998-99	5446	11220	4218
1999-00	3445	8454	3387

Source: ADBP Annual Report (various issues)

Appendix 4.12 Aerial Spraying in Pakistan, (1970-71 to 1998-99)

Year	Sprayed Area (000 Hectares)
1970-71	486
1971-72	826
1972-73	837
1973-74	1248
1974-75	1585
1975-76	1825
1976-77	2196
1977-78	1315
1978-79	920
1979-80	380
1980-81	250
1981-82	240
1982-83	270
1983-84	250
1984-85	319
1985-86	173
1986-87	294
1987-88	270
1988-89	80
1989-90	80
1990-91	110
1991-92	231
1992-93	376
1993-94	36
1994-95	89
1995-96	0
1996-97	62
1997-98	79
1998-99	49

Source: Agricultural Statistics of Pakistan (various issues)

Appendix 7.1 Acceptable Daily Intake (ADI, mg/Kg body weight) and Maximum Residues Limits (MRLs, mg/Kg) of selected pesticides in some foods of plant origin.

Pesticides	ADI	Brinjal	Okra	Bitter gourd	Squash	Apple	Cottonseed Oil/Cake
Carbofuran	0.01	0.1	0.1	0.1	0.1	0.1	0.1
Dichlorvos	0.004	0.5	0.5	0.5	0.5	0.1	-
Phosphamidon	0.0005	0.2	0.2	0.1	0.1	0.5	-
Esfenvalerate	0.02	0.5	0.5	0.5	0.5	2.0	0.1
Dimethoate	0.01	1.0	1.0	1.0	1.0	1.0	-
Lindane	0.008	-	-	-	-	0.5	-
Diazinon	0.002	0.5	0.5	0.5	0.5	0.5	0.1
Methyl-parathion	0.02	0.2	0.2	0.2	0.2	0.2	0.05
Fenitrothion	0.005	0.1	0.1	0.05	0.05	0.5	-
Malathion	0.02	0.5	0.5	-	-	2.0	-
a-endosulfan	0.006	2.0	2.0	2.0	2.0	1.0	0.5
Azinphos-methyl	0.005	0.5	0.5	0.5	0.5	1.0	0.2
Cypermethrin	0.05	0.2	0.2	0.2	0.2	2.0	0.2
Deltamethrin	0.01	0.2	0.2	0.2	0.2	0.1	0.1

Source: Codex Alimentarius, (1993). Vol. 2, Ed. 2. + Supplement 1. Pesticide residues in food.
Joint FAO/WHO food standards program Codex Alimentarius Commission

Appendix 7.2 Pesticide residues (mg/Kg) in Cotton seed oil from different locations in Multan Division.

Pesticides	Location I		Location II		Location III	
	I	II	I	II	I	II
Carbofuran	-	-	-	-	-	-
Dichlorvos	0.075	0.074	0.094	0.085	1.272	1.300
Phosphamidon	0.167	0.170	0.192	0.186	-	-
Esfenvalerate	-	-	-	-	-	-
Dimethoate	1.784	1.781	-	-	-	-
Lindane	0.026	0.029	-	-	-	-
Diazinon	-	-	-	-	-	-
Methyl-parathion	-	-	1.112	1.106	0.513	0.509
Fenitrothion	0.050	0.048	1.070	1.074	0.361	0.400
Malathion	0.059	0.062	4.195	4.121	0.581	0.567
a-endosulfan	-	-	-	-	-	-
Azinphos-methyl	-	-	-	-	-	-
Cypermethrin	-	-	-	-	-	-
Deltamethrin	-	-	-	-	-	-
TOTAL	2.161	2.164	6.663	5.572	2.727	2.776

Location I = CSO-6a, Location II =CSO-5a, Location I =CSO-4a,

Appendix-7.3 Pesticide residues (mg/Kg) in Cottonseed cake from different locations in Multan Division.

Pesticides	Location I		Location II		Location III	
	I	II	I	II	I	II
Carbofuran	-	-	-	-	-	-
Dichlorvos	0.215	0.218	0.112	0.109	0.064	0.059
Phosphamidon	0.212	0.209	-	-	-	-
Esfenvalerate	0.012	0.010	0.020	0.023	-	-
Dimethoate	2.185	2.188	1.590	1.602	0.182	0.178
Lindane	-	-	-	-	0.011	0.014
Diazinon	0.200	0.197	0.044	0.041	0.002	0.002
Methyl-parathion	0.843	0.836	0.109	0.110	0.043	0.037
Fenitrothion	0.245	0.249	0.300	0.295	0.897	0.904
Malathion	0.598	0.601	1.770	1.680	4.011	4.050
a-endosulfan	-	-	-	-	-	-
Azinphos-methyl	-	-	-	-	-	-
Cypermethrin	-	-	-	-	-	-
Deltamethrin	-	-	-	-	-	-
TOTAL	4.510	4.508	3.945	3.860	5.210	5.244

Location I = CSC-6a, Location II = CSC-5a, Location I =CSC-2a

Appendix 7.4 Pesticide residues (mg/Kg) in randomly collected composite soil samples in Multan Division

Pesticides	No. of sites	Depth-I	Frequency	Depth -II	Frequency
Carbofuran	2	0.09 - 0.20	2	Traces	1
Dichlorvos	5	0.05 - 0.24	5	0.01 - 0.17	4
Phosphamidon	2	0.04 - 0.20	2	0.03	1
Esfenvalerate	3	Traces	3	0.01 - 0.11	3
Dimethoate	3	0.14	1	0.10 - 0.31	3
Lindane	2	-	0	Traces - 0.02	2
Diazinon	4	0.01 - 0.17	4	0.01 - 0.04	3
Methyl-parathion	6	0.03 - 0.89	6	0.03 - 0.77	5
Fenitrothion	6	0.47 - 1.22	6	0.15 - 0.73	6
Malathion	5	0.36 - 1.73	5	0.14 - 1.57	5
a-endosulfan	2	0.19 - 0.27	2	Traces	2
Azinphos-methyl	4	0.42	1	0.07 - 1.90	4
Cypermethrin	-	-	-	-	-
Deltamethrin	-	-	-	-	-

(-) stands for not detected.
Each figure represents mean of the two replicates with CV range ± 2 - 8%.

Appendix 9.1

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Appendix 9.2

Conceptual Framework of National Integrated Pest Management Programme

Rationale

In the sixties and seventies, in a bid to increase production due to population pressure, among other approaches, pesticides found support to prevent the loss of productivity in Pakistan. This led to pro-pesticide government policies resulting in their increased use. Since 1980, when pesticides import, distribution and sale were transferred from public to private sector, the pesticide consumption has risen manifold. By 1999, an overall increase of 1139% has occurred. This had led to misuse/overuse of pesticides and their negative impacts have been observed including residues in food chain, contaminated ground and supply water, extinction of wildlife, loss of biodiversity and threat to human health etc.

Pesticide use and productivity are mostly considered to be positively correlated analysis shows that this may not be the case always. In Pakistan this is a reality where, although pesticide use in cotton is constantly increasing, the productivity is not. Generally it is believed that it is not possible to get as much or higher productivity, using methods and approaches other than pesticides. But this is not so; for example, in case of wheat, management of rusts, has been successfully demonstrated using host plant resistance; whereby, improved genotypes of wheat with higher yield potential and rust resistance are being continuously developed through the National Wheat Improvement Programme comprising of national wheat breeders, National Wheat Coordinated Programme and Crop Diseases Research Institute. Similarly, in cotton and vegetables IPM approaches have been successful and both research as well as practice of IPM at farm level has shown success. The most recent example being the ToT and FFS model tested in Vehari popularly known as the "***Vehari Project***", where pesticide use was considerably reduced without affecting production through farmer participatory skill enhancement programme using ecological principles.

Although, work on research and development, and IPM practice was initiated a long time ago in Pakistan and has gained momentum in the last decade through both national and international cooperation projects, IPM has not been institutionalized as in other countries. It has to be placed as a coherent programme including all components at the federal and provincial level. There is awareness and commitment at the highest level in the Government to rationalize the use of pesticides and to adopt the alternative approaches and strategies based on IPM rationale. To achieve this, it is necessary to translate the Governments strategy into action plan whereby the IPM moves from project approach to a viable and sustainable national programme.

IPM was identified as a key element of sustainable agricultural development in the Policy and Strategy for Agriculture developed by Government of Pakistan as part of its response to increasing misuse/overuse of pesticides and their negative impacts on the society in the Country. This commitment is reflected in the Chief Executive's speech on 28th May 2000 at the 2nd anniversary of atomic explosion urging agricultural sector to rationalize the use of pesticides. A consultative process among potential stakeholders has begun, which would culminate in the launching of the National Integrated Pest Management Programme (Nat-IPM).

National IPM Programme (Nat-IPM)

National IPM Programme would be guided by the IPM Inter-Ministerial Advisory Committee, which has been established by MINFAL and is headed by the Secretary MINFAL. The overall goals of the Programme are established in the light of the policy statement given in the policy and strategy document, "Agricultural Strategies for the First Decade of New Millenium" issued in June 2000. The agreed programme would be implemented by partner organizations a0 nd coordinated by Nat-IPM. Currently, a project management unit has been established at National Agricultural Research Centre Islamabad under the auspices of Pakistan Agricultural Research Council – an apex body of the Ministry of Food, Agriculture and Livestock. Various federal and provincial public sector research and development organizations, NGOs and international organizations may participate actively in the Nat-IPM. The Nat-IPM would develop task forces, led by individual research and development organizations, to develop a coherent response to key issues and challenges affecting IPM research and implementation in the country.

Vision Statement

Achieve environmentally sound and sustainable agricultural production ensuring food security, social equity, self-reliance and economic welfare of the producer.

Goal

Large scale and sustainable implementation of IPM in Pakistan, rationalizing the use of pesticide while maintaining production levels and increasing farmers' profit.

Purpose

The National IPM Programme will be established for the purposes of:

- Improved management of insects, diseases, nematodes, weeds and rodents,
- Educating the public and agricultural community and
- Integrating crop management and cultural practices, field scouting, economic thresholds and biochemical & biological control to reduce the use of chemical pesticides.

Objectives

The overall objective is to ensure better coordination and adoption of effective IPM approaches that are more responsive to the needs of practitioners and clients

Specific Objectives

- Enhance communication, coordination and strengthen collaboration among IPM stakeholders.

- Make efforts to promote ecologically sound and issue oriented IPM approaches for the befit of the society.
- Facilitate the formulation and execution of projects, advocating optimum use of available resources to enhance productivity of cropping systems.
- Communicate the results of these efforts, the benefits of IPM and relevant policy decisions to the public widely.
- Establish International Linkages.

Strategic Steps and Actions

- Facilitate review of plant protection and IPM policies.
- Introduce/promote IPM philosophy in educational institutions by pursuing respective departments for inclusion of IPM policies and syllabi in schools, colleges and universities.
- Enhance public awareness and establish IPM information network (NIPMIN) to provide updated science based information to the stakeholders.
- Promote and coordinate research & development in IPM including study of various agro-ecosystems and indigenous knowledge.
- Facilitate and coordinate IPM implementation by provincial extension departments and promote cooperation & collaboration between institutions and provinces.

The National IPM Programme shall include policy analysis, education, information dissemination & public awareness, research & development and field implementation. Above steps will be pursued in a manner that encourages:

- Expanded research on biological and cultural pest management technologies and on crop and pest resistance issues.
- Use of sampling methods, economic thresholds, monitoring technology, pest forecasting and the effects of weather on pest and crop parameters.
- Delivery of current and new IPM technologies to the agricultural industry through cooperative extension.
- Minimized levels of pesticides in feed, food and the environment.
- Minimized economic losses due to crop, animal and storage/post harvest pests.

  Expanded farmer participatory research and training.

Policy analysis

Policies are made for the well being of the society and they must commensurate with the developments so fast happening around the world. Thus the policies require review from time to time in order to be compatible and progressive. The Nat-IPM Programme would facilitate such reviews of plant protection and IPM policy as and when required or as advised by the Inter-Ministerial Advisory Committee and will provide feed back for onward recommendation to the Government. The Nat-IPM would thus designate a policy analyst who will coordinate all such activities.

Education

Implementation of any programme into action requires manpower, having knowledge and understanding of that particular field, best achieved through education. Increased pesticide use has created health and environmental problems, therefore, need is to create the awareness among general public to develop pressure groups against pesticide misuse and train IPM specialists who can develop new and alternative pest management technologies. This could only be achieved by introducing IPM philosophy in schools leading into special IPM courses at university level, not done currently. The Programme will pursue the respective departments for the inclusion of such syllabi in schools, colleges and universities. This will also help organize special IPM courses/trainings for current teachers to develop a strong cadre of educationists in IPM philosophy and practice.

Information dissemination and public awareness

Information generated can only be useful if delivered in a manner that is understood by the users. This should not only sensitize them about the issue, but also help in increasing responsiveness, resulting in achieving the goal i.e., adoptions of given technology package. The Programme will create a National IPM Information Network (NIPMIN), which would be dedicated to making the latest, most accurate and science-based unbiased information on pest management available to the stakeholders, through establishment of data base and web-site at federal, provincial and local levels. Programme will work on development of effective delivery system so that, the messages conveyed are adopted by the stakeholders. To create awareness among policy makers, researchers, teachers, intellectuals and general public, all forums and means of information will be used, so that the society by and large is sensitized to hazards and rational use of pesticides.

Research and Development:

Research and development is an integral part of dynamic system without which, development does not occur. Dynamic as agro-ecosystem is therefore, changes do take place in time and space, necessitating continuous eco-system monitoring and analysis. The Programme through an R&D Coordinator will interact with provincial units on this aspect and would help in initiating need based R&D activities and if needed, will provide and/or arrange technical assistance. R & D activities require funds on regular basis and the Programme would seek funds from different sources and convince through MINFAL, the funding agencies including International sponsors to support the R&D activities in the IPM sector.

Field implementation (IPM practice)

Field implementation of any agricultural practice is done by Agriculture Extension Departments in the provinces. Thus the implementation of IPM practices/activities in the field have to be by provincial authorities working at farm level. The Nat-IPM however, shall coordinate various activities in different provinces so that the inter-provincial experience sharing is developed. The Programme will also coordinate with various national agencies, NGOs such as Rural Support Programmes and international organisations for promoting effective IPM practices in the country. Provincial coordinators will also be nominated in consultation with National IPM Implementation Committee and respective provincial departments, who will keep contact with Nat-IPM, provincial policy makers and within the provincial system. The agricultural officers with the help of field assistants will be the main force for implementing IPM technologies, while Deputy Directors Agriculture (DDAs) will monitor the activities and keep contact with provincial coordinator.

Modus Operandi

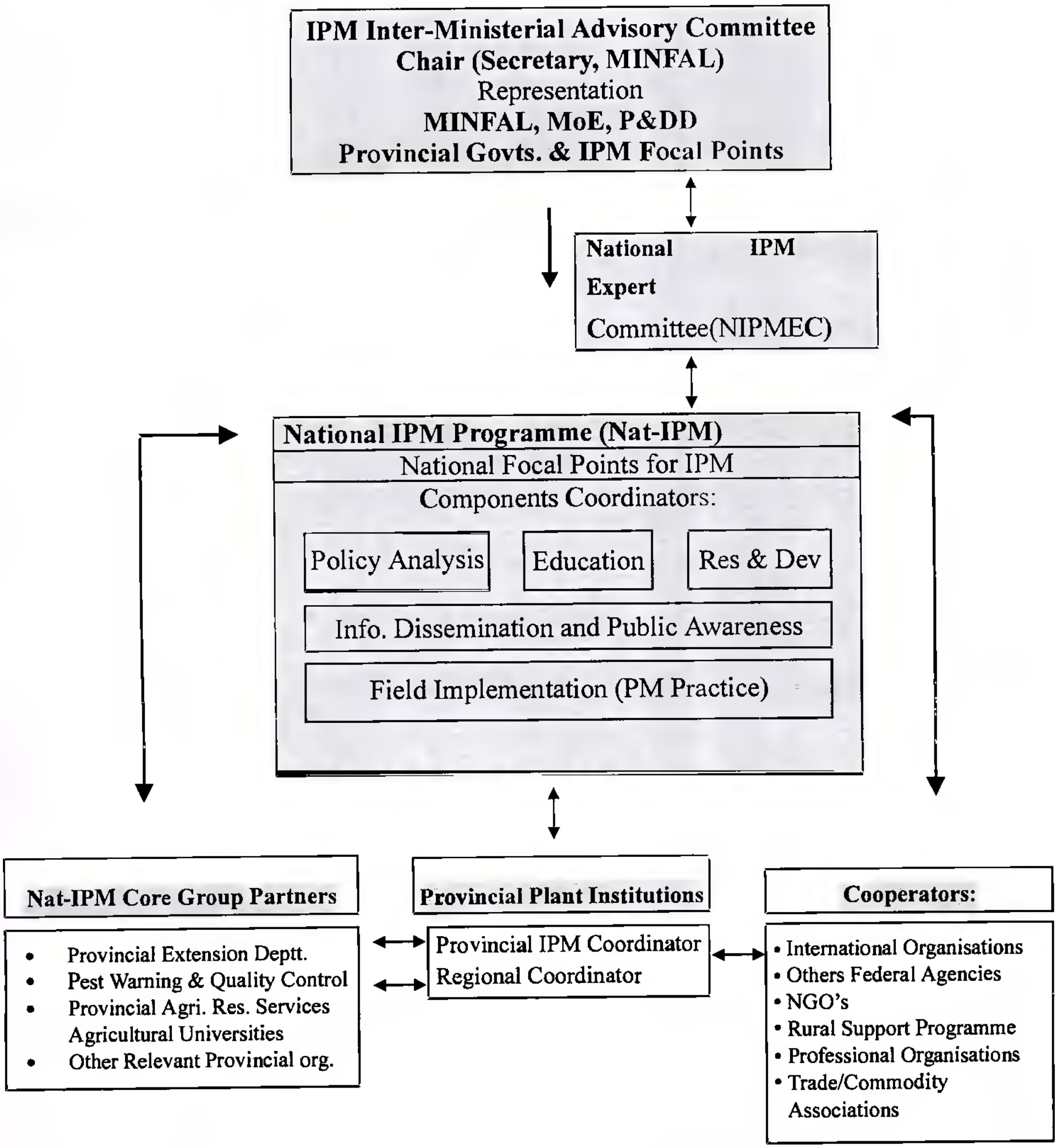
The National IPM Programme (Nat-IPM) will be led by the National Focal Point for IPM as the overall Coordinator and assisted by five component coordinators, one each for policy analysis, education, information dissemination & public awareness, research & development and field implementation (Annex-1). Nat-IPM would work under the guidance of IPM Inter-Ministerial Advisory Committee (IPM-IMC) and would be technically supported by the National Expert Committee (NIPMEC). It will keep close liaison with NIPMEC members, relevant federal and provincial research and extension departments, committees and IPM units. It will also encourage interaction between various institutions.

IPM-IMC is a policy making body chaired by the Secretary MINFAL and represented by MINFAL, Ministry of Environment, Planning and Development Division, Provincial Governments and the MINFAL Focal Point for IPM as its Secretary (Annex-2). While NIPMEC is an expert committee, comprising of experts, in all the disciplines of plant protection sector from various federal as well as provincial institutions as determined by the IPM-IMC (Annex-3). NIPMEC will steer the Nat-IPM and will devise and develop strategies for promotion of IPM as well as identify and prioritize areas for IPM R & D. It will also assist the Government of Pakistan through the IPM-IMC in formulating IPM policies.

Currently, there are three on-going IPM projects at federal level, which would ultimately take the shape of a nationally established IPM Pprogramme.

Annex a

National IPM Programme



IPM Inter-Ministerial Advisory Committee (IPM-IMC)

Objective: The objective of the Committee is to promote IPM in the Country through policy development, reform and adoption

Functions:

- Provide a platform/forum for consultation of various stakeholders;
- Provide vision and guidance in the implementation of IPM;
- Facilitate effective and efficient execution of IPM by coordination and ensuring cooperation of stakeholders;
- Periodically review and monitor the progress of the IPM implementation program.

Membership:
The Advisory Committee (IPM-IMC) chaired by the Secretary, Ministry of food, Agriculture and livestock (MINFAL) will have Membership representation from MINFAL, Ministry of Environment, Planning and Development, Provincial Governments and International Organizations. The National IPM Focal Point/Coordinator will act as Member/Secretary.

National IPM Expert Committee (NIPMEC)

Objective: Objective of the NIPMEC is to assist the IPM Inter-Ministerial Advisory Committee IPM-IMC) and Nat-IPM on technical matters to help translate the policies recommended by IPM-IMC and approved by Government of Pakistan in to action.

Functions:

The Committee will function more like an IPM Technical Committee or a Think Tank. It will:

- Identify and prioritize areas for IPM R & D.
- Devise and develop strategies for promotion of IPM.
- Advise and steer national IPM implementation programme.
- Assist the GOP through the IPM-IMC in formulating IPM policies. Suggest to the National IPM Programme, the venues for global cooperation and collaboration
- Suggest organization of meetings/workshops on IPM.

Membership:

The NIPMEC will be chaired by the National Focal Point for IPM and will have membership representation from experts from various institutions as determined by the IPM-IMC. Donors may join the meetings when necessary or when funding for a project proposed by NIPMEC is under consideration.

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