ANALYSIS OF PESTICIDE USE IN PAKISTAN

A MULTI-DISCIPLINARY STUDY TEAM REPORT

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SUMMARY

Agriculture is the foundation of the economy of Pakistan. It provides food for its rapidly growing population and a source of raw material for its principal industries. The present population is over 65 million and about three-fourths live in rural areas. Agriculture directly accounts for 35% of the GNP. However, at the present time it is estimated that 80% of the population is malnourished. The government is making every effort to increase agricultural production. Pakistan's potential agricultural production is tremendous. The Indus Plain area contains the world's largest integrated irrigation system of about 30 million acres. Since the beginning of the green revolution in 1960, the total production of cotton, rice, and sugarcane has more than doubled. However, many factors limit current production. Efficient pest management systems are vital to protect the crops from serious attack by various insects, weeds, and pathogens. A limited quantity of modern pesticides have been introduced into a relatively non-mechanized agricultural system.

The mission of this study team was to provide technical assistance on the efficiency and safe use of agricultural pesticides. The team traveled extensively in the agricultural areas and observed the local conditions of pesticide manufacture, formulation, distribution, storage, and application. In addition, the team considered the potential pollution of pesticides in the local environment and the possible effects on public health.

Considering the world shortages of food and energy it is imperative that the efficiency of agricultural production be increased. Likewise, pesticides are precious world commodities. Procedures and techniques developed to minimize pesticide losses during transport, storage and application may produce real economic savings as well as minimize hazards to health and pollution of the environment.

Specific suggestions are given on pesticide regulations related to registration, establishment of toxicity categories, and a special "restricted" use category for certain dangerous compounds. Suggestions are given on methods to increase the involvement of the private sector in the sales and distribution of pesticides with the Agricultural Extension Service providing an increased effort in demonstrations, advisement and education on use of pesticides. Rigid standards for quality control on granular formulations of highly toxic pesticides are of utmost importance.

Several factors related to reducing losses and hazards during distribution are mentioned. This includes distribution in consumer-sized containers, attachment of label with ingredients, precautions and directions for use on each container. Also mentioned are minimum standards for strength of containers and storage conditions to minimize losses during transport or due to severe climatic conditions.

A professional agricultural engineering research section should be established to design and develop suitable pesticide application equipment for conditions in Pakistan. This unit could effectively assist in training Agricultural Extension staff on application techniques to improve efficacy and minimize hazards. Toxic compounds placed in a "Restricted" use category should only be applied by qualified applicators which utilize specified protective clothing. Research is also needed to determine effectiveness and possible losses for aerial ULV applications. In diversified farming areas, highly toxic materials should not be applied by aerial ULV applications.

It is essential that a program be developed to monitor the pesticide pollution of crops and the environment. Exported products should be carefully monitored to avoid severe economic loss if rejected on the world market. An educational program is needed to alert the public to hazards of collecting food or forage from adjacent to treated fields. There should be federal support of health oriented agencies to establish centers to assist in the diagnosis and treatment of pesticide poisoning cases. All agricultural agencies should be equipped with first aid kits for treatment of organophosphate and other pesticide emergency treatments. A central registry should be established to document all pesticide poisoning of humans, fish, wildlife and livestock. Federal funds should be provided to support field research studies on human health problems of pesticides and educational programs on pesticide safety.

There should be active coordination between agriculture, health and the military in matters of pesticide usage. Pest management research should be conducted to determine optimum utilization of pesticides and alternatives to minimize necessity for synthetic pesticides. The government should consider sponsoring future seminars in pesticide safety with multidisciplinary participation.

I. RECOMMENDATIONS

A. PESTICIDE REGULATIONS

1. Non-agricultural sale and use of pesticides should be regulated. Highly toxic pesticides and certain others should not be available to the general public or sold in local markets.

2. Pesticide registration requirements. Registration of all pesticides should be based on performance and residue data from treatments using the type of equipment that will be used under actual field conditions. Regulations should prohibit unregistered use of any pesticide. Performance and residue data should be required from applications at least four times the recommended rate. Since much of these pesticides are applied by hand it is conceivable that the recommended rate could easily be exceeded by this amount. These high rates would provide important information on possible plant damage or residues that are likely to occur from field use.

3. Toxicity categories. For purposes of cautionary labeling, toxicity categories should be defined with respect to formulation and routes of exposure. Toxicity categories used in the United States could serve as useful guidelines. Also, a study should be made of various graphic symbols that might be used to alert illiterate farmers to the relative dangers of pesticides.

4. Pesticides approved by the government for use in Pakistan should be limited to those which are most useful and safe to handle under local conditions. While one can set rather definite standards for toxicity, usefulness is a relative term which depends upon the availability and number of alternative materials, relative cost ease of handling, and of course effectiveness under the various conditions of anticipated use. In our view usefulness can only be determined by a consensus of technical experts who are familiar with the performance of pesticides in their areas. On the basis of acute dermal toxicity to experimental animals and use experience in the United States, we suggest that the following pesticides approved for use in Pakistan are particularly dangerous for spray applicators.

a. Azodrin^{R}

b. Bidrin^{R} (Carbicron^{R})
c. dieldrin
d. methyl parathion

e. phosphamidon, (Dimecron^{R})
f. dichlorvos (DDVP)

We recommend that this group of chemicals, plus additional ones as required, be put into a "Restricted" use category. Applications of chemicals in this category should be restricted to qualified applicators and used only if satisfactory protective clothing is available and utilized.

Phorate (Thimet^{R}), aldicarb (Temik), and disulfoton (Disyston^{R}) which are also highly toxic are not included since they are used only in the form of granules in Pakistan. As such their dermal toxicities are greatly reduced provided the granules are nearly dust-free. However, "dusty" formulations of

phorate and disulfoton have caused illnesses and deaths in Pakistan as related elsewhere in this report. Since these materials are broadcast by hand we strongly suggest that studies be conducted soon to determine what effect they may have on blood cholinesterase levels. The manufacturers of these products should be requested to participate in these studies and provide the necessary financial support as a condition for continued registration.

Microencapsulation of pesticides offers a method to reduce dermal toxicity of spray formulations. At the present time methyl parathion is available in a microencapsulated formulation (PENCAP M^{R}) that can be applied as a spray with reduced hazard to the applicator.

B. PROCUREMENT AND ADMINISTRATION OF PESTICIDES

1. The Agricultural Extension Service in each province should be relieved of all responsibility for distributing, selling, and applying pesticides so they can devote more effort to demonstrations and teaching.

2. A procedure should be initiated which will assure private distributors of a timely supply of pesticide products. This is necessary to encourage the private sector to furnish adequate sales outlets and technical services. The present markup of 35% permitted distributors, should be subjected to a careful cost analysis to determine if this margin will permit repackaging in small containers, transportation, sales commissions, technical service, demonstrations, promotional literature, visual aids, etc.

3. The subsidized price of pesticides should be the same in all provinces to minimize black market operations.

C. OPERATION OF PROVINCIAL DEPARTMENTS OF AGRICULTURE (EXTENSION)

1. Plant protection specialists with training in the safe use and handling of pesticides and equipment should be employed to bring about better communication between the research institutes and the Agricultural Assistants. These specialists could stimulate more demonstration programs involving farmer's field and equipment.

2. Agricultural Assistants need more support and recognition commensurate with their responsibilities. Their efficiency could be greatly improved if some means of readily available transportation could be provided.

D. FORMULATION PLANTS

1. Worker safety. Agriculture and public health agencies should cooperate in establishing realistic standards for environmental conditions and protective clothing required for workers in pesticide formulation and manufacturing plants.

2. Standards and rigid quality control should be imposed on all highly toxic pesticides formulated as granules. Standards should be set on the particle size range with limits on amount of fines or dust. Technology is available to make granules with less than 0.1% fines. Registration of granular pesticides should also require pesticide efficacy data for each type of granular base used by a formulator.

E. PESTICIDE DISTRIBUTION

1. Container size. Plans should be made to discontinue the practice of dispensing pesticides from large containers into small ones at the point of sale to the farmer. This will necessitate procurement of pesticides in small, consumer-sized containers or repackaging after the products are imported.

2. All containers should be clearly labeled as to ingredients, precautions, and directions for use.

There should be a clearcut and active federal policy to bring all domestic health and agriculture pesticides under controlled systems of standards of quality and proper labeling including accurate designation of inert and active ingredients. We recognize that the preceding recommendations cannot be implemented in the near future. Therefore, we suggest that steps be taken immediately to prepare (or request manufacturers to prepare) labels that can be attached to the farmer's small containers when they are brought to the stores to be filled. These labels could be tags with wire for attachment to handles or spouts.

3. Containers should meet at least the specifications of strength required by the Department of Transportation in the United States. Bags of toxic dry formulations should be shipped in steel containers as is now being done by one formulator.

4. A complete review of regulations and practices to minimze pesticide or other hazardous chemical leakage during transport should be carried out at the highest administrative level and that such practices, including decontamination, be reviewed and agreed upon by the Departments of Agriculture and Health. Because of recent reports of leakage of pesticides in transport, along with the potential for mass disaster due to contamination of commodities, it is urgent that such a review be immediate.

5. There should be promulgated standards for the proper storage of pesticides including provision for sheds with convection or forced draft ventilation and safe position for proper drainage in the event of spillage or flood.

F. PESTICIDE MIXING AND APPLICATION

1. A professional Agricultural Engineering Research section should be established. A logical location would be at the Agricultural Research Institute at Lyallpur or under the Agricultural Research Council. One major task should be to design and develop suitable granule and spray application equipment for conditions in Pakistan. Worldwide, very little effort has been devoted to pesticide applicator design for use in developing countries. In Pakistan the use of sophisticated spray equipment is a long way in the future. Thus, we feel that some equipment could be developed that may be propelled by oxen and designed whereby the operator would not be required to walk through the sprayed area. Likewise, designs for simple hand-operated sprayers should be considered. This unit could also effectively assist the Plant Protection Institute in training Agricultural Assistants and other Agricultural Extension staff on calibration, maintenance. nozzle selection, and operation of pesticide equipment.

2. "Restricted" use pesticides. Certain highly toxic pesticides should only be distributed to those who have demonstrated competence in their safe handling and use. A system of certification of competent applicators should be inaugurated. One possible method of regulation would be to limit the sale or distribution of the "Restricted" chemicals to those holding such a certificate. Standards should also be set up to specify the minimum protective clothing that must be used when handling and applying the "Restricted" chemicals.

3. An aerial research section should be established to provide basic data on aerial application performance under local conditions. Suggested topics that the group should consider:

a. Evaluate insect control efficacy and drift residues as well as air samples for each material proposed for aerial ULV application. In many cases efficacy data on this type of application has not been conducted by the manufacturer, only a very few materials are registered for ULV application in the United States. Tests should include comparisons with application rates up to 50 liters/ hectare.

b. Conduct a pollution monitoring study near a large scale aerial application to determine drift residue hazards and loss of material from treatment area.

c. Evaluate the possibility of utilizing a high concentrate granular formulation for aerial application treatments on paddy. This type of formulation could minimize drift hazards and may be more effective than aerial spray applications. It is conceivable that a 30%-40% granule could be used at an application rate of 2-4 lb./acre.

d. Evaluate the possibility of using aerial photographs to assist the pilot in planning, executing, and recording his flight missions. Another approach to assist the pilot is to evaluate an "automatic flagman" for releasing markers along the flight path. The marker could also be printed with warnings to stay out of area until a marked date.

4. In diversified farming areas the team urges the abandonment of aerial ULV applications of highly toxic materials. Suggestions on materials to be included in this classification are listed as "Restricted" materials in the first section, Pesticide Regulations.

5. Aerial ULV applications should be limited to materials that have been tested and evaluated for this type of application.

6. All pilots should be given a short course covering all chemicals applied by aircraft. The course should be updated annually and should include information on the mode of action on the pesticide, effects on other plants, animals, humans, antidotes and medical treatments.

7. All aircraft liquid loading systems should be converted to incorporate a "closed system" method of transfer. This should include self-priming transfer pumps, and bottom loading valves with quick disconnect fittings. Separation of tank from pilot's compartment by means of a "belly" tank would be desirable.

G. PROTECTIVE CLOTHING AND EQUIPMENT

1. Technology has not produced protective clothing and equipment which is inexpensive and practical for use in situations involving physical activity and high temperatures. Yet we know that pesticides are most dangerous when temperatures are high because of volatility and/or more rapid and complete absorption by the skin. In order to protect workers from the highly toxic pesticides such as methyl parathion we recommend the following:

a. If the application is such that the worker can expect his clothing and skin to become wet with spray, waterproof clothing, shoes, head covering and rubber gloves must be worn and his face covered with a respirator or at least a cloth mask. This may require that these pesticides be restricted to conditions where such protection can be utilized, for example in the early morning hours or in the more temperate regions of Pakistan.

b. If the application can be done without undue risk of wetting the clothing or skin, reasonable protection is offered by cloth overalls or trousers and a long sleeved shirt. These will intercept the spray droplets and minimize contact with the skin provided wetting does not occur. Some form of head and face covering is important since studies with parathion have shown absorption in this area is higher than for most other parts of the body.

2. Goggles, rubber gloves, and waterproof aprons should be worn by those handling and mixing concentrate materials.

3. Workers should not be allowed to handle highly toxic materials if they have cuts, abrasions, or dermatitis in areas of likely exposure. Pesticides are absorbed very rapidly through breaks in the skin.

4. Personal cleanliness is of the utmost importance and must be considered along with protective clothing. Body and clothes should be washed with soap and water each day as soon after exposure as possible. Soap and water should be available in the fields for emergency and routine use.

5. Additional precautions are described in literature available in Pakistan. However, an educational program is needed to persuade farmers of their value in protecting human life. We believe the hazard of skin contact is not fully appreciated.

H. PESTICIDE POLLUTION OF THE ENVIRONMENT

1. Residue monitoring of crops and environmental samples is essential to estimate the hazard of current and future pest control practices in Pakistan. Specifically, there should be a methodological system of monitoring pesticide residues in; domestic and exported food and tobacco, human and animal tissues, and selected environmentally important areas of water, soil, air and various food chain organisms. Results should be published in scientific journals.

2. An educational program is needed to alert the public to hazards of collecting food or forage from or adjacent to treated fields.

3. Use of chlorinated hydrocarbon insecticides in Pakistan. Before a decision concerning a ban or restrictions on the use of chlorinated hydrocarbon insecticides is made, we suggest the following points be considered:

a. Excluding instances of misuse, these materials have not been shown to have any detrimental effects on public health after 25 or more years of use in the United States. Small residues of DDT, dieldrin, and heptachlor are frequently found in fat tissues of the general population but no relationship to ill health has been proven. Amounts found in fat tissues have remained more or less constant.

b. There has been a steady decline in the use of chlorinated hydrocarbon insecticides in the United States for the past 10 or 15 years because of the development of resistance and more effective insecticides and pest control techniques. Some are no longer protected by patents and are therefore of less economic interest to manufacturers.

c. The nearly complete ban on DDT in the United States was largely the result of environmental concern, not public health. This is still a controversial decision which has not received unanimous support from scientists. Many believe the use of DDT should have been restricted rather than banned. Recently the U.S. Environmental Protection Agency allowed the use of DDT in the State of Washington to control certain pests damaging forests and pea crops. No other insecticides were known which could provide as effective and economical protection and EPA decided the benefits outweighed the risks.

d. Nearly all uses of aldrin and dieldrin were banned in the U.S. following our return from Pakistan. This decision was based primarily on mouse feeding studies which indicate these chemicals can cause cancer and are therefore a threat to man. However, the U.S. Environmental Protection Agency obviously does not consider the threat to be immediate since it has permitted existing supplies to be used in accordance with label directions.

e. Alternative insecticdes should be reviewed carefully from the standpoint of usefulness, economics, and toxicity. The chlorinated hydrocarbon insecticides are generally less hazardous to applicators than the organophosphorus compounds.

f. It is generally agreed that the use of chlorinated hydrocarbon insecticides should be restricted or phased out. However, unless there is an imminent hazard to public health or a threat of irreparable damage to some segment of the environment, this process should be deliberate and include the development of acceptable alternative control measures before any essential use is discontinued. Such a process has been taking place in the U.S., although in some instances uses have been banned for which there are no alternative control measures. If suitable control measures are not found, production of certain crops will be reduced or discontinued.

I. MEDICAL SERVICES FOR TREATING PESTICIDE POISONING

1. A standard organophosphate and other pesticide first aid kit should be devised and distributed to all federal agricultural agencies and concerned

health care facilities, public or private, at nominal cost. Inasmuch as agricultural accidental poisoning potential is greatest with dermal toxicity, such a kit should be arranged to facilitate treatment of such cases. There should be provision for orderly replacement of supplies which have a propensity for deterioration.

2. There should be federal support for health oriented agencies to be established to aid and assist by telephone or in person response in the diagnosis and treatment of pesticide poisoning and to assist in the follow-up investigation and reporting of pesticide poisoning. Such centers may be associated with financially supported laboratories which may perform follow-up testing of biological materials to confirm diagnosis and assist in monitoring the elimination of the pesticide from the patient.

3. The National Formulary should contain antidotes which are specific for pesticides or other poisons.

J. CASE REPORTING SYSTEM AND SCIENTIFIC INVESTIGATIONS

1. There must be established a central registry where cases of alleged pesticide poisoning of humans, fish, wildlife and livestock including honeybees are documented along with complete follow-up reports. Such reports should be promulgated to all interested parties.

2. There must be federal funds provided to support field research studies of the human health problems of pesticides such as the program currently established within the Department of Entomology, Agriculture University, Lyallpur. However, this local program, supported by the U. S. Educational Foundation (Fulbright-Hays Program) is expected to terminate within a few months. A federally funded program should include provision for widespread dissemination of findings to all agriculture and health agencies concerned with the problems of proper administration of pesticides.

3. There must be federal funds provided to support field level demonstration projects of pesticide safety education with educators preferably recruited from the public health disciplines. Such instruction should not supplant already existing instructional efforts carried out by agricultural agencies but should supplement and enlarge such efforts within agricultural fields and should interface with health care delivery systems at the field level.

4. There should be programs aimed to encourage schools of medicine to maintain instruction in the field of pharmacology and therapy of pesticide poisoning and to encourage academic studies of the epidemiological aspects of pesticides and their relation to public health.

5. It is recommended that this report be widely disseminated outside of the field of agriculture in the hope that it may stimulate interest in research into the potential health hazards of improperly used pesticides.

K. INTERAGENCY COORDINATION

1. There should be active liasion and coordination at the highest possible administrative level between agriculture, health and the military

in matters of pesticide usage in order to aid and assist each other in the proper choice and utilization of pesticides and to minimize enhancement of vector resistance by the activities of any sector utilizing pesticides.

2. Effective pest management must include alternatives to the unilateral use of pesticides. It is recommended that there be coordination at the highest administrative level between all agencies concerned with research and application of alternatives to pesticide usage whether such programs are public or private. Knowledge gained in either sector should immediately be disseminated in order that all those concerned be fully apprised of the current status of such research.

3. There should be consideration for future training seminars in pesticide safety with multidisciplinary participation. Such seminars could include a limited participation course in pesticide analytical techniques. It is recommended that such a seminar be held where most complete attendance could be assured from representatives of public and private sectors of agriculture, health and health education, military and others concerned. Federal sponsorship with possible additional support by other agencies could be considered.

4. The Federal Government should assess the current availability and funding support for various foreign programs of instruction in safe pesticide management. Due consideration should be given to support of qualified trainees to attend these programs.

II. MISSION OF STUDY TEAM

The formation of this study team and subsequent report were the result of a request from the Central Department of Plant Protection (CDPP) to USAID, Islamabed, through the Economic Affairs Division, Government of Pakistan. The Central Department of Plant Protection is responsible for all aerial spraying and for general administration of Pakistan federal regulations on pesticide registration, handling and use. The request was for technical assistance on the safe use of agricultural pesticides. Specifically, experts were requested to:

A. Evaluate present use of pesticides under local conditions.

B. Make recommendations for adopting necessary precautions and safety measures appropriate for large scale use of pesticides in Pakistan.

C. Provide technical advice on symptoms caused by pesticide poisoning and recommend para-medical treatment including antidotes.

D. Evaluate possible pesticide pollution problems and make recommendations for evaluating and minimizing hazards.

It was suggested the consultants spend considerable time in the field observing actual conditions. The scope was to include: (a) following the pesticides through the distribution channel from port of arrival to end user. The study team was to consider type of pesticide in use, methods of handling, transport, storage, distribution and application, and make recommendations to mitigate the hazards of pesticides. In addition to ground application problems, the team was to consider problems associated with ultra-low-volume aerial application of pesticides, (b) reviewing available information on adequacy of medical services, system of reporting poisoning, and capability for measuring and evaluating levels of pesticides on food crops and in the environment. Recommendations were to cover possible improvements.

USAID Islamabad fully concurred with CDPP, because of the large number of pesticides in use, the lack of sophistication of pesticide market channels, and the low level of education of the ultimate users. The potential hazards associated with the use of pesticide is a serious problem for Pakistan. The study should provide an opportunity for AID to have a competent review of safety implications related to pesticides procured under AID loan.

III. PROCEDURE

The local conditions and pesticide use patterns were assessed by field trips from July 17 to August 28, 1974. A complete itinerary including dates, places and people contacted is included in Appendix E. Maxwell and Yates traveled together from July 17 through August 11. Davis joined the pair at Peshawar on August 6, and the three visited points together through August 11. Davis proceeded alone on the rest of the itinerary.

In summary, Maxwell and Yates visited the major cities of Karachi, Hyderabad, Multan, Lyallpur, Lahore, Islamabad, and Peshawar. Figure 1 illustrates the areas visited by the team. At each location meetings were arranged with directors and scientists at various research institutes and universities. Four chemical formulating plants were visited as well as a pharmaceutical plant and pesticide manufacturing plant. Two meetings were held with members of the Agricultural Chemical Association as well as many individual discussions and field plot inspections. In each province meetings were held with the Director of Agriculture, Plant Protection Officers, and staff. Trips were arranged to visit provincial, district, and tehsil (local village) areas where pesticides and application equipment were stored. Many trips were made to see field conditions and field applications of pesticides by progressive farmers and some small farmer application activities. Discussions were held with many of the Agricultural Extension Staff including Agricultural Assistants, Field Assistants, and beldars. The beldars were the farm laborers who made the field applications of most of the pesticides. Agricultural aircraft sites and equipment were observed in each province and discussions held with the crew members. Also, facilities were inspected and discussions held at the Central Department of Plant Protection. Davis continued on after Peshawar to Lahore, Lyallpur, and Karachi to meet with and view facilities of directors, administrators, and scientists of agricultural agencies and universities, medical education and research facilities, public health and private industry. Laboratories were visited and equipment evaluated. Discussions were held regarding current problems and solutions sought.

No visits were made in the province of Baluchistan, as it accounts for only 5% of the agricultural production.

Fig. 1 Map of locations visited by the team.

IV. EVALUATION OF PRESENT USE OF PESTICIDES UNDER LOCAL CONDITIONS

A. PESTICIDE REGULATIONS

The registration, labeling, storage, and sale of pesticides in Pakistan are regulated by the Agricultural Pesticides Ordinance, 1971, and rules adopted for implementation of this Ordinance in 1973. They provide the Central Government with broad authority to regulate nearly every aspect of the sale and use of pesticides in agriculture. Although it would appear that the Central Government controls the pesticide registration we were informed that provincial regulations may be in conflict. What may be approved at one level of government may not be approved at another. As nearly as we could determine, the regulations do not address non-agricultural pesticides which are sold in local market places to the general public without regard to effectiveness or toxicity. We observed some of these products at a local formulating plant and noted that the active ingredients were not listed. The plant representative was reluctant to disclose this information since competitors might be able to get the ingredients at less cost and undersell him at the market. With the high population of flies and other pest insects prevalent in Pakistan we suspect that large quantities of these pesticides are used by those who can afford them. Perhaps significantly, a large proportion of the products packaged by this formulating plant were in containers of one imperial gallon. We were told these are purchased by home owners.

The rules pertaining to registration of pesticides are of a general nature. These essentially require 2 to 3 years' performance data in Pakistan and evidence that they can be used as directed without causing harm to man, livestock, or crops. We presume more specific guidelines are available, but they were not provided during our visit. Accordingly, our recommendations include requirements for registration which we believe should be considered.

Highly toxic pesticides must be labeled with the word "poison" and "danger," and the skull and crossbones symbol. However, the term "highly toxic" is not defined and we are concerned that the warning words and symbols may not be understood by illiterate farmers.

B. PROCUREMENT AND ADMINISTRATION OF PESTICIDES

The procurement and administration of pesticides in Pakistan has long been and continues to be a serious problem which interferes with the effective use of pesticides and the development and use of safety procedures.

Until the 1973 crop season all pesticides were procured and distributed by the Central and Provincial Governments. This system was inadequate to meet the country's needs and millions of dollars worth of pesticides are reported to have deteriorated in government storage. Just prior to the 1973 crop season 11 private distributors were allowed to participate in the distribution and sale of pesticides in the Punjab Province with the idea that they would have greater incentive than government agencies to sell their products and provide technical information and services. The distribution of pesticides in this province (excluding pesticides applied by air which are furnished free by the Central Plant Protection Department) is divided between the private distributors, 75%, and the Department of Agriculture (Extension) 25%.

The distribution and sale of pesticides in the other provinces, Sind, Baluchistan, and NWFP are still handled entirely by their respective Departments of Agriculture (Extension). However, since nearly 80% of the pesticides in Pakistan are used in Punjab it is estimated that about 50% of all pesticides are now sold through private distributors.

We understand that government is not satisfied with the results of the first year's effort in Punjab by the private distributors and recommendations have been made to prohibit several from participation in the 1974 season. The evaluation of these private distributors was based on: (1) the amount of pesticide sold in relation to their allotment, (2) the technical staff in the field, (3) the amount of contract spraying done, and (4) the availability and distribution of promotional and safety literature. We concur that these are valid points for evaluation, but we are concerned that the private distributors were not given the opportunity to develop their full potential. Under the current procurement program the government determines how much money will be spent each year to import pesticides in Pakistan for distribution by private distributors in Punjab. Selected distributors may then request that pesticides be purchased by the government and delivered to the Port of Karachi. Each distributor must order a quantity of pesticide equal to his allotted share of the purchasing budget. Shares are determined by dividing the budget equally among the distributors.

The government subsidizes the farmer by providing the pesticide to the distributor at 25% of the delivered price. The distributor is permitted to sell the pesticide at a 35% mark up from his purchase price. The cost of transportation from Karachi, storage, repackaging, promotional material, technical service, etc., must be borne by the distributor. The Department of Agriculture in Punjab sells to growers at the same price as the private sector distributor. In the other provinces all pesticides are sold to farmers by the Departments of Agriculture at a subsidized price of 50%.

A major disadvantage of this procurement program, whether it involves public or private distribution, is the uncertainty of an adequate supply of the right pesticide at the right time each year. The planning and development of pest control programs, or sales and technical service programs, becomes almost impossible to carry out. Pesticides may not be received at all, they may be received in smaller quantities than anticipated, or they may arrive too late to be used effectively that season. In the latter case the pesticide must be stored until the next season or perhaps even longer if the pest problem does not then materialize. Stored materials present a hazard, particularly under conditions existing in Pakistan, and they are subject to rapid deterioration because of high temperatures. If deterioration is undetected or ignored, resulting in failure to control pests, it will be difficult to convince farmers that pesticides can benefit crop production or that confidence can be placed in public or private distributors. The cost of storage and losses due to deterioration must be borne by the distributor. Given the uncertainty of supply and the fixed mark up price there does not appear to be adequate incentive for a private distributor to develop or expand a sales and technical service program. Such programs are needed so that the Provincial Departments of Agriculture (Extension) can divorce themselves from pesticide sales, distribution and application, and concentrate on education. Private distributors cannot be completely objective in recommending pest control practices. This is an area that Extension can best

serve, but it can do so only if it is strong and has the confidence of the farmers. Ideally, Extension and private distributors should complement one another. Other problems created by the uncertain supply of pesticides include the following:

1. Growers purchase pesticides long before they need them in order to be assured of an adequate supply. If the pest problem does not develop, the pesticide may be used for pests or crops not covered by directions.

2. Lack of suitable pesticides encourages use of more readily available pesticides which may be less effective or not labeled for the intended use.

3. Mixtures of several pesticides are sometimes used simply to extend the use of a preferred pesticide which is in short supply. Such mixtures are often not tested and could increase risk to spraymen and crops, and reduce effectiveness of pest control.

4. Shortages and differential in prices among the provinces encourages black market sale of pesticides. It is unlikely that such sales are accompanied by adequate technical service and safety information.

5. Adulteration of pesticides in short supply has been reported.

C. OPERATION OF PROVINCIAL DEPARTMENTS OF AGRICULTURE (EXTENSION)

Each province has a Department of Agriculture, Extension Service, which assists farmers in all phases of agricultural production. While they differ slightly in their organization and operation they function in a similar manner and contact with farmers is always made through Agricultural Assistants and Field Assistants. These persons have key positions and the success of any educational program depends on their support and enthusiasm. In many respects their duties are comparable to those of county agents in the United States.

The Agricultural Assistant is assigned a certain area, usually about 100,000 acres containing 10 or 12 villages. He has several Field Assistants working under his direction. Currently they are able to cover only about 25% of their assigned areas. All Agricultural Assistants have at least B.A. degrees and some have M.Sc. degrees in various agricultural fields. Field Assistants usually have two years of post high school education in an agricultural field. The Agricultural Assistant is expected to spend about half his time in the field advising and making decisions on agronomic or horticultural problems, fertilizer requirements, etc., and identifying pests and recommending appropriate control and safety procedures. He also stores and sells pesticides, and if time permits he will see that the material is applied with equipment kept by the Extension Service for this purpose. Such applications are actually made by the Field Assistants using portable hand or power sprayers. No charge is made for these applications except for the cost of the pesticide.

We were unable to meet with many of the Agricultural and Field Assistants, but comments received from several sources, including private distributors, indicate they are generally quite capable. However, there are many obstacles which prevent or discourage the most efficient use of these capabilities. Among the more important are the following:

1. Training in plant protection and safety procedures is inadequate in many instances. Each province has a research institute which provides this training but these are short on facilities and manpower, and it is difficult for them to impart knowledge from research to Extension personnel. This situation appeared more acute in Sind Province than Punjab. It was also brought to our attention that no one at the research institute at Sind had ever gone abroad for study in any area of plant protection while many had done so in Punjab.

2. Agricultural Assistants and their staff are not normally furnished with transportation. This severely limits the areas they can cover and their contacts with farmers. It probably contributes to the large volume of unused and broken spray equipment observed at most Extenison offices we visited. One can hardly expect enthusiasm for maintaining equipment and transporting it several miles by foot or bicycle. This situation also encourages association with the larger more progressive farmers who are able to provide transportation, while the smaller farms are neglected. In Punjab 75% of the farms are considered small, 12 1/2 acres or less. This accounts for 36% of the agricultural acreage in the province.

3. Agricultural Assistants are very poorly paid and do not have the support or recognition commensurate with their responsibilities.

4. The number of Agricultural Assistants is inadequate, but this could be compensated to a great extent by greater mobility.

These factors contribute to low efficiency and encourage poor maintenance of equipment, adulteration of pesticides, black market activities, and neglect of small farmers. Obviously the quality of education in plant protection and safe use of pesticides has suffered. If the sale and distribution of pesticides is ultimately assumed entirely by private firms, as we believe it should be, the Extension Service must have the confidence of the farmers and be able to recommend efficient and safe use of these pesticides. If Extension is not recognized as an unbiased, reliable source of information its functions may be largely assumed by the private firms in a less objective manner.

D. FORMULATION PLANTS

We visited four pesticide formulation plants, one of which also manufactured BHC and DDT. In addition we saw one pharmaceutical plant that planned to incorporate pesticide formulation in the future. We noted a wide range of conditions, from very good to poor, related to worker safety and protective clothing utilized by the workers. The most unsatisfactory conditions were generally found in granular or dust formulating facilities. One of the areas that appeared very hazardous was a bagging operation of BHC and DDT wettable powder. The work area was not sufficiently ventilated. The area had a highly offensive odor, a very high dust level and was extremely hot. The workers did not have adequate protective clothing. Most worked with bare feet and bare hands and wore a loose gauze mask. A satisfactory respirator and protective clothing would certainly be desired for this type of condition, but probably most important would be to improve plant dust collection equipment and ventilation to improve the workers' environment.

Quality control of the granular product was found to be another area of concern. Probably, poor particle size control was related to the disastrous Thimet incidents discussed later in this report.

Particularly with very toxic pesticides it is necessary to eliminate fine particles from the granular formulation. Typical clay base granules may partially break down in shipment and handling and would not be satisfactory for hand applications used in Pakistan. However, technology is available for formulating the very toxic materials on a "sand core" base coated with a polyvinyl material. This special granular material can be made "dustless," with certainly less than 0.1% fines.

E. PESTICIDE DISTRIBUTION SYSTEM

1. Containers

a. Size—for economic reasons, most liquid pesticides are imported in 45 gallon (imperial) drums. These are transported to the various distribution centers and stores. At the store level distribution becomes particularly hazardous. There is transfer from bulk, often 45 gallon drums, to whatever container the beldar brings. This is often a one-gallon oil can but may be a glass, plastic or other container of any size. We were told that one customer, lacking a suitable container, unwrapped his turban, poured a granular pesticide therein, and replaced it on his head for transport.

The 45 gallon drums are labeled with the name of the chemical, often nearly illegible, but there are no directions for use. Directions are given verbally by the seller; containers brought by the farmer are not marked to identify their contents.

The need for consumer-sized, well labeled containers is obvious. Most farms are small and often crops are diversified so that a particular chemical may be needed in amounts to cover only one or two acres. One formulator in Pakistan has developed one gallon plastic and aluminum containers, but they are not being used because of cost.

The Province of Punjab has recently decided to order its pesticide imports in five gallon containers. This will be a decided improvement, but there will still be a need to transfer to smaller containers at the pesticide stores.

Even though small labeled containers are highly desirable, the Government of Pakistan should be alert to the problem of container proliferation that will result. There will be a great temptation to re-use these small containers for many other purposes and steps should be taken to guard against the hazards involved.

Packaging of pesticide granules poses less of a problem as far as size is concerned. Most that we observed were in the range of 10 to 20 pounds which is appropriate for small farming operations. These containers were appropriately labeled with cautions and directions for use.

b. Durability

We observed a great deal of variability in strength of containers used for pesticides. Some 45-gallon drums contained extra heavy rims and heavy gage steel that survived rough handling without leaking.

On the other hand, a shipment of Gusathion in 5.5-gallon metal containers fared rather badly. They were noted to be leaking in several storage areas. In one such area, there were about 200 of these five gallon containers that were completely empty. Their contents, about 1000 gallons, had leaked out during transport on railway cars.

We learned of problems involving bags of granules which had broken, even though made of cotton and lined with polyethylene. In one instance a girl was reported to have died after eating granules of Di-Syston spilled at a loading site. The site was also used for loading sugar. In another tragedy, similar bags containing Thimet granules were unloaded from railroad cars. Some bags were broken and resulted in the death of one worker and the illness of two others.

One formulator is now shipping bags in sealed metal containers with good results.

c. Disposal

It is generally recommended that empty pesticide containers be reconditioned or destroyed. Drums used by the Central Department of Plant Protection are recycled for use as containers for pesticides or petroleum products. We were unable to ascertain with certainty what was done with drums used by the Departments of Agriculture, Extension. In one instance, we were told the drums are auctioned to the highest bidder with instructions not to use them for water, food, or feed. Another time we were told that all empty drums are stockpiled. We did not see the drums being used or stockpiled.

Steel drums are a desirable commodity, however containers contaminated with pesticides pose a very serious threat if they moved into the hands of the general public.

2. Transportation

All pesticides are procured by the Government and arrive at the Port of Karachi. From there they are distributed by rail or truck. Although we were unable to witness actual transport operations, the condition of the containers testified to the rough treatment received in transit. Poor roads and loading procedures appear to be major contributing factors.

Transportation of pesticides is regulated by the Department of Explosives in Pakistan. Regulations prohibit movement of pesticides in the same conveyance with people or other commodities. As nearly as we could determine there are no requirements for reporting spills or other accidents involved in the transport of pesticides. However, we were informed that spills have been reported to the government agency to whom the pesticides were shipped. There does not appear to be any specific procedure to decontaminate in event of leakage.

The previous mentioned pesticide loss discussed under container durability involved 8000 gallons of Guthion, 20% emulsifiable concentrate, in 5.5 gallon drums that were shipped by railroad. Over 1000 gallons were lost in transit due to crushing of the smaller containers by the larger drums. We were told that the cars were "cleaned up" but could not determine who did it or how it was done. We are concerned that spills of this kind may not be properly cared for and result in contamination of commodities including food which may be transported in the same conveyance at a later date.

3. Storage

We did not visit any storage areas belonging to the private sector. Storage areas of the Departments of Agriculture, Extension, are extremely poor. In many instances, drums are stored in the open where they are subjected to rain and temperatures above 100°F. We observed many drums that were so badly corroded they were leaking and identifying marks were completely gone. It is very likely the chemicals had undergone considerable deterioration. An accumulation of spilled pesticides--liquids, dusts, and granules--was evident in most storage areas visited. Some covered storage was generally available which was used primarily for bags of pesticides and spray equipment. Although conditions within the storage areas were not considered adequate or safe for workers, the areas were usually secured with locked doors and gates to keep out unauthorized persons.

F. PESTICIDE MIXING AND APPLICATION

At the present time over 11 million acres are planted to the three major kharif crops of cotton, paddy and sugarcane. Although all of these crops are perpetually attacked by insects, less than 10% of the plantings are protected by means of pesticides. Thus a large production capability is lost to a variety of pests. The task of treating this vast acreage is very difficult under present cultural techniques. The average size farm is about 5 acres with a common field block of 180 ft. by 180 ft. In many areas the blocks are interspersed with different crops as well as fallow land because of lack of irrigation water. Most of the small farmers utilize bullocks for plowing and planting operations. In the Multan area, a large center for cotton production, only 1% of the farms, representing 16% of the acreage, has a farm size greater than 50 acres. The following table includes an estimate by the Central Department of Plant Protection of the acreage that is in sufficiently large blocks, and free of obstacles, that may be suitable for aerial spraying.

Crop	Acreage	Acreage suitable for aerial spraying
Cotton	5,400,000	1,000,000
Paddy	4,230,000	2,275,000
Sugarcane	1,318,000	380,000
Total	11,148,000	3,655,000

As shown, only about 30% of the above crop acreage is suitable for aerial application. Thus it is evident that for the near future a great deal of effort should be concentrated on improving the ground application capability.

1. Problems related to ground applications

a. Granules The process of formulating pesticides on a presized

inert carrier is theoretically an ideal technique for handling and applying toxic pesticides. This technique is of course not suited for application to plants that require a thorough coverage of their foliage. However, it is suitable for root systemic materials or treatments to soil or water surfaces. From a safety viewpoint the applicator does not have to mix or handle a highly concentrated formulation and dermal absorption is greatly reduced, as compared to most liquid formulations. In addition, fine particles can be minimized to reduce drift or inhalation problems.

Granules are applied almost entirely by hand from a pouch consisting of a piece of cloth slung over the applicator's shoulder. This type of application is particularly important for the control of rice borers in paddy. Diazinon is the insecticide most used, although Furadan and Eklux show promise as alternative materials. We were told that gum boots and rubber gloves were available for Extension workers in the Punjab Province, but doubt was expressed they were ever used. We heard of only one possible illness due to hand application of Diazinon granules. In this instance the farmer died, but there were extenuating circumstances and the cause of death was not confirmed.

However, last year 5 people died in the Multan area due to handling or applying Thimet granules. Also, an incident occurred this year in the Hyderabad area where a crew was unloading Thimet granules which resulted in one fatality and 2 illnesses. Accurate details could not be obtained, but one or more of the following factors was likely attributable to the consequences: (1) quality control on the size of granule was poor with a high percent of fines, (2) the type of inert carrier was not pretested for absorbtive and release characteristics, (3) the granular material did not have adequate strength and produced some fine particles during transit, and (4) the people did not use approved protective respirators, gloves, or other protective clothing. In any case the best safety measure is to provide a safe formulation that would not require highly protective clothing. It should be noted that we regularly asked what protective equipment was worn by the applicator. In most instances we found that the person applying granules did not wear gloves or other protective equipment.

b. Sprays Again, we regularly asked and observed the safety equipment and procedures used during spraying operations. We were very pleased to find that all governmental officials were very much aware of the hazards and necessary precautions that spray applicators should follow. We were given several brochures and leaflets that were published on this subject. Also, the progressive farmers we met were very much aware of the hazards. However, two major problems appeared in many places: (1) either there was a lack of protective clothing available or the protective clothing was unsuited for use during high temperature conditions, or (2) the man doing the application was not adequately trained and did not fully recognize the hazards. The education of the small farmers will be very difficult since we were told that of the present generation in the small villages, about 90% are illiterate.

At the present time application equipment and assistance for application is provided by the Agricultural Extension Office in the Provinces of Sind and North West Frontier. In Punjab the Agricultural Extension staff is

responsible for distribution and application of about 25% of the material and the public sector the remaining 75%. In most areas there is not adequate equipment or personnel to cover all the area and the farmer must assist in the application. Punjab has recently initiated a program whereby hand compression sprayers are sold at a 50% subsidy to the farmer. This appears to be a very logical approach to assist the small farmer and encourage him to use pesticides. However, even with this subsidy the small farmer may not have sufficient capital and may have to purchase a sprayer jointly with his neighbors.

Mixing and loading is one of the most hazardous operations since the operator may be exposed to the concentrated material. We repeatedly saw mixing operations where the loader, with bare hands, bare feet, and cotton clothing poured the concentrate materials such as Endrin, Guthion, Meta Systox, Zolone or DDT into small measuring vessels and then into an open mixing tank. In one case, after the worker finished pouring the concentrate into the tank he casually immersed the whole container into the spray solution and used his bare fingers in rinsing out the measuring container.

At Hyderabad we were told of many illnesses among farmers in the Sind Province caused primarily by exposure to methyl parathion. These farmers do not wear protective clothing and we were told by one official that they treat pesticides as if they were fertilizers.

In Multan we viewed a demonstration by Extension of the use of protective equipment during actual field applications. It consisted of a cloth mask over the nose and mouth, impervious clothing, and rubber gloves. It was obvious the men were not used to this equipment, and furthermore it would be physically impossible to wear it more than a few hours early in the morning because of the high daytime temperatures. The owner of the farm where the demonstration was conducted told us that methyl parathion was the leading cause of illness among his workers. Of particular interest was his observation that these illnesses occurred only to those using the Solo backpack power sprayer and the Jico power sprayers. He knew of no illnesses from the use of hand compression sprayers.

The availability of suitable application equipment is another major problem related to safety. The most common power sprayer is the Jico Major or Jico Minor, manufactured in Pakistan. This sprayer is not suitable for use in cotton, paddy or sugarcane. A few progressive farmers operate tractor mounted power sprayers. However, these are not suitable for paddy, or late applications on sugarcane or cotton since they are generally low clearance tractors. We did not see any high clearance tractors. The majority of sprayers that we saw were either the backpack power driven air blast sprayer or the 3-4 gallon air compression type hand sprayer. We were repeatedly told that from 60% to 80% of the sprayers were out of order at any given time and that most sprayers only lasted 6 to 9 months. The major problems with equipment seems to be related to three factors: (1) spare parts are generally not available, (2) lack of care because of government ownership, with no incentive to keep equipment in repair, and (3) lack of training in regards to maintenance, nozzle selection and operation.

The most serious safety problem is related to the basic design. The hand sprayers required the operators to walk through the sprayed area. Also, the lack of proper maintenance may result in leaky gaskets, hose, etc., which

could directly expose the operator. Because of the above factors, many persons related that it is very common for the workers to develop nausea, headaches, etc. As a result, some large farmers said it was difficult to hire operators for their spray equipment.

2. Problems related to aerial applications

a. Granules At the present time the Central Department of Plant Protection does not have dispersal equipment for handling dry materials with their present fleet of aircraft. However, in view of the apparent success of granular applications applied by hand for some pest problems it would appear to be an ideal method for certain aerial applications.

b. Spray The CDPP operates a fleet of 10 DeHavilland "Beaver" aircraft fitted with two AU 3000 Micronair Atomizers per aircraft. In an effort to expand the aerial application service the CDPP has contracted the services of three private sector firms; Agricultural Aviation and Fumigation Ltd., both Pakistani firms with Piper and Cessna agricultural aircraft and Ciba-Geigy with their Pilatus-Porter agricultural aircraft. Appendix A lists the projected plan of crops and areas to be covered by aerial applications during 1974. The cost of chemicals and applications is borne by the GOP and there is no direct cost to the farmers. In brief the CDPP plans to spray about 1.0 million crop acres and with multiple application plans to spray a total of 2.1 million acres. The private sector plans to treat 730,000 acres with a total of 1.4 million sprayed acres. We visited aerial spray operations in Sind, Punjab and North West Frontier provinces.

All of the aircraft operations we visited involved the application of pesticide without dilution. The different materials being used at that time were as follows: diazinon, Carbicron, and Sumithion. Although mixing was not required, in some cases the operation of transferring the pesticide concentrate to the aircraft was somewhat hazardous. Protective clothing was generally utilized, however a completely closed system with self-priming pump and bottom loading valves and quick disconnect couplings would be highly desirable. We understand that attempts are underway to provide this type of equipment and hope that in the near future it is available for all agricultural aircraft.

The normal flight procedure was for the pilot to use maps with a scale of 1" = 2 miles and his judgement to pick out landmarks to fly long runs in the order of 6 miles in length. He utilized an electric switch to turn the pump on and off as required for spraying or skipping the very small blocks of different crops or fallow land. The pilot, without any assistance from ground control, would attempt to fly a 120 ft. swath spacing. In some areas the blocks were 180 ft. wide and he would apply three swaths for an area two blocks wide. It appeared that it would be desirable to have a more precise guidance system for application and recording of treated areas to avoid possible skips or double treatment of some areas.

In areas with no obstructions the normal operational procedure was to fly at a 20 ft. height with a wind velocity of [illegible] MPH, 15 ft. height for 5-7 MPH, and a 10 ft. height for 8-10 MPH. The operations were stopped for winds greater than 15 MPH or a temerature greater than 95°F. Also with low

wind velocity and a temperature of 90-95°F, the height was reduced to 15 ft. The blade angle was normally set such that for the ULV applications the drop size was 80-100μm Volume Median Diameter (VMD). A swath spacing of 120 ft. was used in all cases.

This type of application is basically a modified drift spray technique. That is, the very fine spray is released at a relatively high elevation and the wind is utilized to increase the swath width. Unfortunately, this technique has two basic limitations: (1) the pesticide recovery in the crop is greatly reduced, and (2) the drift into adjoining areas is greatly increased. In a recent paper by R. J. Courshee and H. H. Coutts*, their data indicates a recovery in the target crop of about 30 to 40% with a VMD drop size of 80-100μm and 80% with a VMD of 120μm.

Theoretically a 100 m drop of unit specific gravity would be displaced 166 ft. if released 20 ft. high with an average wind velocity of 5 MPH. Likewise, a 50μm drop would be displaced 600 ft. for the above conditions. It should also be noted for a spray with a VMD of 80-100μm would have from 10 to 15% of the spray less than 50μm. Thus we were very much concerned about the hazards of drift if highly toxic pesticides are sprayed by this technique. In much of the cotton areas we observed a considerable number of trees, villages, waterways, people, a variety of crops and considerable livestock. Thus a great deal of food for livestock and/or people may be contaminated from the spray drift. In our discussions we heard numerous accounts of animals and birds being killed from aerial sprays. However, we could not verify this information and doubt that any accurate data are available on this aspect.

Data from the University of California shows that a boom and nozzle system designed to produce a spray with a VMD of 450μm and dispersed from a 5 ft. height will produce a placement spray with 90-95% within the target area. At 200 ft. downwind the fallout would be about 1% of the concentration under the aircraft. If a higher release height is required because of obstacles, it is even more important that the number of drops below 100μm be kept to a minimum.

In summary, the use of ULV sprays have several attractive features: (1) the major advantages are that the cost and time of application are significantly reduced due to a larger acreage covered per load as well as an increased swath width resulting from "drift" of the finer drop spectrum discussed above, (2) there is less chance of complete "skips" in plant coverage from poor aircraft guidance because of the extended wide drift pattern, (3) certain insecticides, such as malathion, have increased effectiveness because of longer residual action. However, each material should be evaluated separately for both phytotoxicity and effectiveness of the ULV form before it is used in the field, and (4) loading aircraft is simpler and less expensive since the spray can be loaded without mixing with water. This may be an important factor in some desert areas.

However, there are some real limiting features of ULV applications compared to low volume techniques. The primary disadvantage is the significant increase in "drift" hazards. The importance of this is directly

*R. J. Courshee and H. H. Coutts, "Patterns of ULV Spraying," Second Symposium for Specialists in Pesticide Application, Pesticide Application by ULV Methods, British Crop Protection Council, April, 1974.

related to the toxicity and characteristics of the particular pesticide. Thus, if a toxic material is applied with a fine drop size spectrum (such as 80-100μm) a very serious health hazard may exist. This is a real problem because of the large number of people, livestock and other edible crops noted earlier. Thus, humans may be contaminated by direct contact or inhalation of the very fine droplets. Indirectly, the drift onto animals and crops pose a serious threat of contamination of the human food supply of milk, meat, or food plants. This is both a domestic public health concern as well as a potential economic concern. For instance, there could be substantial financial loss if agricultural products shipped out of Pakistan did not meet world wide pesticide tolerance levels.

2. Another important economic consideration is the efficacy of the pesticide treatment. In general, ULV application may fail or have reduced effectiveness due to reduced residues, coverage or distribution of the spray on the treated plant surfaces. Each type of application for each crop-chemical-pest combination must be evaluated. This is of particular economic concern because of the worldwide shortage of pesticides and in particular the shortage of supplies in Pakistan. Thus, it is important that one effective application be made rather than several less effective applications.

G. PROTECTIVE CLOTHING AND EQUIPMENT

The importance of protective clothing and equipment is generally recognized by those we visited at the research institutes, universities, provincial departments of agriculture, and the Central Department of Plant Protection. However, we observed that workers in the fields and in formulating plants were often inadequately protected from the hazards of pesticide exposure associated with their work. These conditions are described in detail in the sections on Formulating Plants (D) and Pesticide Mixing and Application (F).

The apparent disregard for protection while handling pesticides is due in part to a lack of understanding of the dangers involved. For example, we observed pesticide applicators wearing pieces of cloth about their nose and mouth for protection against inhalation, but they paid little or no attention to the rest of their bodies. It was obvious they were not concerned about skin absorption, yet dermal exposure is generally the most important route of penetration into the body. This is particularly true when mixing pesticides or using portable air blast and compression type sprayers which produce relatively large droplets. On the other hand, fine mists such as those produced by the battery powered ultra low volume hand sprayers observed in Pakistan, or dusts, can be more dangerous by inhalation than skin contact.

Perhaps the most important factor contributing to the lack of worker protection is the unavailability of lightweight clothing and equipment which is inexpensive and suitable for use in high temperatures.

H. PESTICIDE POLLUTION OF THE ENVIRONMENT

Only one study of pesticide pollution has been done in Pakistan*. Fat

*Mughal, M. A., and Rahman, M. A., Organochlorine Pesticide Content of Human Adipose Tissue in Karachi, Archives of Environmental Health, 27:396-398, 1973.

from human subjects in Karachi contained mean total DDT-equivalent concentrations of 25 parts per million as compared with mean concentrations of 2.3 in Germany, 12.4 in Hungary, 5.2 in France, 2.6 in U.K., 2.0 in Holland, 10.1 in Italy, 9.5 in USA, and 3.8 in Canada. Only India equaled Pakistan with 25.1 ppm. Studies in Miami, Florida, USA, revealed that general population levels of DDT and its metabolites are indicators of home dust contamination. Those homes sprayed or dusted with DDT mixtures give rise to the highest tissue levels. It would appear most likely that the same holds true in the Karachi study. In Karachi malarial control depends upon DDT home spraying on an intensive basis. Vector resistance has resulted in an increased use of DDT and BHC. However, future plans call for a shift to malathion. Another potential source of human contamination is the proprietary home pesticide preparations. The contents of such materials are a trade secret, a practive which must be prevented by remedial legislation.

As for other geographic areas and types of pesticide environmental pollution in Pakistan we may only speculate in the complete absence of monitoring of residues in agricultural products, water and air. We have seen and heard enough about pesticide application practices to know that environmental pollution is to be expected where pesticides are used.

No tolerances have been established in Pakistan for any pesticide. For the present the Government is relying on residue data and tolerances from other countries.

We learned that several of the technical representatives of private manufacturers have collected crop samples from Pakistan for analysis by their laboratories. A general recommendation by the Government is to wait one week after spraying to graze livestock and two weeks before harvesting a food crop. If this recommendation is followed, the hazard associated with many chemicals would seem to be minimal. However, it is extremely difficult to monitor or enforce these waiting periods. A principal concern is with fruit, vegetable, and forage crops. We do not know what pesticides are being used on these crops except for apples, citrus, mangos, and almonds. According to the Gazette of Pakistan, Extra, October 9, 1973, there are no pesticides registered for other fruits, vegetables or forage crops. Yet it is obvious that pesticides are being used on these crops, either intentionally or inadvertently as in the case of aerial spraying.

Agricultural crops or their production are the chief export commodity of Pakistan. Many consuming nations have established monitoring systems for pesticide residues on agricultural products. The potential economic loss to Pakistan is great if quality control is not assured at this end. We have heard of one shipment of tobacco which was refused by the receiving country on the basis of unacceptable organochlorine residue.

Perhaps the gravest area of concern at the moment is the consumption of vegetables, melons, herbs, etc., which have been sprayed incidentally because they were growing in fields of cotton or some other crop. We have been told these volunteer plants are sought and eaten by local people who do not appreciate the potential danger of pesticide residues. Unconfirmed reports of illnesses and one death have been related to us. Although we cannot estimate the magnitude of this problem there appears to be no question that a potential for serious harm exists. A similar problem involves the

use of forage grasses from ditch banks and margins of fields. The local populace is continually scavenging grass from all sources to feed their livestock.

Environmental contamination would appear to be slight if only because such a small percentage of the crops are now treated. Of the total crop area in Pakistan, only 5 to 10% is treated. However, the use of pesticides will increase, so it is not too early to begin planning a monitoring system to alert the government to problems of contamination before they become serious. This is also the time to become concerned about the use of canal water for filling sprayers, washing containers and equipment, and for disposal of unused pesticides. This water is routinely used for bathing and drinking by man and beast.

The use of DDT in Pakistan is largely restricted to a mixture called Zolone DT which is used on cotton to control a complex of insects including pink and cotton bollworms. This is a liquid formulation containing DDT and Zolone. In 1973, 58,000 imperial gallons of this formulation was procured for use on cotton. We have no statistics on the amount actually used or the acreage treated. As mentioned earlier, DDT is also used in malaria control programs, but resistance has apparently developed and malathion will probably be used in the near future. Pesticide runnoff into mosquito breeding spots is expected to intensify the problem of vector resistance. The consensus of opinion among those interviewed is that agriculture plays some role in the rise of mosquito resistance to DDT in Pakistan.

Bee keepers also have had problems. Some hives apparently have been forced to be relocated.

Endrin has been used on sugarcane, rice, and cotton, but it was not included in the approved list of pesticides permitted for registration this year.

Dieldrin, BHC, and heptachlor are the only other chlorinated hydrocarbons used to any extent in Pakistan. They are approved primarily for termites, grasshoppers, and certain soil insects.

I. MEDICAL SERVICES FOR TREATING PESTICIDE POISONING

The capability of readily diagnosed and treated pesticide poisoning is most needed in the agricultural areas. Here the greatest hazard is dermal absorption, which produces a slower onset, longer duration, and a relatively milder, albeit fatal on occasion, clinical course of illness. Yet these areas are grossly deficient in facilities to diagnose and treat pesticide induced illness. Organophosphates, the bulk of the insecticides utilized on crops, are the one group of poisons most easy to treat if early diagnosis is made. The first step toward diagnosis is an awareness of the possiblity that illness may occur.

There is universal belief among agricultural departmental authorities that the health care facilities are neither aware nor properly equipped to care for pesticide poisonings. Organophosphate deaths while patients are under medical care lend support to this belief. Organophosphate poisoning illness can undergo a dramatic reversal to cure if large dose and continual

antidotal therapy is carried out with the physician in constant, not occasional, attendance. Experience in the United States clearly indicates that the average physician faced with his first case of organophosphate poisoning will undertreat, much to the detriment of the patient. In one reported series* patients diagnosed died due to lack of more intensive care and half of the patients accidentally poisoned by parathion were not diagnosed correctly before death. Only after an intensive series of hospital educational seminars by public health physicians did this unhappy situation cease. Therefore, the solution to the medical care problem of poisoned patients is an intensive program of education of hospital physicians and dispensary staffs by trained public health workers along with appropriate wall posters, literature and diagnostic aids such as simplified blood cholinesterase testing kits.

First aid treatment is important before the patient is moved to a medical care facility. Although many top level administrators and scientists within the agricultural sector are quite knowledgeable about general aspects of pesticide illness first aid treatment, they have been placed at a disadvantage by lack of consultative assistance from physicians who have made a study of pesticide poisonings. As a result we have observed that first aid instructions are not arranged in an order most compatible with the usual dermal absorption poisoning seen in agricultural workers. Most current directions start with the assumption that the patient may have ingested poison and suggest induction of vomiting by salt water. It is not surprising to find this remedy espoused for any poisoning including dermal. There is needed medical instruction of agricultural workers at all levels of responsibility, particularly the lower, by specially trained medical or public health workers utilizing instructional material applicable to the common problems.

A standard first aid kit for common pesticide poisonings should be devised and made available at little or no cost to all public and private sectors with provision for replacement of obsolete components on a regular basis. It would be a mistake to make the kit too complex. It should be oriented only toward pesticide poisoning, otherwise the components may be misused. In one instance we encountered a first aid kit at a pesticide application site which contained various items for minor wounds and headaches. It also had mixed together poorly marked ampules of morphine and atropine. An officer in charge was under the erroneous conception that any of the ampules was the antidote. In event of an organophosphate poisoning the administration of the former would be expected to kill an ill, not fatally poisoned, patient.

J. CASE REPORTING SYSTEM AND SCIENTIFIC INVESTIGATIONS

There is no system. Various officials interviewed had picked up a story of poisoning through a newspaper report or word of mouth. A farmer who becomes ill and dies at home stands a good chance of being buried without the case being investigated, unless suspicion is raised. Village leaders, often illiterate, are not in a position to be suspicious of such deaths unless an epidemic occurs. That such events are likely to occur is evident from only one human poisoning study program in existence in Pakistan today. This

*Davis, J. H., et al, Occurrence, Diagnosis, and Treatment of Organophosphate Pesticide Poisoning in Man, Annals of the New York Academy of Sciences, 160:383-392, June 23, 1969.

temporary program is at Agricultural University, Lyallpur, where a beldar testing and interview program is being carried out by the Department of Entomology with the assistance of a Fullbright-Hays scholar. Interviews with approximately 125 beldars indicate that they have no knowledge or concept of what insecticides they are using. About 5-10% give a history of an episode of unconsciousness which caused alarm. These are the survivors who have had a brush with death. See Appendix B.

A two-phase reporting system is needed. The first is a concerted effort to have all sources of information about poisonings collected by a central agency with proper attempts at follow-up and verification of details. The second is to establish pesticide monitoring teams within the major areas of pesticide use. These teams would be expected to continue work of the type commenced at Lyallpur and would also investigate episodes of pesticide poisoning. The results should be forwarded directly to a central agency. Data of this type can then be used to improve safety in pesticide usage. The essential element of such a team would be a public health-trained individual with special training in pesticide hazards. Transportation should be available and this could be coordinated with other agencies if necessary.

It is desirable to have local in-depth pesticide use and misuse monitoring performed on a selected basis. Such studies elsewhere have quickly and economically demonstrated sources of danger before chemical illness has resulted. Unfortunately, there is no laboratory currently equipped and staffed for such a program. There is interest and potential on the part of scientific workers interviewed but, without modification, there is no hope of a program within the existing structure. There is need for at least one well supplied and administered health oriented program, the function of which would be to interview, observe pesticide practice, obtain blood and urine specimens and engage in teaching. It would coordinate with simple public health observation and teaching teams noted above. Its laboratory would analyze and assist in technical supervision and coordination. Ideally the laboratory should be housed within and coordinated with a medical teaching institution which has already demonstrated excellence in handling of clinical problems. Currently the only medical institution with such potential is the Jinnah Post Graduate Medical Centre, Karachi.

An alternative would be to coordinate such activities through a laboratory which is already active in the field of pharmacology and physiology. Such a laboratory exists in Islamabad. The National Health Laboratories are the best equipped and staffed in the nation. Its director, a physician, is cognizant of the many ramifications of health and the economic benefits which accrue from assurance of quality control. The National Health Laboratories has a close geographic and good potential working relationship with the shortly-to-build agricultural center of the Agricultural Research Council, Islamabad. Those aspects of pesticide management which depend upon laboratory analyses of pesticide metabolites in man and animal could be coordinated through the National Health Laboratories. The costs would be nominal as much, but not all, necessary equipment is present and the staff is competent to handle the analyses in both a routine and a developmental manner. An administrative advantage is that this institution is ideally suited, geographically and governmentally, to engage in cooperative studies with other agencies with rapid top level administrative concurrence. See Appendix E.

K. INTERAGENCY COORDINATION

It is apparent that pesticide-related health problems are of general concern. The potential to remedy problems is present. Institutes and laboratories exist. However, there was noted a frequent problem. Laboratory instrumentation common to many countries is in extremely short supply. Without instruments and supplies scientists are retarded in their accomplishments. Although the economic problems of the nation are many, agriculture remains the main source of foreign exchange. Time consuming routine governmental procedures must be speeded up and streamlined in this sector of the economy. Multi-agency cooperative ventures must be encouraged. Efficient use of pesticides play a proper role in assuring increased agricultural exports. The problems cited in this report indicate breakdown in efficiency. Illness and environmental pollution are indicators of economic waste of expensive imported materials. Also workers make ill by poison or malaria cease to be productive and this retards economic growth. Any administrative changes which improve pesticide safety assure a positive cost benefit.

Numerous epidemics of pesticide or other chemical poisoning have occurred in many portions of the globe. The local Thimet disaster was a source of embarrassment to the government and resulted in suspension of a chain of administrative personnel. The potential for a severe political problem of this type, or worse, remains. If a cargo of a highly toxic pesticide were to leak in a railway wagon and flour then contaminated during shipment in the same conveyance, an entire embassy staff or other prominent sector of society could die overnight. Such an event happened recently in Indonesia and involved two families which had supped together.

The solution is a rational policy that accepts pesticide safety as an integral part of the prime economic goal of Pakistan. Monitoring of man and his environment is crucial to this program. Coordination must be obtained at the highest level of federal and provincial agencies of agriculture, labor, and health. Military authorities should be included as such programs affect the strength of the nation. Money placed strategically in a few selected laboratories for the most modern equipment and selected personnel to work with these agencies could ward off trouble and contribute much to the unimpeded agricultural growth of Pakistan.

APPENDIX A

ACTION PLAN SHOWING THE AREA TO BE AERIALLY SPRAYED BY PRIVATE AND PUBLIC SECTOR DURING THE YEAR 1974

Figures in lakh acres (1 lakh = 100,000)

Province	Crop	Total Area under cultivation	To be treated by CDPP		To be treated by private parties	
			Actual acres	Spray acres	Actual acres	Spray acres
Sind	Paddy	21.00	-	-	3.35	6.70
	Cotton	12.00	1.65	4.00	-	-
	Sugarcane	2.10	0.80	2.40	-	-
		35.10	2.45	6.40	3.35	6.70
Punjab	Cotton	42.00	1.95	6.00	-	-
	Paddy	20.00	0.75	0.75	4.00	7.25
		62.00	2.70	6.75	4.00	7.25
N.W.F.P.	Sugarcane	2.15	2.15	4.30	-	-
	Maize	8.44	0.50	1.00	-	-
	Tobacco	0.65	0.40	0.40	-	-
	Orchard	0.65	0.40	0.80	-	-
	Oilseed	1.59	0.50	0.50	-	-
	Rice	1.32	0.50	0.50	-	-
		14.77	4.45	7.50	-	-
Baluchistan	Oilseed	0.70	0.40	0.40	-	-
	Orchard	0.25	0.07	0.21	-	-
		0.95	0.47	0.61	-	-
Grand Total:		112.82	10.07	21.26	7.35	13.95

APPENDIX B

Episodes of Accidental Human Poisoning

These are only the tip of the iceberg and consist of a few anecdotes related to us from various sources. The absence of any poisoning incidence data collection system coupled with the absence of any means to properly investigate poisoning illness or death keeps this list smaller than the true figure. Suicides by pesticides are known also.

1. Parathion - spray plane leader.

2. Carbecronn - spray plane leader went home, became ill, died after three days of hospitalization.

3. Disyston granules - farm worker applied to cotton, died day after transfer to hospital.

4. Endrinn - beldar sold an organochlorine to man with lice problem in family. Material applied to heads and 4 died.

5. Hydrogen phosphide - three workers poisoned while fumigating grain with aluminum phosphide.

6. Thimet granules - one died and 2 made ill while unloading containers of poor quality.

7. Thimet granules - improperly formulated and used granules distributed by hand. Five farm workers said to have died. Granules had been formulated with brick dust and then were diluted with sand at time of application.

8. Disystron granules - child ate pesticide mistaking it for spilled sugar.

9. Frequent poisoning of farm workers - a study now in progress reveals that about 5-10% of 126 beldars interviewed related a history of illness (loss of consciousness) which required hospital treatment. Same study shows that about one quarter have a cholinesterase blood level of 50% or less of normal.

APPENDIX C

Symptoms and Treatment of Pesticide Poisoning

Pesticides cover a wide range of toxic chemicals used for a wide variety of purposes. Modes of toxic action are too variable for any blanket treatment program to apply. Accordingly one should be concerned with what is most likely to occur. Within agriculture the two most common classes of toxicants are the organophosphates and the organochlorines. The mode of action of each group is different. The biochemical basis of toxicity of organophosphates is best understood. These pesticides block the function of cholinesterase, an enzyme, at nerve endings which keeps acetylcholine, the chemical transmitter of the nerve impulse, from rising to non-physiological levels. The organophosphate combines with the cholinesterase and normal nerve impulses cease. This in turn results in physiological response, the most striking being excessive bronchial secretions with watery foam issuing from the mouth and nose, constricted pupils, sweating, nausea, vomiting, diarrhea and muscle twitching, paralysis and respiratory failure. Recognition of this sequence is made by observation of the patient and inquiry as to his exposure to pesticides.

Most agricultural pesticide poisonings are due to skin absorption. Obviously the skin, hair and clothing may have been contaminated. Alkaline cleaning agents hydrolyze organophosphates. Vigorous scrubbing with strong soap and water are an early part of the treatment. The effective initial antidote is atropine 2 to 4 milligrams given every 5 to 10 minutes until the pupils of the eyes dilate, the skin becomes dry and the pulse becomes rapid. This must be maintained around the clock with the patient always under observation in order that injections can be given when signs of organophosphate poisoning reappear. As a first aid measure intramuscular injections can readily be given by relatively unskilled workers. Oximes. Oxime therapy with another agent, pralidoxim, is recommended to overcome muscle weakness. This must not be substituted for atropine but must be given after atropine is started. It is doubtful that this drug would be readily available except at larger medical centers. Throughout therapy oxygen should be given. Only if there is reason to believe that the patient took the poison by mouth should any efforts be made to induce vomiting. This should not be done if the patient is unconscious, for inhaled vomitus is injurious to lung tissue.

Highly toxic organochlorine pesticides, such as endrin, are likely to induce illness by dermal contact. The most obvious signs are sudden severe convulsive seizures. There is no specific antidote for this class of poisons. Maintenance of the airway and oxygen is helpful. Seizures should be controlled by intravenous barbiturates and diphenylhydantoin (Dilantin) by physicians skilled in their use.

Again, if dermal absorption is suspected vigorous washing of skin and hair is indicated. As noted above, if oral intake is suspected vomiting may be induced following the same precautions.

Diagnostic chemical tests are in order for organophosphatic poisoning but no blood cholinesterase testing is being performed for this purpose at Jinnah Post Graduate Medical Center or elsewhere. Tests for urinary metabolic by-products of pesticides and measurements of pesticides in blood are not

available in Pakistan and only available in a few centers elsewhere in the world. However, cholinesterase testing should, and can be, made readily available at any hospital which has a basic chemical diagnostic laboratory.

APPENDIX D

Current Pesticide Safety Instruction at University of Miami School of Medicine

1. A limited number of physicians and health workers have been offered a course of instruction in public health as it relates to agricultural use of pesticides and the problems of diagnosis of acute poisoning and monitoring of man and his environment.

2. Special laboratory instruction in pesticide analyses has been given in conjunction with a seminar. Laboratory equipment, including gas chromatographic apparatus, is transported to the location of the international seminar along with instructional staff.

3. The director of these services is:

Dr. John Davies
Professor and Chairman
Department of Epidemiology and Public Health
University of Miami School of Medicine
Miami, Florida, U.S.A.

APPENDIX E

Contacts and Locations Visited in Pakistan

Date	Place	Agency	Person
7/16	Islamabad	USAID	Dr. Richard R. Newberg, D/AP
			S. A. Chughtai, O/AP
			Chester Bell, AD/CDE
			E. T. Bullard, O/AP
			Francis J. Murphy, AD/PHN
		CDPP	Fariduddin Ahmad, Director, CDPP
		GOP	Malik Khuda Bakhsh Bucha, SAPM
7/17	Karachi	CDPP	Fariduddin Ahmad, Director, CDPP
			Z.K. Tariq Aerial, Pest Control Officer
			Mansoor Ahmed Sial, Operational Manager, Aerial Wing
			Dr. Abdul Ghafoor, D. Director Quarantine
		ARC	Dr. Zafar Masood
		FAO	Michael Way
7/18	Karachi	CDPP	Mansoor Ahmed Sial, Op. Manager Aerial Wing
		Agricultural Aviation Ltd.	S. Mansoor A. Shah
7/19	Karachi	Jaffars Bros. Ltd.	Dr. Mansoor Ahmad Dr. K. Ziauddin
		Union Carbide	A. K. Aslam
		Hoechst Pak. Ltd.	Horst Schrempp
7/19	Karachi	Bayer	Syed Kamal Ahmed
		Pakistan Burmah Shell	R. M. Bokhari

Date	Place	Agency	Person
7/19 (cont.)		May & Baker	M. S. Mirza
		Sandoz	Saleem Majidullah M.S.H. Khan
		Formulation plants	
7/20	Karachi	Jaffar Bros. Ltd.	Dr. K. Ziauddin A. K. Aslam
		Pak. Burmah Shell	R. M. Bokhari Mr. Ali
		Agro. Chemi-als Ltd.	Abdur Rafi
7/22	Karachi	University Karachi	Dr. Syed H. Mahmood, Registrar Mr. Sher Khan, Entomologist Mr. Manzoor Ahmad, Entomologist Dr. (Mrs.) Tirmizi, Head Zool. Dept.
7/22	Karachi	FAO-Vertebrate control	T. J. Roberts Dr. J. Greaves Dr. George Fulk
		CDPP	Dr. Abdul Ghafoor, Dep. Director Plant Quarantine
7/23	Karachi	Pak. Council Sci. & Industry Research (PCSIR)	Mr. M. Aslam, Director Dr. Qureshi, Head Engr. Res. Division and Mr. Sabir
		Central pesticide stores of agriculture extension, Malir	
7/24	Hyderabad	Sind. Agr. Dept.	Sarfraz Beg. Plant Protection Off. Abdul Matin Khan, Section Officer
		Farmer	Nazir Siddiqui
		Sandoz pharmaceutical plant, extension stores and spray demonstration	
7/25	Kuri	CDPP Aerial operation	Masood Ejad, Pilot, Mujahid Engineer, Mueen Entomologist
		Extension Store	Assistant PPO, Agr. Assistant
7/26	Tandojam	Agr. Research Institute	Dr. Memon, Director, K. M. Naqvi, Entomologist
		Agriculture engineering workshop	
		Sind Agriculture College	Dr. Makki, Entomologist A. B. Bhatti, Head, Agr. Engr.

Date	Place	Agency	Person
7/27	Lahore	Punjab Ag. Dept. (Extension)	Mr. M. A. Salam, Director, Sadique, Plant Protection Officer, M. H. Khan, Secretary Agriculture M. A. Bajwa, Deputy Director Plant Protection
		Plant Protection Institute	G. Q. Chaudry, Director
		Extension store (divisional)	
7/29	KalaShah Kaku(LHR)	Rice Research Institute	Dr. Abdul Majid, Director A. R. Dar, Entomologist
		Ittehad Chemicals Ltd. (formulating and manufacturing DDT and BHC)	
7/29	Lahore	Dept. of Agric.	Agr. Assistant Office, Field Asst., Beldar
	Shahdara	Dept. of Agric.	Agriculture Assistant Office
	Lahore	U.S. Consulate	Mr. Griffin
		FMC Corp.	Mr. Chaudhry
7/30	Lahore	Farmer	Kazim Khan (Maj. Gen. (Retired)
		Farmer	Bucha Mango Orchard
		Union Carbide experiment plots--sugarcane	
	Lahore	Dept. of Agric.	Agric. Assistant Offices
7/31	Lahore	Agr. Chemicals Assoc.	Mohammad S. Gill, Chairman (about 20 members present)
	Lahore	Jaffar Bros.CIBA Geigy Aerial, Survey of paddy area	Irshad Ahmed
		Dept. of Agric.	M. A. Bajwa, Dep. Director, Plant Protection, Agr. Asst.
		CIBA-Geigy	R. Levers, S. M. Saleem
		Dawood Chem. Ltd.	Dr. Mohammad Rafique

Date	Place	Agency	Person
8/1	Lyallpur	Agr. Research Institute	Dr. Sanaullah, Director
		Plant Protection Institute	Dr. G. Q. Chaudry, Director Dr. Khawaja Abdul Haque (ex-director)
	Samundri	Farmers	
		Spray demonstration by Field Assistant	
8/2	Lyallpur	Agr. Research Institute	Entomology, Plant Pathology (Dr. Kausar) Ag. Chemist (Hayat M. Bhatti)
8/3	Multan	Dept. of Agric. (Extension)	M. L. Chaudhry, Dep. Dir., Agr. M. Shafi, Asst. Plant Protection Officer
			Maqbool Ahmed [illegible] Asst. Dir of Agriculture
		Spray demonstration - farmer	Field and Agriculture Assistants
		Integrated rural development program, Billiwala, Stores	
		Multan Cotton Res. Inst.	Entomology, Plant Path. Plant Breeding
		FAO	Dr. Jose Giles, Genetics
8/5	Lahore	Dept. of Agr.	M. A. Bajwa, Deputy Director Plant Protection
		Ciba-Geigy	S. M. Saleem
8/7	Chakdara	Aerial Spray Unit	Mr. Ghulam Sarwar Chaudhry Asst. Quarantine Entomologist Mr. Wazir Farooqi, Engr. in charge Captain S. A. Badshah, Pilot
8/8	Peshawar	Agr. Dept., NWFP Tarnab	S. G. Zakrya, Dir. of Agr. NWFP S. S. Hussain, Plant Prot. Off. Deputy Director Agr. for tribal areas Nural Haq, Asst. Dir. District of Peshawar
		Central pesticide store NWFP, Tarnab	

Date	Place	Agency	Person
8/8 (cont.)	Peshawar	Civil Secretariat	M. Abdul M. Khan, Additional Secretary of Agric., NWFP
		Nahqi Pesticide Store & Farmers	Mr. Abdul Ali Jan Agricultural Assistant, Integrated Rural Development Program
8/9	Peshawar	Agr. Research Inst., Tarnab	Mr. M. H. Shah, Director
		Soil Services and Food Technology Laboratories	Dr. Assim Dr. Rashid Khan Entomologist
		Provincial Public Analytical Lab.	Public Analyst
		Landi Kotal	Badshah Gul Azad, Agric. Asst.
8/10	Islamabad	Staff House	Dr. Carl Koehler, Prof. Entomology Univ. California, Pest Management Team
			Dr. Farid ud din Ahmed, Plant Protection Advisor and Director, Plant Protection Dept.
8/11	Murree	Cereal Disease Research Station	Mr. Naeem Ullah Asst. Mycologist
			Dr. Hussain Helmy, Plant Physiologist, Cairo, Egypt
8/12	Islamabad	USAID	Mr. Terence D'Souza Mr. Niel A. Dimick
8/13	Lahore	Pakistan Medical Res. Center Univ. of Maryland	Dr. R. K. Saka, Geneticist Dr. M. Aslam Khan, Geneticist and Entomologist
		Malarial Eradication Training Institute	Mr. S. D. Pervez, Entomologist Mr. Rai Mushtaque, Sanitarian
8/15	Lahore	Bayer	Sultan Ali Chaudhry, Tech. Director Syed Kamal Ahmed, Crop Production Officer
8/16	Lyallpur	Agric. Univ.	Dr. Ali A. Hashmi, Entomologist Miss Barbara Thompson, Fulbright Scholar Researcher

Date	Place	Agency	Person
		Plant Protection Institute	Mr. Ch. Ghulam Qadir, Director Khawaja Abdul Haq, Retired Dir. Mr. Niazi, Chemist
8/17	Lahore	Agric. Dept. Punjab	Mr. Muhammad Ali Bajwa Deputy Director, Plant Protection
8/19	Karachi	Medical Import Export Depot	Dr. Khawaja Rashid Hussain, Officer in Charge
		Jibhah Post Graduate Medical Center	Dr. B. A. Qureshi, Director Dr. Abdul Latif Minhas, Internist
		Burmah Shell	Mr. R. M. Bokhari, Chemical Manager
8/20	Karachi	CDPP	Mr. Sarwat Siddiqui, Asst. Entomologist
		Jinnah PGMC	Prof. A. Taur Rahman, Biochemist Dr. M. M. Rab, Internist
8/21	Karachi	PCSIR	Dr. M. Aslam, Director Dr. S. Shahid Husain, Mycologist Dr. M. Anwar Ullah, Entomologist
	Karachi	Vertebrate Pest Control Center	Dr. J. H. Greaves Dr. George W. Fulk
		CDPP	Dr. Fariduddin Ahmed, Director
8/23	Islamabad	Ministry of Health	Brigadier M. A. Chowdry Director General
		Planning Dept.	Dr. Siraj-ul-Haq Chief, Health Section
8/28	Islamabad	USAID	Dr. Floyd Williams Agric. Advisor - Research
		National Health Laboratories	Col. M. I. Burney Executive Director Dr. Z. A. Jan

VI. ACKNOWLEDGEMENTS

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