

VS - PN-ABT-357 91704

VERTEBRATE PEST MANAGEMENT IN PAKISTAN

By

Joe E. Brooks, Ejaz Ahmad and M. Munir Asif

**A Govt. of Pakistan/USAID Project
Vertebrate Pest Control Project
Denver Wildlife Research Center
Animal and Plant Health Inspection Service
Science and Technology
U. S. Department of Agriculture**

**Final Project Report
(Unpublished)**

June 1991

CONTENTS

	Pages
1. INTRODUCTION	1
2. OBJECTIVES	1
3. MAJOR ACCOMPLISHMENTS	2
3.1 Research	2
3.2 Technology Transfer	3
3.3 Training	3
3.4 Institutionalization	5
3.5 Reporting	6
4. PROJECT CONSTRAINTS	6
5. REMAINING CRITICAL ISSUES	7
6. LIAISON BETWEEN VPCL/NARC AND DWRC	10
7. LIAISON BETWEEN DWRC AND THE UNIVERSITY OF AGRICULTURE, FAISALABAD	10
8. SUGGESTED RESEARCH WORKPLANS FOR THE FUTURE	11
8.1 Porcupine	11
8.2 Wild boar	11
8.3 Pesticides in the environment	11
8.4 Bait formulation and marketing at NARC	11
8.5 Continued technology transfer at Gujrat	12
8.6 Continued preparation of outreach and training materials	12
8.7 Continued cooperation with the University of Agriculture, Faisalabad	12
9. COOPERATION AND LIAISON WITH OTHER AGENCIES	12
10. ACKNOWLEDGEMENTS	14
11. VERTEBRATE PEST CONTROL PROJECT STAFF	15
12. VPC PROJECT OUTPUTS	15
12.1 Training Given by the VPC Project	15
12.2 List of Graduate Theses from UAF	15
12.3 Training Materials Produced by the VPC Project	18
12.4 Published and Unpublished Reports	19
12.4.1 Publications	19
12.4.2 Manuscripts in Preparation	20
12.4.3 M. Phil. Thesis.	20
12.4.4 Unpublished Technical Reports	21
12.4.5 Information Brochures	23

Annex-I

VERTEBRATE PEST MANAGEMENT IN PAKISTAN

FINAL REPORT OF THE VERTEBRATE PEST CONTROL PROJECT

November 1985 - June 1991

by Joe E. Brooks. Ejaz Ahmad and M. Munir Asif

1. INTRODUCTION

The Government of Pakistan (GOP)/ U. S. Agency for International Development (USAID)/Denver Wildlife Research Center (DWRC) Vertebrate Pest Control Project (VPCP), a subcomponent project under the Food Security Management (FSM) Project was initiated on November 1, 1985, with the arrival of the DWRC resident biologist and closed on June 30, 1991, a period of 5 years and 8 months. It was originally conceived as a post-harvest vertebrate pest management project, but based upon surveys that found low grain losses and minor vertebrate pest infestations in public sector grain storage facilities, the project began work on other post-harvest situations, such as wholesale commodities markets in urban centers and farm and village food storage losses. At the request of the Ministry of Food and Agriculture (MINFA), work also was started on pre-harvest situations and this work expanded in 1988 when a new scope of work was prepared.

The Pakistan Agricultural Research Council (PARC) and the National Agricultural Research Centre (NARC) agreed to let the VPC Project have space in the newly completed F-Laboratory Block at NARC. They provided a small laboratory, 3 offices, and a godown in which to keep caged animals and store equipment and supplies. The VPC Project staff occupied these quarters in January 1986. This base of operations has served us well. These offices and laboratory are now jointly occupied by both the VPCP and the VPCL/NARC but will be solely occupied by the VPCL after the end of June. This provides the VPCL with their base of operations.

2. OBJECTIVES

The objectives of the VPC project were:

2.1 To assist the four Provincial Food Departments in Sindh, Punjab, Balochistan, and North-West Frontier Province (NWFP) to strengthen their capabilities in vertebrate pest control operations and loss assessment methods in grain storage facilities.

2.2 To assist the Pakistan Agricultural Storage and Services Corporation (PASSCO) to strengthen and improve their vertebrate pest control operations and loss assessment methods in grain storage facilities.

2.3 To improve the quality of adaptive research programs for stored grains.

2.4 To assess the problems of vertebrate pest-caused losses of stored grains at farm level and develop methods to reduce losses.

2.5 To assist the Pakistan Agricultural Research Council (PARC) to strengthen the capabilities of their vertebrate pest control laboratories at Karachi and Islamabad and upgrade the applied research program in bird and rodent control in stored grains.

2.6 To assess major vertebrate pest problems in pre-harvest crops and attempt to implement operational pest control in pilot and large-scale trials, leading to the development of safe, effective, and inexpensive methods that farmers can use to protect their crops from animal damage.

3. MAJOR ACCOMPLISHMENTS

3.1 Research

- We carried out and completed surveys of 349 provincial grain storage structures and in 52 PASSCO structures in the four provinces and 25 outdoor grain storage depots. Grain losses due to vertebrate pests were low, 0.1 to 0.3%, and could easily be dealt with through better structural maintenance and simple good housekeeping practices.

- We estimated rodent populations through trapping and activity indices at 4 large city wholesale commodities markets and at 13 other smaller city markets in Punjab Province. Losses due to rodent consumption and contamination of commodities was estimated at 0.2 to 0.5% of the total 1.25 million metric tons moving through the markets each year.

- We sponsored a 3-year research study of farm and village stored food losses under a cooperative research agreement with the University of Agriculture, Faisalabad. Rodent populations in farm and village structures were estimated to consume and contaminate 30 kg of commodities per year per farm or village family.

- We carried out and completed pre-harvest vertebrate pest damage assessments in wheat, rice, sugarcane, maize and groundnut fields in 1986, 1989, 1990 and 1991. Damage to wheat varied from 3.3% cut tillers in 1989 to 8.4% in 1991 in Gujrat District.

- We carried out and completed the following cooperative research studies on wild boar with the Principal Investigator, Dept. of Agricultural Entomology, University of Agriculture, Faisalabad:

- Agricultural importance of wild boar in Pakistan
- Morphometrics of wild boar
- Reproductive biology and population structure
- Methods of aging using tooth irruption patterns and eye lens weight
- Food habits and habitat use
- Use of anticoagulants as toxicants for wild boar control
- Development of baits and bait delivery system for wild boar control
- Determined movement patterns with radiotelemetry

• We carried out laboratory studies on the comparative toxicity of three anticoagulants to *Rattus rattus*.

• We carried out a study of the diet of the bandicoot rat captured from wheat and rice fields.

• We carried out and completed a field and laboratory study of the reproductive biology and population structure of *Rattus rattus* from the Rawalpindi grain market.

• We carried out and completed a field and laboratory study of the reproduction, diet, and hormone levels in the lesser bandicoot rat, *Bandicota bengalensis*, on the NARC campus. This led to an MPhil degree for one counterpart scientific officer.

3.2 Technology Transfer

• We carried out a field experiment in technology transfer to farmers in a 2,200 ha wheat- and rice-growing area near Kunjah, Gujrat District. This covered five crop cycles from 1989 wheat to 1991 wheat seasons. At the end of 5 crop cycles, 34% of the farmers were using poison baits in rodent control and one pesticide dealer in Kunjah was producing and selling ready-made rodenticidal baits. Thus, a small seed of rodent control technology had been transferred in this area during 5 crop cycles.

• We demonstrated the use of rodent control technology in experimental fields on the 600 ha National Agricultural Research Centre, Islamabad, from February through May 1987.

3.3 Training

• We developed a grain storage manual, posters, brochures, audio slide sets, and video training cassettes for grain storage operational personnel (Fig. 1). These materials were used by the Storage Technology Development and Transfer (STDT) project to train over 1500 provincial and PASSCO grain storage personnel.

• We produced posters, handbills, farmers handbooks, and video training cassettes for training farmers in rodent control

methods in wheat and rice (Fig. 2).

- We developed a womens' handbook and a video training cassette for pest management methods for rural women (Fig. 3).

- We compiled a Vertebrate Pest Management Training Manual for training research scientists, Agricultural officers and agricultural extension workers (Fig. 4).

- We participated in 5 two- to three-week Vertebrate Pest Management training courses at the Training Institute, NARC. Five international students from Syria, Somalia, and Uganda attended besides Pakistani participants.

- We provided anywhere from 1/2 day to 5 days of training in the field to over 2,000 persons, from farmers to research scientists (Summarized in Section 12.1).

- Counterpart staff on the VPC Project and the VPCL/NARC staff received formal training in 20 different subjects at the Training Institute, NARC. Three counterpart staff participated in international training at Colorado State University and Denver Wildlife Research Center, Colorado, USA. One counterpart (I. Hussain) took an M.Phil. degree at Quaid-i-Azam University while on the project. One counterpart scientist took 6-weeks training in ecotoxicology methods at DWRC, Denver and Laredo, Texas.

- We expended about \$ 34,000 on cooperative research studies carried out by the Dept. of Zoology, University of Agriculture, Faisalabad. This resulted in assistance to 44 graduate students and the preparation of 3 PhD theses, 11 MPhil theses and 30 MSc theses (Fig. 5) on vertebrate pest subjects. These included: (Titles in Section 12.2)

- Crop damage and food habits of house sparrows

- Reproductive biology and habitat use by rose-ringed parakeet

- Ecology, reproduction, and food habits of rodents in crop lands, farm and village structures, and in urban structures

- Strategies of rodent control in a wheat, sugarcane and fodder agroecosystem

- Methods of indexing porcupine populations

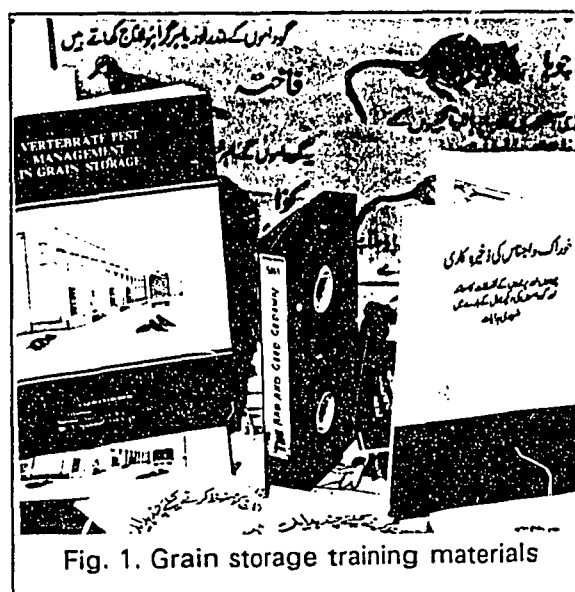


Fig. 1. Grain storage training materials

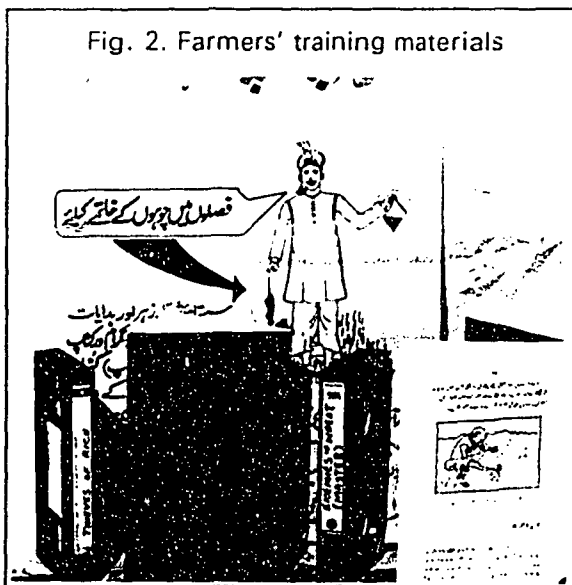


Fig. 2. Farmers' training materials

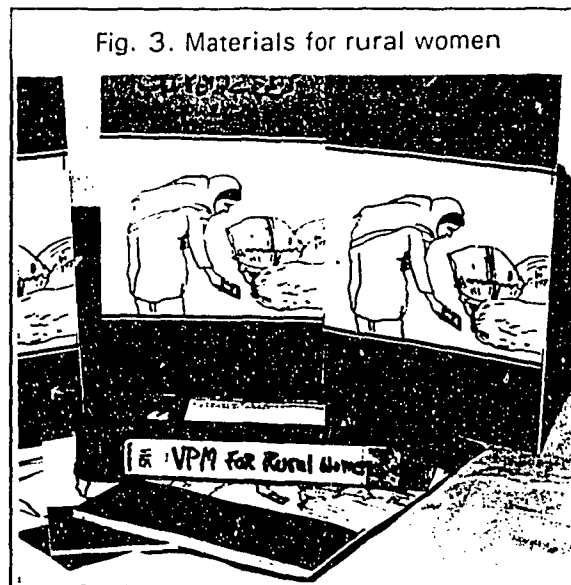


Fig. 3. Materials for rural women

3.4 Institutionalization

- Institutionalization of vertebrate pest management at NARC was accomplished by training GOP counterpart scientists in VPM methods in the field and in the laboratory for 4 years and in transferring many items of equipment, supplies, and vehicle to the VPCL/NARC at the end of the project. This was also done by incorporating VPM into the NARC Master Research Plan for the Year 2000 (Annex 1). Vertebrate pest management now is a recognized part of crop protection in the NARC program.

- Institutionalization of vertebrate pest management as part of the graduate level curriculum in Pakistan was accomplished this last year. The Department of Zoology, University of Agriculture,

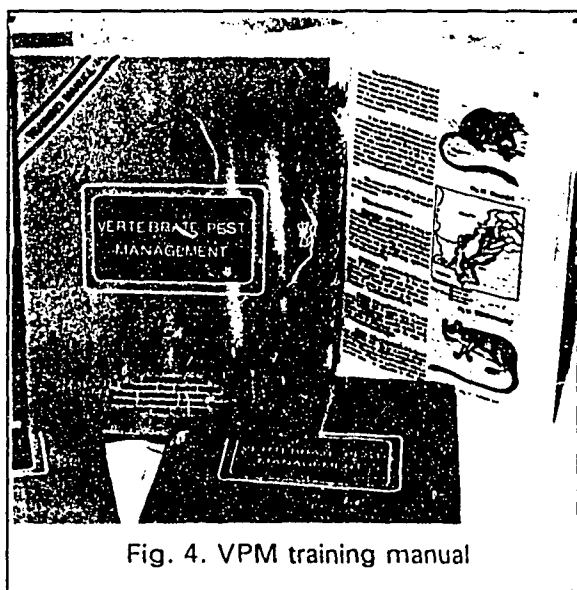


Fig. 4. VPM training manual

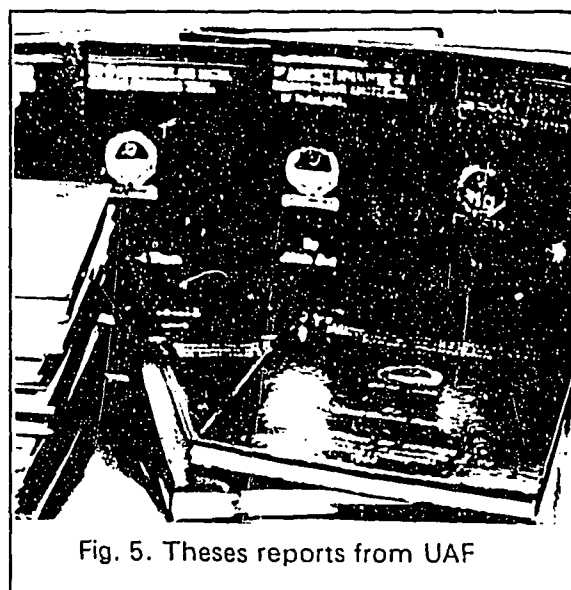


Fig. 5. Theses reports from UAF

Faisalabad, has initiated a one semester graduate course in vertebrate pest management, using the Vertebrate Pest Management Training Manual as its core textbook. Likewise, the Department of Agricultural Entomology, University of Agriculture, Faisalabad, has done the same, also using the Training Manual as its core text. Thus, the teaching of vertebrate pest management at the graduate level in country has been started.

- The video training cassettes, printed handbooks, brochures, posters, and the VPM training manual have been sent to all interested agencies, including agricultural training institutes, agricultural universities, food departments, and departments of agriculture, throughout Pakistan, indicating that additional copies are available if they want to use them. The use of these materials should broaden the interest and information available on VPM within the country.

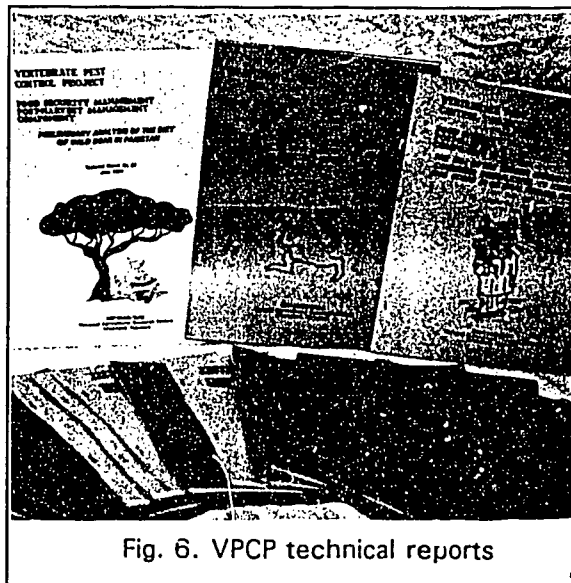


Fig. 6. VPCP technical reports

3.5 Reporting

- Quarterly reports of project progress were issued and distributed to USAID, Governmental agencies, DWRC and other interested agencies in the U.S.

- Twenty eight Technical Reports were issued reporting the findings of the project and usually containing recommendations (Fig. 6). Titles are listed in Section 12.4.

- Thirteen scientific articles have been published in popular, semi-popular, and peer-reviewed scientific journals (Section 12.4). Eight more manuscripts are in preparation.

- Six informational brochures (Fig. 7) were prepared and used for general public information (Section 12.4).

4. PROJECT CONSTRAINTS

4.1. The most obvious constraint has been the short life of the project. Five years and 8 months is a very short time in which to carry out research, develop appropriate technology and strategies, and transfer these to the end users. Normally these might be expected to cover an 8 to 10 year period before achieving the project objectives. This means that certain issues have been addressed but, at this time, not completed.

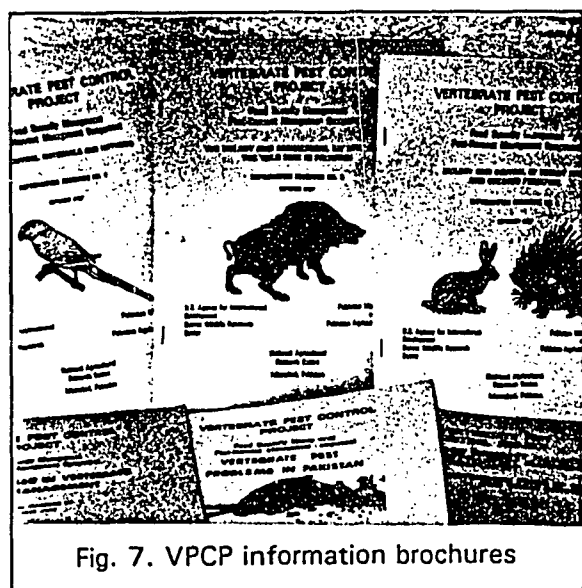


Fig. 7. VPCP information brochures

4.2. The VPCL sub-unit was not established at NARC until July 1989, giving little time for VPC Project staff to work with and help train the GOP VPCL staff in field and lab techniques.

5. REMAINING CRITICAL ISSUES

The ending of the VPC Project after 5 years and 8 months of work has resulted in a number of important activities that remain uncompleted. These unresolved issues are considered critical. The return on the considerable investment by USAID and the Government of Pakistan will not be fully realized unless mechanisms

can be developed to address the sustainability issues of institutionalization, technology development and implementation, and information transfer. Additional issues that need resolving are:

- Registration of pesticides for control of animal damage

Five technical chemicals have been registered in Pakistan for control of rodents in fields or post-harvest storage. Considerable additional work remains to be done to validate the effectiveness of these materials for different rodent species and crop conditions and to develop and register additional materials for control of damage by rodents, wild boar, and various bird species. Such work includes studies of appropriate formulations and packaging, methods for determination of pesticide residues, toxicity trials, field studies of effectiveness and economic benefit, and environmental assessment. Such studies should be an important continuing feature of the NARC component of the VPCL. Protocols could be developed for these activities to serve as models for future efforts by Pakistani scientists.

- Development of a Masters Training Curricula and Training Package for Agricultural Extension Workers

Vertebrate pest management (VPM) as a component of crop protection currently is not taught at the agricultural extension training institutes in the provinces. This leaves agricultural extension personnel with a serious gap in knowledge in giving advice to farmers on how to cope with animal damage before and after harvest. There clearly is a need here to develop and to train Master Trainers in VPM so they can teach operational extension field personnel. A kit of training manuals, handbooks, audio-visual and video aids are needed to assist the Master

Trainers in their teaching. The VPCL staff should start developing these materials in coordination with the provincial extension departments and training institutes.

- Private sector marketing mechanism for formulation and distribution of quality rodenticide baits

Techniques have been developed for effective use of zinc phosphide rodenticide baits for control of rat damage to wheat, rice, sugarcane and stored products, using ready-made bait (Fig. 8). The material is now registered for this purpose and field trials have been conducted to demonstrate effectiveness. Unfortunately, farmers are unable to find and purchase ready-made baits in village or town markets. Small packets of zinc phosphide sometimes can be found which farmers can use to make fresh baits. Often these are adulterated with charcoal or graphite, giving poor results when used and undermining farmer confidence. Mechanisms need to be developed to involve private formulators to manufacture quality baits and to distribute these and other bait materials widely to farmers.

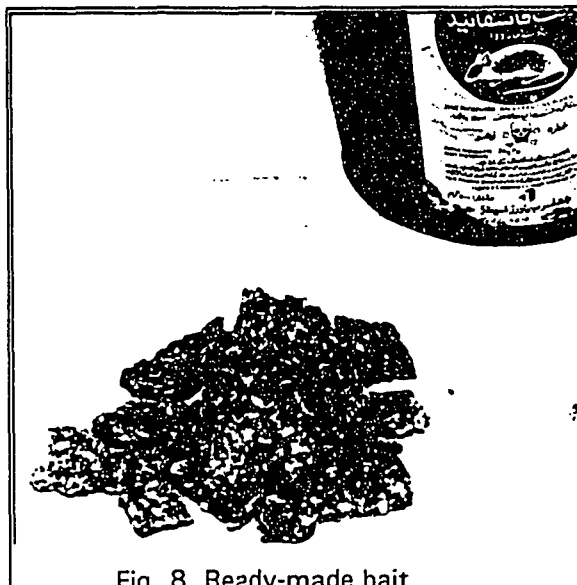


Fig. 8. Ready-made bait

- Development of methods for farmer control of wild boar

Preliminary work has been done on development of toxic baits for control of wild boar; however, this approach appears to have a number of potential limitations, including the large amounts of bait required, potential hazards for non-target wildlife, and the effort needed to obtain data required to register toxicants. If other methods for protecting fields could be developed, these might have considerable advantage for direct use by farmers. No studies have been conducted but numerous possibilities exist for investigation of frightening devices, barrier fencing, snaring, repellents, and guard animals. Further study of wild boar behavior and preliminary evaluation of techniques to reduce wild boar activity in particular locations are needed to assess the feasibility and practicality of successful development of such techniques.

- Rodent control strategy

Preliminary work suggests the possibility of protecting food grain and sugarcane crops on an annual basis by focusing rodent control efforts at points in the crop cycle before rat distribution and invasion occurs. Sugarcane fields appear to be the key source

of animals sequentially invading other crops. Focusing chemical rodent control efforts in a small fraction of agricultural land area during particular times of the year would minimize use of chemicals and reduce overall costs and effort. A problem is organization of farmers to assure activities are carried out. The approach needs to be evaluated in farm-based field studies and recommendations need to be prepared for use by extension personnel.

- Implementation of methods for porcupine control in hillside agriculture in NWFP and Azad Jammu and Kashmir

Porcupines are reported to be a serious constraint to reforestation and hillside agricultural development in NWFP and Azad Jammu and Kashmir. They cut newly planted tree seedlings and damage maize fields. Simple, inexpensive, effective and environmentally acceptable methods for control of porcupine populations in these areas are required. One possible strategy for managing porcupine damage that appears feasible is eliminating them from the early stage reforestation areas by chemical control. Porcupines are slow breeders and may not re-populate the area for several years until trees are older and less susceptible to damage. This strategy needs to be evaluated in appropriate field areas. If chemical control materials are developed, they should also be evaluated in agricultural areas where crops receive porcupine damage.

- Control of crop damage by pest birds

Very little work has been done by the VPC Project on pest birds, either damage assessments, biology and behavior, and control. There is a need to develop methods to control parakeet damage to sunflower. The damage by birds to wheat and rice needs careful assessment. The importance of several species of sparrows, particularly the role of house sparrows and the migratory montane sparrow, feeding on wheat and rice, needs clarification. As time permits, these problems should be tackled. A study has been proposed to be done at UAF on the comparative feeding habits of several sparrow species, as a beginning. Several studies on the nesting requirements of parakeets have been completed at UAF and one is in progress. The present staff of the VPCL/NARC have had extensive experience in assessing damage by parakeets to crops and in the use of trapping as a control measure.

- Damage assessment methods

Very few methods of assessing vertebrate pest damage to crops have been standardized. The statistical basis for design of data collection and analysis of damage data are needed. For example, when measuring rodent damage to wheat or rice, there are at least three different methods in use in selection of fields, in selection of sampling points within fields, in the size of the sampling unit, etc. Wildlife biologists need guidance in this area. A damage

assessment manual is needed, laying out suggested procedures and methods of data analysis. Production of a damage assessment manual for several crops and pest species would be a major contribution to vertebrate pest management.

6. LIAISON BETWEEN VPCL/NARC AND DWRC

One of the chronic problems affecting USAID/DWRC projects is how to maintain communication between the sister institutes after the funding ends and expatriate personnel return to Denver. DWRC often can facilitate the procuring of timely scientific articles as photocopies, offer advice on project design and implementation, provide follow-up evaluation of project progress, and provide assistance to counterpart personnel taking advanced degree training in the U.S.

Many of these things can be done by use of fax and telex. PARC has fax and telex facilities (fax no. 92-51-812968 and telex no. 5604 PARC PK). These can be used by VPCL/NARC to contact DWRC on a timely basis. Ordinary overseas airmail provides another option. USAID also will forward any fax or telex messages sent from DWRC to the VPCL project. The Pakistan project coordinator in DWRC will continue to communicate with the Pakistan project, regarding new literature, preparation of scientific manuscripts for publication, and ready to offer any advice on request.

It is recommended that at least one TDY by a DWRC staff member be made to the VPCL/NARC each year. It may be possible for DWRC staff to stop-over in Islamabad going to or coming from Bangladesh, where the present project runs until the end of September 1992.

It would be helpful if all future VPCL progress reports, technical reports, and published articles are sent to DWRC. Staff at DWRC would also be ready to provide editorial assistance for any manuscripts or other materials being prepared for publication.

7. LIAISON BETWEEN DWRC AND THE UNIVERSITY OF AGRICULTURE, FAISALABAD.

Liaison between Principal Investigators at the University of Agriculture, Faisalabad (UAF), and DWRC will be maintained by the International Programs Research Section at Denver and the Pakistan Program Coordinator at Denver. Much the same arrangements as for communication with the VPCL/NARC will be followed. There are still 14 theses reports to be finished and copies of these will sent on to Denver when completed. Denver staff will be ready to answer any requests from UAF and will, in turn, try to keep UAF informed of any new developments in the field of vertebrate pest management.

8. SUGGESTED RESEARCH WORKPLANS FOR THE FUTURE

The VPC Project has shown what can be accomplished by a small group of dedicated individuals. We undertook an ambitious program of damage surveys, basic research studies, and technology development in both pre-harvest and post-harvest areas, along with the development of training and outreach materials for a variety of audiences. We attempted technology transfer in rodent control to farmers in an irrigated wheat- and rice-growing area in Gujrat District. These provide a good beginning for the present VPCL project to carry on. Some suggested areas of work for the future for the VPCL/NARC are given below:

8.1 Porcupine

Studies on the biology and behavior of the crested porcupine are needed in south Asia. This species has been little studied in this area and many things about its basic biology and behavior are not known. A live-trapping study of porcupines in the barani areas should be done. Basic data on the reproduction, population structure, methods of aging animals, its food habits, its preferences for baits, methods of bait delivery and the best toxicants to use for its control are needed.

8.2 Wild boar

Continued work on baits and bait delivery systems for wild boar control is needed. The use of furrow baiting with pelletized baits should be thoroughly field tested. Pelletized baits should be made with some degree of water-proofing and with suitable binders. The anticoagulants are effective against wild boar but require a large amount of bait. Other suitable toxicants should be sought. Bromethalin is one that should be tested.

8.3 Pesticides in the environment

The entire issue of ecotoxicology in vertebrate pest management in Pakistan is yet to be examined. It is recommended that studies of the environmental fate and animal fate of the common rodenticides, zinc phosphide, coumatetralyl, and warfarin, be studied in Pakistan.

8.4 Bait formulation and marketing at NARC

The idea of starting up a pilot operation to formulate and market rodenticidal baits by the VPCL at NARC is interesting. For about \$25,000 a pilot manufacturing plant could be set up, with bait mixer, pelletizing machine, and packaging machine. Costs of baits could be recoverable through sales and perhaps even the initial capital investment could be recovered. Bait packets could be marketed under the NARC label. The idea of the pilot plant would be to show private industry that such a venture is feasible.

Funds might be available from the Private Enterprise Office of USAID, or PARC might consider going with a cooperative agreement with private investors.

8.5 Continued technology transfer at Gujrat

The effort at technology transfer in the Kunjah area of Gujrat should be continued. The project has gained a lot of credibility with the farmers in the area. Now is the time to follow-up with more advanced strategies, such as the control of rats in sugarcane in the fall when most of the ground is prepared for wheat. The area lends itself well to using one-half for reference and the other half for treatment, since it is bisected by a canal. Greater effort should be made to motivate farmers to inspect their fields before damage becomes severe and to take timely control actions.

8.6 Continued preparation of outreach and training materials

The VPCP has shown how simple, reasonably inexpensive training and outreach materials can be prepared by biologists, not having to wait for extension or audio-visual specialists to do the work for them. With the present materials as examples, the VPCL should continue to produce Additional outreach and training materials where needed. The VPCL/NARC has been left with a storehouse of informational and training materials. These should be liberally distributed to any interested parties or agencies.

8.7 Continued cooperation with the University of Agriculture, Faisalabad.

The cooperative relationship now established with the Principal Investigators at the University of Agriculture, Faisalabad should be continued. Since they are the only scientists in the country working on vertebrate pests besides the VPCL/NARC and the VPCL/Karachi, it makes sense for the units to cooperate. The graduate curriculum at Faisalabad will be used to turn out the next generation of vertebrate pest specialists and wildlife biologists in the country.

9. COOPERATION AND LIAISON WITH OTHER AGENCIES

The VPCP cooperated and net-worked with a variety of provincial, national, international, and USAID agencies and projects in implementing its work. These included:

Federal Govt. Agencies:

- Pakistan Agricultural Storage and Services Corporation, Lahore
- Pakistan Atomic Energy Commission, Islamabad
- Ministry of Planning, GOP, Islamabad
- Quaid-i-Azam University, Islamabad

- Pakistan Museum of Natural History, Islamabad
- Capital Development Authority, Islamabad
- Islamabad Capital Territory, Extension Division, Islamabad
- Storage Cell, Ministry of Food and Agriculture, Islamabad
- Animal Sciences Institute, NARC, Islamabad
- Entomological Research Laboratories, NARC, Islamabad
- Technology Transfer Unit, NARC, Islamabad
- Farm Operations and Services, NARC, Islamabad
- Vertebrate Pest Control Laboratory, Karachi
- Pest Management Research Institute, Karachi

International Agencies:

- World Pheasant Society, England
- U. N. Food and Agriculture Organization
- Barani Agricultural Research & Development Project (BARD), NARC, Islamabad (Canadian-funded)
- Crop Maximization Programme, NARC, Islamabad and Kunjah (Italian-funded)

USAID:

- FSM Storage Technology Development and Transfer Project, Kansas State University
- FSM Agricultural Data Collection Project, USDA
- FSM Economic Analysis Network Project, Chemonics
- MART Farming Systems Research Project, NARC, Islamabad and Jinder, Fateh Jhang

Govt. of Punjab:

- Punjab Provincial Livestock Development Research Institute, Kherimurat, Fateh Jhang
- University of Agriculture, Faisalabad
- Punjab Department of Food, Lahore
- Barani Agricultural College, Rawalpindi
- Punjab Forest Department, Lahore

Govt. of Sindh:

- Sindh Department of Food, Karachi

Govt. of Balochistan:

- Balochistan Department of Food, Quetta
- Balochistan Agricultural Research Institute, Quetta

Govt. of NWFP:

- North-western Frontier Province, Department of Food, Peshawar
- Agricultural University, Peshawar

- Peshawar University, Peshawar

Govt. of AJ&K:

- Integrated Hillfarming Agricultural Development Programme, Muzaffarabad, Azad Jammu and Kashmir
- In-service Agricultural Training Institute, Garhi Dopatta, Muzaffarabad, Azad Jammu and Kashmir

10. ACKNOWLEDGEMENTS

Our sincere thanks go to the two Program Officers that gave the project and staff their whole-hearted support, Dr. Barry Primm and Dr. Tom Olson. Also, to the two Agriculture and Rural Development Officers at AID Pakistan, Al Hankins and "Pat" Peterson, we want to extend our appreciation for their interest, sound advice, and excellent support for the project. To all the other staff at AID/Pakistan, who eased our path, especially Dr. Zakir Hussain, A. M. Khalid, and Mohammad Farhad, go our salutes.

To the Principal Investigators at the University of Agriculture, Faisalabad, Drs. M. A. Beg and A. A. Khan in the Department of Zoology, and to Dr. M. H. Khan, Department of Agricultural Entomology, may we say it was a pleasure to have worked with you and your graduate students. Best wishes for the future.

For the support that was given to the project by the former Chairman of PARC, Dr. Amir Muhammed, we are deeply appreciative. Special appreciation is extended to the Director-Generals of NARC, who during the past 5 1/2 years have allowed the VPC Project to occupy space in the Pest Management Wing of the laboratory block. The use of facilities at the National Agricultural Research Centre greatly facilitated the project in achieving its objectives. And this has helped immensely in institutionalizing the vertebrate pest management programme at NARC.

We especially appreciate the professionalism and friendship given us by our Govt. of Pakistan counterparts on the VPCL/NARC project. It is not easy to merge the work, schedules, and logistics of two separate units, yet because of the informality of our relationship, it was done. We wish them all the best in their future work.

To all the staff at the Denver Wildlife Research Center, we couldn't have done it without your back-up support. The staff members who provided TDY visits, advice and training helped greatly in boosting staff morale, capabilities, and in providing interesting experiences. To those TDY'ers recruited from other agencies, Jim Miller and Phil Gipson, we express our gratitude.

Without our cooperating farmers at Ratwal, near Kherimurat, much of the work on baiting for wild boar control would not have been accomplished. Our thanks to Wahid, Salim and Mahboob.

11. VERTEBRATE PEST CONTROL PROJECT STAFF

Members who worked on the VPCP staff sometime during the life of the project:

Joe E. Brooks	Team Leader
Ejaz Ahmad	Program Specialist
M. Munir Asif	Program Specialist
Liaqat Ali	Program Assistant
Kamran Rafi	Program Assistant
Christine D'Souza	Program Assistant
Sikander Hayat	Program Assistant
Barbara Neilson	Secretary
Shafiq A. Mughal	Secretary
Yousaf Khan	Driver
Mohammad Nawaz	Driver
Talat Pervaiz	Driver
Mohammad Hanif	Driver
Nasim Ijaz	Driver
Mohammad Ilyas	Laborer/Animal Caretaker
Gul Zaman	Laborer

12. VPC PROJECT OUTPUTS

12.1 Training Given by the VPC Project

Year	Participants	No. of Mandays
1986	42	31
1987	366	626
1988	33	214
1989	656	563
1990	524	388
1991	419	214
Totals	2040	2036

12.2 List of Graduate Theses from UAF

Karim, A. 1987. Foraging and feeding behaviour of rose-ringed parakeet. M.Phil. thesis in Zoology

Sarwar, M. 1987. Breeding behaviour, nest density and roosting habits of the rose-ringed parakeet. M. Phil. thesis in Zoology

- Akhtar, M. 1989. Seasonal and age specific variations in body weight and cranial measurements of Indian gerbille (*Tatera indica*). M.Phil. thesis in Zoology
- Arshad, R. 1989. Studies on the body mass, body size, cranial measurements and life history variables in the short-tailed mole rat (*Nesokia indica*). M.Phil. thesis in Zoology
- Nighat, R. 1989. Seasonal and age specific morphologic and reproductive changes in house rat (*Rattus rattus*). M.Phil. thesis in Zoology
- Jamil, M. 1990. Food habits of *Rattus rattus* in Faisalabad City. M.Phil. thesis in Zoology
- Siddiqi, M. J. I. 1990. An analysis of the scats of the small Indian mongoose (*Herpestes auropunctatus*) to know its food habits. M.Phil. thesis in Zoology
- Ubaidullah, M. 1987. Abundance and distribution of rats and mice burrows in recently harvested cereal crops. M.Sc. thesis in Zoology
- Anwar, M. 1987. Distribution and abundance of rat burrows on embankments and non-crop areas. M.Sc. thesis in Zoology
- Begum, S. 1987. A study of baculum of Genus *Mus*. M.Sc. thesis in Zoology
- Kayani, A. R. 1988. Abundance and distribution of porcupine burrows in irrigated forest plantations. M.Sc. thesis in Zoology
- Inam, M. 1988. Foraging and feeding behaviour of rose-ringed parakeet in field crops and orchard. M.Sc. thesis in Zoology
- Khan, M. 1988. Distribution of porcupine dens in embankments and croplands in central Punjab. M.Sc. thesis in Zoology
- Mustafa, S. 1989. Studies on body weight, reproduction and age structure of *Tatera indica* (Indian gerbille) from central Punjab. M.Sc. thesis in Zoology
- Siddique, M. 1989. Seasonal changes in the abundance of *Bandicota bengalensis* in an irrigated cropland. M.Sc. thesis in Zoology
- Saeed-ur-Rehman. 1989. Movement patterns and seasonal changes in the abundance of *Tatera indica* and *Suncus murinus* in the canal irrigated farmlands of central Punjab. M.Sc. thesis in Zoology

- Ambreen, Z. 1989. Studies on body weight, reproduction and age structure of *Mus musculus* from central Punjab. M.Sc. thesis in Zoology
- Khan, H. A. 1989. Movement patterns and seasonal changes in abundance of *Mus musculus* in canal irrigated farmlands. M.Sc. thesis in Zoology
- Rana, N. 1989. Studies on changes in body weight, age structure and reproduction in a cropland population of *Bandicota bengalensis*. M.Sc. thesis in Zoology
- Aslam, M. 1989. Seasonal changes in body weight, age structure and reproductivity in *Rattus rattus*. M.Sc. thesis in Zoology
- Wahla, A. M. 1989. The patterns of distribution and control of porcupine in Faisalabad Tehsil. M.Sc. thesis in Agricultural Entomology
- Khan, M. S. 1990. A method for inhibiting the soft-furred field rat (*Rattus meltda*) population in the wheat-sugarcane-fodder agrosystem of Faisalabad. M.Sc. thesis in Zoology
- Butt, A. 1990. Food habits of *Bandicota bengalensis* in a wheat-sugarcane-fodder agrosystem of Faisalabad. M.Sc. thesis in Zoology
- Hassan, M. R. 1990. Inhibiting lesser bandicoot rat (*Bandicota bengalensis*) population in a wheat-sugarcane-fodder system of cropland. M.Sc. thesis in Zoology
- Khan, A. A. 1990. Population density and reproduction in house rat (*Rattus rattus*) living in some groceries and sweet shops of Faisalabad City. M.Sc. thesis in Zoology
- Amir, R. 1990. Food habits of *Tatera indica* in a wheat-sugarcane-fodder cropland of Faisalabad. M.Sc. thesis in Zoology
- Akhtar, T. 1990. Food habits of *Rattus meltda* in the croplands of Faisalabad. M.Sc. thesis in Zoology
- Ali, A. 1990. Population density and reproduction in house rat (*Rattus rattus*) living in residential houses and grain shops of Faisalabad City. M.Sc. thesis in Zoology
- Mubarik, S. 1990. Food habits of *Mus musculus* in sugarcane-wheat-fodder croplands of Faisalabad. M.Sc. thesis in Zoology

12.3 Training Materials Produced by the VPC Project

- Training Manual: Vertebrate Pest Management, J. E. Brooks, E. Ahmad, I. Hussain, S. Munir, and A. A. Khan (Eds.). 1990. 206 pp. PARC, Islamabad. ISBN 969-409-064-4.
- Reference Manual: Vertebrate Pest Management in Grain Storage Centres. 1991. 38 pp. + appendices. ISBN 969-409-073-3
- Handbook: Anaj ke godam: Nuksandeh janwaroon ke barey main aik rehnuma kitab (Grain Storage: Handbook on Vertebrate Pest Management). 1988. 24 pp. In Urdu.
- Handbook: Fasloon main choohon ka tadaruk (Rat control in crops). 1990. 32 pp. In Urdu. (A handbook for farmers).
- Handbook: Gharelo choohay aur un ka tadaruk (Commensal Rodents and Their Control). 1991. 33 pp. In Urdu (A handbook for rural women).
- Handbook: Jangli soor aur un ka insdaad (Wild boar, its Biology and Control). 1991. 21 pp. In Urdu.
- Handbook: Saih uskay nuqsanat aur tadaruk (Porcupine, Their Damage and Control). 1991. 13 pp. In Urdu.
- Pamphlet: Anaj ko mahfooz karney ke chand hidayat (Some instructions about grain storage). 1988. An Urdu pamphlet.
- Poster: Godamoon main anaj ko nuksan puhchaney waley janwar (Vertebrate pests of grain storage godowns). 1988. In Urdu.
- Poster: Ghaley ke godamoon ke safai aur imarat ke dekh bhal (Maintenance and sanitation of the grain storage godown). 1988. In Urdu.
- Poster: Anaj ke godamoon main choohon ke insidad ke tareekay (Instructions about rat control in the grain storage). 1988. In Urdu.
- Poster: Choohay makao - fasal bachao (Kill the rats - save the crop). 1989. In Urdu.
- Poster: Zahar pao - choohay makao (Use the poison - kill the rats). 1989. In Urdu.
- Farmers Handbill: Choohay makao - fasal bachao (Kill rats and save the crop). 1989. In Urdu.
- Farmers Handbill: Dhan key chor (Thieves of paddy). 1989. In Urdu.

Video Training Cassette: Dhan key chor (Thieves of paddy). 1989.
In Urdu. 13 min.

Video Training Cassette: Khurab godam aur acha godam (Bad godown
and good godown). 1988. In Urdu and English. 22 min.

Slide Set: Khurab godam aur acha godam (Bad godown and good
godown). 1988. (With audio cassette in Urdu). 28 min.

Video Training Cassette: Gandum ka dushman (Enemies of Wheat).
1991. In Urdu and English. 12 min.

Video Training Cassette: Garelo choohay aur inka tadaruk (Rodent
control for households). 1991. In Urdu.

12.4 Published and Unpublished Reports

12.4.1 Publications

Brooks, J. E. 1986. Survey of public storage areas in four
provinces completed. The Econogram 2(2):2.

Brooks, J. E. 1987. Crop and stored food losses caused by
vertebrate pests in Pakistan. The Econogram 3(2):304.

Brooks, J. E., E. Ahmad and I Hussain. 1987. A newly-reported
pest bird in Pakistan: The crested lark. Pakistan J. Zool.,
19:437-438.

Brooks, J. E., E. Ahmad and I. Hussain. 1987. The desert hare
(*Lepus nigricollis*), a minor pest of agriculture in
Pakistan. Pakistan J. Zool., 19:438.

Ahmad, E., I. Hussain and J. E. Brooks. 1987. Vertebrate pests
of Pakistan. In: Integrated Pest Management: Training
Manual, Training Institute, NARC, Islamabad, pp. 332-348.

Hussain, I., E. Ahmad and J. E. Brooks. 1987. Control of
vertebrate pests in Pakistan. In: Integrated Pest
Management: Training Manual, Training Institute, NARC,
Islamabad, pp. 349-370.

Ahmad, E., I. Hussain and J. E. Brooks. 1988. Vertebrate pest
infestations in PASSCO grain storage centres. Proc. 8th
Pakistan Congr. of Zool., pp. 269-277.

Brooks, J. E., E. Ahmad and I. Hussain. 1988. Characteristics of
damage by vertebrate pests to groundnuts in Pakistan. Proc.
Vert. Pest Conf., Calif. 13:129-133.

Brooks, J. E., E. Ahmad, I. Hussain and M. H. Khan. 1989. The agricultural importance of the wild boar (*Sus scrofa* L.) in Pakistan. *Trop. Pest Manage.*, 35(3):278-281.

Brooks, J. E. 1989. The Eurasian wild boar in Pakistan agriculture. *The Econogram* 5(4):2,5.

Brooks, J. E., E. Ahmad and I. Hussain. 1990. The chronic oral toxicity of three anticoagulant rodenticides to *Rattus rattus*. *Pak. J. Sci. and Industr. Res.*, 33:218-220.

Brooks, J. E. and G. K. LaVoie. 1990. Rodent control to reduce post-harvest losses of stored foods. *World Grain*, Nov./Dec.

Hussain, I., Joe E. Brooks E. Ahmad and Shahid Munir. 1991. Vertebrate pests of groundnut and their control. *Progressive Farmer* 11(2): (In press)

12.4.2 Manuscripts in Preparation

Ahmad, E., J. E. Brooks, I. Hussain and M. H. Khan. Reproduction in Eurasian wild boar in central Punjab, Pakistan.

Brooks, J. E., E. Ahmad and I. Hussain. Reproductive biology and population structure of *Rattus rattus* in Rawalpindi, Pakistan.

Ahmad, E., I. Hussain and J. E. Brooks. Losses of stored foods due to rats at wholesale grain markets in Pakistan.

Asif, M. M., J. E. Brooks and E. Ahmad. Diet of the lesser bandicoot rat, *Bandicota bengalensis*, in wheat and rice crops in central Punjab, Pakistan.

Ahmad, E., J. E. Brooks and M. H. Khan. Food habits of the Eurasian wild boar in central Pakistan.

Hussain, I., M. M. Asif, J. E. Brooks and E. Ahmad. Enlarged litter size in *Bandicota bengalensis* captured from wheat fields.

Hussain, I., M. M. Ahmad and J. E. Brooks. Effect of diet and seasonal variations on the reproduction of the bandicoot rat, *Bandicota bengalensis*.

12.4.3 M. Phil. Thesis.

Hussain, I. 1989. Effect of diet and seasonal variations on the reproduction of the bandicoot rat, *Bandicota bengalensis*. M.Phil. thesis, Quaid-i-Azam University, Islamabad.

12.4.4 Unpublished Technical Reports

- Brooks, J. E., M. H. Khan, E. Ahmad and Z. Hussain. 1986. The importance of wild pigs to sugarcane production in Faisalabad District. Tech. Rept. No. 1, 18 pp.
- Brooks, J. E. and E. Ahmad. 1986. Vertebrate pest infestations in Punjab Provincial food storage facilities. Tech. Rept. No. 2, 19 pp.
- Ahmad, E., M. H. Khan and J. E. Brooks. 1986. Wild boar and rodent damage to wheat in Faisalabad District. Tech. Rept. No. 3, 6 pp.
- Ahmad, E. and J. E. Brooks. 1986. Vertebrate pest infestations in Sind Provincial food storage facilities. Tech. Rept. No. 4, 13 pp.
- Ahmad, E. and J. E. Brooks. 1986. A survey of vertebrate pest infestations in provincial grain storage facilities in North-West Frontier Province and Baluchistan. Tech. Rept. No. 5, 13 pp.
- Brooks, J. E., E. Ahmad and I. Hussain. 1986. A partial research bibliography on the biology and control of feral pigs and wild boar. Tech. Rept. No. 6, revised, 53 pp.
- Brooks, J. E. and E. Ahmad. 1986. Vertebrate pest infestations in provincial food storage facilities in Pakistan. Tech. Rept. No. 7, 24 pp.
- Ahmad, E., I. Hussain and J. E. Brooks. 1986. Vertebrate pest infestations in PASSCO grain storage centres. Tech. Rept. No. 8, 12 pp.
- Brooks, J. E., E. Ahmad and I. Hussain. 1986. Damage by vertebrate pests to groundnut in Pakistan. Tech. Rept. No. 9, 16 pp.
- Ahmad, E., I. Hussain, M. H. Khan and J. E. Brooks. 1987. Vertebrate pest damage to maize in Faisalabad District. Tech. Rept. No. 10, 6 pp.
- Brooks, J. E., E. Ahmad and I. Hussain. 1987. Rodent control at the National Agricultural Research Centre, Islamabad. Tech. Rept. No. 11, 12 pp.
- Brooks, J. E., E. Ahmad and I. Hussain. 1987. Rat populations and stored food losses at a Pakistan grain market. Tech. Rept. No. 12, 9 pp.

- Brooks, J. E., E. Ahmad and I. Hussain. 1987. The chronic oral toxicity of several anticoagulant rodenticides to *Rattus rattus*. Tech. Rept. No. 13, 7 pp.
- Brooks, J. E., E. Ahmad and I. Hussain. 1988. The use of anticoagulants in wild boar control: preliminary field trials. Tech. Rept. No. 14, 9 pp.
- Brooks, J. E., I. Hussain and E. Ahmad. 1988. A partial research bibliography of the rose-ringed parakeet (*Psittacula krameri*). Tech. Rept. No. 15, 16 pp.
- Hussain, I., J. E. Brooks, E. Ahmad and S. Munir. 1988. Biology and behaviour of the lesser bandicoot rat, *Bandicota bengalensis*, with a partial research bibliography. Tech. Rept. No. 16, 36 pp.
- Brooks, J. E., E. Ahmad, I. Hussain and S. Munir. 1988. A partial research bibliography of the crested porcupine, Genus *Hystrix*. Tech. Rept. No. 17, 16 pp.
- Ahmad, E., I. Hussain and J. E. Brooks. 1988. Losses of stored foods due to rats at Punjab wholesale grain markets. Tech. Rept. No. 18, 17 pp.
- Brooks, J. E., M. H. Khan, E. Ahmad, I. Hussain and S. Munir. 1989. Some preliminary observations on the biology of wild boar in Pakistan. Tech. Rept. No. 19, 19 pp + appendices.
- Brooks, J. E., E. Ahmad, I. Hussain and S. Munir. 1989. Rodent control in wheat and rice: A large-scale demonstration in Gujrat, Phase I. Tech. Rept. No. 20, 12 pp.
- Brooks, J. E., E. Ahmad and I. Hussain. 1989. Reproductive biology and population structure of *Rattus rattus* in Rawalpindi, Pakistan. Tech. Rept. No. 21, 18 pp.
- Ahmad, E., A. A. Khan, I. Hussain, S. Munir and J. E. Brooks. 1989. Rodent control in wheat and rice: A large-scale control demonstration in Gujrat, Phase II. Tech. Rept. No. 22, 11 pp.
- Brooks, J. E., E. Ahmad, I. Hussain, S. Munir, M. H. Khan and M. M. Asif. 1990. Field evaluation of candidate toxicants, baits, and bait delivery systems for control of wild boar. Tech. Rept. No. 23, 13 pp.
- Ahmad, E., J. E. Brooks, I. Hussain and M. H. Khan. 1990. Reproduction in Eurasian wild boar, *Sus scrofa*, in central Punjab, Pakistan. Tech. Rept. No. 24, 14 pp.

Brooks, J. E., E. Ahmad, S. Munir, I. Hussain, M. M. Asif and A. A. Khan. 1991. Transfer of rodent control technology to farmers in a wheat and rice growing area. Tech. Rept. No. 25, 6 pp.

Asif, M. M., J. E. Brooks and E. Ahmad. 1991. The diet of the lesser bandicoot rat, *Bandicota bengalensis*, in wheat and rice crops in central Punjab, Pakistan. Tech. Rept. No. 26, 6 pp.

Ahmad, E., J. E. Brooks and M. H. Khan. 1991. Preliminary analysis of the diet of wild boar in Pakistan. Tech. Rept. No. 27, 10 pp.

Asif, M. M., M. H. Khan, E. Ahmad, J. E. Brooks and R. Johnson. 1991. Movements of wild boar as determined by radio-telemetry and visual sighting. Tech. Rept. No. 28, pp.

12.4.5 Information Brochures

Vertebrate pest problems in Pakistan. 1986. Inform. Brochure No. 1.

Chemicals used in vertebrate pest management. 1986. Inform. Brochure No. 2.

The biology and agricultural importance of the wild boar in Pakistan. 1987. Inform. Brochure No. 3.

Bird control materials and methods. 1987. Inform. Brochure No. 4.

Biology and control of desert hare and crested porcupine. 1987. Inform. Brochure No. 5.

Vertebrate pests of groundnut and their control. 1989. Inform. Brochure No. 6.

APPENDIX-1. FROM THE NARC RESEARCH MASTER PLAN 1988 - 2000

Vertebrate Pest Management

Vertebrate pests are a recurring problem for farmers in production of cereal grains, sugarcane, oilseeds, vegetables and fruits. Pre- and post-harvest losses due to vertebrate pests amount to several billion rupees per year. The major production problems are:

- Rats and mice cause pre-harvest crop losses in wheat, rice, and sugarcane.
- Wild boars damage maize and sugarcane production.
- Rats and mice cause post-harvest grain losses averaging about 30 kilograms per farm family per year.
- Porcupines are a major pest in agro-forestry programmes.
- Parakeets and other pest birds cause losses of oilseed crops (sunflower), grain, and citrus, mango, and guava.
- Farmers lack good methods for reducing these losses.

Goals and objectives. The principal aims of the vertebrate pest management programme are:

- To protect the major economic crops and stored food grains from vertebrate pests through simple, safe, inexpensive, and socio-economically acceptable technologies.
- To develop an environmentally safe and acceptable plant protection system.
- To extend developed technology through outreach and extension activities.

Mandate. Vertebrate pest management is to develop technologies, or adapt existing ones, to reduce crop losses caused by vertebrate pests at farm level and to protect stored grain.

Current programme. The vertebrate pest management project at NARC is still to be institutionalized. It began in 1985 with funds from USAID. The Denver Wildlife Research Center supplies technical back-up. The VPC project has surveyed pest-caused food losses in both public (provincial and PASSCO) grain storage facilities and in the private sector (wholesale grain markets and farmhouses). The most serious losses occur in farm and village storage. However, losses of crops before harvest are much more significant than post-harvest losses and the project has also worked equally on farmers' problems with vertebrate pests in food crops.

The main activities are identification and quantification of vertebrate pest problems in grain storage and in pre-harvest crops; development of new strategies and technologies to deal with rodents, wild boar, and several species of pest birds; development of training and extension materials for agricultural extension workers, grain storage personnel, and farmers.

Proposed programme

Priority 1

- Studies on the biology and behaviour of wild boar, leading to development of

- toxicants, baits, and bait delivery systems for control methods.
- Demonstrate existing technologies on the control of rodents in wheat and rice through operational research in different agro-ecological zones.
 - To develop vertebrate pest control technologies for onward transmission to FSR/farmers, CMP programme, BARD etc.
 - Studies of the stability of several rodenticides under local environmental conditions.

Priority 2

- Laboratory and field evaluation of various toxicants, repellents, bait materials, and formulations against major vertebrate pests.
- Development and evaluation of pre-harvest damage assessment methods.
- To study the fluctuation of rat population with rotation of crops and seasons in different agro-ecosystems.

Priority 3

- To study the biology of parakeet and other major bird pest species affecting cereal crops, oilseed crops, fruit orchards and to evaluate effective control techniques.
- To study porcupine biology, ecology in croplands and forestry areas and to evaluate various toxicants and fumigants for control.

Priority 4

- To assess the economic losses and develop control methods on pika, Murree vole, and other vertebrate pests in fruit orchards of mountainous valleys of Punjab, NWFP, and Baluchistan.
- To study the cost/benefit ratio of various control techniques of vertebrate pests in different crops.
- Development of technology transfer and outreach materials for use by agriculture extension workers.
- Development of technology and transfer of extension and outreach materials for grain storage management.

Advanced research. Advanced research will involve studies of aging methods for wild boar and porcupine; histological studies of animal tissues for reproductive and hormonal changes; of animal, plant and soil samples for pesticide residues using chromatography and UV spectrophotometry; animal movements will be studied using radio-telemetry.

Linkages and relationships. On campus, the vertebrate pest management project cooperates with the entomology, oilseeds, maize, and wheat programmes. Close cooperation exists with the BARD programme regarding pest damage to groundnut, rapeseed and chickpea. The project cooperates with the farming systems research programme and with the training of rural women under FSR. Field work is carried out near Fatehjang to help reduce crop damage by wild boar and rodents. The project works closely with the crop maximization programme in a control demonstration area at Kunjah, Gujrat District, in providing an adaptable technology to farmers to protect wheat and rice from rodent damage. The project cooperates in devising work plans, surveys, and training with the Pest Management Research Institute, Karachi, and with the technology and transfer unit at NARC, in providing training to farmers in the Capital District. The project assists the Training Institute, NARC, in a once-a-year 2- to 3-week training course in Vertebrate Pest Management. Cooperative research studies are carried out with several principal investigators at the University of Agriculture, Faisalabad, on pests of irrigated crop lands.

Close linkages exist between the project and the Economic Analysis Network, Agricultural Data Collection and the Kansas State Food and Feed Grain Institute projects under Food Security Management.

International linkages are maintained with the FAO, Rome, and other FAO offices; with WHO, Geneva; with Colorado State University, Kansas State University, Food and Feed Grain Institute, and with the Denver Wildlife Research Center, Denver, Colorado. The Vertebrate Pest Section, Bangladesh Agricultural Research Institute, Joydebpur, Bangladesh, works in close cooperation with the VPC project at NARC.

Expected accomplishments

- Transfer of existing technology to farmers through demonstrations on the control of rodent damage to wheat and rice.
- Complete research studies on the basic biology and behaviour of wild boar, porcupine, and rose-ringed parakeet.
- Development of efficient, inexpensive control methods for wild boar, porcupine in forestry, rose-ringed parakeet in sunflower, and pika and voles in apple orchards.
- Transfer of control technology and strategies to farmers through extension and training materials, pilot field trials, and large-scale control demonstrations.
- Pre-harvest damage assessment methods will be available for accurate collection of crop loss data and for precise evaluation of control methods.
- The stability, environmental hazards, and efficacy of several vertebrate pest toxicants under Pakistan conditions will be understood and recommendations on their safe use will be made.
- Control strategies based upon the seasonal fluctuations and movements of vertebrate pests in croplands will be developed and implemented.
- Development of a multimedia training package on vertebrate pest control for use by agricultural extension workers, grain storage personnel, and farmers, and dissemination of informational, extension, and training materials.

VERTEBRATE PEST MANAGEMENT: Resource Requirements

Project Title	Prior- ity	1988 / 89		1989 / 90		1990 / 91		1991 / 92		1992/93-1995/96 Annual average		1996/97-1999/00 Annual average	
		Staff*	Op.F**	Staff	Op.F	Staff	Op.F	Staff	Op.F	Staff	Op.F	Staff	Op.F
1. Studies on the biology and behaviour of wild boar, leading to development of toxicants, bait and bait delivery systems for control methods.	1	1.0	40000	1.0	51064	1.0	60000	1.0	60000	1.0	80000	-	-
2. Demonstrate existing technologies on the control of rodents in wheat and rice through operational research in different agro-ecological zones.	1	1.0	40000	1.0	60000	1.0	61496	1.0	58645	1.0	80000	1.0	150000
3. To develop vertebrate pest control technologies onward transmission to FSR/farmers, CMP program, BARD etc.	1	1.0	40000	1.0	52000	1.0	60000	1.0	50000	1.0	80000	1.0	150000
4. Studies of the stability of several rodenticides under local environmental conditions.	1	1.0	30000	1.0	40000	1.0	50000	-	-	-	-	-	-
5. Development of vertebrate pest control methods for sugarcane.	2	-	-	-	-	-	-	0.3	40000	0.5	50000	-	-
6. Lab and field evaluation of various toxicants, repellents, bait materials and formulations against major vertebrate pests.	2	-	-	-	-	-	-	0.4	50000	0.5	50000	-	-
7. Development and evaluation of pre-harvest damage assessment methods.	2	-	-	-	-	-	-	0.3	40000	0.5	65297	-	-
8. Study the fluctuation of rat population with rotation of crops and seasons in dif. agro-ecosystems.	2	-	-	-	-	-	-	-	-	0.5	65000	-	-
9. To study the biology of parakeet and other major bird pest species affecting cereal and oilseed crops, fruit orchards and evaluate effective control techniques.	3	-	-	-	-	-	-	-	-	-	-	1.0	125000
10. Porcupine biology, ecology in croplands & forestry areas and to evaluate various toxicants/fumigants for control.	4	-	-	-	-	-	-	-	-	-	-	1.0	125000

continued

VERTEBRATE PEST MANAGEMENT (continued)

Project Title	Priority	1988 / 89		1989 / 90		1990 / 91		1991 / 92		1992/93-1995/96 Annual average		1996/97-1999/00 Annual average	
		Staff*	Op.F**	Staff	Op.F	Staff	Op.F	Staff	Op.F	Staff	Op.F	Staff	Op.F
11. To assess the economic losses and to develop the control methods on Pika, Murree vole and other vertebrate pests in fruit orchards of mountainous valleys of Punjab, NWFP and Baluchistan.	4	-	-	-	-	-	-	-	-	-	-	0.5	65000
12. To study the cost/benefit ratio of various control techniques of vertebrate pests in different crops.	4	-	-	-	-	-	-	-	-	-	-	0.5	67444
13. Development of technology transfer and outreach materials for use by agriculture extension workers to disseminate new knowledge to farmers.	4	-	-	-	-	-	-	-	-	-	-	0.5	60000
14. Development of technology and transfer of extension and outreach materials for grain storage management situations.	4	-	-	-	-	-	-	-	-	-	-	0.5	50000
Total		4.0	150000	4.0	203064	4.0	231496	3.0	298645	5.0	470297	6.0	792444
BUDGET													
Staff Costs: Existing (1988/89 + 3%/year)			254700		262341		270211		278318		315275		454040
Additional			0		16902		33509		38536		35679		45910
Operational Funds			150000		203064		231496		298645		470297		792444
Total (1988/89 + 15%/yr through 1991/92, then + 10%/yr)			404700		465405		535216		615498		821251		1292394

* Number of scientists (BP 17-20) 1 SSO, 3 SO. Includes those on study leave or secondment.

** Operational Funds = Total budget (in rupees) less salaries and allowances, rent of residential buildings, and pension contribution