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This progress report of the USAID-sponsored International Programs Research Section at the Denver Wildlife Research Center (DWRC) documents work conducted at project field stations in Bangladesh and Pakistan during 1988, and outreach activities from DWRC to increase food production by reducing the risk of agricultural losses caused by vertebrate pests. Outreach activities involved contact with 52 different countries, with technical assistance and training provided in several areas. The ultimate aim of the pest management research program is to develop safe, effective, economical control methods which are suitable and practical for traditional farmers and acceptable in the broader context of agricultural development.

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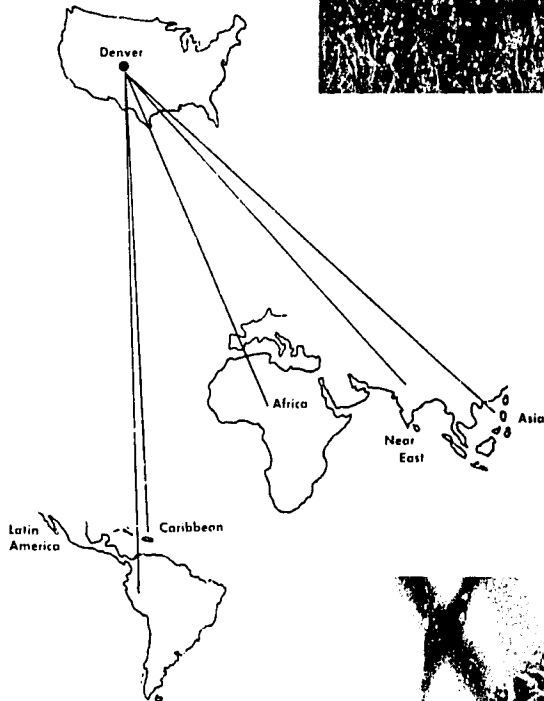
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# VERTEBRATE DAMAGE CONTROL RESEARCH IN AGRICULTURE ANNUAL REPORT 1988



Denver Wildlife Research Center  
Animal and Plant Health Inspection Service  
U.S. Department of Agriculture

Agency for International Development

PN-ABD-004

# 1988 ANNUAL PROGRESS REPORT

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## Unpublished Report

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## THE COVER

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The cover illustrates two of the most severe animal damage problems under investigation by the USAID-sponsored International Programs of the Denver Wildlife Research Center (DWRC): rodent and bird damage to agricultural crops both pre- and postharvest. Research at DWRC and in the field involves evaluating a variety of management methods including chemical, physical, cultural, or other techniques that have potential to provide safe, economical, and environmentally sound methods to reduce vertebrate damage in agriculture. The pest species, crop, farming and storage methods, environmental factors, and a host of other considerations may influence the manner in which a particular problem is addressed.

Vertebrate damage in agriculture involves a variety of crops and species of animals, primarily birds and rodents. Direct losses occur typically at planting and sprouting, during the milk or dough stages (for grains), just before harvest, or during postharvest storage conditions. Field projects have been initiated to conduct studies to find ways to reduce or alleviate this damage in several countries of South and Central America, Africa, and Asia.

In many areas of the world, rodent damage to field crops, such as rice in Asia, severely reduces the human food supply and increases the risks to individual farms. In localized areas, rodents may be a principal factor limiting crop production; often, rodents unobtrusively remove a share of production before harvest--crop after crop, season after season. Although there are more than 1,600 kinds of rodents, only about 50 are considered significant agricultural pests.

Agricultural losses to birds are not as well documented as those to rodents. Various species of parrots, parakeets, blackbirds, weavers, doves, seed-eaters, pheasants, and waterfowl are among the types of birds known to cause damage to agriculture around the world. Actual losses are difficult to assess because damage is usually concentrated in limited areas and, due to the mobility of birds, is often seasonal, sporadic, and hard to predict. The red-billed quelea in Africa is undoubtedly the most important bird pest species in the world.

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# VERTEBRATE DAMAGE CONTROL RESEARCH IN AGRICULTURE

## INTRODUCTION

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Increasing food production is one of the most important challenges facing mankind. In some developing countries the disparity between available food and population is both widespread and acute, despite the fact that about one-half of the world's population is actively engaged in agriculture. Millions of people in scores of nations still suffer hunger, malnutrition, and starvation. The reasons are many and complex, but certainly vertebrate pests (primarily rodents and birds) are important factors. Historically, they have not received the degree of attention given to other agricultural pests so that, with few exceptions, little reliable information on the species involved, degree of damage, and the economic impact is available. Damage is, however, unquestionably calculated in hundreds of millions and perhaps billions of dollars annually. Recognizing this, the U.S. Agency for International Development (USAID) has supported a vertebrate pest research and management project within the International Programs Research Section (IPRS) at DWRC since 1967 under Participating Agency Service Agreements (PASA's) as provided for in Section 632B of the Foreign Assistance Act of 1961, as amended.

The cooperative program was first established between the Administrator, USAID, and the Secretary of the Interior delegating the U.S. Department of the Interior (USDI), U.S. Fish and Wildlife Service, to conduct studies to reduce food losses caused by rats, bats, and noxious birds on a worldwide basis. This cooperative agreement was continued with the U.S. Department of Agriculture (USDA)/Animal and Plant Health Inspection Service (APHIS) with the transfer of Animal Damage Control (ADC) from USDI to USDA on December 19, 1985. In October 1988, IPRS was further transferred from ADC to Science and Technology under APHIS. Funds are provided to DWRC by USAID Missions and the USAID Bureau of Science and Technology to maintain a core group of international vertebrate pest specialists in the IPRS at the DWRC to implement the cooperative agreement.

The program goal is to evaluate vertebrate pest situations and, when circumstances warrant, develop environmentally acceptable methods to reduce their damage. Goals are accomplished by in-country programs, TDY activities from the DWRC, supervisory and administrative functions from the DWRC, and problem-oriented research and training using expertise available at the DWRC. The program currently is comprised of a DWRC-based outreach project and field station projects in Bangladesh and Pakistan.

The DWRC-based staff (1) coordinate overall programs, (2) respond to USAID Mission requests for problem definition studies and management research, (3) represent the program to other organizations, (4) coordinate DWRC-based training for USAID-funded participants, (5) brief visitors, (6) develop cooperative programs with international organizations and research institutions, (7) provide technical information to USAID Missions or other

cooperators, and (8) assist USAID personnel in program development and negotiations with foreign governments.

The DWRC field station projects (1) establish the technical capabilities and support within governments and the agricultural sector to conduct programs in vertebrate pest research and management, (2) develop new and adapt existing practical, low-cost, and environmentally sound methods and technology to evaluate and reduce preharvest and postharvest crop losses to vertebrate pests of significant regional importance under local conditions, (3) provide onsite training in research and management methods to reduce losses by vertebrate pests, and (4) help ensure the institutionalization of a vertebrate pest management (VPM) capability in the host country.

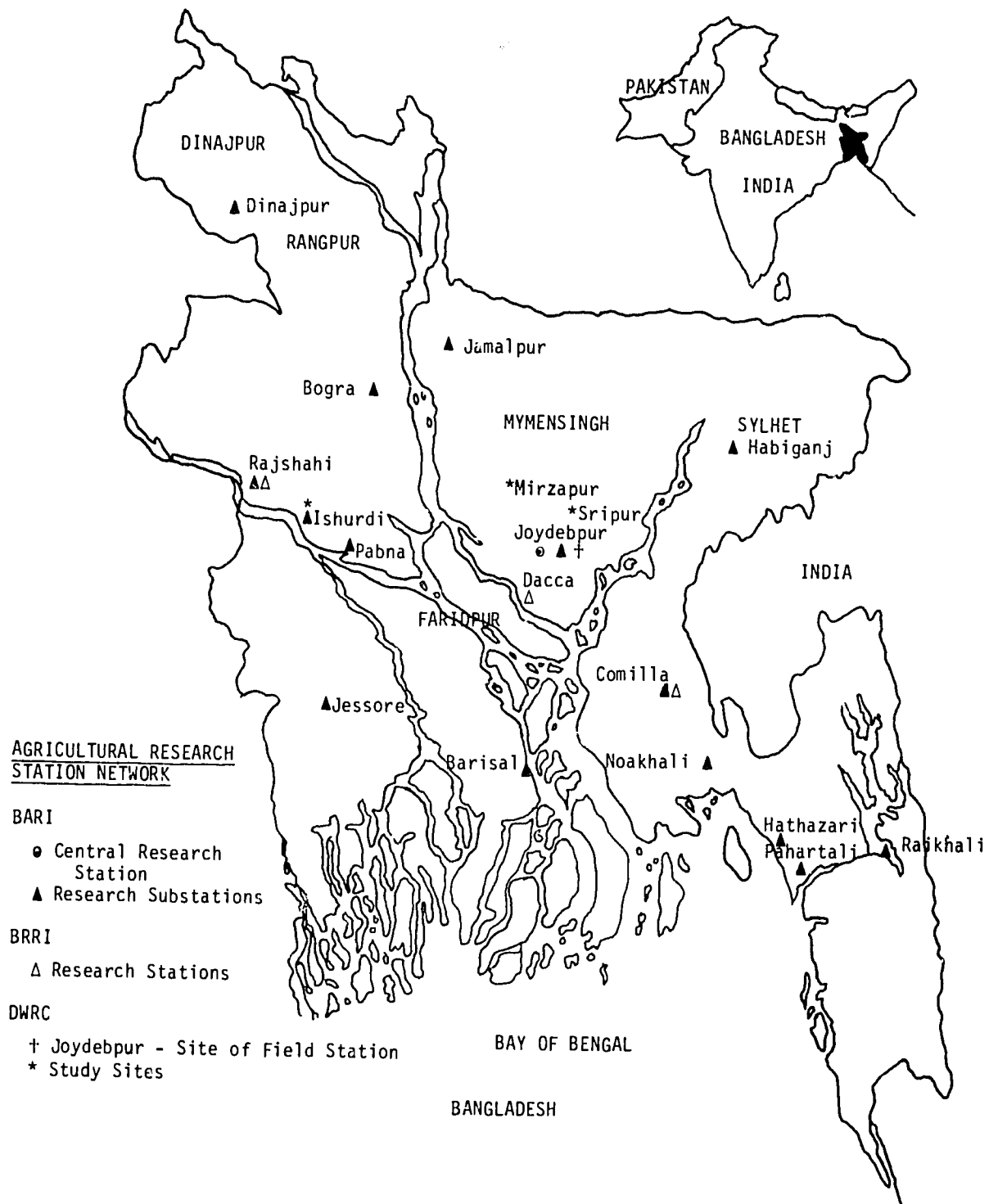
For many years, DWRC has been recognized as a leading organization in researching vertebrate pest damage problems and developing useful tools for VPM. Its problem-solving team approach has led to developing and using new methods, materials,<sup>1</sup> and techniques for vertebrate pest control, resulting in monetary savings in many developing countries. The ultimate aim of this pest management research program is to develop safe, effective, and economical control methods which are suitable and practical for traditional farmers and acceptable in the broader context of agricultural development. Self-sustaining, in-country programs are the expected end result of this project. Vertebrate damage problems in Africa, Asia, and Latin America are continuously reviewed with the aim of adapting current techniques or materials to specific problem situations in a crop protection-oriented management program which will provide an effective means of long-term crop protection.

The project incorporates a flexible program of applied research, technology transfer, and training. Research activities incorporate laboratory investigations at DWRC and selected laboratories in developing countries with associated field trials at appropriate sites in specific problem areas. A team approach, using the services of an interdisciplinary group of scientists and technicians with diverse backgrounds and experience, coupled with active involvement of foreign investigators, results in practical solutions suited to local requirements. In addition, it creates a professional network for continuing cooperation with indigenous institutions. Training of local counterparts and institutionalization of both research functions and implementation programs are viewed as integral parts of the overall project.

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<sup>1</sup>Throughout the report, reference to trade names does not imply endorsement by U.S. Government or cooperating foreign agencies.





### BANGLADESH

#### Introduction

The vertebrate pest control program in Bangladesh was instituted in November 1978. A Vertebrate Pest Section has been established within the Entomology Division of the Bangladesh Agricultural Research Institute (BARI) at Joydebpur, 32 km north of Dhaka. USAID/DWRC activities from the onset involved assisting in organizing the Section, purchasing commodities, developing the laboratory, and implementing research activities. A combination laboratory-office building, the Vertebrate Pest Control Laboratory (VPCL), was completed in July 1979; several outdoor animal facilities have since been added. To date, two Ph.D. scientists and three M.S. scientists have been trained and are working with the Project in a wide variety of laboratory and field research activities and have produced numerous technical reports and publications. The Project has established and is maintaining cooperative ties with the Bangladesh Rice Research Institute (BRRI), the Ministry of Agriculture (MOA), Department of Agriculture Extension (DAE), and other organizations. Backstop support and technical assistance in various aspects of laboratory and field studies are provided by the DWRC. The present Project Leader, Dr. Michael M. Jaeger, arrived in October 1986, succeeding Mr. Joe E. Brooks (1981-1985) and Mr. Richard M. Poché (December 1978-1980).

The VPCL continues to maintain a highly successful research program that is developing practical control techniques and strategies, and staff are working with extension personnel throughout the country to implement these strategies. AID/Dhaka and BARI signed an agreement to continue DWRC/IPRS involvement in vertebrate pest research and control activities between January 1, 1988-June 4, 1991.

The objectives of this Project are to:

1. Increase the available food supply.
2. Develop management strategies for important agricultural situations and household stored food.
3. Appraise the nature and magnitude of losses caused primarily by rodents and jackals, and develop, if appropriate, environmentally responsible methods to reduce these losses.
4. Coordinate activities with other organizations to maximize results.
5. Institutionalize in-country research and management programs.



The Vertebrate Pest Control Laboratory at the Bangladesh Agricultural Research Institute (BARI) was constructed in 1979 with the goal of providing objective scientific information for developing strategies to reduce vertebrate pest damage.



The Vertebrate Pest Control Laboratory has several outdoor facilities, including pens to hold jackals, an enclosure for behavioral studies or toxicant evaluation for rodents, and an aviary for birds.

The work plan developed in 1986 continued to be implemented. Baseline data were collected on preharvest rat damage to ripening wheat and rice, post-harvest rodent damage in grain stores in farmers' houses, and jackal movements and damage potential. This work is being conducted in two large study areas that represent two ecological zones (wet plains and dry lands) where cereal production is concentrated. The different pest problems are being studied in each area each month to evaluate their interrelationship and determine opportunities for integrated pest management.

### Preharvest Rodent Damage

A 15-month study describing preharvest rodent damage at two 4,800-ha study sites was completed. The study sites represented the transplanted aman rice agroecosystem and the broadcast-deepwater aman rice system. Preliminary results have shown that the number of rat burrows per hectare in both study sites peaked in November/December at the end of the aman rice crop. A second smaller peak occurred in March coincident with wheat crop maturation. Pulse and mustard fields were used by the lesser bandicoot rat (*Bandicota bengalensis*) until adjacent wheat fields matured and became more attractive. These results were used to model when and where rat control would be most cost-effective in relation to the four major grain growing seasons in Bangladesh (aman rice, boro rice, wheat, and aus rice). It was concluded that control should focus on the aman crop.

A field study was also initiated to compare two rodent control strategies: early-flood, deepwater aman rice (July-August) baiting on high ground vs late-flood (September-October) baiting on high ground. A 4,800-ha site was chosen at Manikganj, and monthly data collection was begun in May. The early-flood treatment comparing fumigation with Phostoxin<sup>®</sup> (aluminum phosphide) with toxic bait injection (5-g wax blocks containing brodifacoum) was applied in early August and directed at rat burrow systems. September flooding destroyed the entire rice crop at this site, making comparison with a later treatment meaningless. However, post-flood burrow counts showed a 56% reduction from the burrow density at the time of treatment. This supports previous data that flooding can substantially reduce rat numbers and, therefore, that control done after peak flooding could be more efficient. The late-flood treatment was moved to an alternate site at Noakali and applied in late October, when the rice crop in that area was flowering. Burrow counts at harvest in mid-December showed that the Phostoxin treatment had reduced burrow density. Results from the brodifacoum treatment were inconclusive; however, rats did remove toxic baits placed in freshly excavated tunnels, even in the presence of mature rice upon which they were feeding.

To support field observation, studies were initiated in the newly modified enclosures at the VPCL, Joydebpur, to determine the numbers of *B. bengalensis* per burrow system, the amount of rice panicles removed per rat per day, the efficacy of Phostoxin as a burrow fumigant, and the acceptance of baits in the presence of a food source. Preliminary results suggest a single adult rat per burrow, an average of 57 g of rice removed per rat per night, and about 75% success in killing rats in burrows with a single tablet of Phostoxin. Information on burrowing behavior is still needed to develop a

model that describes the amount of damage per burrow system per day, thus permitting extrapolation of burrow density data to crop losses.

### Postharvest Rodent Damage

A long-term study of losses in stored grain, concomitant with the preharvest study, was completed in the same areas using the same sampling design. Like the preharvest study, the objective was to describe the spatial and temporal pattern of postharvest losses to rodents through a model whose components include the seasonal pattern of grain storage, the numbers and spatial distribution of farmsteads, and the seasonal fluctuations in the numbers and types of rodents. At both sites, the seasonal trends in rodent numbers and stored grain were bimodal and overlapped, peaking (1) at the time of the aman rice harvest in December-January and (2) after the boro-rice harvest in July-August when flooding was widespread.

To support postharvest field work, four outdoor animal enclosures at BARI were modified to simulate grain storage conditions in farmers' houses. Tests to determine the relative trapability among the four species of small mammals most commonly found in these houses will provide information necessary to complete the damage model of the above study. This phase will be completed during 1989.

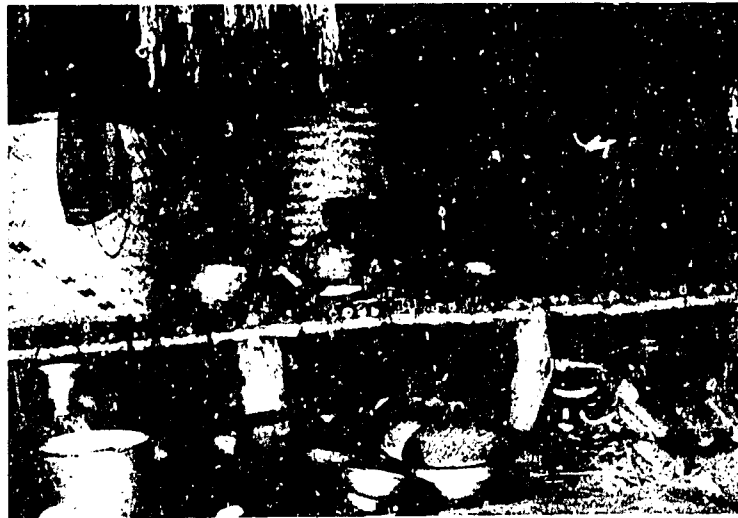
### Jackal Predation on Poultry and Livestock

In November 1988, a 25-km<sup>2</sup> study site was selected and mapped near Sripur for a long-term study comparing the possible damage caused by jackals in relationship to their potential predation benefits on rodents.

A study also was begun with caged jackals at BARI to determine the average daily consumption of rats and the number of scats and length of time the remains of one rat may be passed. This information will be used to model the impact of jackals on the rat population.

### Analysis of Commercially Available Zinc Phosphide

Packets of zinc phosphide ( $Zn_3P_2$ ) were widely available to farmers for use in rodent control. However, farmers have apparently been losing confidence in the quality of  $Zn_3P_2$  being marketed. Therefore, packets of commercially distributed  $Zn_3P_2$  have been collected from three or more distributors in Dhaka, Comilla, Tangail, and Joydebpur, and sent to DWRC to analyze the percent of  $Zn_3P_2$  during 1989. Perhaps the results from this analysis will provide farmers with the confidence in this rodenticide to once again use it for rodent control.



Field research priorities on rodent damage to preharvest crops (top) and rodent damage to on-farm postharvest storage (center) will lead to implementation of management strategies. Research into the ecology of jackals (bottom) will result in the determination of the economic importance of this species as a pest to sugarcane and livestock in Bangladesh.

### Personnel and Training

An important objective of this Project is training BARI professional staff in research methods. Both research and extension scientists received such training during 1988.

1. Mr. Rajat K. Pandit, VPCL, returned in April from the University of the Philippines at Los Baños with an M.S. in Zoology. The title of his thesis was "Rodenticidal Properties of Crude Extracts of *Manihot esculenta* Crantz, *Dioscorea hispida* Dennst., and *Thevetia peruviana* (Pers.) Merr."
2. Mr. Yousuf Mian, VPCL, completed the lengthy process of nomination for Ph.D. training. He is presently enrolled in Wildlife Biology at Colorado State University; his training will emphasize statistics, computer use, and modeling rodent population and food losses in grain storage facilities.
3. Mr. Santosh K. Sarkar, DAE, began his Ph.D. research at Dhaka University under the direction of the DWRC Project Leader. He is looking at the socioeconomic aspects of preharvest rat control strategies in the deep-water rice agroecosystem at Manikganj.
4. Mr. Sayed Ahmed, BRRRI, is doing Ph.D. research in Wildlife Biology at Colorado State University with research supervision by Mr. Lynwood Fiedler at DWRC.
5. Mr. Emdadul Haque continued his postgraduate studies at Dhaka University. His research topic is "The biology, agricultural importance, and control of the short-tailed mole rat, *Nesokia indica*, in Bangladesh."

### Technical Assistance Support

In addition to ongoing administration, equipment procurement and shipping, literature searches, manuscript preparation, and technical assistance support, DWRC provided the following backstopping support:

1. The Bioelectronics Laboratory prepared 10 radio collars for jungle cats and refurbished others for jackals and rats. Receivers for radio tracking were also modified to provide more channels. In addition, portable and vehicle-mounted sound systems for censusing jackals in response to taped calls were prepared and sent.
2. Mr. Yousuf Mian was accepted into a Ph.D. graduate program at Colorado State University under the supervision of Dr. Gary White. Mr. Mian's specialty will be applied statistics in wildlife management. Dr. David Otis, statistician and Chief, Bird Control Research Section, is informally assisting in this graduate program. In addition, Mr. Sayed Ahmed (BRRRI) will conduct his Ph.D. research at DWRC under the supervision of Mr. Lynwood Fiedler. Mr. Ahmed also received computer training at DWRC.

3. Studies have continued toward developing a low-cost, nonedible carrier for rodenticides that can be used in both rat burrows and in storage structures. The belief is that rodents will ingest the toxicant when attempting to remove the carrier while grooming. This may eliminate some of the current problems in ingested baits such as bait preferences, novelty, and bait shyness.
4. A week of training in computer use was provided to the Project Leader at DWRC during TDY in conjunction with home leave. Programs were developed for establishing data sets on the computer soon to be purchased by the Project, and graphics were reproduced by computer for use in project reports, seminars, and publications.
5. An internal review of the Project research was held at BARI in April to evaluate past activities and to formulate hypotheses for future research that will lead to appropriate management strategies. In addition to the VPCL/BARI professional staff, Mr. Joe Brooks (Pakistan Vertebrate Pest Control Project Leader), Drs. Richard Bruggers (Chief, IPRS) and Russell Reidinger, Jr. (Director, DWRC) participated as well as Messrs. T. Hossain (Deputy Director) and S. Sarkar (Senior Instructor) from the MOA, DAE Plant Protection Wing, and Mr. Kevin Rushing (Project Officer, Office of Food and Agriculture from USAID).
6. Ms. Linda Raver, USDA/Office of International Cooperation and Development (OICD)/Technical Assistance Division (TAD) visited Bangladesh between March 24-April 2 to help clarify PASA financial matters with Michael Jaeger and the AID Comptroller's Office.

### Miscellaneous

Several activities were undertaken to improve Project outputs. These included construction to modify the outdoor rat enclosure, to enclose a storeroom as a conference room/library and to repair the roof of the laboratory at the Project's BARI facility; purchase of a third Toyota Land-Cruiser to facilitate field work; and assistance by Dr. Alan Buckle, ICI Agrochemicals (United Kingdom), in providing a rodenticide formulated in wax blocks for experimental use in testing a control strategy and visiting the Project to help implement these tests.





## PAKISTAN

### Introduction

The Vertebrate Pest Control Project (VPCP) was initiated in March 1985 under the Government of Pakistan and USAID Post-harvest Management Component of the Food Security Management (FSM) Project. Short-term assignments related to Project planning and defining specific vertebrate pest problems were completed. Mr. Joe Brooks, Project Leader, VPCP under the FSM Project, arrived October 1985 in Islamabad to implement research and training on postharvest losses caused by rodents and birds.

The objectives of the VPCP in Islamabad are:

1. Assist the four Provincial Food Departments in Sind, Punjab, Baluchistan, and North-West Frontier Province (NWFP) to strengthen their capabilities in vertebrate pest control operations and loss assessment methods in grain storage facilities.
2. 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.
3. Improve the quality of adaptive research programs for stored grains.
4. Assess the problems of vertebrate pest-caused losses of stored grains at farm level and develop methods to reduce losses.
5. Assist the Pakistan Agricultural Research Council (PARC) to strengthen the capabilities of their pest control laboratories at Karachi and Islamabad and upgrade the applied research program in bird and rodent control in stored grains.

Since 1985, it has been found that preharvest losses of grains and other crops were equal to or even more significant than losses in storage facilities. Accordingly, the Joint Secretary for Food in the Ministry of Food, Agriculture, and Cooperatives asked USAID for assistance and recommended that the VPCP also work on preharvest problems, particularly those with which farmers consider the most serious. This added another objective to the program.

6. Assess major vertebrate pest problems in preharvest crops and attempt to implement operational pest control in pilot and large-scale trials. Develop safe, effective, and inexpensive methods that farmers can use to protect their crops from animal damage.

### Preharvest Pest Studies

Maize fields in the Faisalabad District were inspected for damage by wild boar (*Sus scrofa*), crested porcupine (*Hystrix* spp.), and rose-ringed parakeets (*Psittacula krameri*). Using road transects, 87 fields in 33 village



Preliminary studies were conducted to determine a method to evaluate rodent damage to peanuts.

areas were surveyed for vertebrate pest infestations and damage. The wild boar was the major pest; evidence of its presence was found in 57 fields; damage was noted in 44 fields and averaged 6.67% of the crop. Farmers had protected their fields by night-guarding, using dogs, firecrackers, and drum-beating to reduce wild boar damage. The crested porcupine had damaged plants in 22 fields; damage averaged 0.38% overall. Rose-ringed parakeets and possibly house crows were damaging cobs in 41 fields; damage averaged 0.41% overall.

A rodent control demonstration was conducted on the 600-ha National Agricultural Research Centre (NARC) campus in Islamabad. A variety of poisons, baits, baiting methods, and traps were used to kill rodents in experimental fields, fallow fields, ditches, canals, drains, and waste areas. From February 1987-June 1988, 19,547 burrows have been treated and rodent populations reduced about 68%. This low rodent population level is now being maintained and even further reduced through a surveillance and maintenance program of modest expense. During November, about 1,800 live rat burrows were treated with 2% zinc phosphide bait. About 100 ready made zinc phosphide bait packets were supplied to Barani Agricultural Research Development (BARD) to keep in their rural centre at Doltala. Techniques to stop wild boar and hare damage to experimental fields at NARC were also implemented.

The comparative toxicities of three anticoagulant rodenticides (brodifacoum, bromadiolone, and coumatetralyl) for the roof rat (*Rattus rattus*) were studied in the laboratory. Preliminary results indicated that brodifacoum is the most toxic, followed closely by bromadiolone. Coumatetralyl was considerably less toxic than the two "second-generation" anticoagulants.

Two hundred forty-six groundnut fields were examined for vertebrate pest damage in the Attock, Rawalpindi, and Chakwal districts. One hundred nine fields had received damage by one or more species of vertebrate pests. Of the 109 infested fields, 52 (47.7%) showed damage to groundnut plants. No attempt was made to quantify damage within fields. The most abundant pests were the short-tailed mole rat (*Nesokia indica*) in 57 fields, wild boar in 30 fields, and the lesser bandicoot rat in 25 fields.

A trip was made to Kunjah, Gujrat to select an area for a large-scale rodent control demonstration in wheat fields with cooperation of the Crop Maximization Programme (CMP). Farmers were contacted and the fields were visited in December. It was decided to select fields in January 1989 and start the control demonstration after the wheat was sown. About 1,000 bait packets of zinc phosphide and 200 of Racumin<sup>R</sup> were delivered to the CMP staff for sale to farmers of the area.

### Postharvest Pest Studies

Godown structures and storage bins ( $n = 349$ ) at provincial grain storage centers in the four provinces in Pakistan were inspected for vertebrate pest damage. Storage centers were randomly selected in Punjab Province; in the other provinces they were selected based upon those still remaining with wheat stocks or upon the advice of the provincial food department officials. Vertebrate pest infestations were recorded at 304 godowns (87.1%). Rodent

infestations were seen in 87 structures; 61 were due to house mice (*Mus musculus*), and 2 to striped squirrels (*Funambulus pennanti*). Rodent infestations were frequently of more than one species. Bird infestations were more common, occurring at 236 godowns, principally due to house sparrows (*Passer domesticus*) and rock doves (*Columba livia*). Few infestations, either of rodents or birds, were recorded as severe. Even here, grain losses would not have exceeded 0.1-0.2% of total grain storage over a 9-month period.

The 3-year study of small mammals and stored food losses at farm and village level is now half-completed. During 18 months of trapping, 1,249 small mammals were captured in 8,235 trap nights. The captured sample consisted of about 70% of *R. rattus*, 13% *M. musculus*, 8% Indian gerbil (*Tatera indica*), and 9% Asiatic house shrew (*Suncus murinus*). Poultry houses showed the highest density of animals, while farm and village houses and shops ran about 7 to 9 animals per structure. Flour mills had lowest densities, 5.3 per structure. Roof rats and house mice occurred in all types of structures; the Indian gerbil was absent from shops and the poultry farm, while the house shrew was trapped from all structures except the poultry farm. Density estimates of roof rats and the other species in the several structures were derived from the change-in-ratio (CIR) method and by the linear regression (LR) of cumulative captures on daily captures. The results are given in Table 1. Realizing that 7 of every 10 animals are roof rats, and knowing that these rats can consume 12.7 g of grain nightly, it appears that 30 to 35 kg of grain could be consumed by these animals per year in the average farm or village house. The amount of foods contaminated and wasted by rats and mice could easily double or triple this estimate.

Table 1. Estimates of population size of small mammals in rural structures of central Punjab.

	No. structures	No. small mammals caught per structure	Estimated population size	
			CIR*	LR*
Village house	90	7	11	9
Village shop	19	8	12	8
Village flour mill	12	5	7	6
Poultry farm	1	28	60	45
Farm house	36	9	12	10
Total/average	158	8	11	10

\* CIR = Change in ratio; LR = linear regression.

The study of the reproductive biology and population dynamics of *R. rattus* living in the wholesale grain market at Rawalpindi was partially completed. A total of 2,327 *R. rattus* (1,175 male and 1,152 female) were trapped during a 14-month period. Pregnancy rate by month varied from a low of 29.9% to a high of 56.1% in July and averaged 39.8%. Litter size at birth averaged 6.1 young. Despite this, the proportion of immature animals in a monthly sample never exceeded 17.6%. Monthly population estimates of rats ranged between 19-125 rats/shop. Roof rats at these densities probably consume about 1 kg of grain/night/shop, or about 365 kg/shop/year.

### Wild Boar Studies

Considerable information was gathered on the biology and economic status of wild boar. Data are being obtained on the population age structure, using the techniques of eye lens weight and annular rings in teeth, and on reproductive biology, morphometrics, damage to crops, and control methods. Initial results suggest that (1) boars can be aged through 24 months using the eye lens weight technique, (2) the main reproductive period is during the spring, (3) adult wild boars from Pakistan seem to be roughly equivalent in size to those of Tennessee, USA, but considerably smaller than animals from Russia, and (4) preliminary damage estimates are about 2.7-4.8% in sugarcane, 2.7% in rice, and 7.3% in wheat. Anticoagulant rodenticides in wheat dough balls and on buried grain and traps are being tested as potential control techniques.

### Flood-associated Food Losses

Unusually heavy rains occurred in the upper catchments of the Punjab rivers during the last week of September. Upstream reservoirs overflowed and heavy floods damaged not only the standing crops but also stored food at the farm and village level. The VPCP was asked by AID/Islamabad to survey different areas of Punjab to estimate the extent of these losses. Fourteen districts (Gujrat, Sialkot, Kasur, Okara, Sahiwal, Vehari, Khanewal, Multan, Toba Tek Singh, Sargodha, Jhang, Faisalabad, Sheikhpura, and Gujranwala) were visited, and 161 farmers were interviewed. The amount of food lost per household in 14 villages was calculated from figures provided by the farmers and averaged 1.25 MT/family; the average family size was 9.

In addition to interviews with the farmers, information on flood destruction was collected from the Deputy Commissioner's Office or from officers of district subdivisions. It was reported that 268,914 houses (averaging 19,208/district) were destroyed, and 166,784 houses (averaging 11,913/district) were damaged by the floods. The extrapolation of the figures obtained in the 14 districts to other unsurveyed districts of the Punjab resulted in an estimated total loss of stored grains due to the floods of 566,205 MT.



Vertebrate Pest Control Project scientists in Pakistan regularly conduct field demonstrations of the proper use of rodenticides.



Tooth wear is being investigated as a way of aging wild boar in Pakistan.

### Technical Assistance Support

Ms. Linda Raver, USDA/OICD/TAD, visited the AID/Islamabad Mission and the Project from April 2-11. The objective of her visit was to locate and help facilitate the transfer of funds in the PASA agreement that remained when the DWRC transferred from the Department of Interior to the Department of Agriculture. She also met Project staff and visited some field sites.

Drs. Russell Reidinger, Director, DWRC, and Richard Bruggers, Chief, IPRS, DWRC, visited the VPCP in Pakistan from April 9-13. Their objectives were to review the work of the Project, review Project needs and concerns, see the Project facilities, and discuss the work plans for the balance of the FSM Project and initiate the preparation of a request and work plans for an extension to the Project.

Mr. James Miller, National Program Leader, Fish and Wildlife, Extension Service, USDA, visited the Project on TDY from August 20-September 6 to assist Project staff in development of a training curriculum and training materials in coordination with the Storage Technology Development and Transfer (STDT) Project for Master Trainers and food department operational personnel in grain storage facilities. Dr. Philip Gipson, Wildlife Ecologist, National Technical Support Staff (NTSS), USDA/APHIS/ADC, also participated in this TDY between August 29-September 2 to confer about the training materials and their development.

Mr. Lynwood Fiedler, Wildlife Biologist, Denver Wildlife Research Center, was in Pakistan from October 14-November 8 to assist the Project Leader of the USAID/DWRC/VPCP, the VPCP staff, the VPCL in Karachi, and Faisalabad University cooperators in developing plans to better meet animal damage control needs of Pakistan. A method for experimentally assessing rat damage in mature groundnut fields was evaluated, and plant samples from one field with rodent burrows were collected. Meetings were held with several graduate students and their faculty advisers at the University of Agriculture, Faisalabad, and suggestions were offered for their planned research activities. Assistance was given to the Project in wild boar trapping and collecting activities near Fateh Jhang and Faisalabad as well as in assembling and testing some radiotelemetry equipment for tracking wild boar.

### Training

A 3-week training course on vertebrate pest control was organized by NARC Project staff and training center personnel and scientists at the VPCL in Karachi between March 13-31, 1988. Eleven participants from Pakistan attended.

VPCP staff spent a considerable amount of time developing training materials for PASSCO and Punjab Food Department Master Trainers and operational personnel. A training curriculum was prepared with training modules and a package of training materials was then developed for the Master Trainers to use in training food department operational personnel. The training package



consisted of an illustrated handbook, an illustrated leaflet, and two colored posters. Three Urdu-narrated sets of slides entitled "Inspection and Assessment Methods," "Sanitation and Maintenance," and "Rodent Control in Godowns" were prepared and a short video-cassette entitled "The Bad Godown and the Good Godown" was developed. The audio-visual material was shown to the participants and the published material was distributed to the Master Trainers for their comments and suggestions. This is part of a cooperative training effort with the STDT Project under FSM in Lahore.

A 1-day training session was provided to Master Trainers at the STDT Project Training Center at Lahore on December 5. The morning session consisted of lectures and demonstrations with color slides and video cassette. In the afternoon, the trainees were given practical field work in rodent and bird control methods in godowns. In addition, a vertebrate pest management in grain storage training package of posters, handbooks, brochures, and slide sets was given to the Master Trainers with which they could adapt to train the provincial and PASSCO grain storage operational personnel.

Mr. Iftikhar Hussain received training in word processing, spreadsheets, and use of data bases during a 2-week computer class entitled "FSR Micro Computer and Data Analysis" from August 6-18 at the Training Institute, NARC.

Mr. Mushtaq-ul-Hassan, a Ph.D. graduate student in the Department of Zoology, University of Agriculture, Faisalabad, received 1 week of training in food habits techniques at the VPCP from August 25-September 1. Mr. Mushtaq is studying the small mammal fauna of farm and village housing of rats and mice in stored foods at farm/village level.

During the month of Ramazan, VPCP staff began learning Word Perfect and reviewed dBase III Plus to retrieve and reformat the data on *R. rattus* reproductive biology and population structure.

On World Food Day, an exhibition was arranged by NARC from October 16-19. An exhibit of pest animals, crop damage, and methods of control was displayed by VPCP staff. The exhibition was visited by diplomats, ministers of Islamic countries, scientists, farmers, and students.

The VPCP has provided numerous research papers to Mr. M. Sarwar, M.S. (Hons) student, Department of Entomology, University of Agriculture, Faisalabad. Mr. Sarwar is working on control of rats in wheat fields at Faisalabad.

### Cooperative Research with Universities

Cooperative research efforts at University of Agriculture, Faisalabad, have resulted in completed studies on a variety of possible vertebrate pests including:

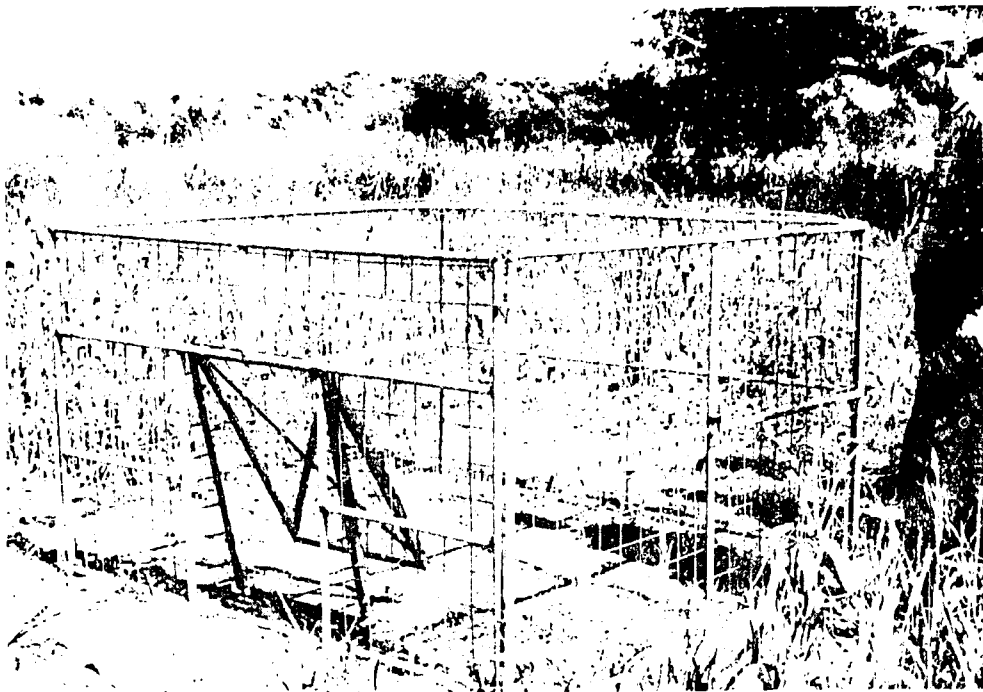
1. Rose-ringed parakeet food and foraging habits (the feeding niche was fairly broad but heavily dependent on agricultural crops such as sunflower, mustard, maize, sweet peas, wheat, sorghum, and orchard fruits).

2. The effectiveness of reflective tape in stopping rose-ringed parakeet damage to sunflower (damage was 6.5% in the covered plot and 7.6, 22.4, and 74.1% in the uncovered plots).
3. Breeding behavior and nest density (cavities in trees were predominant nest sites; young hatched in late April and fledged by July 11; *Acacia arabica* trees were mostly used).
4. Estimating rodent burrow densities on canal embankments in crop and noncrop areas.
5. Estimating porcupine burrow densities and control techniques relative to their damage to reforestation areas of Azad Kashmir.
6. Evaluating in-field postharvest wheat losses due to the lesser bandicoot rat.
7. Censusing rodent populations in farm and village structures relative to losses they inflict to on-farm stored grain.

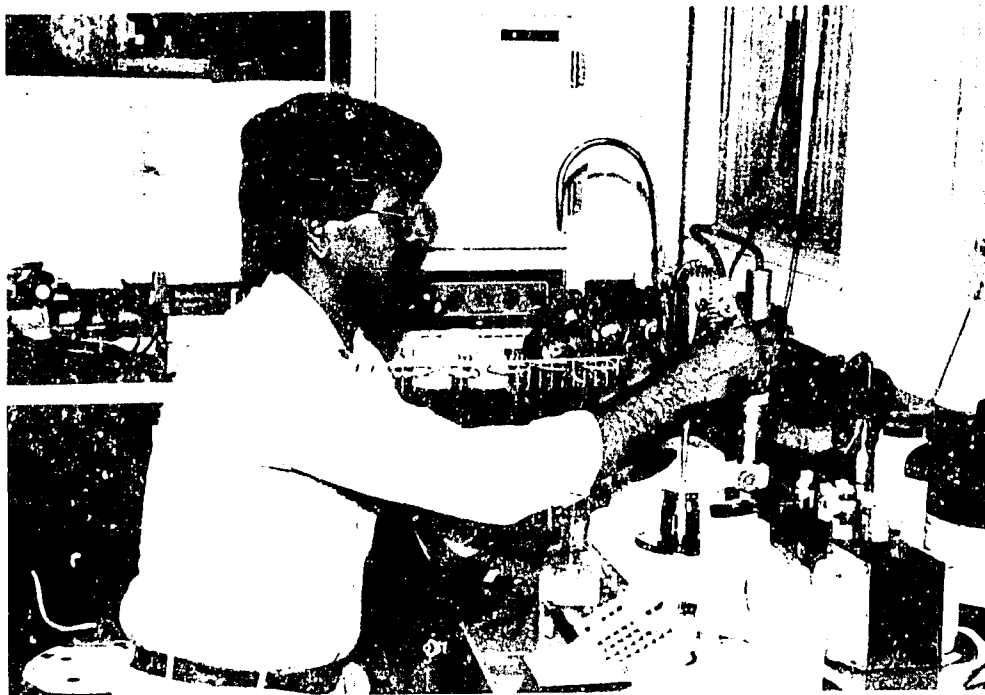
A 1-year study on "Seasonal variation in food and its effect on reproductive biology and physiology in *Bandicota bengalensis*," was initiated by Mr. Iftikhar Hussain as part of his research for a M.Phil. Degree from Quaid-i-Azam University. Seventy-seven lesser bandicoot rats were trapped from different areas/fields of the NARC campus in Islamabad. Of the 77 rats trapped, 40 were female and 37 were male. No pregnant female was collected. Epididymal tubules were visible in 13 (35%) of the males, all in October and November. Tubules were not visible in the males trapped in December ( $n = 11$ ). The regression in weights of testes and seminal vesicle began in August and continued until December. Blood sera of these rats were taken for hormone assays. Food habit studies suggest the main dietary component in October-December to be the rhizomes of several species of grasses common on the NARC campus.



Video films and posters were prepared in Urdu for training of food storage personnel in Pakistan.



Several techniques, including cage traps, are being evaluated as a way to catch wild boar in Pakistan.



Food habit studies are an integral component of vertebrate pest research in Pakistan.

## OUTREACH ACTIVITIES

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The objectives of the DWRC outreach program are to:

1. Provide supervisory, administrative, and temporary duty (TDY) support for foreign field stations.
2. Conduct cooperative problem-oriented research at DWRC based upon field program priorities.
3. Develop and implement proposals for VPM programs worldwide.
4. Provide scientific support, on request, to AID/Washington, USAID/Missions, and foreign governments by:
  - a. Providing TDY technical assistance to developing countries.
  - b. Arranging and providing training for foreign VPM technicians, administrators, and graduate students at DWRC.
  - c. Coordinating VPM participation in international workshops, symposia, and conferences.
  - d. Responding to inquiries and foreign assistance requests to DWRC through correspondence, reports, publications, and cooperative research.
5. Work closely with international organizations, including the Food and Agriculture Organization (FAO) of the United Nations, World Bank, Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM), Desert Locust Control Organization for East Africa (DLCO-EA), and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) on research problems of mutual interest.
6. Perform supervisory and program development functions at DWRC.

During 1988, DWRC staff traveled to Asia, the Caribbean, Africa, and Europe at the request of USAID, USAID Missions, USAID/Washington, the Food and Agriculture Organization (FAO) of the United Nations, and foreign governments to assess vertebrate pest problems; to review, evaluate, and coordinate present and future research programs; to evaluate the impact on the environment of locust control sprays; and to present seminars. TDY activities from DWRC have become an increasingly important part of the project, and DWRC will continue to respond to such requests, as many types of short-term evaluations and cooperative studies with host-country scientists may be carried out expeditiously in this manner. This travel involved 256 person-days in the following countries:

Antigua/Barbuda  
Bangladesh  
Barbados  
Bhutan  
Chad

Dominica  
Grenada  
Kenya  
Pakistan  
St. Kitts/Nevis

St. Lucia  
St. Vincent/Grenadines  
Senegal  
United Kingdom

Travel dates, persons involved, countries visited, and the purpose of each trip are outlined briefly in Table 2. Detailed information is contained in individual trip reports on file at IPRS, DWRC.

### Technical Assistance

A strategy for followup technical assistance consultancies to selected countries in the Sahel affected by the 1986-87 rodent outbreak was developed for implementation. Mr. Keith LaVoie visited Chad from March 27-April 28 to continue assessment of the rodent problem in agriculture, to train extension agents in rodent control methodology, and to conduct experimental evaluation of rodenticides. Field research and training were conducted in the Sahel near N'Gouri and in lowland rice near Bongor in the south. In the Sahel there are serious chronic rodent problems in the irrigated quadis, in dry-land agricultural areas, and in the grasslands. The primary rodent pest in the N'Gouri area quadis (interdune depression) was the Nile rat (*Arvicanthis niloticus*). The primary rodent pest in the dry-land areas was the pygmy gerbil (*Gerbillus andersoni*). Small plot evaluations of warfarin, chlorophacinone, and zinc phosphide indicated that zinc phosphide was the most effective, but the two anticoagulants also gave acceptable results. Agricultural extension personnel were trained in the safe and effective use and evaluation of warfarin grain bait in quadis. The Bongor area also had a serious chronic rodent problem in the rice fields. The primary rodent pest was *A. niloticus*. Rodent populations appeared to peak in March soon after the December harvest and began a natural decline until about June. Rodent control operations had been conducted in February and March by MOA, Plant Protection personnel, using selected Klerat<sup>R</sup>, a wax block bait containing 0.005% brodifacoum, as the primary control tool. MOA personnel also were trained in safe and effective methods for anticoagulant grain bait application and efficacy evaluation.



A Chadian farmer methodically digs out rats in his rice field after harvest, believing that it will help reduce damage and increase yields in the next crop. These rats are used as a dietary supplement, which also provides an incentive for this endeavor. Poisonous snakes are often encountered in the rat burrows.



Chadian family farms, such as this, grow millet and sorghum in years when rains are adequate; unfortunately, these crops must also be shared with rodents and birds.

Table 2. International travel for technical assistance projects by USAID/DWRC personnel during 1988.

Date	Name	Location	Purpose of trip
Mar 27-Apr 28	G. K. LaVoie	Chad	Conduct research and training related to rodent problems in selected Sahelian agricultural areas in Chad.
Apr 6-26 Apr 6-20	R. L. Bruggers R. F. Reidinger	Pakistan and Bangladesh Pakistan and Bangladesh	Assist personnel at field stations in reviewing Vertebrate Pest Management (VPM) research activities and formulating future project strategies.
Apr 13-19	J. E. Brooks	Bangladesh	Participate in Bangladesh VPM research review.
Aug 5-26 Jul 28-Sep 5	R. L. Bruggers J. O. Keith	Kenya and England Kenya	Determine environmental contamination of fenthion when sprayed over ploceid bird species roosting in marsh vegetation in Kenya, present paper at Pan-African Ornithological Congress in Nairobi, and finalize draft of book " <i>Quelea</i> --Africa's Bird Pest."
Aug 11-Sep 1	L. A. Fiedler	St. Kitts/Nevis, Antigua/Barbuda, Dominica, St. Lucia, St. Vincent/Grenadines, Grenada, and Barbados	Consult with the Ministries regarding pilot rodent control demonstration projects.



Table 2 (Cont'd)

Date	Name	Location	Purpose of trip
Aug 20-Sep 6 Aug 29-Sep 2	J. E. Miller <sup>a</sup> P. S. Gipson <sup>b</sup>	Pakistan	Assist Pakistan Project Leader in developing training programs with extension materials, for technology transfer of vertebrate pest prevention and control information to Master Trainers that would enable them to train End Users to prevent losses from stored grain facilities.
Sep 26-Oct 26	G. K. LaVoie	Bhutan	Assess storage facilities of Food Corporation of Bhutan in five geographic areas to determine type and extent of rodent infestations.
Oct 10-Nov 3 Nov 3-24	C. E. Knittle R. A. Dolbeer	Senegal	Assess the impact of large-scale locust control operations on nontarget wildlife.
Oct 14-Nov 8	L. A. Fiedler	Pakistan	Develop project plans, assess rodent damage in mature groundnut fields, and assist in conducting wild boar research.

<sup>a</sup> National Program Leader, Fish and Wildlife, Extension Service, USDA.

<sup>b</sup> Wildlife Ecologist, National Technical Support Staff, USDA/APHIS/ADC.

At the request of Kenya MOA and FAO, Drs. Richard Bruggers (IPRS), and James Keith (Mammal Control Research Section) evaluated the environmental impact of fenthion applied to roosts of ploceid birds in marsh vegetation in Kenya during August 1988. Two marsh roosts of ploceid weavers (*Quelea quelea*, *Quelea cardinalis*, and *Ploceus rubiginosus*) were aerially sprayed with Queletox<sup>®</sup> (60% fenthion). Pre- and postspray samples of vegetation, water, insects, amphibians, fish, and target and nontarget birds were collected. Clean samples were spiked with technical grade fenthion to determine recovery. About 500 samples were collected. Samples were prepared for fenthion residue analysis by freezing in liquid nitrogen or extracting with petroleum ether for water and with methanol for all other materials. Samples are being analyzed for residue by the Analytical Chemistry Section at DWRC. The study was a cooperative effort among FAO, MOA/Plant Protection Division/Crop Protection Branch, Kenya, and USDA/APHIS/S&T/DWRC personnel. This project was conducted with funds provided to APHIS/S&T by USAID under the Project "Vertebrate Pest Management Systems R&D" and FAO through FAO/UNDP Crop Protection Project Division, Crop Protection Branch. FAO will provide support to Mr. John Ngondi, MOA/Crop Protection Branch, Kenya, who will be at DWRC in 1989 to help analyze the data and begin writing the report.



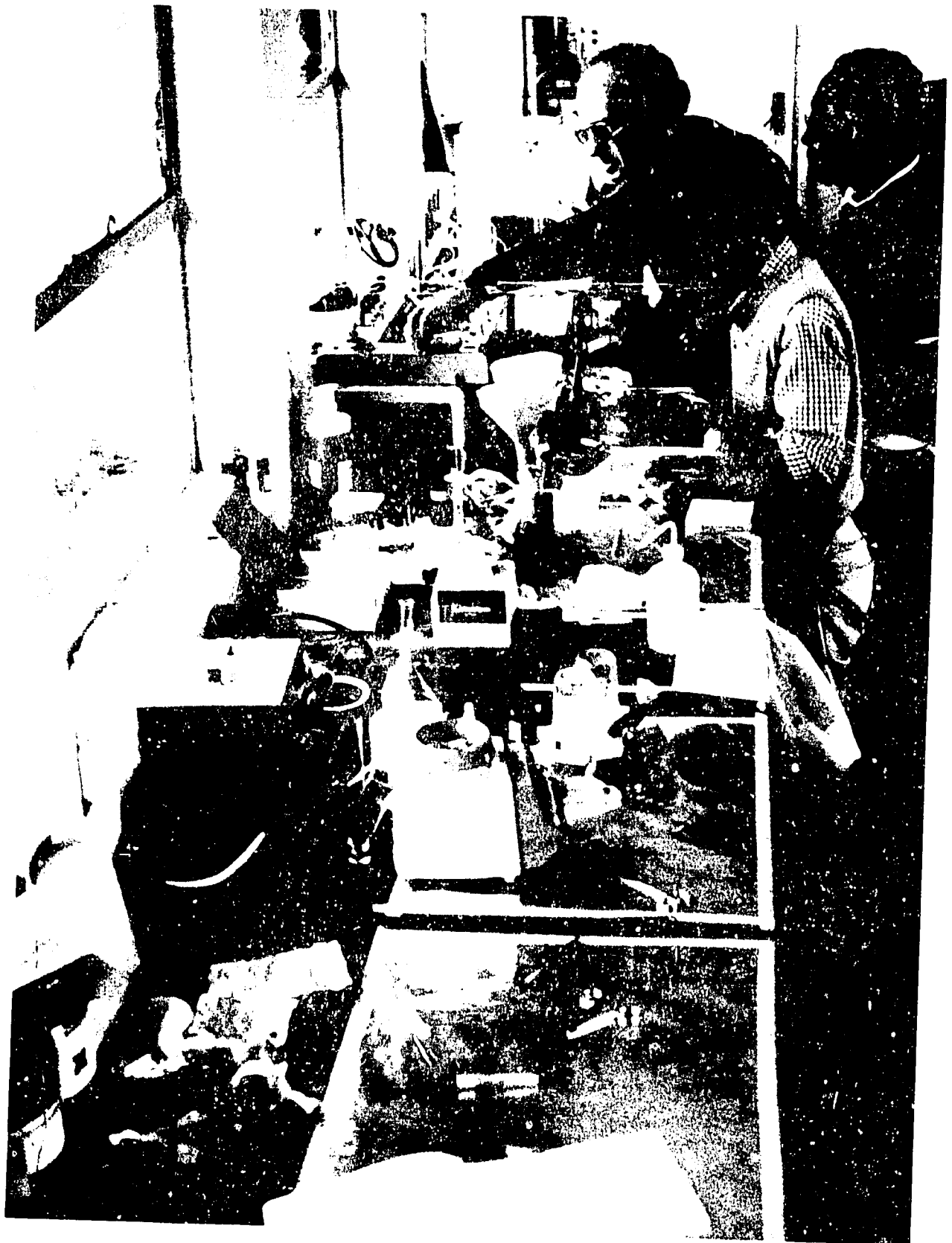
DWRC scientists cooperated with the Kenya Ministry of Agriculture, Crop Protection Branch, to evaluate the impact on aquatic ecosystems and nontarget wildlife of fenthion sprays used to control quelea.



A variety of samples including water, vegetation, soil, insects, and aquatic organisms such as fish and tadpoles (which are shown being collected in this photo) were sampled before and after sprays to determine contamination.

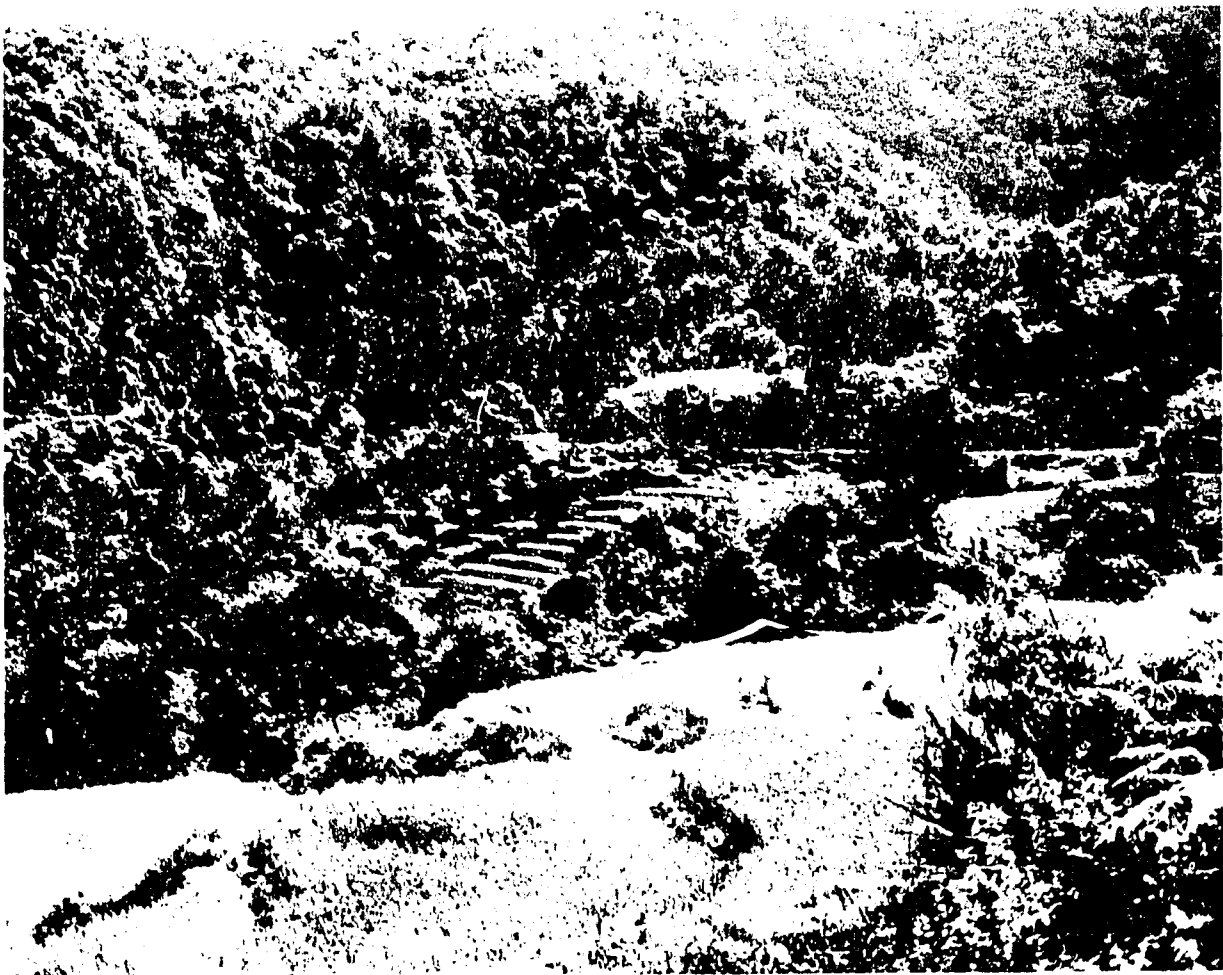


Local village children collected dead nontarget birds following the sprays.

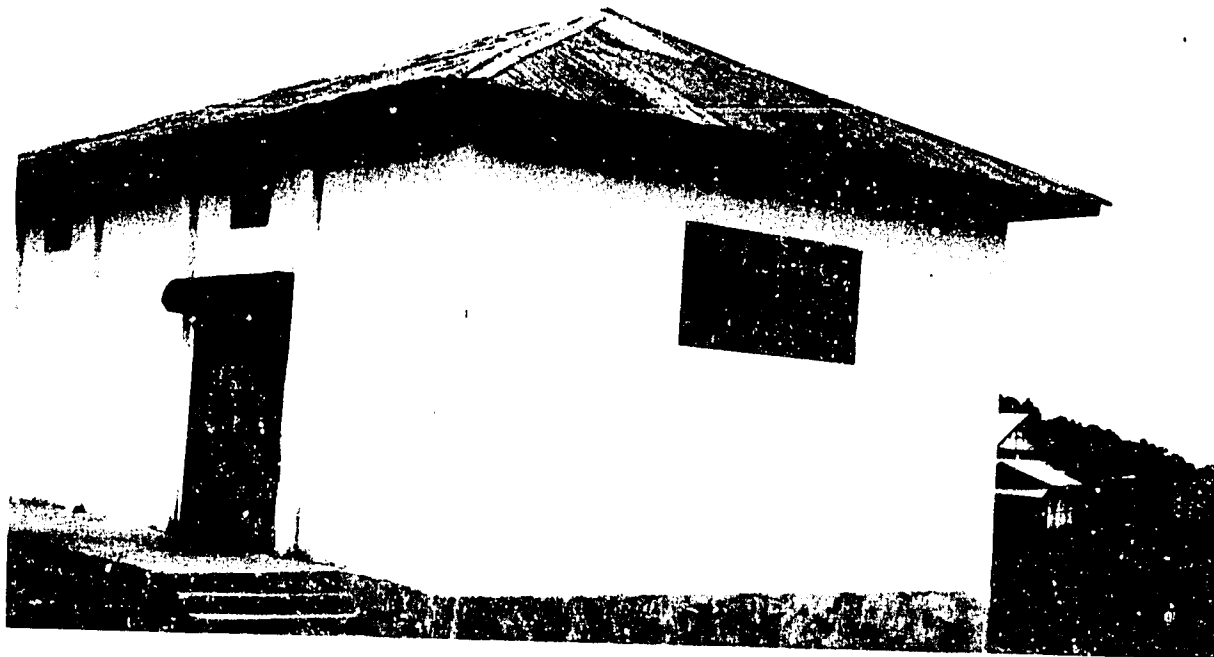


All samples were extracted and/or prepared for residue analysis at the laboratory of the National Plant Breeding Center in Njoro, Kenya.

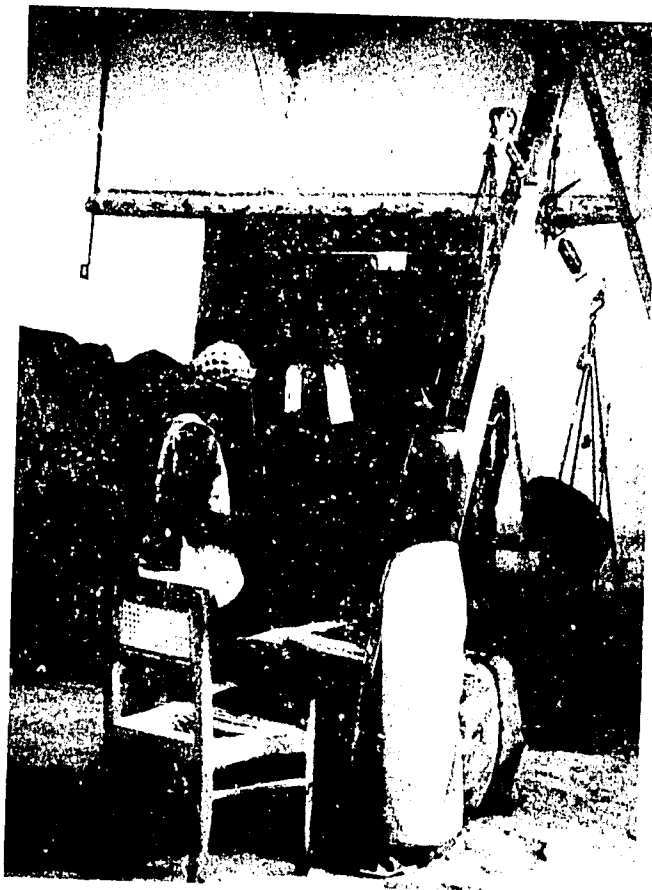
Mr. Keith LaVoie visited Bhutan from September 26-October 26, on a consultancy for FAO to evaluate the impact of rodents in Food Corporation of Bhutan (FCB) storage facilities in five geographic areas. The primary pest species were *B. bengalensis*, *R. rattus*, the Norway rat (*Rattus norvegicus*), and *M. musculus*. The degree of infestation ranged from moderate to intense and seemed to be related to the length of time a crop was stored, the physical condition of the storage structure, and the associated sanitation conditions. It was estimated that about 4% of the food stores was consumed by rodents and an additional 10-20% was contaminated. It appeared that the rodent problem could be alleviated in some of these situations through proper structural modifications and maintenance. Training of MOA personnel in sanitation and control methods would also reduce losses and health hazards from rodents.



The primary cereal crop of Bhutan is rice, which is grown during the wet season. These same fields are often used to grow wheat during the dry season.



The Food Corporation of Bhutan (FCB) is an agency of the Royal Government of Bhutan, responsible for transport, storage, and wholesale distribution of grains and other food commodities. FCB owns numerous storage facilities.



Rodents often gain entry to warehouses in Bhutan through open doors.



Rodent infestations are so severe in some warehouses in Bhutan that even commodities, such as these bags of salt, are heavily damaged.



The Bhutanese have no history of vertebrate pest control. Trapping rodents to determine their identity was a novel experience to this Bhutanese counterpart.



Photographs of locust control in Morocco in 1954 depict the seriousness of such invasions (Photo credit: FAO).



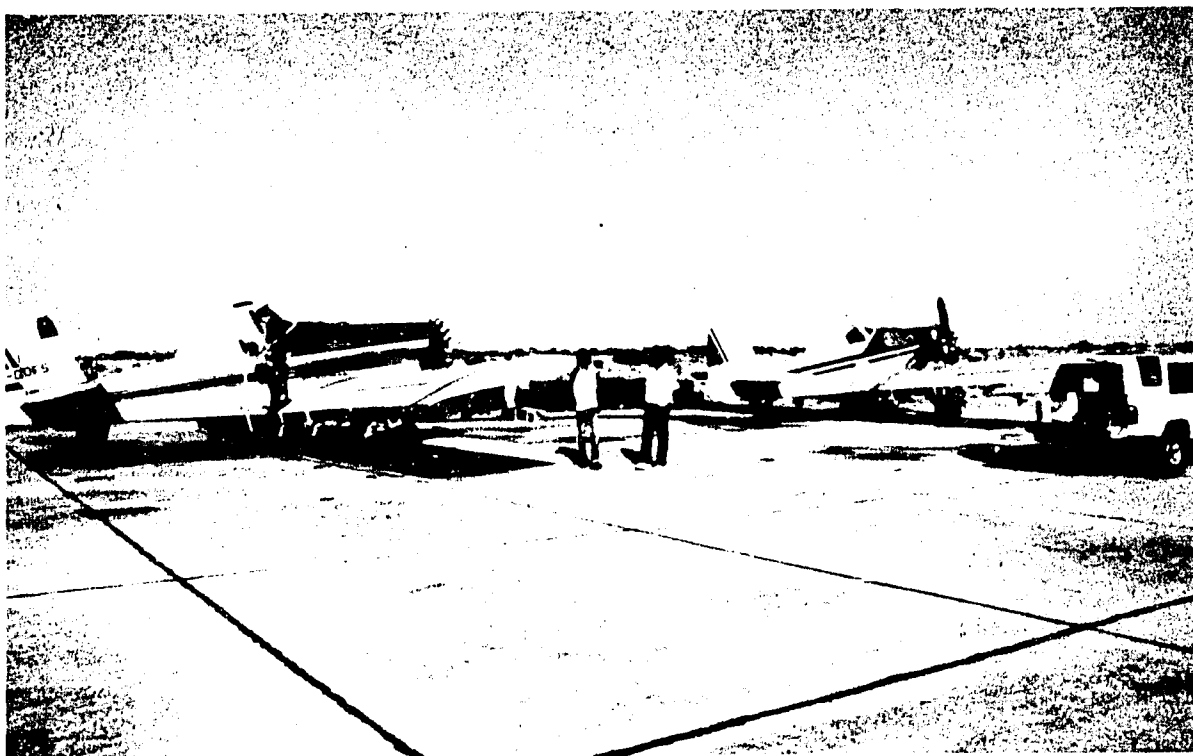
DWRC provided two Environmental Specialists to be part of a USAID-funded locust control spray team for 6-8 weeks in Senegal, West Africa: Mr. Edward Knittle, Wildlife Biologist, (Chemical Development/Registration Section) from October 10-November 3, and Dr. Richard Dolbeer, Wildlife Biologist (Bird Control Research Section) from November 3-24. These were DWRC's first consultancies to assess the impact of large-scale locust control operations on nontarget wildlife; much greater involvement is planned for 1989. Recommendations from these consultancies included the following: all contractors should handle pesticides properly, wear proper clothing, and use proper equipment; a standardized policy on barrel draining, rinsing, and disposal needs to be developed; large planes need better navigation and ground marking aides to assist them in providing uniform coverage over treatment blocks; more extensive pre- and posttreatment environmental assessments need to be conducted to determine the extent, if any, of adverse effects; a standard procedure is needed for evaluating the level of locust kill after a spray in a treatment block; and malathion or carbaryl should be used whenever possible, in lieu of fenitrothion which is the most likely to adversely impact the environment.



DWRC scientists assisted a multinational locust control team for USAID by monitoring the impact on the environment and nontarget wildlife of chemicals used to spray bands of locusts in Senegal (Photo credit: FAO).



Locusts will readily consume both natural grasslands and village gardens during their outbreaks.



Unimog ground sprayers and Piston Thrush spray planes were used by Senegalese Crop Protection Service teams and U.S. contract spray personnel to spray locusts.

Mr. Lynwood Fiedler visited Pakistan October 14-November 8 to assist the Project Leader of the USAID/DWRC/VPCP, the VPCP staff, the VPCL in Karachi, and Faisalabad University cooperators explore needs and options for future DWRC assistance in VPM to Pakistan, begin assessing rodent damage to ground-nuts, and assist in wild boar trapping activities.

### Training

IPRS continued collaboration with the Department of Wildlife and Fisheries of Colorado State University (CSU), Fort Collins, in international VPM training. DWRC biologists continued to teach classes in the biennial VPM course during the fall semester. About 8 months of assistance was provided at DWRC to CSU post-doctorate candidate Dr. Sohail Soliman in research to develop a toxicant delivery system which utilizes a gel-like material designed to contact rodents and deliver a lethal dose of toxicant during grooming. From this work, Dr. Soliman developed two research papers to be published in Egyptian scientific journals. Assistance was provided to Mr. Sayed Ahmed, an International Rice Research Institute-sponsored Ph.D. candidate, in developing a research proposal to develop a toxicant delivery system utilizing rodent grooming behavior applicable to *B. bengalensis* for use by Bangladesh farmers. Agreement was reached to permit Mr. Yousuf Mian and Mr. Ejaz Ahmad, DWRC Project counterparts at the Bangladesh Agricultural Research Institute and the National Agricultural Research Centre in Pakistan, respectively, to formally apply for admittance into a Ph.D. program at CSU. Mr. Mian will have, as his research objective, development of a strategy to reduce postharvest losses to stored grain by rodents in Bangladesh, while Mr. Ahmad will be working on methods to alleviate wild boar problems.

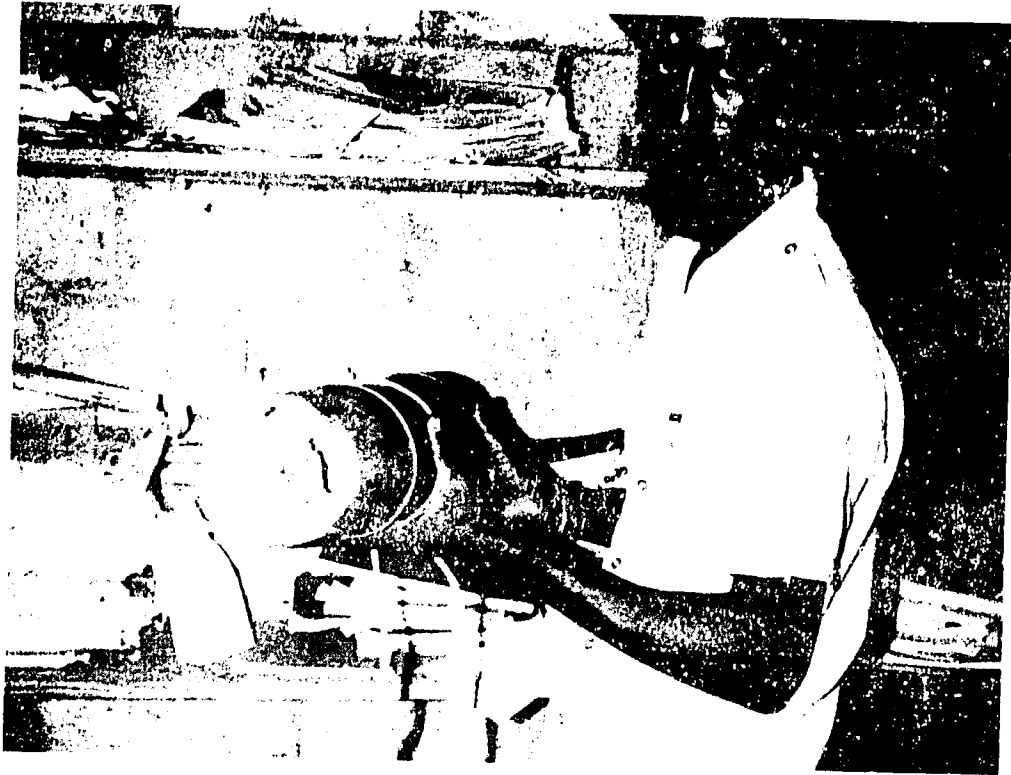
Mr. Lynwood Fiedler made the third of four consultancies to the Caribbean from August 11-September 1 to initiate pilot rodent control demonstrations on priority crops on the islands of Antigua/Barbuda, Barbados, Dominica, Grenada, St. Lucia, St. Kitts/Nevis, and St. Vincent/Grenadines. This consultancy was the result of an agreement on August 18, 1986, among FAO and seven eastern Caribbean countries to implement a rodent control project. The project was initiated in May 1987 when Mr. Fiedler visited and assessed the main agricultural and health-related rodent problems in each country.

The followup consultancies have consisted of:

1. Conducting a 7-day rodent control training course in November 1987 in Grenada for 20 FAO-sponsored participants representing crop protection, extension, and public health. This course consisted of lectures, a Caribbean rodent control manual, slides, overheads, and rodent control field demonstrations.
2. Developing data collection procedure forms and providing on-site training at the demonstration projects to allow Ministry personnel to collect data on which to base rodent control recommendations.



DWRC implemented rodent pest training programs and control demonstrations on several islands in the Caribbean between 1987 and 1989. On Barbados and St. Vincent, where rodents damage sugarcane and root crops, respectively, species identity and density were determined using snap trap and inked tracking tiles (Photo credit: John Williams, Pan American Health Organization).



In Grenada, pilot demonstrations of rodent control, using local bamboo bait holders, were implemented in field and storage situations by the Pest Management Unit, Ministry of Agriculture (Photo credit: John Williams, Pan American Health Organization).

Since this program was initiated in 1987, Antigua, Grenada, and St. Vincent have conducted rodent control training programs involving MOA, Ministry of Health (MOH), and other agencies concerned with rodent problems. Rodent control committees have been established on Barbados, Dominica, and St. Vincent to coordinate implementation of rodent control work. The other countries have been encouraged to do likewise. The fourth and final phase is to be conducted in early 1989 and will include evaluating the demonstration projects and proposing a 5-year rodent control plan for each country.

Mr. James Miller, National Program Leader, Fish and Wildlife, Extension Service, USDA, visited Pakistan for DWRC from August 20-September 6, where he assisted the Government of Pakistan (GOP), DWRC/VPCP in Islamabad, Project Leader Joe Brooks, and counterpart staff in preparing curricula, manuals, and audio visual aids for training courses in VPM in public sector grain storage facilities. Dr. Philip Gipson, Wildlife Ecologist, NTSS, USDA/APHIS/ADC, also participated in this activity from August 29-September 2.

Three foreign students (Mr. Herbert Okurut-Akol, Uganda; Ms. Ethel Rodriguez, Uruguay; and Ms. Maria E. Zaccagnini, Argentina) completed graduate programs in VPM at CSU. DWRC/IPRS personnel have been involved in planning and organizing the theses research of these students.

IPRS (1) distributed over 700 informational brochures announcing the "2nd International Short Course in Vertebrate Pest Problems and Solutions in Developing Countries," organized by CSU with DWRC involvement, to be held August 14-27, 1989, at CSU, and (2) distributed 95 informational brochures announcing the Pakistan Agricultural Research Council's 5th training course in VPM which was held March 13-31, 1988, in Pakistan. DWRC Project Leader in Pakistan, Joe Brooks, and VPCP scientists conducted this course.

During 1988, IPRS received and responded to 198 requests from 52 countries for information, training, and technical assistance. Reprints and reports totaling 2,507 were provided to scientists and pest control specialists worldwide (Table 3).

Table 3. Requests to DWRC for assistance during 1988.

Type of request or activity	Total No.
Information on International Programs	36
Information or Literature on Research and Crop Protection Methods	95
Information on Graduate Schools in VPM	6
Materials/Photographs	15
Requests for DWRC Scientist TDY's	
- Project Development	3
- Workshops	3
- Symposia/Conferences	7
- Research, Technical Assistance	9
Requests of DWRC for	
- Funds	6
- Research Opportunity	3
- Training	9
- Hiring	6
No. International Visitors	16
No. Reprints Distributed	<u>2,507</u>
TOTAL	2,721

Originating countries:

Antigua/Barbuda, Australia, Bangladesh, Barbados, Belgium, Burma, Cameroon, Canada, Chad, Chile, Costa Rica, Cuba, Dominica, Ecuador (Galapagos), Egypt, Ethiopia, France, Ghana, Grenada, Guinea-Bissau, Haiti, India, Indonesia, Iraq, Italy, Ivory Coast, Kenya, Malaysia, Mali, Mexico, Nigeria, Pakistan, Panama, Philippines, Poland, St. Kitts/Nevis, St. Lucia, St. Vincent/Grenadines, Senegal, Somalia, South Africa, Spain, Sudan, Taiwan, Tanzania, Uganda, United Kingdom, United States of America, West Germany, Yugoslavia, Zambia, Zimbabwe.

## Research Proposals

IPRS prepared three VPM proposals for consideration. One research proposal was submitted to the USAID/Office of the Science Advisor for "Enhancing Chemical Repellents with Sensory Cues to Reduce Bird Damage to Agricultural Crops in Uruguay." A short-term consultancy proposal was submitted to the MOA and Crop Development, Kenya, for a DWRC consultancy to assess the environmental impact of quelea roost spraying in aquatic habitats. A third proposal was prepared at the request of the MOA, Ethiopia, to assist them in rodent management.

## Project Management

During 1988, APHIS underwent a major reorganization. Dr. Richard Bruggers served on the APHIS International Implementation Team and worked with the committee members in Hyattsville during May. Dr. Bruggers' role was to help determine whether the IPRS should be included in the newly formed International Services of APHIS or stay as part of DWRC and move to the APHIS/Bureau of Science and Technology. It was decided that IPRS, because of its research emphasis, should remain with DWRC.

Drs. Russell Reidinger, Jr., Director, and Richard Bruggers, Chief, IPRS, DWRC, visited the project field stations in Pakistan and Bangladesh between April 6-26. The primary purposes of these visits were to assist Project biologists Joe Brooks (Pakistan) and Michael Jaeger (Bangladesh) and their counterpart staff in reviewing past, and planning future, VPM research activities. In addition, pertinent MOA and USAID Mission personnel in both countries were briefed by the Director on how DWRC organizational changes will positively impact DWRC backstop support to the two projects.

Dr. Richard Bruggers attended a 2-day symposium in Washington, D.C., on September 26-27, entitled "Agricultural Development: Today and Tomorrow." The symposium was presented by the Office of Agriculture, Bureau for Science and Technology, USAID. The purpose of this symposium was to provide a forum for AID/S&T Bureau project representatives and USAID staff to share information and future guidance on programs; to interact on points related to the Office of Agriculture Research Agenda for 1990's, sustainable agriculture, program strategy, and operational issues; and to focus attention on ways to maintain and improve program operation, coordination, and effectiveness.

Mr. Greg Garbinsky, USDA/OICD/Worldwide Programs, was in Denver, Colorado, March 31-April 1 to meet with IPRS at DWRC to set up budget tracking procedures for the core Resources Support Services Agreement (RSSA) and review other 1988 activities.





A Senegalese farmer indicates one of numerous spots where rodents have dug and eaten potatoes in his field.



Communal vegetable production areas in Senegal are plagued by vertebrate pests; note the "scare-crows" in the field to deter bird damage. Rodent damage is no less severe, but these pests are less visible.

## PERSONNEL

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### International Programs Research Section<sup>1</sup>

Richard L. Bruggers	Section Chief
Jean A. Alleman	Program Assistant
D. Sue Brinegar	Clerk-Typist
Joe E. Brooks	Wildlife Biologist (Pakistan)
Lynwood A. Fiedler	Wildlife Biologist
Marilyn A. Harris	Editorial Assistant
Michael M. Jaeger	Zoologist (Bangladesh)
G. Keith LaVoie	Wildlife Biologist
Donna J. Scott*	Program Assistant
Sandra L. Vana-Miller	Biological Technician
Annaliese E. Valvano**	Editorial Assistant

\* Ms. Scott left IPRS in May 1988 to work for the Department of State in Zambia.

\*\* Mrs. Valvano retired in June 1988.

### Bangladesh (Counterpart Personnel)

Abdul Karim	Chief Scientific Officer
Emdadul Haque	Senior Scientific Officer
Yousuf Mian	Senior Scientific Officer
Parvin Sultana	Senior Scientific Officer
Mosharof Hossain	Scientific Officer
Rajat Kumar Pandit	Scientific Officer

### Pakistan (Counterpart Personnel)

Ejaz Ahmad	Research Scientist
Christine Ann D'Souza	Program Assistant
Liaquat Ali	Secretary
Iftikhar Hussain	Research Scientist
Shahid Munir	Research Scientist
Mohammad Ilyas	Rodent Control Laborer
Gul Zaman	Rodent Control Laborer

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<sup>1</sup> Fully funded under a Participating Agency Service Agreement (PASA).

## PUBLICATIONS

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- Brooks, J. E., E. Ahmad, and I. Hussain. 1988. Characteristics of damage by vertebrate pests to groundnuts in Pakistan. Proc. 13th Vertebr. Pest Conf., Monterey, California, 13:129-133.
- Dolbeer, R. A., L. A. Fiedler, and H. Rasheed. 1988. Management of fruit bat and rat populations in the Maldive Islands, Indian Ocean. Proc. 13th Vertebr. Pest Conf., Monterey, California, 13:112-118.
- Elias, D. J. and M. W. Fall. 1988. The rodent problem in Latin America. Pages 13-28 in I. Prakash, ed. Rodent Pest Management. Chapter 2. CRC Press, Boca Raton, Florida. 480 pp.
- Fall, M. W. and B. E. Johns. 1988. Metallic flake particle markers for determining the feeding behavior of rats at bait points. Vertebrate Pest Control and Management Materials: 5th Volume, ASTM STP 974, S. A. Shumake and R. W. Bullard, eds., American Society for Testing and Materials, pp. 128-133.
- Fiedler, L. A. 1988. Rodent problems in Africa. Pages 35-65 in I. Prakash, ed. Rodent Pest Management. Chapter 4. CRC Press, Boca Raton, Florida. 480 pp.
- Hoque, M. M. and L. A. Fiedler. 1988. Rat control in coconut. College of Agriculture, University of the Philippines at Los Baños, College, Laguna, Philippines. National Crop Protection Center. Tech. Bull. No. 3. 20 pp.
- Tobin, M. E., P. P. Woronecki, R. A. Dolbeer, and R. L. Bruggers. 1988. Reflecting tape fails to protect ripening blueberries from bird damage. Wildl. Soc. Bull. 16:300-303.

## INTERNATIONAL VISITORS

Date	Name	Representing
Jan-May	Dr. Sohail Soliman	Ain Shams University, Faculty of Science, Department of Zoology, Abbasia, Cairo, A.R. Egypt
Jan 20	Mr. Kamal Kamarudin	MARDI, Kuala Lumpur, Malaysia
Feb 8-9	Dr. Hailu Kassa	Crop Protection and Regulatory Department, MOA, Ethiopia
Feb 8-9	Dr. Ahmed Mubarik	Pakistan Agricultural Research Council, Grain Storage Research Laboratory, Pakistan
Mar 7	Dr. Alan Buckle	ICI Agrochemicals, United Kingdom
Mar 7-8	Dr. Graham Martin	Kenyata University, Nairobi, Kenya
Mar 7-11	Dr. Melanda Hoque	National Crop Protection Center, Philippines
Mar 9-11	Dr. John Wilson	Biology Department, Queensland Institute of Technology, Australia
May 28, Jul 22, Sep 30	Mr. Sayed Ahmed	Bangladesh Rice Research Institute
Sep 4-Dec 30	Ms. Ethel Rodriguez	Uruguay
Oct 7	Mr. Alonso Aguirre	Mexico (Student at Colorado State University, Fort Collins, Colorado)
Nov. 10	Ms. Elizabeth Aguilera- Garramuno Mr. Sayed Ahmed Mr. Herbert Okurut-Akol Ms. Ethel Rodriguez Ms. Julieta Von Thungen Ms. Maria E. Zaccagnini	Colombia  Bangladesh Uganda Uruguay Argentina Argentina (Graduate students at Colorado State University, Fort Collins, Colorado)

## **PARTICIPATION IN MEETINGS, CONFERENCES, SEMINARS**

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Brooks, J. E., L. A. Fiedler, and G. K. LaVoie. Attended the 13th Vertebrate Pest Conference held on March 1-3 and the 6th American Society for Testing and Materials (ASTM) Symposium on March 4, both meetings in Monterey, California. Mr. Brooks presented a paper "Characteristics of Damage by Vertebrate Pests to Groundnuts in Pakistan." Mr. Fiedler chaired the Small Mammal Task Group of the ASTM E35.17 Subcommittee on Vertebrate Control Agents.

Bruggers, R. L. Attended a 2-day symposium in Washington, D.C. on September 26-27, titled "Agricultural Development: Today and Tomorrow," presented by the Office of Agriculture, Bureau for Science and Technology, USAID.

Keith, J. O. Presented a paper "Use of Trace Elements in Feathers for Identifying Subpopulations of *Quelea (Quelea quelea)*" by J. O. Keith, R. L. Bruggers, C.C.H. Elliott, and D. L. Otis at the Pan-African Ornithological Congress in Nairobi, Kenya, on August 31.

## SPECIAL REPORTS AND BROCHURES

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### Technical Reports

- Brooks, J. E., E. Ahmad, and I. Hussain. The use of anticoagulants in wild boar control: preliminary field trials. Technical Report No. 14. Vertebrate Pest Control Project, Food Security Management, Post-Harvest Management Component; Islamabad, Pakistan; April 1988. 9 pp.
- Brooks, J. E., I. Hussain, and E. Ahmad. A partial research bibliography of the rose-ringed parakeet (*Psittacula krameri*). Technical Report No. 15. Vertebrate Pest Control Project, Food Security Management, Post-Harvest Management Component; Islamabad, Pakistan; June 1988. 16 pp.
- Hussain, I., J. E. Brooks, E. Ahmad, and S. Munir. Biology and behaviour of the lesser bandicoot rat, *Bandicota bengalensis*, with a partial research bibliography. Technical Report No. 16. Vertebrate Pest Control Project, Food Security Management, Post-Harvest Management Component; Islamabad, Pakistan; September 1988. 36 pp.
- Brooks, J. E., E. Ahmad, I. Hussain, and S. Munir. A partial research bibliography of the crested porcupines, Genus *Hystrix*. Technical Report No. 17. Vertebrate Pest Control Project, Food Security Management, Post-Harvest Management Component; Islamabad, Pakistan; September 1988. 16 pp.
- Ahmad, E., I. Hussain, and J. E. Brooks. Losses of stored foods due to rats at Punjab Wholesale Grain Markets. Technical Report No. 18. Vertebrate Pest Control Project, Food Security Management, Post-Harvest Management Component; Islamabad, Pakistan; November 1988. 17 pp.

### Trip Reports\*

- Bruggers, R. L. and J. O. Keith. 1988. Trip Report--Kenya and England. 6 pp.
- Bruggers, R. L. and R. F. Reidinger, Jr. 1988. Trip Report--Pakistan and Bangladesh. 11 pp.
- Dolbeer, R. A. 1988. Environmental assessment for U.S. locust control program. Trip Report--Senegal. 12 pp. and 2 appendices.
- Fiedler, L. A. 1988. Prevention of food losses through rodent control. Trip Report--Caribbean. 6 pp. and 3 appendices.

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\* Trip reports are on file at the IPRS, DWRC.

- Fiedler, L. A. 1988. Project planning, groundnut rodent damage assessment, and wild boar research. Trip Report--Pakistan. 8 pp. and 2 appendices.
- Knittle, C. E. 1988. Environmental assessment, locust control program. Trip Report--Senegal. 4 pp. and 1 appendix.
- LaVoie, G. K. 1988. Trip Report--Bhutan. 14 pp. and 2 appendices.
- LaVoie, G. K. 1988. Trip Report--Chad. 12 pp. and 5 attachments.
- Miller, J. E. 1988. Trip Report--Pakistan. 7 pp.

#### Other Reports and Documents

- Brooks, J. E. 1988. Status of vertebrate pests research and management in Pakistan: an overview. Submitted to Pest Management Research Institute (PMRI), Karachi, Pakistan. 8 pp.
- Brooks, J. E., M.S.K. Rana, E. Ahmad, I. Hussain, A. A. Khan, and A. R. Khokhar (compilers and editors). 1988. Training Manual on Vertebrate Pest Management, PARC, Islamabad, Pakistan. 255 pp.
- Bruggers, R. L., L. A. Fiedler, and G. K. LaVoie. 1988. Project proposal--rodent pest management research and control in West Africa. Submitted to USAID/Africa Bureau for approval. 20 pp. and attachments.
- Elliott, C.C.H. and R. L. Bruggers. 1987. Preliminary proposal for a consultancy on the side effects of quelea spraying in aquatic habitats. Submitted to MOA and Crop Development/Kenya for approval. 2 pp.
- Fiedler, L. A. and G. K. LaVoie. 1988. Ethiopian rodent project draft proposal. Submitted to Ethiopian Government. 10 pp. and attachments.
- LaVoie, G. K. 1988. Project document draft proposal for rodent control in Food Corporation of Bhutan storage facilities. Submitted to FAO, Rome. 5 pp.
- Rodriguez, E., R. L. Bruggers, and R. W. Bullard. 1988. Proposal for enhancing chemical repellents with sensory cues to reduce bird damage to agricultural crops in Uruguay. Submitted to USAID/Office of the Science Advisor for funding. 5 pp.
- Vertebrate Pest Control Project. 1988. Anaj ke godam: nuksandeh janwaroon ke barey main aik rehnuma kitab. (Grain storage handbook in Urdu on vertebrate pest management.) A GOP/USAID/DWRC Project, National Agricultural Research Centre, Islamabad, Pakistan. 24 pp.
- Vertebrate Pest Control Project. 1988. Anaj ko mahfooz karney ke chand hidayat. (Grain storage pamphlet in Urdu on vertebrate pest management.) A GOP/USAID/DWRC Project, National Agricultural Research Centre, Islamabad, Pakistan. 6 pp.

Vertebrate Pest Control Project. 1988. Grain storage: handbook on vertebrate pest management. A GOP/USAID/DWRC Project, National Agricultural Research Centre, Islamabad, Pakistan. 24 pp.

Vertebrate Pest Control Project. 1988. Ghaley key godamoon ke safai aur imarat ke dekh bhal. (Poster in Urdu on maintenance and sanitation of the grain storage godown.) A GOP/USAID/DWRC Project, National Agricultural Research Centre, Islamabad, Pakistan.

Vertebrate Pest Control Project. 1988. Godamoon main anaj ko nuksan puhchaney waley janwar. (Poster in Urdu on vertebrate pests of grain storage godowns.) A GOP/USAID/DWRC Project, National Agricultural Research Centre, Islamabad, Pakistan.

Vertebrate Pest Control Project. 1988. Reference manual: vertebrate pest management in grain storage centres. A GOP/USAID/DWRC Project, National Agricultural Research Centre, Islamabad, Pakistan. 30 pp.

NOTE: Further information on special reports or publications can be obtained from the authors or the agency for which the report was prepared.