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10. Abstract (optional - 250 word limit)

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 FY-89 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 58 different countries, with technical assistance and training provided in several areas. The ultimate aim of this 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.

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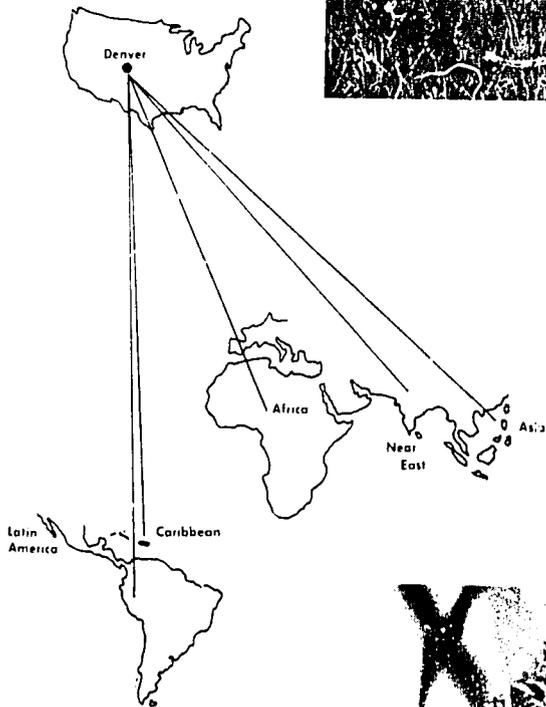
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VERTEBRATE DAMAGE CONTROL RESEARCH IN AGRICULTURE ANNUAL REPORT FY-89



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

Agency for International Development

ANNUAL PROGRESS REPORT

Fiscal Year 1989

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**U.S. Department of Agriculture
Animal and Plant Health Inspection Service/Science and Technology
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Unpublished Report

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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

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.

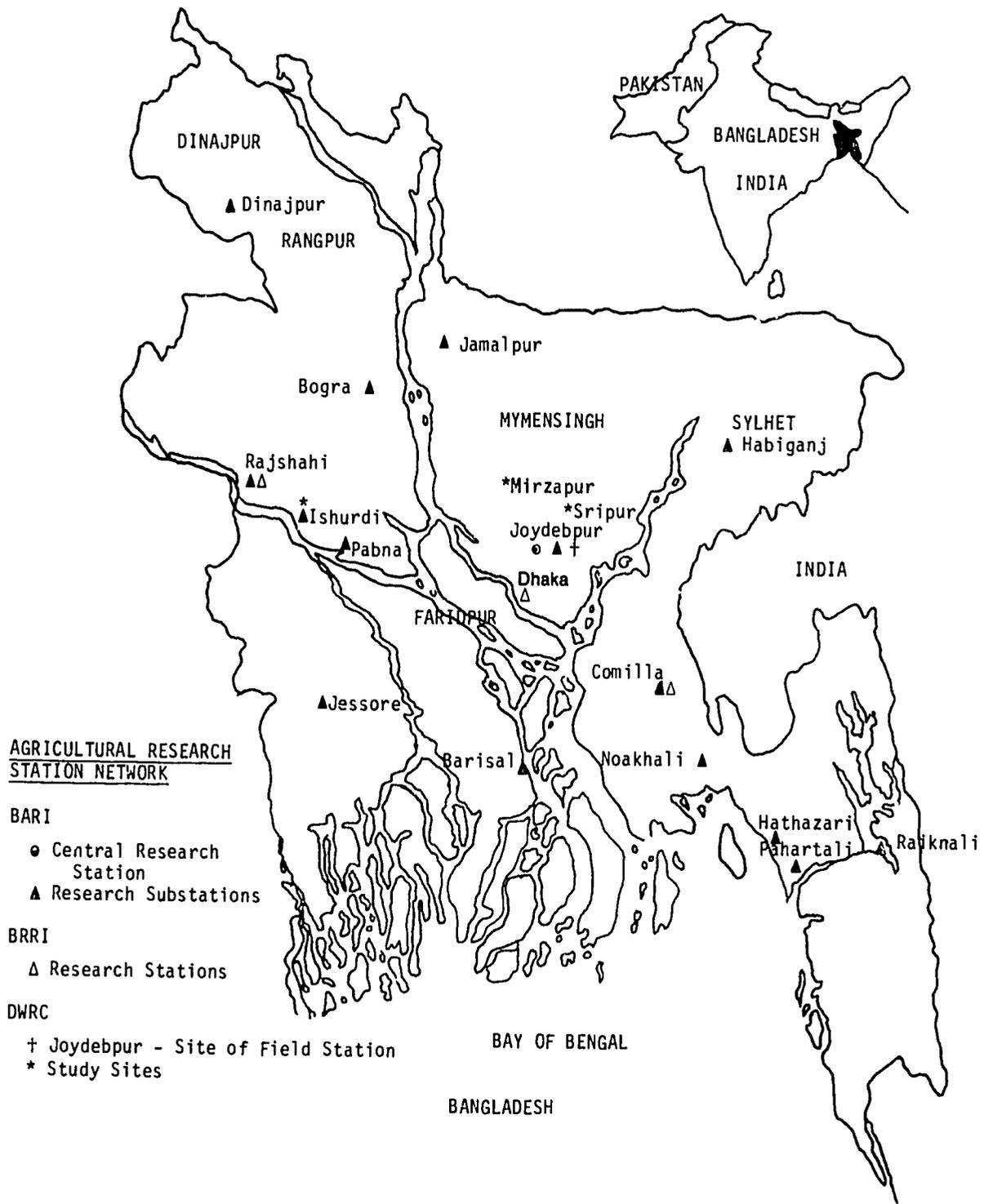
The DWRC-based staff (1) coordinate overall programs, (2) respond to USAID mission requests for problem definition studies and management research, (3) represent the program to other organizations, (4) coordinate DWRC-based training for USAID-funded participants, (5) brief visitors, (6) develop cooperative 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,¹ 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 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.

¹ 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 December 1978. A Vertebrate Pest Section (VPS) was 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 VPS, purchasing commodities, developing the laboratory, and implementing research activities. A combination laboratory-office building 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 VPS is developing practical control techniques and strategies, and staff are working with extension personnel throughout the country to implement these strategies. DWRC/IPRS involvement in vertebrate pest research and management activities is funded into June 1993. The present project leader, Dr. Michael Jaeger, arrived in October 1986, succeeding Mr. Joe Brooks (1981-1985) and Mr. Richard Poché (December 1978-1980). Dr. Jaeger will leave in October 1990, and the project will then be maintained on a TDY basis out of the DWRC, Denver, Colorado.

Objectives

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.

Accomplishments During FY-89

Research followed the schedule of the project work plan developed in 1986. Focus was on the principal problem--preharvest damage to rice and wheat by burrowing rats. During FY-89 efforts were directed toward defining the problem, determining appropriate and environmentally responsible control methods, determining the most cost effective seasonal strategy for control, and implementing this technology.

Rodent Populations and Crop Patterns

A 15-month study was completed which described rodent populations at two 4,800-ha study sites. The study sites represented the transplanted aman rice agroecosystem and the broadcast, deepwater aman (July-October) 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. A model was developed to help determine 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.

Rodent Control Methods

At present the only rodenticide generally available to Bangladeshi farmers is unformulated zinc phosphide. Farmers have been reluctant to purchase the product because of the lack of success that they have had with it. This has been presumed to be due to their lack of understanding on how to formulate it and the generally poor quality of the zinc phosphide available in markets. To evaluate the quality of the locally marketed product, five packets of each of 21 different brands were purchased from several different areas including Dhaka, Comilla, Tangail, and Joydebpur and sent to DWRC for assay by the Analytical Chemistry Section. Twenty of 21 brands had purity less than the standard 80%, and 15 of these were less than 40%. Several had no detectable amounts of the active ingredient. These results suggest that this product is frequently adulterated or possibly contains no active ingredient at all.

Alternative rodenticides (aluminum phosphide and brodifacoum) were tested and showed promising results. Both have subsequently been registered for use in Bangladesh. Fumigating rat burrow systems with aluminum phosphide tablets (Phostoxin®) resulted in cost effective control in trials on 4,800-ha study sites conducted in both the 1988-89 aman rice and 1989 wheat seasons. The anticoagulant rodenticide, brodifacoum (Klerat®, provided by ICI Agrochemicals, United Kingdom) was tested in active rat burrow systems ($n = 130$) at Bagzam, Tangail, during August and September 1989. These burrow systems were in and around farmers' houses. Use of either one or two 5-g wax blocks/burrow was equally effective, and both were more effective than no treatment ($P < 0.005$). In addition, tests using *Bandicota bengalensis* in outdoor enclosures at the VPS Laboratory at Joydebpur showed that rats would

eat the baits near rice panicles upon which they had been feeding and that rats would die within their burrow systems. These results show that treating burrow systems by placing either the bait or the fumigant inside the burrow opening and sealing it off--as opposed to using surface baits outside of burrows--can minimize the dosage per treatment, reduce the number of treatments to one, and minimize both the primary and secondary hazards to nontarget wildlife.

Seasonal Strategy for Rodent Control

A large-scale field study (4,800 ha) was undertaken between May 1988 and December 1989 to determine which of two seasonal strategies of rat control is more effective in deepwater rice growing areas: burrow treatment at peak flood (July-August), when rats are the most concentrated (high ground), or as the flood is receding (September-October) and as the population of burrowing rats is beginning its main annual increase. Prior research (1986-88) had shown that preharvest rat damage is greatest in aman rice (November-December) and becomes progressively lower in wheat (February-March), boro rice (April-May), and aus rice (July-August) coincident with a dry season decline in burrow density. Modeling suggested that control could be most cost effective if done prior to flowering of the aman crop. The peak flood treatment was done in early August, but was followed in early September by unusually late, severe flooding, which destroyed the rice crop throughout the study area. This late flooding also reduced the density of rat burrows by 56% of the early August level, and burrow density remained low through the subsequent wheat and boro rice seasons. The recession flood treatment experiment was moved to an alternative site where the flooding had been less severe. This resulted in lowering burrow densities to near zero at harvest in the treated areas compared to a threefold increase in the controls. Results of this study suggested that treatment should not be undertaken until after the peak flood and treatment following flood recession in September-October can be very cost effective and can have a carryover effect to the subsequent wheat and rice seasons.

To support these field observations, studies were initiated in the newly modified enclosures at the VPS Laboratory, 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.

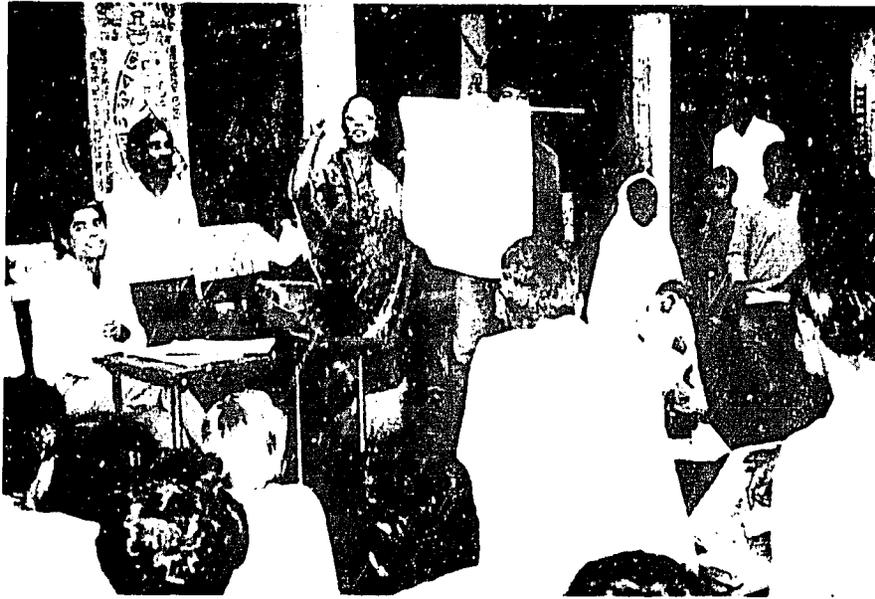
Implementation of a Rodent Control Strategy

Farmer acceptance of the methods and seasonal strategy for preharvest rat control was tested between August and November 1989 during the aman season. Preparations for and initiation of this study were begun in early 1989 and included arranging for the use of PL-480 Title III funds through the Bangladesh Agricultural Research Council (BARC) and establishing contacts with the MOA's Department of Agriculture Extension and local government authorities. The study was conducted in 4,800-ha sites at Comilla and at Ishurdi.

The principal objective of this study was to determine whether farmers would effectively use the technology if provided with good quality rodenticides and instructions. Efforts were made to eliminate confounding variables such as quality and availability of the rodenticides and the training level of the local extension service. Arrangements were also made for Bangladeshi consultants to determine whether economic or social constraints were likely to affect farmer participation. Data from this evaluation are currently being analyzed.



One aspect of this large-scale rodent control demonstration was to compare the efficacy and cost effectiveness of baiting with zinc phosphide bait cakes and fumigating with Phostoxin® tablets in bandicoot burrow systems in rice.



An important aspect of the large-scale rodent control demonstration was instructing farmers in the proper use of the control techniques.

Jackal Predation

Research began in 1988 to develop a large-scale and long-term study to better understand the impact of predators, primarily jackals, on the major rodent pest species, and to compare the agricultural damage caused by both rodents and jackals. Work has concentrated on mapping the study site, developing a technique to census jackals, and determining the average weight in rats a jackal might reasonably consume per day. This predator research program was continued in FY-89, but with the principal aim of determining the benefits of jackals and jungle cats to rodent control relative to the damage they cause to poultry and livestock. Some evidence suggests that these predators can be an important biological control agent for burrowing rats in Bangladesh and, therefore, should be managed responsibly.

A 25-km² study area was established near Sripur for a long-term study of the impact of predators, principally jackals, on agriculture in Bangladesh. A technique to census jackals was evaluated using taped jackal calls played through a speaker system mounted on top of a vehicle. An effort was made to distinguish the number of different jackals responding. Tests were conducted 1 night a week over a 3-month period from April through June. Calls were broadcast from within 9-12 randomly selected 1-km² blocks during the night between 2100 and 0600 hours. Two types of responses were found: vocalizing and/or approaching the vehicle within the range of a high-powered search light. Results showed that jackal responses were greatest between midnight and 0300 hours. Preliminary results suggest that the maximum distance from which a response could be heard was 500 m and that, therefore, the maximum area sampled during each trial was 0.78 km². Based on this, the average number of jackals responding/km² during the 40 trials from midnight to 0300 hours was 2.5 animals. This censusing technique looks promising and worth further testing.

The consumption of rats by caged jackals is being studied to determine the number of rats eaten by a jackal in a day, and the time and number of jackal scats in which a single rat will be passed. This information is necessary for modeling the impact of jackals on both rats and poultry. Preliminary findings are that caged animals consume an average of roughly 500 g/day or the equivalent of two *R. bengalensis*. An average of a single scat was voided per day, and a rat would be passed in a single scat the day after consumption.

Training and Future Research

A 1-day workshop was convened by the Bangladesh Agricultural Research Council to review the current status of vertebrate pest research in Bangladesh. Presentations were made by the VPS professional staff and the DWRC project adviser who, in addition, edited the proceedings. One outcome of this meeting was the formation of a national committee, which includes the DWRC project adviser and a VPS representative, to recommend vertebrate pest research needs.

During June and July, an external review team including Dr. William Jackson, Professor Emeritus from Bowling Green State University, Bowling Green, Ohio, and Dr. Paul Marko, Associate in Rural Development, Burlington, Vermont, visited the DWRC and also the Bangladesh field station to evaluate the project activities. The external review team recognized the many achievements of the

project and gave the following principal recommendations: (1) DWRC technical assistance should continue until June 1993 through a series of short-term TDY's, (2) the VPS should be established as its own Division within BARI, and (3) the DAE should look into all aspects of assuring the quality of the zinc phosphide that is being sold in markets.

Project scientists participated in a variety of training opportunities. Mr. Yousuf Mian began his Ph.D. program at Colorado State University (CSU); his training will emphasize statistics, modeling, and computer use in describing and evaluating vertebrate pest problems. Mr. Mian also completed the 2nd International Short Course in Vertebrate Pest Problems and Solutions in Developing Countries at CSU between August 14 and 27, 1989. Mr. Santosh Sarkar, DAE, continued his Ph.D. research (Dhaka University) under the direction of the DWRC project leader. Mr. Sayed Ahmed, BRRRI, continued his Ph.D. research in vertebrate pest management at CSU. Dr. Parvin Sultana, Mr. Emdadul Haque, and Mr. Rajat Pandit received basic instruction in DOS and word processing from Beximco Computers in Dhaka.

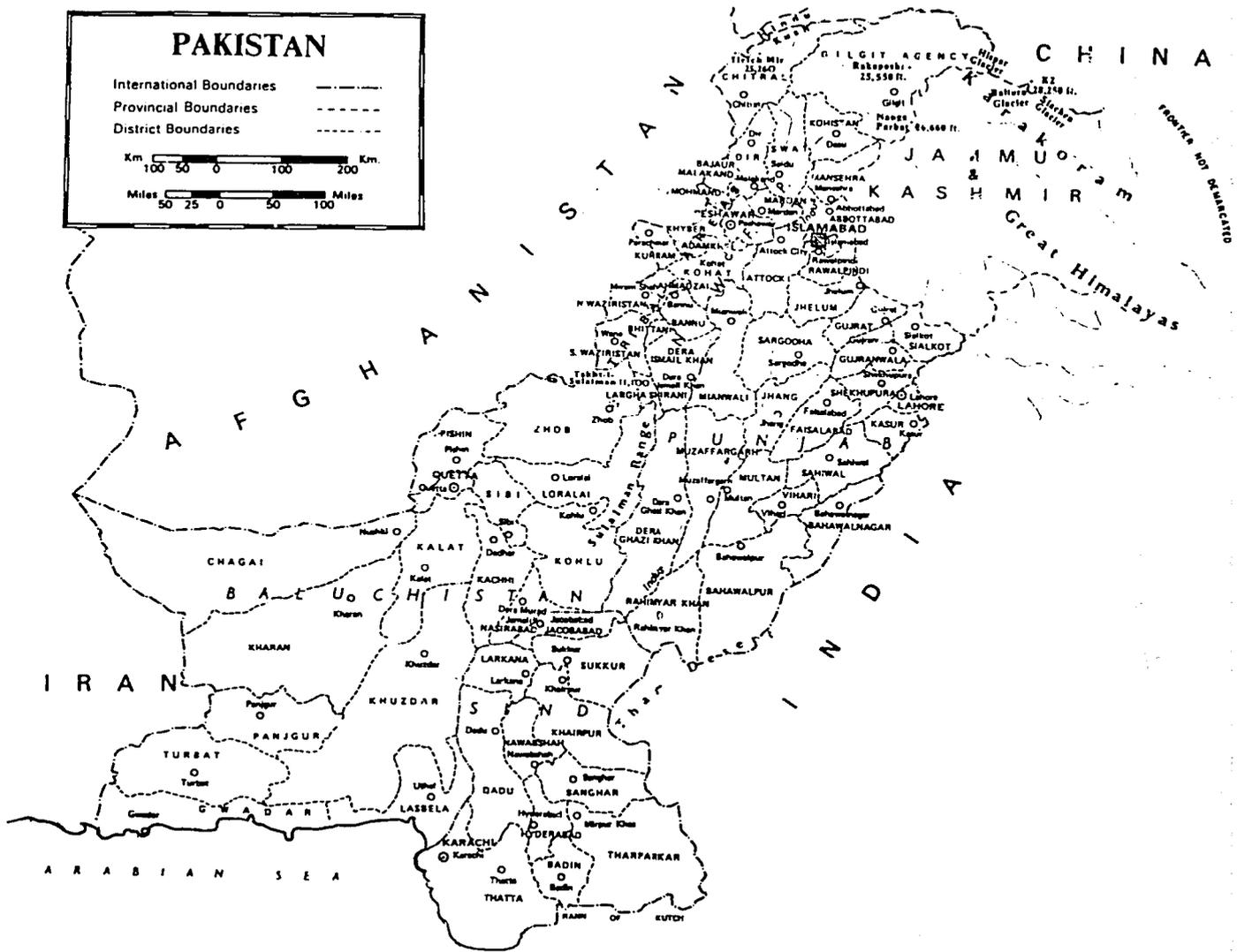
Mr. Pandit successfully completed a 6-week predator pest research consultation with DWRC. Mr. Pandit spent the period of July 31 to August 12 at the DWRC Predator Control Research Section field station in Logan, Utah, where he worked with Dr. Frederick Knowlton, project leader. From August 14 to 27, Mr. Pandit attended the 2nd International Short Course at CSU. Between August 28 and September 8, Mr. Pandit worked at the DWRC headquarters in Denver where he was involved in a variety of predator-related activities including making sonograms of jackal calls, collecting over 200 predator publications, setting traps and snares at a Colorado ranch where sheep were being killed, discussing research proposals, and acquiring experience using a bibliographic reference computer program, Procite.

Dr. Parvin Sultana and Project Leader Michael Jaeger also lectured in the Farming Systems Training Course given by CHECCHI.

PAKISTAN

International Boundaries - - - - -
 Provincial Boundaries - · - · -
 District Boundaries - - - - -

Km 100 50 0 100 200 Km.
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PAKISTAN

Introduction

The Pakistan project was initiated in late 1985 under a USAID mission-sponsored agreement with USDA/DWRC. The DWRC has provided an in-country project leader to direct efforts to increase human food supplies, determine whether there is a problem of vertebrate losses of stored grains, develop indigenous capabilities of meeting vertebrate pest problems using integrated pest management methods, and institutionalize in-country research programs. Scientists and facilities of the DWRC provide support for the vertebrate pest control efforts in Pakistan on a reimbursement basis. Funding support for this project currently ends in June 1991. The project leader, Mr. Joe Brooks, is scheduled to return to DWRC in June 1990. Current plans are for DWRC to provide technical assistance and back-stopping support to the project from July 1, 1990, until June 30, 1991, through TDY visits.

Objectives

1. Increase the available food supply.
2. Appraise the nature and magnitude of stored grain losses and agricultural losses caused by vertebrate pests.
3. Develop integrated control programs for important vertebrate pest problems in agriculture and grain storage facilities.
4. Coordinate activities with other international organizations to maximize results.
5. Develop indigenous capabilities.
6. Institutionalize in-country research and control programs.

Accomplishments During FY-89

A large-scale control demonstration of rodent control in wheat and rice was initiated in January 1989. It will be conducted through at least three crop cycles or until May 1990. Readymade rodenticidal baits were made available to farmers at a nominal cost. A multimedia awareness and motivational campaign for farmers, employing posters, handbills, video cassettes, personal contact, and farmers' training sessions, was held during the first wheat season. Wheat damage by April 1989 was minimal (0.6%); consequently, very few farmers implemented rodent control. By May 1989, just at harvest, damage had increased to 3.3%, due to an influx of rats from harvested sugarcane fields.

A post-season evaluation of the multimedia awareness and motivational campaign disclosed that one-third of the farmers were aware of the readymade baits and, of these, 65% had learned of them through the posters. The rest learned of the readymade baits through handbills, personal contact, or while at the Crop

Maximization Program (CMP) workshop or the Union Council office. Eleven (10%) of the farmers had used readymade baits, and 90% reported they were effective. More baits would have been used had the rodent damage to wheat been more severe.

New posters and handbills were prepared in August for the rice season control demonstration. A video tape on rodent control in rice was made and shown to farmers throughout the control demonstration area. Again, however, rodent damage was slight, averaging only 0.3% of cut tillers in late September, only 4 weeks before harvest. This was attributed to heavy rains in late July which flooded the entire area for more than a week, probably killing many rats in the fields.

Wild Boar Biology and Control

A cooperative research study on the biology and control of wild boar in agricultural areas was undertaken with the University of Agriculture, Faisalabad. The objectives of the study are to describe the biology and behavior of wild boar and to develop simple, safe, effective, and inexpensive methods of reducing their damage to crops. During the period March 1987 to September 1989, a total of 406 wild boar was collected.

Animals were aged by tooth eruption patterns and wear on the third molar. Separating the sample into age groups revealed that half were 12 months or less, one-quarter were 12-24 months old, and the remainder were 3-6 years old. It appears there is fairly rapid annual population turnover.

Wild boar were found to breed mainly in the months of December to March, with the majority of young born between April and August. In both 1988 and 1989, only a few pregnant animals were seen during August and September.

Males and females were found to be sexually mature at 7 months, and young-of-the-year females made a significant contribution (7 out of 30 pregnancies) to the breeding effort in 1988. In 1989, only 2 out of 19 pregnancies were attributable to young-of-the-year females. Litter size for all females averaged 5.8 ± 2.3 , but was greater for older females (>24 months = 6.6 ± 2.2) compared with younger females (<24 months = 4.8 ± 2.2).

Males grew to significantly longer body lengths and heavier body weights than did females. The heaviest male weighed 135 kg; the heaviest female, 85 kg. Females predominated in the collection, 226 to 180, a 1:0.8 sex ratio.

The critical period for wild boar survival in the cropland areas appears to be May through July, after wheat is harvested but before maize, sorghum, and sugarcane are tall enough to provide food and cover. At this time, the wild boar usually retreat to dense growths of marshy grasses or mesquite/acacia thickets. However, from a management strategy, it may be more appropriate to reduce their numbers during the major breeding season, i.e., during December through March. Field evaluations of candidate toxicants, baits, and bait delivery systems are being carried out with this strategy in mind.



In 1 night, wild boars can destroy crops such as maize and thereby cause devastating losses to the small farmer.

Preliminary field trials to evaluate the effectiveness of anticoagulant baits for controlling wild boar were completed in April 1989. Wild boar had been causing heavy damage to wheat fields in the Punjab Barani Livestock Research Institute near Fateh Jhang. Anticoagulants, mixed with sugar in wheat dough balls, seemed to be very well accepted by boars. However, trials to use hog feeders as a delivery mechanism that would permit only hogs to remove baits were unsuccessful. While these hog feeders effectively excluded jackals and porcupines, wild boar would not use them in the Fateh Jhang area. In subsequent work near Faisalabad, wild boar did use the hog feeders after 6 nights and continued to feed from them for another 4 weeks. Innovative baiting methods will be needed if wild boar control is eventually deemed necessary.

Institutionalization of Vertebrate Pest Management In-Country

Vertebrate Pest Management (VPM) was included in the National Agricultural Research Centre (NARC) Research Master Plan, which will soon be formally accepted and printed. This is a main step toward institutionalization of a vertebrate pest research and management activity in Pakistan.

A VPM Subunit of the Pest Management Research Institute (PMRI), Karachi, was established at NARC in July 1989. Mr. A. Aziz Khan, principal scientific officer, was transferred to NARC along with four other staff members. This is another step forward in institutionalization of VPM at NARC and in Pakistan.

Cooperative Research with Universities

Long-term studies in the reproductive ecology and food habits of lesser bandicoot rats (*Bandicota bengalensis*) on the NARC campus are continuing. During the past 12-month period, 290 rats have been analyzed for reproductive biology, food habits, and hormone assays. The most unexpected results have been related to the breeding periods, with pregnant females being found only during July-August 1988 and April-May 1989. The apparent lack of breeding activity during the other 8 months is still unexplained.

Food habits were analyzed from the stomach samples taken from 96 rats during the year. Most rats were trapped from wheat fields and fallow wheat fields following harvest. A few were trapped in groundnut, rice fields, and grassy areas. Three foods predominated in the monthly samples: (1) the leaves, stems, panicles, and grains of wheat; (2) seeds, flowers, and rhizomes of *Desmostachya bipinnata* and (3) *Cynodon dactylon*. Wheat consumption started in November and continued through August. There was an inverse relationship between the consumption of wheat and *Desmostachya* during the months of November to March. By April, wheat constituted more than 95% of the dietary intake. This continued through June. *Desmostachya* was seen in the stomachs during 9 of the 12 months; *Cynodon* occurred in 5 months beginning in July, peaking in August, and finished by November. Groundnut and rice appeared in September and October. Minor dietary items were *Cyperus rotundus* (1.2%), *Convolvulus* sp. (0.4%) and insects (0.2%). This work is being conducted by Mr. Iftikhar Hussain in partial fulfillment of a M.Phil. degree at Quaid-i-Azam University.

Several students initiated and/or completed several studies of vertebrate pest problems under a cooperative research agreement between the Vertebrate Pest Control Project (VPCP) and the University of Agriculture, Faisalabad. Dr. Mirza Beg coordinated this research, which included the following work:

- Akhtar, Mumtaz. 1989. Seasonal and age specific variations in body weight and cranial measurements of Indian gerbille (*Tatera indica*). M.Phil. Thesis, University of Agriculture, Faisalabad. 86 pp.
- Ambreen, Zahida. 1989. Studies on body weight, reproduction and age structure of *Mus musculus* from central Punjab. M.Sc. Thesis, University of Agriculture, Faisalabad.
- Arshad, Rubina. 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, University of Agriculture, Faisalabad. 132 pp.
- Aslam, Muhammad. 1989. Seasonal changes in body weight, age structure and reproductivity in *Rattus meltda*. M.Sc. Thesis, University of Agriculture, Faisalabad. 63 pp.
- Inam, Muhammad. 1988. Foraging and feed behaviour of rose-ringed parakeet in field crops and orchards. M.Sc. Thesis, University of Agriculture, Faisalabad. 69 pp.

- Kayani, Amjad Rashid. 1988. Abundance and distribution of porcupine burrows in irrigated forest plantations. M.Sc. Thesis, University of Agriculture, Faisalabad. 66 pp. and appendix.
- Khan, Hammad Ahmad. 1989. Movement patterns and seasonal changes in abundance of *Mus musculus* in canal irrigated farmlands. M.Sc. Thesis, University of Agriculture, Faisalabad. 98 pp.
- Khan, Muzaffar. 1988. Distribution of porcupine dens in embankments and croplands of central Punjab. M.Sc. Thesis, University of Agriculture, Faisalabad. 90 pp. and appendix.
- Maqbool, Mohammad. 1989. The studies on population dynamics and reproduction of rat and mice in a wheat-rice-fodder agroecosystem. M.Phil. Thesis, University of Agriculture, Faisalabad.
- Mukhtar, Muhammad Khalid. 1989. Movement patterns and seasonal changes in the abundance of *Millardia melitana* in the canal irrigated farmlands of central Punjab. M.Sc. Thesis, University of Agriculture, Faisalabad. 93 pp.
- Mustafa, Samina. 1989. Studies on body weight, reproduction and age structure of Indian gerbille (*Tatera indica*) from central Punjab. M.Sc. Thesis in Zoology, University of Agriculture, Faisalabad.
- Nighat, Rukhsana. 1989. Seasonal and age specific morphologic and reproductive changes in house rat (*Rattus rattus*). M.Phil Thesis, University of Agriculture, Faisalabad. 102 pp.
- Rana, Naureen. 1989. Studies on changes in body weight, age structure and reproduction in a cropland population of *Bandicota bengalensis*. M.Sc. Thesis. University of Agriculture, Faisalabad. 71 pp.
- 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, University of Agriculture, Faisalabad. 103 pp.
- Siddique, Muhammad. 1989. Seasonal changes in the abundance of *Bandicota bengalensis* in an irrigated cropland. M.Sc. Thesis, University of Agriculture, Faisalabad. 89 pp.

Mr. Lynwood Fiedler, IPRS, DWRC, visited the project between October 14 and November 8, 1988, to assist project staff in implementing project activities for the remainder of the current project (until June 1991), testing a method to evaluate rodent damage to groundnut, and evaluating training materials and subject matter for the master's training agenda.

Dr. George Matschke, wildlife biologist, Mammal Control Research Section, DWRC, was in Pakistan from February 3 to March 6, 1989, to assist the project

staff in developing methods of trapping and netting wild boar for eventual use in radiotelemetry studies, evaluating current wild boar research, developing future research plans, and establishing a piggery in which to study the growth and behavior of wild boar. The piggery was established in April and contains an observation blind from which boars can be photographed.

Dr. Richard Bruggers, Chief, IPRS, and Ms. Linda Raver, USDA/Office of International Cooperation and Development (OICD), Washington, were in Pakistan from April 8 to 14 to assist the project leader in preparing a Concepts Paper and budgets for a follow-on technical assistance project.

Training and Extension

The VPCP is cooperating with the Kansas State University Storage Technology Development and Transfer (STDT) Project in giving master's training and operational staff training to Pakistan Agricultural Storage and Services Corporation (PASSCO) and Provincial Food Department personnel. The STDT Project has prepared a training manual in both English and Urdu. A part of this manual incorporates the vertebrate pest control (VPC) material previously prepared. The revised VPC reference manual and the Urdu language version of the grain storage handbook have been printed, and 500 copies of the handbook and 100 copies of the reference manual have been supplied to the STDT Project.

In-service training was provided to an FAO trainee (Mr. Oluca James from Uganda) in April and May and involved 28 man-days. Mr. James assisted in fieldwork at Gujrat in wheat surveys and was given training in a variety of other VPM techniques.

At the request of Ch. Wilayat, Assistant Director, Barani Agricultural Research and Development (BARD) Project, based at NARC, training in methods of rodent control in wheat was given at Daultala on February 8, 1989, to approximately 71 farmers. Readymade baits were made available to the farmers of the area at cost.

During FY-89, the project staff received training in "M-STAT," "Lotus 1-2-3," "The use of photogray in agricultural research," "The use of videography in agricultural research," "Research management," and "Integrated pest management in grain storage."

A 2-week training course in VPM was presented to 14 participants (including three FAO-sponsored participants--two from Syria and one from Uganda). The training course was held at the NARC Training Institute from March 18 to 30, 1989. Practical demonstrations in both lecture sessions and the field were emphasized. (The individuals from Syria and Uganda stayed on with the project for an additional 3 weeks for in-service training.)

The project staff also provided training in many aspects of VPM to over 480 individuals including farmers, high school students, agricultural officers, and extension officers on 16 different occasions. In addition, training and training materials, including reference manuals, slide sets, video cassettes,

and posters related to grain storage management, were provided to master trainers at the STDT Project training center. Since completion of their training in January 1989, these master trainers have provided similar training to 396 other participants.

Mr. Brooks presented three lectures at the FAO/Pakistan Agricultural Research Council (PARC) master's training in "Integrated Pest Management in Grain Storage" to 22 participants on May 31. These lectures were on "Biology and ecology of rodents in grain storage," "Pest birds in grain stores," and "Chemical control of vertebrate pests." A control demonstration on vertebrate pests was presented with the assistance of Messrs. Ejaz Ahmad and Shahid Munir.

Mr. Brooks received an International Honor Award from USDA/OICD during FY-89 in recognition of his work in Pakistan.

Radio broadcasts from Lahore were given on control of wild bear and porcupine. Lectures and training were given to agricultural officers from the Faisalabad Plant Protection Institute.

On World Food Day, an exhibition was arranged by NARC from October 16 to 19, 1988. 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, students, etc.



Understanding concerns of Pakistani farmers is vital in the development of a National Vertebrate Pest Management Plan.



Up-to-date technical information on control of vertebrate pests is made available through displays and training sessions by the National Agricultural Research Centre and the U.S. Agency for International Development in Pakistan.

DENVER-BASED OUTREACH ACTIVITIES

Introduction

In 1967 a cooperative program was established between the Administrator, U.S. Agency for International Development (USAID), and the Secretary of the Interior delegating the 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, the DWRC was further transferred from APHIS/ADC to APHIS/Science and Technology. Funds are provided to DWRC by USAID missions, regional bureaus, and the USAID Bureau of Science and Technology to maintain a core group of international vertebrate pest specialists in the International Programs Research Section (IPRS) at the DWRC to implement the cooperative agreement. The program goal is to evaluate vertebrate pest situations in Asia, Latin America, and Africa and, when circumstances warrant, develop and implement environmentally acceptable methods to reduce vertebrate pest damage. International vertebrate pest management requires field visits, liaison, and ongoing interchange with pest control research and implementation organizations--both domestic and foreign. Goals are accomplished by in-country programs, TDY activities, supervisory and administrative functions from the DWRC, and problem-oriented research and training using expertise available at the DWRC.

Objectives

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 vertebrate pest management (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, such as the Food and Agriculture Organization (FAO) of the United Nations, World Bank, 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.

Accomplishments During FY-89

Outreach Consultancies

During FY-89, DWRC staff traveled to Asia, the Caribbean, Africa, and Europe at the request of USAID missions, USAID/Washington, FAO, 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 and nontarget wildlife of locust control sprays; and to participate in workshops and conferences. TDY activities from DWRC are an 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. Travel during FY-89 involved 340 person-days in the following countries:

Antigua/Barbuda	Dominica	Pakistan
Bangladesh	Grenada	St. Kitts/Nevis
Barbados	Italy	St. Lucia
Bhutan	Mauritania	St. Vincent/Grenadines
Chad	Morocco	Senegal

Travel dates, persons involved, countries visited, and the purpose of each trip are outlined briefly in Table 1. Detailed information is contained in individual trip reports on file at IPRS, DWRC.

Mr. Keith LaVoie, wildlife biologist, IPRS, worked in Bhutan from September 26 to October 26, 1988, on a consultancy for FAO, to evaluate the impact of rodents in grain storage facilities. 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 were consumed by rodents and an additional 10-20% were contaminated. It appeared that the rodent problem could be alleviated in some of these situations through proper structural modifications and maintenance. Training of Ministry of Agriculture (MOA) personnel in sanitation and control methods would also reduce losses and health hazards from rodents.

Mr. Edward Knittle, wildlife biologist, Chemical Development/Registration Section, and Dr. Richard Dolbeer, wildlife biologist, Bird Control Research Section, completed a 6-week consultancy (October 10 to November 24) requested

through the IPRS by USAID/Senegal as part of a team to monitor the general conditions under which pesticides were being stored, transported, handled, and applied during emergency locust control operations and to identify the impact of spraying locusts on nontarget wildlife in west Africa. These were DWRC's first consultancies to assess the impact of large-scale locust control operations on nontarget wildlife.

Mr. Lynwood Fiedler, wildlife biologist, IPRS, visited the Pakistan Vertebrate Pest Control Project (VPCP) between October 14 and November 8 to assist project staff in implementing project activities for the remainder of the current project (until June 1990), testing a method to evaluate rodent damage to groundnut, and evaluating training materials and subject matter for the master's training agenda.

Mr. Keith LaVoie traveled to Senegal and Mauritania between January 29 and February 21, 1989, to work with the MOA to gather data on chronic rodent infestation in crops in the Senegal River Valley. This activity involved identifying pest rodent species and quantifying damage. This was one of several consultancies planned for 1989 to Sahelian countries to better define the chronic rodent pest situation.

Dr. George Matschke, wildlife biologist, Mammal Control Research Section, traveled to Pakistan between February 3 and March 6 to assist the USAID/DWRC/VPCP in wild boar biology and control. Dr. Matschke assisted VPCP scientists and DWRC project leader, Mr. Joe Brooks, in designing a 4-year research proposal. In addition, he assisted in and demonstrated techniques of live-trapping, chemical immobilization, and radiotracking, and began evaluating potential chemical toxicants as control methods.

Mr. Lynwood Fiedler traveled to the eastern Caribbean from February 8 to March 2 in the last of four consultancies sponsored by FAO to assist several islands to implement rodent pest management to reduce food losses. The islands receiving this technical assistance include Barbados, St. Kitts, Antigua, Dominica, St. Lucia, St. Vincent, and Grenada.

Dr. Richard Bruggers, Chief, IPRS, traveled to Bangladesh and Pakistan from March 29 to April 15 to assist Dr. Michael Jaeger, project leader in Dhaka, Bangladesh, in preparing for an upcoming external review of the Vertebrate Pest Project and in planning the direction of activities for the remainder of the project. Dr. Bruggers also assisted the DWRC project leader in Pakistan in planning project activities through June 1990 and investigating the feasibility of various options for DWRC assistance to the Government of Pakistan (GOP) beyond June 1990.

Dr. James Keith, wildlife biologist, IPRS, consulted in Morocco from March 31 to April 9 at the request of USAID/Rabat to initiate a project to evaluate the direct (toxic) effects of locust control sprays of malathion and fenitrothion on the environment and nontarget wildlife. This project will involve cooperative studies with the Government of Morocco, the Peace Corps, and USAID. A proposal for FY-90 was developed which consists of three phases--training of Moroccan scientists, gathering of baseline data, and finally, the experimental application and evaluation of insecticides to study areas.

Table 1. International travel for technical assistance projects by USAID/DWRC personnel during FY-89.

Date	Name	Location	Purpose of trip
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.
Jan 29-Feb 21	G. K. LaVoie	Senegal and Mauritania	Assess rodent problems to agricultural areas in the Senegal River Valley in Senegal and Mauritania.
Feb 3-Mar 6	G. H. Matschke	Pakistan	Assist the cooperative vertebrate pest management program with wild boar control.
Feb 3-17	J. O. Keith	Senegal and Italy	Participate in USAID locust meeting and in planning for international cooperation on studies to determine environmental effects of locust control.
Feb 8-Mar 2	L. A. Fiedler	St. Kitts/Nevis, Antigua/Barbuda, Dominica, St. Lucia, St. Vincent/Grenadines, Grenada, and Barbados	Evaluate pilot rodent control demonstration projects initiated in August 1988 and plan recommended rodent control efforts for the next 5 years for each of these countries.

Table 1. Continued.

Date	Name	Location	Purpose of trip
Mar 29-Apr 15	R. L. Bruggers	Bangladesh and Pakistan	In Bangladesh, assist in developing and planning project activities and training needs and prepare for External Review of the USAID-funded VPM component of the Agricultural Research Project; and in Pakistan, assist in developing a Concepts Paper for project extension and exploring resource support options for project continuation.
Mar 31-Apr 9	J. O. Keith	Morocco	Plan for training in ecotoxicological methods and conduct research to evaluate environmental effects of organophosphate insecticides used in locust control.
Apr 23-May 12	L. A. Fiedler	Chad	Determine the logistic considerations and requirements for establishing a rodent control field station with a DWRC biologist working in Chad under USAID project funds.
Jun 27-Sep 3	J. O. Keith	Senegal	Conduct studies in Senegal of the impact on birds of the use of insecticides to control African migratory locusts.
Sep 11-Oct 13	J. O. Keith	Senegal	Complete studies in Senegal of the impact on birds of insecticides used to control African migratory locusts and grasshoppers.
Sep 21-Oct 24	L. A. Fiedler	Bangladesh	Assist the Vertebrate Pest Section in implementing a field research/demonstration project on preharvest rat control in rice.



Determination of rodent species and densities in Caribbean field crops, such as peanuts, requires training of crop protection personnel in trapping techniques and rodent identification.



Rodent control training in the Caribbean included the use of tracking tiles to measure efficacy of control as shown in this food storage facility on St. Vincent.



More effective methods for crop protection are available in the Sahelian Africa, but traditional tools such as the sling-shot are used in Senegal to protect crops from birds. Extension of new cost effective methods is needed.



Vegetable production in Mauritania is a family operation. Rodent damage to these small plots can often exceed 50% and result in a complete loss of cash income to farmers.

The necessary documents were finalized by USAID to establish a new USAID/DWRC field station in Chad, Africa. This field station will begin in FY-90 and will be involved in setting up a rodent population monitoring system, assessing acute and chronic rodent damage, evaluating and field testing bait delivery systems and providing the necessary training to Chadian scientists to eventually implement their own rodent management program. Mr. Lynwood Fiedler visited Chad from April 23 to May 12 to determine the logistic considerations and requirements for establishing this rodent field station. Discussions were held with personnel of AID/N'Djamena and Chad MOA regarding a number of points related to personal (housing, vehicle recreation, consumables, etc.) and work-related (office, vehicle, contract logistical support services, etc.) needs.

Dr. James Keith was in Senegal from June 27 to September 3 and again from September 11 to October 13 to conduct studies of the impact on birds of the use of insecticides to control African migratory locusts and grasshoppers. These studies were conducted cooperatively by FAO, France, the Netherlands, Senegal, the United Kingdom, and the United States. The study team included aquatic biologists, ecologists, terrestrial entomologists, ichthyologists, ornithologists, a pesticide application specialist, an expert in soil micro-organisms, and toxicologists. The extent of ecological and biological processes covered by the study team was extensive, and results should provide a good basic assessment of the kinds of environmental effects that result from applications of fenitrothion and chlorpyrifos.

Mr. Lynwood Fiedler was in Bangladesh from September 21 to October 24, 1989, to assist the Government of Bangladesh and the USAID/DWRC-supported Vertebrate Pest Section and DWRC project leader in implementing a large-scale pilot demonstration of rodent control in rice. This rodent control demonstration was conducted in two 48-km² sites and tested the field efficacy and farmer acceptance of two control techniques and a rodent management strategy.

Supportive Research Activities

In 1988 a DWRC consultancy supported by FAO enabled an evaluation of the environmental effects of fenthion used for quelea control in Kenya. The team organized to conduct this work consisted of two IPRS biologists, Analytical Chemistry Section chemists, the FAO quelea project leader in Nairobi, and Mr. John Ngondi, a senior pest control specialist in the Kenya MOA. The fieldwork was conducted in Kenya during August 1988. Fenthion residue analyses in samples were begun in 1989 and are continuing, and Mr. Ngondi worked at DWRC from March 13 to April 3, 1989, to begin preparation of a manuscript reporting results of the research.

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 with ingested baits such as bait novelty, preferences, and shyness.

The DWRC Analytical Chemistry Section completed an assay of over 100 samples of the rodenticide zinc phosphide, which was purchased from local markets in Bangladesh. Twenty of 21 samples were <80% pure, with 15 of 21 samples having

less than 40% a.i. These results may partially explain why farmers no longer purchase the material for rodent control in Bangladesh.

Participation in Meetings, Conferences, Seminars

Dr. James Keith attended the 1st Annual Conference for the Society for Ecological Restoration and Management in Oakland, California, between January 16 and 20, 1989. The purpose of the Society is to encourage the development of ecological restoration and management as a scientific discipline and a strategy for environmental conservation.

Messrs. Lynwood Fiedler and Keith LaVoie attended the 9th Great Plains Wildlife Damage Control Workshop in Fort Collins, Colorado, on April 19.

Dr. James Keith participated in the 1989 Desert Locust Grasshopper Workshop in Dakar, Senegal, between February 6 and 9. The workshop discussed the current locust situation in the Sudan/Sahelian countries, the country action plans for 1989, technical aspects of locust control, and environmental issues. Participants included representatives from the USAID missions, Office of Foreign Disaster Assistance, FAO, and international locust control experts. Following this meeting, Dr. Keith was at FAO headquarters, Rome, between February 13 and 17 to represent USAID at a Working Group Session to design an FAO/Dutch/British/American environmental assessment project. DWRC/IPRS involvement in the development of this multinational research effort was from the standpoint of trying to minimize the impact of chemical control operations (e.g., locusts and perhaps birds and rodents) on the environment and nontarget wildlife.



Bird counts on transects were used to evaluate effects of insecticides applied in Senegal for locust control.

Dr. Keith was invited to speak at Ohio State University on May 5 on "The history of DDT, its uses, and environmental effects." His talk was part of a seminar series on "Technology and the Environment" that was organized by Dr. Tony Peterle. Invited speakers from throughout the United States and Canada participated in these seminars to help inform students and the general public about the environmental limits that exist to the use of technology.

Training

IPRS continued collaboration with the Department of Wildlife and Fisheries of Colorado State University (CSU), Fort Collins, in international vertebrate pest management training. DWRC biologists continued to teach classes in the biennial VPM course during the fall semester. 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 *Bandicota bengalensis*, for use by Bangladesh farmers. Agreement was reached to permit Mr. Yousuf Mian, DWRC project counterpart at the Bangladesh Agricultural Research Institute, to formally apply for admittance into a Ph.D. program at CSU.

DWRC and CSU completed on August 25 their 2nd International Short Course in Vertebrate Pest Problems and Solutions in Developing Countries. Twelve individuals from the countries of Bangladesh, Guinea-Bissau, Indonesia, Japan, Malawi, Mexico, Philippines, and Uganda attended this 2-week course, which was organized by IPRS. About 50 individuals from the United States (including 30 DWRC staff members), Argentina, Australia, England, Hungary, and Uruguay presented information. Topics included basic field and laboratory research techniques; pre- and postharvest pest problem identification; field demonstrations of control techniques and crop protection methods; specialized marking, monitoring and surveillance techniques; library information attainment, exchange, and retrieval; computer applications and statistical considerations; and pest management strategies.

Mr. Rajat Pandit, scientific officer from the Vertebrate Pest Section, Bangladesh Agricultural Research Institute, Joydebpur, Bangladesh, successfully completed a 6-week predator pest research consultation with DWRC. Mr. Pandit spent the period of July 31 to August 12 at the DWRC Predator Control Research Section field station in Logan, Utah, where he worked with Dr. Frederick Knowlton. Between August 28 and September 8, Mr. Pandit worked at the DWRC headquarters in Denver where he was involved in a variety of predator-related activities including making sonograms of jackal calls, collecting over 200 predator publications, setting traps and snares at a Colorado ranch where sheep were being killed, discussing research proposals, and acquiring experience using a bibliographic reference computer program, Procite.

A week of training in computer use was provided to the Bangladesh project leader at DWRC in conjunction with his home leave. Programs were developed for establishing data sets on the project computer soon to be purchased, and graphics were reproduced by computer for use in project reports, seminars, and publications.

Visitors

Dr. David Bathrick, Chief, Office of Agriculture, Bureau of Science and Technology (S&T)/AID, visited DWRC in October 1988 for orientation on the DWRC research capabilities and to discuss continued involvement of IPRS in the AID/S&T Bureau mandates.

During the week of March 6, 1989, IPRS hosted an external review team comprised of Mr. Allen Hankins, USAID, Asia Bureau, and Dr. William Jackson, Bowling Green State University, Bowling Green, Ohio. The purpose of this review was to conduct a mid-term technical and performance evaluation of the implementation of the Vertebrate Pest Management Systems Participating Agency Service Agreement between USAID, S&T, USDA, and DWRC. The review team was extremely supportive of DWRC implementation of this AID-funded program.

On June 18 and 19, IPRS again hosted an external review team consisting of Drs. William Jackson and Paul Marko, Associate in Rural Development, Burlington, Vermont. The purpose of this review was to evaluate DWRC technical assistance and backstopping support to the USAID/DWRC vertebrate pest field station in Bangladesh. This second review team was also very positive about DWRC backstopping support to the Bangladesh project and to the entire project in general.



In 1989, an international team of scientists gathered in Senegal to study the effects of locust control in terrestrial and aquatic habitats.



Insect-trap data depicted changes in the availability of bird foods after applications of insecticides for locust control in Senegal.



Food habits and brain cholinesterase levels were monitored in birds to assess the impact of locust insecticides used in Senegal.

During Fiscal Year 1989, IPRS received and responded to 250 requests from 58 countries for information, training, and technical assistance. Reprints and reports totaling 2,376 were provided to scientists and pest control specialists worldwide (Table 2).

Table 2. Requests to DWRC for assistance during Fiscal Year 1989.

Type of request or activity	Total No.
Information on International Programs	26
Information or Literature on Research and Crop Protection Methods	82
Information on Graduate Schools in VPM	11
Materials/Photographs	55
Requests for DWRC Scientist TDY's	
- Project Development	21
- Workshops	3
- Symposia/Conferences	5
- Research, Technical Assistance	5
Requests of DWRC for	
- Funds	9
- Research Opportunity	11
- Training	14
- Hiring	8
No. International Visitors	30
No. Reprints Distributed	<u>2,376</u>
TOTAL	2,656

Originating countries:

Angola, Antigua/Barbuda, Argentina, Australia, Bangladesh, Barbados, Bhutan, Brazil, Burkina Faso, Burma, Canada, Chad, Chile, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Ethiopia, France, Gambia, Grenada, Guinea-Bissau, Hungary, India, Indonesia, Iraq, Israel, Japan, Kenya, Malawi, Malaysia, Mauritania, Mexico, Morocco, Netherlands, New Zealand, Nigeria, Pakistan, Panama, Philippines, Poland, St. Kitts/Nevis, St. Lucia, St. Vincent/Grenadines, Senegal, Singapore, Solomon Islands, Spain, Tunisia, Uganda, United Kingdom, United States of America, Uruguay, Venezuela, West Germany, Yugoslavia, and Zambia.



In Senegal, herdsman of the Poular tribe helped search for dead birds in savannas treated with insecticides for locust control.

PERSONNEL

International Programs Research Section¹

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)
Peter J. Johns*	Biological Technician
G. Keith LaVoie	Wildlife Biologist
Sandra L. Vana-Miller**	Biological Technician

* Mr. Johns began working with IPRS during August 1989.

** Ms. Vana-Miller left IPRS in May 1989.

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	Program Specialist
Christine Ann D'Souza***	Program Assistant
Liaqat Ali	Secretary/Program Assistant
Barbara Neilson	Secretary
Yousaf Khan	Driver
Raja Mohammad Nawaz	Driver
Abdul Aziz Khan****	Principal Scientific Officer
Iftikhar Hussain****	Scientific Officer
Shahid Munir****	Scientific Officer
Mohammad Afzal****	Scientific Assistant
Liaqat Ali****	Laboratory Attendant II
Mohammad Ilyas	Rodent Control Laborer
Gul Zaman Khan	Rodent Control Laborer

*** Ms. D'Souza left the project in May 1989.

**** GOP counterpart staff are assigned to NARC.

¹ Fully funded under a Participating Agency Service Agreement (PASA).

PUBLICATIONS

- Ahmad, E., I. Hussain, and J. E. Brooks. 1988. Vertebrate pest infestations in PASSCO grain storage centres. *Proc. Pak. Cong. Zool.* 8:269-277.
- Brooks, J. E. 1989. The Eurasian wild boar in Pakistan agriculture. *Econogram* 5(4):2,5.
- Brooks, J. E. 1986. Survey of public storage areas in four provinces completed. *The Econogram* 2(2):1.
- 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(4):438.
- Brooks, J. E., E. Ahmad, and I. Hussain. 1987. A newly-reported pest bird in Pakistan: the crested lark. *Pakistan J. Zool.* 19(4):437-438.
- 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.
- Brooks, J. E., E. Ahmad, I. Hussain, and M. H. Khan. 1989. The agricultural importance of the wild boar (*Sus scrofa* L.) in Pakistan. *Tropical Pest Management* 35(3):278-281.
- Bruggers, R. L., M. M. Jaeger, J. O. Keith, P. L. Hegdal, J. B. Bourassa, A. A. Latigo, and J. N. Gillis. 1989. Impact of fenthion on nontarget birds during quelea control in Kenya. *Wildl. Soc. Bull.* 17:149-160.
- Dolbeer, R. A., L. A. Fiedler, and H. Rasheed. 1988. Management of fruit bat and rat populations in the Maldiv Islands, Indian Ocean. *Proc. 13th Vertebr. Pest Conf., Monterey, California*, 13:112-118.
- Fiedler, L. A. 1988. Rodent pest problems and management in eastern Africa. *FAO Plant Prot. Bull.* 36(3):125-134.
- Jaeger, M. M. and R. L. Bruggers. 1989. Flocking and seasonal movements of *Quelea quelea* and *Agelaius phoeniceus* in relation to crop damage. *Agric. Zool. Rev.* 3:271-315.
- Mitchell, G. C., F. L. Powe, M. L. Seiler, and H. N. Mitchell. 1989. An annotated bibliography on rodent research in Latin America, 1960-1985. *FAO Plant Production and Protection Paper* 98, FAO, Rome. 363 pp.
- Soliman, S. 1988. Developing a tracking-edible gel/toxicant delivery system for control of *Rattus norvegicus* and *Mus musculus*. *Proc. Egypt. Acad. Sci.* 38:179-185.

INTERNATIONAL VISITORS

Date	Name	Representing
<u>1988</u>		
Sep 4-Dec 30	Ms. Ethel Rodriguez	Uruguay [Graduate student at Colorado State University, (CSU) Fort Collins, Colorado]
Oct 7	Mr. Alonso Aguirre	Mexico (Graduate student at CSU)
Nov 10	Ms. Elizabeth Aguilera- Garramuno Mr. Md. Sayed Ahmed Mr. Herbert Okurut-Akol Ms. Ethel Rodriguez Ms. Julieta Von Thungen Ms. Maria Elena Zaccagnini	Colombia Bangladesh Uganda Uruguay Argentina Argentina (Graduate students at CSU)
<u>1989</u>		
Jan 1-Sep 30	Mr. Md. Sayed Ahmed	Bangladesh Rice Research Institute, Joydebpur, Bangladesh
Feb 7	Mr. Herbert Okurut-Akol	Uganda (Graduate student at CSU)
Feb 17	Mr. Jess P. Sumangil	Crop Protection Division, Bureau of Plant Industry, Metro Manila, Philippines
Mar 13-Apr 3	Mr. John Ngondi	Ministry of Agriculture, Nairobi, Kenya (Student at Bowling Green State University)
Mar 23-24	Dr. Hugh Spencer	Cape Tribulation Field Study Centre, Queensland, Australia
Mar 23	Mr. & Mrs. Gerhard Redwanz	Somali-German, Bird Damage Prevention Project, Mogadishu/Somalia
Mar 31-Sep 30	Dr. & Mrs. John Wilson (and family)	Centre for Population Management, Queensland University of Technology, Brisbane, Australia

International Visitors (Continued)

Date	Name	Representing
May 9	Dr. Enriche Boucher	Argentina (Post-doctorate sabbatical at CSU)
	Ms. Maria Elena Zaccagnini	Argentina (Graduate student at CSU)
Jul 31-Sep 8	Mr. Rajat K. Pandit	Bangladesh Agricultural Research Institute (BARI), Joydebpur, Bangladesh
Aug 24	Dr. C.O.R. (Chris) Everard	Medical Research Council, Leptospira Laboratory, Barbados, West Indies
Aug 24-25	Mr. J. R. Ocen Ayer	Uganda
	Mr. Alfesene Balde	MDRA-DPV, Guinea-Bissau
	Dr. Chris Everard	Barbados, West Indies
	Dr. Masahiko Ishibashi	Japan
	Mr. Haxwell S. Jamusana	Malawi
	Mr. Md. Yousuf Mian	Bangladesh
	Dr. Paciencia P. Milan	Philippines
	Mr. Joseph Mugisa	Uganda
	Dr. Etelka Nikodemusz	Godollo University, Hungary
	Dr. Nagy Emil	Godollo University, Hungary
	Mr. Rajat K. Pandit	Bangladesh
	Mr. Alejandro Velasco Said	Bolivia and Mexico
	Mr. Leonard D. Sefu	Malawi
	Mr. Sudibyo	Indonesia
Dr. Beatriz Villa Cornejo	Mexico (Participants in 2nd International Short Course in Vertebrate Pest Problems and Solutions in Developing Countries)	
Aug 30	Ms. Elizabeth Aguilera-Garramuno	Colombia
	Ms. Ethel Rodriguez	Uruguay
	Ms. Maria Elena Zaccagnini	Argentina (Graduate students at CSU)

PARTICIPATION In MEETINGS, CONFERENCES, SEMINARS

Fiedler, L. A. and G. K. LaVoie. Attended the 9th Great Plains Wildlife Damage Control Workshop in Fort Collins, Colorado, April 19, 1989.

Keith, J. O. Attended the 1st Annual Conference for the Society for Ecological Restoration and Management in Oakland, California, January 16-20, 1989.

Keith, J. O. Participated in the Desert Locust Grasshopper Workshop in Dakar, Senegal, February 6-9, 1989; represented USAID at a Working Group Session to design an FAO/Dutch/British/American environmental assessment project, Rome, Italy, February 13-17, 1989.

Keith, J. O. Presentation at a seminar series on "Technology and the Environment" at Ohio State University, Columbus, Ohio, May 5, 1989.

SPECIAL REPORTS and BROCHURES

Technical Reports

- 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.
- Brooks, J. E., E. Ahmad, and I. Hussain. Reproductive biology and population structure of *Rattus rattus* in Rawalpindi, Pakistan. Technical Report No. 21. Vertebrate Pest Control Project, Food Security Management, Post-Harvest Management Component; Islamabad, Pakistan; July 1989. 18 pp.
- Brooks, J. E., E. Ahmad, I. Hussain, and S. Munir. Rodent control in wheat and rice: a large-scale control demonstration in Gujrat, Phase I. Technical Report No. 20. Vertebrate Pest Control Project, Food Security Management, Post-Harvest Management Component; Islamabad, Pakistan; June 1989. 12 pp.
- Brooks, J. E., M. H. Khan, E. Ahmad, I. Hussain, and S. Munir. Some preliminary observations on the biology of wild boar in Pakistan. Technical Report No. 19. Vertebrate Pest Control Project, Food Security Management, Post-Harvest Management Component; Islamabad, Pakistan; March 1989. 19 pp. and 3 appendices.

Information Brochures

- Hussain, I., J. E. Brooks, E. Ahmad, and S. Munir. Vertebrate pests of groundnut and their control. Information Brochure 6. Vertebrate Pest Control Project, Food Security Management, Post-Harvest Management Component; Islamabad, Pakistan; March 1989. 15 pp.

Trip Reports*

- Bruggers, R. L. 1989. Trip Report--Bangladesh and Pakistan. 10 pp.
- Dolbeer, R. A. 1988. Environmental assessment for U.S. Locust Control Program--Senegal. Trip Report--Senegal. 16 pp.
- Fiedler, L. A. 1989. Planning for the establishment of the proposed rodent control project in Chad. Trip Report--Chad. 9 pp. and 4 appendices.
- Fiedler, L. A. 1988. Project planning, groundnut rodent damage assessment, and wild boar research. Trip Report--Pakistan. 8 pp. and 2 appendices.

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

- Fiedler, L. A. 1989. Prevention of food losses through rodent control. Trip Report--Caribbean. 15 pp. and 2 appendices.
- Fiedler, L. A. 1989. Trip Report--Bangladesh. 4 pp.
- Keith, J. O. 1989. Environmental effects of insecticides used in locust control. Trip Report No. 1--Senegal. 4 pp. and 7 attachments.
- Keith, J. O. 1989. Environmental effects of insecticides used in locust control. Trip Report No. 2--Senegal. 3 pp. and 4 attachments.
- Keith, J. O. 1989. Locust/Grasshopper Management Workshop and planning meeting studies of locust insecticide effects on the environment. Trip Report--Senegal and Italy. 5 pp. and 4 attachments.
- Keith, J. O. 1989. Trip Report--Morocco. 4 pp. and 2 attachments.
- Knittle, C. E. 1988. Trip Report--Senegal. 4 pp. and 1 appendix.
- LaVoie, G. K. 1988. Trip Report--Bhutan. 14 pp. and 2 appendices.
- LaVoie, G. K. 1989. Trip Report--Senegal and Mauritania. 16 pp.
- Matschke, G. H. 1989. Project planning and wild boar research. Trip Report--Pakistan. 14 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, and S. Munir (compilers and editors). 1989 (Pre-publication copy). Training Manual on Vertebrate Pest Management, PARC, Islamabad, Pakistan. 239 pp.
- Keith, J. O. 1989. Research proposal--ecological effects of some insecticides used for locust control in Africa. Submitted to USAID/Africa Bureau for approval. 6 pp.
- Keith J. O. 1989. Research proposal--training, research and monitoring to evaluate the effects of locust insecticides on the environment. Submitted to USAID/Rabat in Morocco. 4 pp.
- LaVoie, G. K. 1988. Project document draft proposal for rodent control in Food Corporation of Bhutan storage facilities. Submitted to FAO, Rome. 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. 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. 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. Reference manual: vertebrate pest management in grain storage centres. A GOP/USAID/DWRC Project, National Agricultural Research Centre, Islamabad, Pakistan. 30 pp.
- Vertebrate Pest Research and Management in Pakistan. April 1989. Presented to the USAID's Management of Agricultural Research Technology (MART) Project as part of a request for a follow-on project for 1990 to 1994-96. A Concepts Paper.

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