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COMPLETION OF ASSIGNMENT REPORT

USAID VERTEBRATE PEST PROJECT

DHAKA, BANGLADESH

DRAFT

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USAID/ DHAKA, BANGLADESH

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I. INTRODUCTION

1. Project Background

In 1977 the Government of Bangladesh (BDG) recognized that vertebrate pests caused serious crop losses in the country but realized that it could not judge with any reliability the extent of losses nor evaluate the effectiveness of on-going control efforts. At the root of the problem in Bangladesh was an almost complete lack of research capability in the specialized field of vertebrate pest management. Without this capability, the BDG had no means to focus on the systematic description, assessment and management of vertebrate pest problems in major staple and high value cash crops. Consequently, current control recommendations were untested and perhaps were unsuited to the specific needs: pests, crops, field conditions and cultural practices of Bangladeshi farmers. Because of this, the Bangladesh Agricultural Research Council (BARC) requested the Rodent Research Center in the Philippines to examine the present status of rodent problems in Bangladesh and to make an assessment of the possibility of setting up a rodent research and control program for Bangladesh which would be aimed at reducing rodent damage to crops in the field and in storage.

The USAID/DWRC Project Leader from the Rodent Control Center, Philippines, Dr. Russell Reidinger, visited Bangladesh from 26 January to 25 February and conducted field surveys, contacted agriculturalists and prepared a report entitled "The Status of Vertebrate Pest Research and Control in Bangladesh and Recommendations." In his report, Dr. Reidinger pointed out that while the estimates of crop damage by farmers and agricultural workers were made without the benefit of damage assessment methods and little supporting data, they did indicate that damage and losses to food crops due to vertebrate pests in Bangladesh was perceived as a serious problem. Many farmers reported that in-field losses became more severe as they adopted more productive "techniques", such as irrigation, high-yield varieties, and fertilizers. Specific recommentations from Dr. Reidinger's report were:

1. Develop a vertebrate pest management research program at Bangladesh Agricultural Research Institute (BARI).

2. Provide formal overseas academic training of counterpart staff in vertebrate pest management (at least one PhD and two MSc).

3. Develop a capability to train scientists in vertebrate pest management at an existing academic agricultural institute.

4. Consider obtaining external assistance to plan and conduct vertebrate pest management research during the early years of the research program.

Best Available Document

5. Establish cooperative ties between this research program and those of other in-country research institutes.

6. Establish similar ties between this research program and the agricultural training and extension organization of the BDG.

In a subsequent visit to Bangladesh in July and August 1977 Dr. Reidinger prepared a detailed project document recommending the establishment of an on-going research capability in vertebrate pest research and management techniques suited to the needs of small farmers. A vertebrate pest research and management project was subsequently started at BARI, Joydebpur, with the assistance of the United States Agency for International Development (USAID). USAID contracted with the U. S. Fish and Wildlife Services Denver Wildlife Research Center (DWRC) for technical assistance and a DWRC Wildlife Biologist arrived in Bangladesh in November 1978 to initiate the project. The initial activities began under the Agricultural Research Grant Phase I and have continued into the Agricultural Research Grant Phase II since June 1981.

At almost the same time, the German Technical Assistance Program (GTZ) began a similar project under the Directorate of Agricultural Extension and Management. Through a formal agreement with BARI and the Ministry of Agriculture, this project was to take the lead in developing training and extension materials in vertebrate pest management while the Vertebrate Pest Project at BARI would provide research findings, lab and field evaluations of control methods, and recommendations of vertebrate pest management methods suited to Bangladesh agriculture. The two programs were to maintain close cooperative ties to prevent duplication of effort.

1.2. Objectives of the Project

The long-range aim of the project is to contribute towards food self-sufficiency in Bangladesh by reducing losses to food grains in field crops and in food stores caused by vertebrate pests. This was to be achieved by the establishment of a Vertebrate Pest Project at BARI, Joydebpur, which would carry out a research and management program upon which the BDG could base a rational vertebrate pest control policy. The specific goals of the project are to:

(a) establish an ongoing VPM research capability in Bangladesh,
(b) develop damage assessment methodologies and initiate national damage assessments,
(c) gain an understanding of the biology of vertebrate pest species,
(d) evaluate traditional pest management strategies,
(e) coordinate program activities with other organizations and institutions, and
(f) develop integrated pest control programs.

1.3 VERTEBRATE PEST PROBLEMS IN BANGLADESH

In order to grasp the significance of the vertebrate pest research and management methods to be outlined later, a brief overview of the major vertebrate pests and crops they damage in Bangladesh is presented. The vertebrate pests fall into three major groups:

1) Rodents (rats, mice, porcupines, squirrels)
2) Birds (mynas, parakeets, crows, weavers, munias, sparrows)
3) Carnivores (jackals, mongoose, civet cats, jungle cats)

There is a fourth group, the fruit-eating bats, about which little is yet known. Their status as pests has yet to be determined. They are known to damage some fruits (mango, guava, banana) but also may be pollinators of these and other fruits, so the damage they do must be weighed against the good they do. As yet, the Vertebrate Pest project has done no work on this group because they were assigned a low pest priority.

The rodents as a group are responsible for the most serious damage to food crops before harvest and to foods in storage. The most damaged cereal grain crop is wheat, which suffers between 2.5% and 12% damage each growing season; the extent of damage depending upon climatic factors such as rainfall during the growing season. The house-dwelling rodents, roof rats, house mice and bandicoot rats, are responsible for stored food losses that average about 50 kg per farm family per year. Porcupines damage root crops and invade pineapple gardens, eating the pineapple from early in the crop growth stages until ripening. The striped squirrel, occurring only on the western side of the country, is a pest of coconut and rice seed beds.

The pest birds are important in reducing yields in wheat because of the damage they do at the sprouting stage. Sprout losses of as much as 50% have been observed; this equates into a loss of yield of about 20% at harvest. Baya weavers are named by farmers as the most important pest of maturing rice. Parakeets and jungle crows can cause losses in maize and sunflowers of as much as 25% of the crop. Jungle crows attack maize not only at ripening stage but also at sprouting. Munias (small finch-like birds) and house sparrows attack millets and maturing rice seed heads.

Jackals are common all over the country. They are omnivorous in food habits; they scavenge from garbage piles and kill chickens. ducks and goats. They eat food crops when in season, such as sugarcane, maize, melons, pineapple and jackfruit. Second only to rodents in importance in Bangladesh agriculture, they may be difficult to control without endangering other small carnivores. The small Indian mongoose is also named by farmers as a killer of chickens, especially small chicks.

The major and minor vertebrate pests are given in summary form in the table below:

RODENTS

Major pests

Lesser bandicoot rat	*Bandicota bengalensis*	Wheat and rice fields Houses and godowns
Greater bandicoot rat	*B. indica*	Deepwater rice swampy areas
Roof or house rat	*Rattus rattus*	Houses, sugar-cane fields
House mouse	*Mus musculus*	Houses and godowns

Minor pests

Short-tailed mole rat	*Nesokia indica*	Root crops
Striped squirrel	*Funambulus pennanti*	Coconut, rice seed beds
Asiatic porcupine	*Hystrix hodgsoni*	Root crops, pineapple

BIRDS

Major pests

Common myna	*Acridotheres tristis*	Sprouting wheat
Pied myna	*Sturnus contra*	Sprouting wheat
Rose-ringed parakeet	*Psitticula krameri*	Maize, sunflower
Jungle crow	*Corvus macrorhynchos*	Maize, water-melon, sunflower
Baya weaver	*Ploceus philippinus*	Rice
House sparrow	*Passer domesticus*	Rice, wheat
Munias	*Lonchura* spp.	Millets

CARNIVORES

Major pests

Golden jackal	*Canis aureus*	Sugarcane, maize melons, goats, chickens
Small Indian mongoose	*Herpestes auropunctatus*	Chickens

Minor pests

Civet cat	*Viverra zibetha*	Chickens
Jungle cat	*Felis chaus*	Chickens

1.4 PROJECT IMPLEMENTATION

1.4.1 National Staff

After the arrival of the resident DWRC wildlife biologist in late November 1978, the Bangladesh counterpart scientist staff were recruited. The new staff members consisted of Mr. Md. Abdul Karim (MSc), Md. Emdadul Haque (BSc), Md. Yousuf Mian (BSc) and Mrs. Parvin Sultana (MSc). Mr. Karim was recruited to be the Head of the proposed Vertebrate Pest Division after he completed studies toward a PhD degree in the United States. Mr. Karim departed for his overseas training at Bowling Green State University, Bowling Green, Ohio on January 1979 and returned to the project on September 1983. Yousuf Mian went to the University of the Philippines, Los Banos on June 1980 and returned with an MSc degree on June 1982. Emdadul Haque also went to the UPLB in November 1980 and returned to the project on September 1982. Mrs. Parvin Sultana left for overseas training for a PhD degree at Colorado State University on March 1983 and returned with the degree on October 1985. One present staff member, Mr. Rajat Pandit will be departing for an MSc degree program at the University of the Philippines, Los Banos in late October 1985. All staff members who received advanced degree training overseas are presently with the project.

Md. Emdadul Haque enrolled in a PhD program at Dhaka University in November 1984 and is studying the biology, agricultural *importance and control of the short-tailed mole rat, Nesokia* indica in Bangladesh.

In addition to the scientific counterpart staff, BARI has assigned a clerk/typist, a laboratory attendant, a driver and a peon to the Vertebrate Pest Section.

1.4.2 International Staff

The first DWRC wildlife biologist on the project was Mr. Richard M. Poche', who arrived in Bangladesh in late November 1978 and opened up the project. Mr. Poche' left the project in December 1980 after sucessful completion of his two-year assignment. Mr. Joe E. Brooks was recruited by the DWRC to take the position of wildlife biologist and arrived on the project in May 1981 and served as resident biologist until his departure in October 1985.

1.4.3 Overseas Scholarships

Four overseas scholarships were completed during the period January 1979 to October 1985. Only one additional scholarship was provided for in the Agriculture Research Grant, Phase I and II and this will be utilized during the period November 1985 to April 1988. Members completing advanced degree training were:

Dr. Md. Abdul Karim, PhD at Bowling Green State Univ., Bowling Green, Ohio, USA, Jan. 1979-Sept. 1983

Dr. Parvin Sultana, PhD at Colorado State Univ., Ft. Collins, Colo., USA, Mar. 1983-Oct. 1985

Md. Yousuf Mian, MSc at the Univ. of the Philippines, Los Banos, June 1980 to June 1982

Md. Emdadul Haque, MSc at the Univ. of the Philippines, Los Banos, Nov. 1980 to Sept. 1982

1.4.4 Study tours and international conferences

1979:- Parvin Sultana attended a 2.5 month training program at the National Crop Protection Center, Los Banos, Philippines, in rodent ecology and control and designing a scheme for monitoring rat populations for anticoagulant resistance.

Mr. Richard M. Poche' attended an International Training Seminar on Vertebrate Pests in Santo Domingo, Dominican Republic, Nov. 21-30, 1979 and presented a paper, "The Vertebrate Pest Control Research Program in Bangladesh".

1982:- J. E. Brooks and Parvin Sultana presented a seminar, "Prevention of Vertbrate Pest Damage to Wheat in Bangladesh" at the BARC, Farmgate, Dhaka, 4 Aug., 1982.

J. E. Brooks attended the Third International Theriological Congress, Helsinki, Finland, 15-20 Aug., 1982 *and presented a paper "A Review of Damage by Bandicota* bengalensis to Wheat in Bangladesh and Methods of Control".

J. E. Brooks, "Prevention of Vertebrate Pest Damage to Wheat", presentation training lecture to Thana Extension Officers at the Workshop on Wheat Production Methods, CERDI, Joydebpur, Oct. 1982.

Parvin Sultana attended the 10th Vertebrate Pest Control Conference, Monterey, California, 23-25 Feb., 1982 and presented a paper, "Methods for Assessing Rat Damage to Growing Wheat in Bangladesh with Examples of Applications" at the 4th ASTM Symposium on Test Methods for Vertebrate Pest Control and Management Materials, Monterey, california, 26 Feb., 1982.

1983:- J. E. Brooks, "Physical and Chemical Methods of Control in Vertebrate Pest Management", presented to the faculty and students of the College of Chemistry, Dhaka University, 14 Nov., 1983.

M. A. Karim presented a paper, "Current status of Vertebrate Pest Management in Field Crops in Bangladesh" at the National Symposium on Agricultural Research, BARC, Farmgate, Dhaka, 22-23 Dewc., 1983.

M. Y. Mian, "Transferable Technology in Vertebrate Pest Management' presented at the training session on Transferable Technology at BARI, Joydebpur, 22 Dec. 1983.

1984:- M. Y. Mian attended the 11th Vertebrate Pest Control Conference at Sacramento, California, 6-8 Mar., 1984. He worked with scientists at the DWRC, Denver, Colo., 9-25 Mar. and reviewed work on postharvest losses of stored foods and the prevention of losses at Kansas State Univ., Manhattan, Kan., 26-28 Mar., 1984.

J. E. Brooks presented a seminar "Vertebrate Pest Problems in Bangladesh" at the Institute of Agriculture and Animal Sciences, Rampur, Nepal, 7 June 1984.

M. E. Haque, "Laboratory Methods in Vertebrate Pest Research", presented at the Crop Production and Extension Resources Management Specialist Training Course, CERDI, Joydebpur, 19 April 1984.

M. A. Karim, "Pest Birds of Bangladesh and Their Control", presented at the Crop Production and Extension Resources Management Specialist Training Course, CERDI, Joydebpur, 19 April 1984.

M. Y. Mian, "Rodents and Their Control in Bangladesh" presented at the Crop Production and Extension Resources Management Specialist Training Course, CERDI, Joydebpur, 19 April 1984.

II. PROJECT RESULTS

2.1 Organization of the Vertebrate Pest Project

The original project documents called for the Vertebrate Pest Project to be organized as a Division within BARI but, when the project was sanctioned by the BDG in 1980, it was formed as a Section within the Division of Entomology. The Section is directly responsible to the Director-General, BARI, through the Head, Entomology. Through the DG, BARI, the Section is responsible to the Member-Director (Crops), BARC and the Vice-Chairman, BARC. The Vertebrate Pest Section prepares an annual Work Plan for the BARC/Winrock program and is evaluated annually by the USAID/BARC internal and external evaluators. Reports are distributed to USAID/Dhaka, BARI, BRRI, BARC/Winrock, DWRC and USAID/Washington, and other interested agencies in Bangladesh.

2.2 Physical Facilities

The Vertebrate Pest Section consists of a laboratory/office structure with outdoor facilities situated on the Joydebpur campus of BARI, located approximately 30 km north of the city of Dhaka. The office/laboratory covers about 360 sq. meters and consists of an office for the clerk/typist, four offices for scientists, a large laboratory room, an animal room for caged rodents and birds, a photographic darkroom, a library room, toilets and a storage room. A 2-vehicle garage is attached. The entire facilities make this one of the best of the vertebrate pest research facilities in Asia.

2.2.1 Laboratory

The laboratory includes facilities for autopsy of animals, toxicological studies, microscopes for food habit analysis, animal cases for taxonomic specimens, and video capabilities for

remote observation of animals at night. The laboratory includes an Apple computer for word processing, statistical analysis, data base compilations and graphics. The animal room includes cages and cage racks for holding rodents for special studies and cages for birds. Duplicating equipment includes a photocopy machine and a mimeograph machine.

2.2.2 Outdoor Facilities

The outdoor facilities consist of a jackal house with 12 runs and nest boxes for the animals, an outdoor 11 by 22 m rodent enclosure and an aviary with 6 experimental rooms for birds. The entire outdoor area is fenced with a 6-foot high chain link fence topped with barb-wire.

2.2.3 Library

The library consists of about 100 volumes of reference books, about 1500 reprint publications on vertebrate pests and the accumulated technical reports and bi-monthly reports of the Section. The photocopier is located in the library for convenience and for security purposes the room is accessible only to the research scientists. The Section has approximately 2000 color slides and two slide projectors, one with cassette sound capabilities, used for trainig purposes.

2.3 RESEARCH HIGHLIGHTS

2.3.1 TOXICOLOGICAL STUDIES

2.3.1.1 Rodenticides

At the beginning of the project it was found that very little information was available on the effect of the common rodenticides on the rodent fauna that occurred in Bangladesh. This meant that basic toxicological studies had to be done on the common rodent pest species, namely *Bandicota bengalensis*, *B. indica*, *Rattus rattus*, and *Nesokia indica*. The facilities at the Vertebrate Pest Section laboratory proved to be ideal for this toxicity testing.

Toxicological studies have been completed on 3 acute toxic rodenticides and several other materials have been partially evaluated. The LD50 values of zinc phosphide, benzene sulfonic acid hydrazide (DRC-4575) and bromethalin were determined for both sexes of *Bandicota bengalensis*. These results indicated that this species is as susceptible to these poisons as is the common Norway rat of North America and Europe. The LD50 of zinc phosphide for the roof rat, *Rattus rattus*, was also determined.

Several anticoagulant rodenticides, which kill rodents slowly by their cumulative action, were evaluated on *B. bengalensis*. It was found that brodifacoum was the most toxic

of the 3 materials tested and that this poison killed this species in 4 to 8 days when animals fed only one day on it. The other anticoagulant of value was coumatetralyl (Racumin), which killed all rats when they fed on it for only 2 days. This material is presently registered in Bangladesh and is available. Diphacinone, the third material tested was found to be the least toxic of the three and was not tested further.

2.3.1.2 Bird repellents

Bird damage to food crops is quite often controlled by the use of chemical repellents which inhibit the birds from feeding on the crop but are not generally lethal to them. Since there was no information on the effective dose and optimum concentration of these materials for the pest bird species that are common in Bangladesh, these materials had to be evaluated under laboratory conditions before they could be taken into the field. Three chemical repellents (copper oxychloride, methiocarb and trimethacarb) and one toxic fright-inducing chemical (4-aminopyridine) were evaluated for their repellency and toxicities on four *species of common pest birds, the rose-ringed parakeet, Psittacula krameri*; the common pigeon, *Columba livia*; the house sparrow, *Passer domesticus*; and the black-backed munia, *Lonchura striata*.

Methiocart was the most repellent of the 3 materials but because copper oxychloride was repellent enough, generally available in the country, and inexpensive, it justified further evaluations in the lab and the field. Copper oxychloride is available as a fungicide on the market in Bangladesh.

The effect of 4-aminopyridine on parakeets, house sparrows and munias justified further lab and field trials. It produced distress calls in parakeets within 10 to 20 minutes; normally in the field these calls given by one bird would frighten the remaining members of a flock away from the area.

2.3.1.3 Jackal toxicants and immobilization agents

The jackal has been tested with 3 toxicants for susceptibility, diphacinone, coumatetralyl and carbofuran. Either of the anticoagulants kill jackals in the normal concentrations used in rodent baits in 3 days feeding. Carbofuran has been effective at 0.5% in baits, killing animals in less than one hour. All 3 materials appear promising and should receive further laboratory and field evaluations.

Jackals were sucessfully immobilized after trapping with ketamine hydrochloride. After injection of 10 to 20 mg/kg, the animals could be handled within 2 to 5 minutes. Twelve animals were sucessfully transported from trapping sites in the field back to the holding facility at Joydebpur within 1 to 2 hr after immobilization.

Jackals prefer fresh raw chopped chicken over all other baits offered, with beef fat ranking next and raw egg and chopped shrimp least. Jackals are attracted to molasses and a bait may be developed with this material.

2.4 VERTEBRATE PEST CONTROL

2.4.1 Wheat field rodent control

Field investigations early in 1979 showed that wheat suffered serious rat damage due to a long period of exposure, lasting about 75 days, from tillering stage to maturity. Surveys of 303 wheat fields in 4 districts in 1979 found that they had 12.1% damage (percent of total stems cut by rats), and the national loss of wheat yield was estimated to be 77,000 metric tons. The lesser bandicoot rat was responsible for causing most of the damage. Another survey in 1982 in 6 districts indicated an average of 8.4% damage at maturity with higher damage in non-irrigated vs. irrigated fields. Radio-telemetry studies in wheat fields showed that the rats spent most of their time within individual fields and the home range averaged only 18 square meters. Such a limited home range indicated that rodenticide applications directly into rat burrows or within 2 m of these burrows should be effective. The number of rat burrow systems per field showed a good correlation with the degree of rat damage in the field. Rats had cut and stored wheat panicles in the burrow systems; as much as 18 kg was retreived from one burrow.

Simulated rat damage studies in wheat crops showed significant yield reductions for damage levels more that 10% and from booting stage onward. The later in the growth cycle the damage occurred, the less likely the wheat plants could produce compensatory growth. Ten percent damage by the time of maturity represents a 10 to 20% loss in yield.

In 1981, the Vertebrate Pest Section undertook a control demonstration in wheat fields in Gazaria Thana, about 40 km southeast of Dhaka. Ready-made bait packets of the rat bisquit bait containing 2% zinc phosphide were offered for sale at several markets in the thana. Response was overwhelming; 200 to 300 bait packets were sold in an hour each time offered. The price was 1 Taka per 100g packet. As the packets were sold the VPS staff told the farmers how and when to use the baits in their wheat fields to kill rats and stop damage to their wheat. Baits were sold during the period that wheat was in the tillering to booting stages. At the time of harvest, wheat fields were randomly selected for rat damage survey from 12 villages served by the markets where the baits had been sold. Fields were examined in a standard manner for rat damage and after assessment the farmer was contacted and asked what method of control he used. The findings disclosed that of 108 wheat fields assessed for damage, 20 (or 18.5%) had been treated with one or more zinc phosphide bait packets. A few others (8) had been treated with locally obtained rat poisons. The majority of farmers, however,

had used no rodenticides. Damage was lowest (2.6%) in the fields where the ready-made baits were used. Fields that received no bait or bait that was made from locally obtained poisons had much higher damage (9.2 and 9.0%, respectively).

This study demonstrated the effectiveness of the ready-made zinc phosphide bait in reducing rat damage to wheat. Farmer interviews during the damage survey and acceptance at the local markets indicated that many more bait packets could have been sold had they been available. The selling of 700 bait packets resulted in 18.5% of the fields being treated; it is estimated that 3800 bait packest would have supplied the entire thana. The study showed that a significant reduction in damage to wheat (about 70%) was achieved with very little supervision of the farmer. The simple instructions given at the time of sale was the only contact made before the pre-harvest survey.

By late 1982, enough information and methods had been derived from the field demonstrations and research to incorporate them into a National Rat Control Campaign to reduce rat damage to wheat. Accordingly, the Vertebrate Pest Section, BARI; the Bangladesh-German Plant Protection Programme of the Directorate of Agricultural Extension Services; and the FAO Project, Strengthening of Agricultural Extension, collaborated in the planning and carrying out of two National Rat Control Campaigns in Wheat in Bangladesh in 1983 and 1984.

Wheat farmers were the target group in both these campaigns. In 1983 efforts were concentrated in 11 primary wheat-growing districts, covering areas where 91% of the wheat is produced in the country. Lesser inputs were given to the 10 secondary districts. In 1984, the campaign was enlarged to cover the entire country.

The campaign objectives were to:

1. create awareness, mainly among farmers, of serious rat problems;
2. motivate farmers to carry out rat control in wheat fields;
3. inform farmers and government agricultural officials of effective rodent control methods;
4. familiarize farmers and pesticide formulators of a cheap, effective, ready-made bait;
5. reduce the damage level in standing crops and particularly in wheat.

The campaigns used all available media (radio, television, farmers' journals, newspapers, posters, instructional leaflets, and school comics) and the respective agricultural extension staff (Table 1). Posters, leaflets, comics, and bait packets were distributed in each district by agricultural extension staff after receiving a 1-day training course. Media materials were further distributed to village level. The ready-made baits consisted of 100 g packets of 2% zinc phosphide.

Table 1. Media distribution in National Rat Control Campaigns.

Description	Number Distributed 1983	1984
Motivational poster	25,000	52,500
Instructional poster	15,000	------
School comics	375,000	------
Instructional leaflet	100,000	1,070,663
Agricultural extension brochures	------	14,285
Rodenticide packets	80,000 a	--------- b

a Number of bait packets made and distributed through the Plant Protection Programme and the Vertebrate Pest Section, BARI. At least another 140,000 were distributed by pesticide dealers directly.

b In 1984, five private pesticide formulators made and supplied 311,000 bait packets by mid-February.

Evaluation of the campaign was done in two ways: Field surveys of wheat fields and farmers' interviews were done by headquarters staff of the Vertebrate Pest Section, BARI and the Bangladesh-German Plant Protection Programme. These surveys were designed to delineate the type and effectiveness of rat control methods practiced in wheat fields, to determine if farmers increased control efforts over the previous year and to estimate the amount of standing wheat saved due to the campaign. A second, independent interview survey of farmers was done by a group of experienced surveyors to establish how many farmers had been reached and motivated to conduct rat control and by what means. A total of 851 fields in 10 districts were surveyed for rat damage and 603 farmers were interviewed about rat control activities by headquarters staff in 1983. In 1984, 866 fields were surveyed in 10 districts and 805 faarmers were interviewed.

The evaluations found that both campaigns had been well-run by field staff and well received by farmers. Both campaigns had achieved their objectives. In 1983 the most effective media materials were radio, friend and posters, in that order. In 1984, posters took the lead, followed by agricultural workers and radio. In 1983, 49% of all farmers did some form of rat control in their fields; this increased to 67% in 1984. In 1983, the independent survey had found that only 6% of all farmers had used the ready-made bait (a good part of this was due to the bait being not available); while in 1984 this proportion had increased to 29%.

When the rat damage in wheat fields was examined against the kind of control that was done, it was found that the ready-made bait in 1983 gave a 56% reduction in rat damage (Table 2) over the fields where no control was done. Locally available poisons were ineffective in most cases. In 1984, the ready-made baits gave only a 41% reduction in rat damage. This may have been due

to an earlier onset of heavy rat infestation and delays in the availability of the ready-made bait after the opening of the campaign.

Table 2. Comparison of rat damage to wheat fields when using several methods of control.

Control Method	Damage Level (%) 1983	1984
No Control	4.44	4.90
Locally available poisons	3.40	4.65
Ready-made baits	1.77	2.08

In 1983, 19% of the wheat plots examined had been treated with the ready-made bait packets, indicating that between 750,000 and 800,000 fields had been treated. Because two or three fields can easily be treated with one bait packet, at least 250,000 to 400,000 bait packets (approximate cost $ 0.10 each) were estimated to have been used by farmers at a cost of $25,000. In addition, the Bangladesh-German Plant Protection Programme and the Vertebrate Pest Section contributed a total of $15,000 for campaign activities. The extrapolated value of the wheat saved equaled $524,375, giving a cost:benefit ratio of the overall campaign of 1:13. In 1984, the percentage of fields treated with ready-made baits increased very slightly to 18.8%. Projecting to a total of 4,250,000 wheat fields in Bangladesh, approximately 797,000 were treated, indicating that about 300,000 to 400,000 bait packets had been sold and used, at a cost to the farmers of $36,000 (approximate cost of $ 0.12 per bait packet). Since the Bangladesh-German Plant Protection Programme and the Vertebrate Pest Section contributed about $50,000 to the campaign costs and the savings in wheat were estimated to be $736,000, the cost: benefit ratio for the 1984 campaign was 1:8.6.

These rat control campaigns in wheat clearly indicate the potential in savings that could be realized if the farmers are provided with good quality bait materials and the information on how and when to use them. There is a potential market of between 1.5 and 4.5 million bait packets just during the wheat season. As many of the farmers also used the bait packets in their houses in attempts to control house rodents in their grain stores, there is a potential year-round market for some 12 million households.

2.4.2 Deepwater rice rodent control

Studies in deepwater rice began in 1979 with detailed investigations of the biology and population dynamics of the rodent species living in deepwater rice fields and on the adjacent island villages. In a 19-month study using over 31,000 trapnights, it was found that the species most destructive to deepwater rice are the lesser bandicoot rat and the greater bandicoot rat. Other species taken in the study area were the roof rat, house mouse, field mouse (*Mus booduga*), soft-furred

rat (*Rattus meltada*) and the little Burmese house rat (*R. exulans*). The roof rat was abundant in villages but seldom captured in fields.

During the period of the study the rodent population peaked in June 1979, February 1980 and October 1980. Annual cycles of rodent numbers are bimodal in the deepwater rice zone and are influenced primarily by flood level, rainfall and available food resources.

One and two nights of trapping to obtain population indices revealed no differences in capture success. One night is recommended. Removal trapping was used to estimate rodent density using a linear regression analysis. Results indicate 7 nights of trapping is needed for accurate density estimates, which was 130 rodents/3.3 ha of island area. Bandicoot rats were reproductively active throughout the year. Percent of females pregnant was 12.2% in 1979 and 26.1% in 1980.

Rodent control efforts demonstrated more effective elimination of animals using rodenticides (88 to 100% efficacy); removal trapping showed some potential but is difficult and labor intensive. If control efforts are stopped for several months, rodent numbers will build up rapidly, suggesting that rodent control efforts are a continuous process.

A second field trial was carried out in 1982 in Tangail. This was a cooperative effort of BRRI/BARI. It was a comparative trial of two rodenticidal baits; 2% zinc phosphide (available in the country) and 0.005% brodifacoum (an experimental anticoagulant). Each material was tested on three experimental islands and three other islands served as untreated controls. Islands were assigned for treatments at random. Both materials were formulated as a bait cake or bisquit in 48% wheat flour and 48% crushed rice with 2% soybean oil and 2% of the rodenticide or concentrate. This was made into a dough with the addition of a small amount of water, rolled flat, cut into small squares and sun-dried. These baits were given in 100 g bait packets to householders living on island/villages, with instructions on how to place the baits overnight. Baits were placed out for 3 nights in each baiting period.

Prior to the start of baiting, tracking tiles were set for 2 nights to establish rodent population indices. As in the previous study, it was found that the data from each night did not differ significantly, so one night was recommended for future studies. Two weeks after baiting was started, tracking tiles were again set to obtain population indices. The difference between the first and second indices was taken as the measure of poisoning success. The poisoning treatments were carried out twice because data indicated that the first poisoning was done a little early in the flood period and animals still were moving from the flooded fields onto the islands.

Poisoning after peak flood was successful for both zinc phosphide (34% reduction from peak activity) and brodifacoum (75% reduction from peak). Trapping on nearby islands resulted in the capture of lesser bandicoot rats, house mice and Asiatic house shrews. Roof rats also were picked up dead on some of the treated islands.

A third attempt to control rat damage in deepwater rice was aimed at the rats in the field and on any high ground as the flood progressed. This was a cooperative study carried out by staff of BRRI/BARI. This was a large-scale trial in Mirzapur, Tangail District and involved an area 1 sq. km in extent with the adjacent 10 or so island/villages. A control (reference) area was selected that matched as closely as possible; this was situated about 5 km distant to the east. Rodent populations were monitored on high ground by counting active burrow openings and by means of tracking tiles. These were done before and after each poisoning operation. The prepoisoning tracking tile indices indicated high activity in the island/villages and fields of the reference area and low activity on roadside high ground, while the area to be treated with 0.005% brodifacoum showed activity mainly at the villages.

Baits were placed after peak flood. Baits were put into or adjacent to all active rat burrows on high ground and bait packets (50 g each) were given to householders to eliminate rats and mice from village structures. In fields, where there was ample evidence of *Bandicota indica*, baits were placed on emergent vegetation or on floats made from banana plant trunks. These were set in areas where rat damage to rice was apparent.

Four baitings were made: mid-August, end of August, mid-September and mid-October. In the treated area, population indices had dropped from a peak of 31.1% positive tiles in August to 4.4% in September and 5.0% in early November. In the reference area, positive tiles climbed from 27.2% in June to 30.0% in August and 37.2% in September. Indices dropped to 13.9% in the reference area in November.

Crop-clipped samples taken from deepwater rice fields from the two areas demonstrated a 41.8% to 124.1% increase in yield from the treated area. The increase was apparent in four different local rice varieties (Table 3).

Table 3. Yield (g/sq. m) of deepwater rice varieties in two areas of Tangail District, November 1983.

Variety	No. fields Each	Yield Reference	Yield Treated	Percent increase Treated vs. Reference
Injal dagha	7	120.5	196.9	+ 63.4
Chamhara	8	150.0	336.1	+ 124.1
Channa baoalia	1	103.6	220.5	+ 112.8
Baron baoalia	1	133.1	188.8	+ 41.8

2.4.3 Sugarcane rodent control

Three species of rats are found in sugarcane in Bangladesh: *roof rats (R. rattus)*, short-tailed mole rats (*Nesokia indica*) and lesser bandicoot rats (*B. bengalensis*). Of these the roof rat is probably the most important. This rat invades sugarcane fields where the fields closely adjoin farmers or village houses. Surveys of rat damage to sugarcane in the Sripur area disclosed that rats had damaged an average of 7.5% of the canes by harvest time; this equalled an average 14% weight loss in canes rat-damaged vs. the undamaged. Surveys of *N. indica* in sugarcane fields found that it invades the fields early in the growth cycle and inflicts some minor damage on the plants about 3 to 4 months after planting. Damage from this species then decreases until harvest even though the rats remain on the field edges. No efforts at field control of rats in sugarcane have so far been attempted.

2.4.4 Porcupine control

Porcupines in Bangladesh damage root crops and pineapple. Only limited work has been done by the VPS on porcupines. One trial of coumatetralyl at the pineapple gardens of the Monasapara Seventh Day Adventist School in Netrakona was entirely successful in stopping damage in a period of 2 weeks of baiting. Coumatetralyl concentrate was dusted onto cubed ripe pineapple and baits were placed out where fresh damage was found and baits replenished as needed.

2.4.5 Rodent control in reduction of stored food losses

Studies of rodent-caused losses of stored foods were begun in 1982. After surveys and consultations with other specialists in the stored food field, it was concluded that losses in Government stores were minimal as compared with the potential losses that were occurring in the millions of farmers houses. Many farm families store all or part of their harvest and these are stored under conditions that invite rodent attack. The most common storage container is the "dole", a woven split-bamboo basket of varying size. Grain, usually paddy (unhusked rice), is simply placed inside the container, filled to near the top and generally left uncovered. Rats and mice can easily climb the sides of the basket to gain access to the grain.

Initial studies were made in the Bhogra village area about 5 km west of Joydebpur. This was a cooperative study of BRRI/BARI. Tracking tiles and traps were used to estimate the numbers of rodents in the houses (24 per month were trapped) before and after removal trapping. It was found that the common rodents living in and around farmers houses were house mice (the most common), roof rats, and lesser bandicoot rats. The roof rats and house mice used the upper parts of the house and the floor while the bandicoot rats mainly use the floor, since this is where their burrows are located. In addition to the rodent species,

the other common animal in and around houses is the Asiatic house shrew, *Suncus murinus*. This animal is an insectivore, related to moles, etc. and probably lives on insects in the houses.

In this first one year study, the rodent populations estimated at the 146 households consisting of 503 structures were 1206 *M. musculus*, 176 *B. bengalensis*, 112 *R. rattus* and 7 *B. indica*, or an average of 2.0 rats and 8.3 mice per farm household. These rodents were estimated to consume and hoard about 53 kg of paddy per farm family per year.

A second one year study was carried out in collaboration with the FAO/BRRI study programme on losses of stored paddy at farm and village level. The study area was in a deepwater rice-growing upazilla in Tangail District. Farmers houses in island/villages were trapped each month for small mammals. Techniques were as used in the previous study except that tracking tiles and traps were set much more extensively throughout the structures to gain more precise information on rodent population densities. Tiles and traps were set on the floor, and on shelves, platforms, lofts and even in the storage baskets in attempts to monitor and capture as many small mammals as possible. In many cases, it proved difficult to catch bandicoot rats and roof rats even though, in the case of the bandicoot rats, there was ample evidence of their presence. Populations were found to fluctuate seasonally; the highest densities occurred in the late fall and early winter months, coinciding with the harvest of the aman rice crop. A second minor peak in abundance was found in the monsoon months, probably due to the flooding of the adjacent fields. Rodents were estimated to number an average of 9.9 house mice and 1.8 rats per farm family. These numbers are known from laboratory studies to be able to consume and hoard 48 kg of paddy per year per farm family.

These findings accord well with those from the previous study. If these findings were extrapolated to the 12 to 13 million farm families in Bangladesh, then the potential loss of stored paddy per year at farm and village level would be 600,000 to 650,000 metric tons.

2.4.6 Jackal Control

An intensive interview survey of farmers about jackal problems was carried out in 11 districts of Bangladesh. The districts were pre-selected to represent the differing physiographic and ecologic areas of the country, but within each district, upazillas and villages were selected at random. A total of 760 (68.4%) of the 1110 farmers interviewed reported problems with jackals: 286 (25.7%) reported damage to field crops and 693 (62.4%) had lost domestic animals due to jackal depradation. Jackals most frequently damaged sugarcane, melons, pineapple, jackfruit, maize, groundnut, cucumber and a variety of other crops. Jackals were reported to kill and eat chickens, goats, ducks, sheep, cattle, pigeons and freshwater prawns. Some

589 farmers lost 4,233 chickens in one year, while 231 lost 521 goats and 162 farmers lost 632 ducks. Predation on domestic animals was most intense in the months of June to August. The total annual loss of crops as reported by the farmers was Taka 228 average and of domestic animals was Taka 186 per farmer. The aggregate loss per farmer was Taka 414 (equals U. S. $16.12 per farmer). Extrapolating this to the 12 million farmers in Bangladesh gives an annual toll of $193 million that is lost to jackal damage to field crops and domestic animals. Jackals occur throughout the countryside; they were reported by one or more farmers in each of the 220 villages that were visited. Farmers were found to do very little jackal control because of lack of knowledge and lack of resources. The most common form of jackal killing was simple chasing and beating and farmers reported to the use of night guards to protect some crops from damage, such as sugarcane and water melons. Despite this, damage still occurred.

Since sugarcane is the most frequently reported field crop to suffer jackal damage, an investigation of jackal damage to this crop was made in the Sripur area of Joydebpur Upazilla in 1984 and 1985. Jackals were found to have damaged 25% of all canes by the time of harvest in the fields examined. When jackals damage sugarcane, they crush the stalks between the internodes; the cane stalk invariably dies afterwards. Thus jackal damage is much more severe than rat damage. Jackal damage occurs throughout the fields since they are much more mobile than are rats. Damage to cane fields stops when the boiling of sugarcane juice to make molasses starts. Jackals then begin visits to the boiling pans after dark to lick the spilled juices and molasses. This is where they were successfully trapped in numbers in 1985.

Jackals have easily been killed with anticoagulant rodenticides such as are now available in Bangladesh. Three days feeding gives 90 to 100% mortality based upon studies on penned jackals at Joydebpur. Another toxicant, carbofuran, at low concentrations, killed jackals within one hour after ingesting the baits. The main problem facing us now in jackal control is to design a bait delivery system that will not kill foxes, civets and jungle cats.

2.4.7 Wheat field bird control

Wheat has become an important crop in Bangladesh during the past decade. BDG officials and farmers have reported a corresponding increase in bird damage to this crop. Bird pests of sprouting wheat are mainly the common myna, *Acridotheres tristis*, and the pied myna, *Sturnus contra*. Other minor pests are the rock pigeon, the collared dove and the house crows. Field trials to reduce bird damage in sprouting wheat were first done in 1979 at Ishurdi. These early trials suggested good potential for methiocarb at 0.5% as a seed dressing for wheat.

Further field trials were conducted in farmers fields and at agricultural research stations in 1981, 1982 and 1983. These trials compared the effectiveness of methiocarb, trimethacarb and copper oxychloride, a fungicide, in repelling birds from wheat sprouts. In general, methiocarb was found to work best at a concentration of 0.25% (since at 0.5% it caused some mortality in village pigeons), trimethacarb was best at 0.5% and copper oxychloride worked at both 0.5 and 1.0%. Methiocarb gave sprout survival in the ranges of 36 to 84% more that the reference plots, and copper oxychloride-treated seeds gave 13 to 71% more sprouts. At harvest, the copper oxychloride plots consistently gave yield increases in the range of 12 to 24% over the reference plots while methiocarb at 0.25% gave yield increases of only 6 to 11%. However, in one final trial in farmers fields in 1983, testing copper oxychloride against chalk powder, the fungicide gave a slight increase at yield over the chalk (about 10%) but it was not statistically significant.

Methiocarb is too expensive for consideration as a bird repellent in Bangladesh and is used only as a standard for field and laboratory evaluations. Trimethacarb has been withdrawn by the manufacturer. Copper oxychloride is an attractive alternative because it is inexpensive and available even though of lower efficacy than the two carbamate compounds.

2.4.8 Maize field bird control

Two species of birds, rose-ringed parakeets and jungle crows, are the main pests of maize in Bangladesh. Most of the damage occurs from the "milk" stage through the dough stages. Jungle crows also damage maize during the sprouting stage. Early attempts to control parakeet damage to maize used the distress-producing chemical, 4-aminopyridine. First five maize cobs were exposed on each side of the field borders by pulling back the leaf sheaths. The next day these were removed. The chemical was dissolved in ethanol at 2% and 4% concentrations and hand-sprayed onto fresh maize cobs from which the leaf sheaths had been pulled back, again exposing five cobs on each side of the field borders. These trials were carried out at Dinajpur. Spraying at milk stage just once before harvest gave a 66 to 93% reduction in damage to maize ears at harvest as compared to nearby untreated plots. The amount of chemical used per plot was inexpensive even though the material itself is expensive. The material is so toxic to all forms of wildlife and man, however, that it may prove too hazardous to consider for general farmer use in Bangladesh.

Another promising method of reducing parakeet and crow damage to maize has been the use of reflective plastic ribbon. This material, which is a polyethylene ribbon silvered on one side and red-colored on the other, has been shown in Bangladesh and other developing countries to repel birds from fields when stretched tautly over the tops of the crop. In this position it catches the sunlight and gives back brilliant flashes. It also picks up the wind and makes a pulsing, humming sound. In field

trials at Joydebpur and Jessore, it has been found to deter parakeet and jungle crow feeding in treated fields for as long as two weeks after installation, reducing bird visits per hour or per day by as much as 80 to 95%. The method is inexpensive, easy to install and more than competitive with the use of human bird-scarers, especially at agricultural research stations. The only disadvantage is that the ribbons are attractive to people and some may be torn down overnight and stolen.

2.4.9 Sunflower bird control

The same reflective ribbon mentioned above has been the only material or device that has been found effective in reducing visits by parakeets to sunflower fields. One field test at Jessore in 1984 demonstrated that parakeets could be discouraged from feeding in a sunflower plot for up to 2 weeks with the use of reflective ribbons installed just at the tops of the tallest sunflower stalks. Bird visits were decreased by more than 90% during the first 10 days after the ribbons were installed. Again, the advantages and disadvantages are as outlined above.

2.5 DAMAGE ASSESSMENT METHODS

2.5.1 Wheat

Damage assessment methods in wheat, a broadcast crop, had to be developed in order to measure crop loss and to judge the effectiveness of control methods. For large surveys, fields are selected for survey in some random manner, either random selection of villages, or a pre-selected interval along roads. When a field is selected, several transects are located along the shorter side of the field and, at a given interval, say 5 steps, a wooden quadrat, 50 by 100 cm and open on one end, is inserted into the wheat crop at the end of the step. The observer then counts all wheat stems in the 0.5 sq. meter area, both cut and uncut by rats. This continues until at least 10 quadrats are counted per field. The percent rat damage is expressed as the number cut divided by the total stems times 100. This method has been used to assess rat damage to wheat for at least 6 wheat growing seasons. The results are given in Table 4.

Table 4. Rat damage to wheat in Bangladesh.

Year	No. Fields Examined	Percent Damage	Estimated National Yield Loss (mt)
1979	303	12.1	77,000
1980	355	3.2	------
1981	189	7.1	------
1982	237	8.4	88,000
1983	851	2.2	21,000
1984	866	2.5	33,000

As can be seen, the damage levels change significantly year to year, depending upon the densities of rat populations in the fall of the year before wheat planting and upon the effects of heavier than normal rainfall in the winter months, which depress rat populations. The least yield losses of 21,000 metric tonnes would represent some 2.6 million dollars of wheat, while the higher damage levels equal 10 to 12 million dollars.

2.5.2 Deepwater rice

Damage assessments in deepwater rice are difficult because 1) during the flood periods they must be made by boat, 2) compensatory growth of the rice plants partially obscures early damage and 3) fluctuation in flood levels often removes evidence of earlier damage. In addition, after the fields are drained of flood waters, they are quickly invaded by rats who inflict damage in the ripening stage. These rats live under the dense cover of the lodged, elongated stems and even their burrow mounds are hard to see. Measures of the damage to deepwater rice during the growth stages indicate it varies from 5% to as much as 70% in individual fields. The compensatory response of deepwater rice has been measured under conditions of simulated rat damage and it has been found that even 5% damage at booting and flowering stages will result in a 26% loss in yield at harvest and higher levels give even greater yield losses.

A detailed analysis was made of rat damage in one field of deepwater rice in October 1982. The 25 by 40 m field was surveyed three weeks after flood waters had receded and just before harvest. It was subdivided into 1 sq. meter grids by means of twine and stakes. Usual methods of damage assessment using wooden frame quadrats were done by four observers. Then the actual number of damaged stems in the entire field was counted meter by meter by 10 observers. It was found that the quadrat sampling in deepwater rice seriously underestimated the actual damage (5.0% damage by quadrat; 7.2% actual).

Following this all burrow systems and runways were mapped and excavated, and all stored panicles were removed, counted and weighed when dry. When the panicles were counted, they totalled 4,643. The most serious drawback of the quadrat sampling was its inability to account for about half of these fresh-cut stems.

Since quadrats were not reliable, another method was devised. This relied upon transect sampling based upon rat burrow systems in rice fields. A 30 m-wide transect was covered by two observers while advancing 300 to 500 meters across deepwater rice fields. All burrow systems were counted in the transects, giving a density of burrow systems per hectare. This data was then tied to the mean amount of stored rice dug from 23 burrow systems in rice fields, which was 1.7 kg. Based upon this average the rat damage at ripening stage to deepwater rice was estimated at 3.2% of total yield in data from 7 deepwater rice-growing upazillas. This figure does not account for the cumulative damage that occurs during the flood period.

2.5.3 Sugarcane

Damage assessments in sugarcane mainly rely upon two methods: 1) Those carried out at harvest which depend upon counts or observations made on cane stalks after cutting from the field and 2) those made on transects or quadrats laid out in cane fields during the growing season, allowing repetitive measures on the same sampling areas. The first method was used in comparison with a modification of the second method in assessing jackal and rat damage to sugarcane in the Sripur area of Bangladesh. The first method, of counting damage on all canes cut from 5 by 5 m plots taken at random from five fields, gave results comparable with counts from a 1.5 m radius circular plot in intact cane stalks when assessing jackal damage but the circular plot did not give comparable damage levels when assessing rat damage. Jackal damage ran 25% of all stalks crushed, while rat damaged stalks averaged only about 7.5% in the same fields. One main reason for this difference is probably dur to jackal damage being distributed throughout the fields while rat damage is clumped in its distribution. The smaller circular plots may have missed some of the rat damaged areas, resulting in lower damage levels.

2.5.4 Maize

Bird damage in maize was most accurately measured with a method that removes every 10th or 20th cob on each row from throughout the field. Damage on each cob is then measured by the cm. of kernels removed from each row of kernels on the sampled cobs. The length of each cob is also recorded. Thus a cob with 12 kernel rows showing an average of 2 cm of removed kernels and measuring 20 cm in length would have 10% damage. The number of cobs with damage out of the total examined is recorded along with the cm rows. This damage data relates almost directly to yield loss when measured in this manner. Parakeets frequently damage only the first quarter or so of the kernels on the cobs while jungle crows attack and pick clean virtually all the kernels on each cob that they damage.

2.5 EXTENSION AND TRAINING

The Vertebrate Pest Section has produced 33 technical reports (Appendix 4.2) summarizing the results of field and laboratory work over the last seven years. These reports are distributd widely to agricultural scientists and extension workers in Bangladesh and to other interested persons in international agencies. The technical reports servce as a means of quickly disseminating research results; they are later revised and prepared for publication as scientific papers. So far, some two dozen scientific papers have been published or submitted for publication to international scientific journals (Appendix 4.3). In addition, an annual review of the work of the Vertebrate Pest Section is contained in the "Annual Report: Vertebrate Damage Control Research in Agriculture", a joint publication of USAID and the DWRC. This annual report is distributed world-wide.

The participation of VPS scientists at conferences, workshops, seminars and training courses was listed previously. In addition, during 1984 and continuing in 1985, the staff of the VPS have undertaken to provide half-day seminars on vertebrate pest problems and control in Bangladesh, illustrated with color slides and narrative, to staff at BARI regional (RARS) and subregional (SubRARS) Agricultural Research Stations, to personnel of Thana Training and Development Centers (TTDC), and to students and training staff at Agricultural Extension Training Institutes (AETI). In 1984 seminars were given to 1,[illegible] individuals.

Radio broadcasts, in Bengali, on vertebrate pest problems in agriculture, have been prepared and given by the VPS staff. In 1984, eight talks were prepared and broadcast.

A training manual on vertebrate pest research and management methods in Bangladesh is in outline and work has started on a draft manuscript. This manual, aimed at agricultural extension workers, will be written in both English and Bengali versions or both will be combined into one manual.

Informal discussions have been held with staff of Bangladesh Agricultural University, Mymensingh, about a vertebrate pest management addition to their curricula.

Vertebrate Pest Section staff have been giving occasional lectures at the Institute of Postgraduate Studies in Agriculture at Salna, Gazipur.

Through the National Rat control Campaign in Wheat, the VPS developed close ties with the Directorate of Agricultural Extension and the Bangladesh-German Plant Protection Programme. Now, however, the GTZ have closed their participation in this programme, unfortunately.

2.6 COOPERATION WITH OTHER AGENCIES

The Vertebrate Pest Section has maintained cooperative ties with a number of national and international agencies in Bangladesh and with several voluntary agencies. The project started with a close, cooperative relationship with the Bangladesh-German Plant Protection Programme in the Directorate of Agricultural Extension Services, culminating in the two national rat control campaigns. Through a letter of agreement between the Directors-General of BARI and BRRI, the Vertebrate Pest Section works with BRRI on cooperative studies and field trials in rice crops. The VPS cooperated in postharvest stored food loss studies with the FAO/BRRI Project on Assessment of Losses of Stored Paddy at Farm and Village Level. Other agencies worked with include the British Overseas Development Agency (ODA) at BRRI, the Bangladesh Ministry of Food, the Bangladesh Sugar Research Institute, CARE, and the Australian-Bangladesh Sugar Industry Project at Muladuli.

Voluntary agencies that the Project has cooperated with include the Christian Reformed World Relief Committee, the Mennonite Central Committee and the Seventh Day Adventists, mainly at their research farms.

The DWRC has provided extensive back-up support in research, administrative matters, and procurement of supplies and equipment. The DWRC provided literature searches and reprints of hundreds of pertinent articles on vertebrate pests. DWRC biologists have provided a dozen or more TDY visits during the last seven years.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Rodent Control

The value of the ready-made rodenticidal bait has been shown in control demonstrations, fields trials and national rat control campaigns. Whether in wheat, deepwater rice or in food stores, the Bangladeshi farmer needs and will utilize to his advantage a good quality, ready-to-use bait. The previous campaigns were carried out using zinc phosphide baits. This is an acute poison with a fairly rapid onset of poisoning symptoms. This frequently leads to poison and/or bait shyness. Survivors of a poisoning treatment will no longer take the baits on a second offering. This limits the usefulness of zinc phosphide. This difficulty is overcome when using anticoagulant baits, such as coumatetralyl, because the poisoning symptoms do not occur until 3 to 5 days after the inital baits are eaten. If these baits were made and widely distributed in Bangladesh, the farmers would have a superior bait that could be used repeatedly against rat and mouse populations until they were eliminated.

The potential savings in wheat, deepwater rice, transplanted aman rice and of grain in storage in farmers houses that could be achieved by the widespread availability and use of an inexpensive, good quality ready-to-use bait makes this an item of high priority to pursue. Pesticide formulators are available with established pesticide dealer outlets in practically every uapzilla. The market is there to be tapped.

Rat damage to wheat, deepwater rice, transplanted aman rice and boro rice should continue to be monitored. Particularly needed is a thorough evaluation of damage to deepwater rice and its effect upon yield in several rice-growing areas and through several seasons.

The reduction of losses of stored foods due to rodents offers great potential for a large economic return. If householders utilized rodenticide bait packets on a continuous basis (treatments every 2 to 3 months) this could cut rodent populations by 80%, resulting in an equal percent reduction in the loss of stored grains. A field demonstration of the practicality and economics of this approach should be attempted.

3.2 Bird Damage to Sprouting Wheat

Simulated bird damage trials, where the observer pulls the wheat sprouts, have shown that yield loss percentwise is about half that of sprout loss. Thus, a 40% loss of wheat sprouts will give a 20% decrease in yield. Forty percent loss is about the average decrease observed in six field trials of bird repellents in 1981-83. It is thus fair to assume that if a good, inexpensive bird repellent was available for farmers use, the individual farmer could increase his yield at nominal cost and effort.

The data on the efficacy of copper oxychloride are equivocal. Further, definitive testing of this material on a wide-scale in an area with a past history of heavy bird damage should be done to settle the issue of whether it is worthwhile pursuing commercially.

Finally, Dr. Sultana has some data from her research in the U.S.A. that carbaryl may make a reasonably effective bird repellent. Since carbaryl is available in Bangladesh, the evaluation of this material certainly should be done.

The bird repellent chemicals should be tested for repellency against baya weavers, common mynas, pied mynas and jungle crows. Carbaryl needs to be tested against the full panel of Bangladesh pest birds.

3.3 Jackal Control

Much additional research needs to be done on the jackal. The basic biology, breeding season, food habits, movements, and densities of jackals is almost a complete unknown in this part of Asia. Each of these areas deserves a separate study. We know we have toxicants that will probably kill jackals in the field; what we need to develop is a baiting delivery system that is specific to the jackal and will not endanger foxes, civets and jungle cats. Further monitoring of jackal damage to sugarcane should be carried out, especially to measure the cumulative damage during the growing season. Our reports of this damage are virtually the only accounts in the literature. Jackals are reported to damage groundnut and observations should be carried out of this kind of behavior.

3.4 Training and Extension

The VPS should continue to provide training seminars to the Agricultural Extension Training Institutes and work up a teaching plan and color slide set with narrativce for use at each of the AETIs. The vertebrate pest research and management training manual should be completed and in print within the next 18 months. VPS staff should continue to provide trining to other scientists within the BARI system as to vertebrate pest problems in specific crops and appropriate control methods.

4. APPENDICES

4.1 PROJECT STAFF

4.1.1 International

Mr. Richard M. Poche', Project Leader, DWRC Wildlife Biologist, November 1979 to December 1980.

Mr. Joe E. Brooks, Project leader, DWRC Wildlife Biologist, May 1981 to October 1985.

4.1.2 National

Dr. Md. Abdul Karim, Head, Div. of Entomology, BARI, June 1979 to the present.

Dr. Parvin Sultana, Senior Scientific Officer, March 1979 to the present.

Md. Emdadul Haque, Senior Scientific Officer, March 1979 to the present.

Md. Yousuf Mian, Senior Scientific Officer, March 1979 to the present.

Mr. Rajat K. Pandit, Scientific Officer, September 1983 to the present.

Md. Shahabuddin Ahmad, Scientific Officer, September 1983 to April 1985.

Md. S. A. M. Rahman, Scientific Officer, March 1981 to February 1982.

Md. Abdul B. Siddique, Laboratory Attendant, June 1979 to October 1983.

Md. Halim Mollah, Laboratory Attendant, October 1983 to the present.

Md. Abdul Latif, Driver, October 1981 to March 1985.

Md. Israfil, Driver, April 1985 to the present.

Md. Wali Ullah, Clerk/Typist, July 1981 to October 1983.

Md. Kafiluddin, Clerk/Typist, October 1983 to the present.

Kudrat Ali, Peon, Oct. 1983 to the present.

4.2 TECHNICAL REPORTS

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Technical Rept. No. 4. Field trial using four rodenticides in deepwater rice. VPS, BARI. February 1980. 21 pp.

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Technical Rept. No. 10. Rodent control in wheat fields. VPS, BARI. August 1980. 12 pp.

Technical Rept. No. 11. A preliminary report on rodent ecology in deepwater rice. VPS, BARI. Nov. 1980. 32 pp.

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Technical Rept. No. 15. Control of pest bird damage to sprouting wheat. VPS, BARI. Feb. 1982. 8 pp.

Technical Rept. No. 16. Rat damage to the 1982 wheat crop in Bangladesh. VPS, BARI. May 1982. 7 pp.

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Technical Rept. No. 18. Laboratory and field evaluation of 4-aminopyridine (Avitrol) as a bird repellent in Bangladesh. VPS, BARI. May 1983. 8 pp.

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4.1 OVERALL ESTIMATES OF CROP AND STORED FOOD LOSSES CAUSED BY VERTEBRATE PESTS IN BANGLADESH

Vertebrate pests, mainly rats, mice, birds and jackals, cause losses to food grain crops, other field crops and domestic animals. From surveys and studies carried out by the staff of the Vertebrate Pest Section, BARI, during the past 6 years, the following estimated crop and animal losses caused by vertebrate pests in Bangladesh were determined:-

Crop	Observed yield (tons)	Percent Damage	Estimated yield loss (tons)	Estimated value of crop loss
Losses caused by rats and mice:- (1983)				
Aus	3,018,000	1.5	46,000	Tk. 253,000,000
Aman	7,483,000	5.0	393,000	Tk. 2,165,900,000
Boro	3,490,000	3.5	127,000	Tk. 699,500,000
Wheat	1,078,000	4.5	51,000	Tk. 173,400,000
Stored Foods (Paddy)		50 kg/farm family/year	600,000	Tk. 3,300,000,000
Losses caused by birds: (1983)				
Wheat (sprouting)		17.0	220,000	Tk. 748,000,000
Wheat (maturing)		0.5	5,400	Tk. 18,000,000
Losses caused by jackals:- (1984)				
Field crops				Tk. 2,736,000,000
Livestock				Tk. 880,270,000
Poultry				Tk. 1,348,660,000
Total losses				Tk. 12,321,730,000

FROM: COMPLETION OF ASSIGNMENT REPORT

JOE E. BROOKS

OCT. 1985