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PROJECT EVALUATION

Pre/Postharvest Rodent/Bird Control R&D

Project Number 936-4120

PASA NO. BST-4120-P-IF-3028-03

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Executive Summary

The evaluation team recognizes the substantial contribution that Denver Wildlife Research Center (DWRC) of the U.S. Fish and Wildlife Service (USFWS) has made to the Foreign Aid program since 1967. Under Participating Agency Service Agreements DWRC has supported developmental research to reduce vertebrate pest damage in agriculture in developing countries. These agreements, with worldwide application, included research on a variety of methods, materials, and control strategies pursued both in Denver and in various LDC field programs to reduce crop damage caused by vertebrate pests through safe, effective and economical methods appropriate for small LDC farmers. The vertebrate pest management systems were also acceptable in the broader context of agricultural development and environmental protection.

Annual economic losses to vertebrate pests are estimated in the millions. In the Philippines, rice losses from rats were estimated at about $60 million. By using an improved baiting method, a $14.0 million loss reduction was realized. In Colombia, by treating 1 million palm trees with anticoagulant rodenticides to reduce rodent damage to coconuts, a $1.0 million annual savings was realized. In Sudan and East Africa, substantial reductions from bird damage were realized by using a chemical repellent for protection of experimental crops. Since 1983 when this project was initiated, close to $600 million in food losses were prevented by using methods developed by DWRC scientists. This compares to the total cost of this project of only $1.6 million.

Under training, thousands of individuals, including farmers, extension agents, technicians, biologists, veterinarians, administrators, and others concerned with agricultural production have received both informal and formal training in many aspects of vertebrate pest management. More than 40 graduate students have received advanced degrees because of the Center's international vertebrate pest control activities. Their thesis research has been guided by DWRC scientists primarily without costs to the Agency. Others have received extensive on-the-job training at DWRC and in their home countries. Approximately 1,000 participants attended training seminars in Bangladesh which were conducted by DWRC professionals.

DWRC is the center of a large network of scientists involved in vertebrate pest management. This activity brings specialists of diverse backgrounds and nationalities into frequent contact with each other. During these contacts the latest break throughs in technologies are exchanged.

Additional data are contained in the Overview Report which is attached as Appendix I. A typical research report which was developed by DWRC on "Reduction of Vertebrate Pest Crop Losses in Haiti" is attached as Appendix II. A listing of the travel undertaken during 1983 and the purpose of the visits is attached as Appendix III; travel during 1984 is attached as Appendix IV. Listings of requests for technical assistance received in 1983 and 1984

by type are attached as Appendix V and Appendix VI. The latter category is only partially funded by S&T/AGR. Appendix VII lists the equipment and facilities and estimated replacement costs of each which is available for AID projects. Appendix VIII lists Research Publications of the International Programs Section.

Recommendations of the Evaluation Team:

1. Establish a "Ribbon" Participating Agency Service Agreement (PASA) with the Denver Wildlife Research Center, U.S. Fish and Wildlife Service, Department of the Interior with emphasis on research and networking to continue the activities funded under the previous agreements.

2. Expand activities in Africa where drought and famine have taken tremendous toll. The quelea bird is the most destructive vertebrate pest in the world. Quelea affect the economies of more than 25 African nations. The quelea is implicated in the most notorious damage to cereals (wheat, rice, millet, and grain sorghum). In South Africa alone, quelea causes a $1.5 million loss in grain sorghum. In Somalia, quelea causes a $150/acre loss to rice and at harvest time, the natives spend the day-light hours chasing the birds out of the fields. (A first-hand report from a member of the evaluation team).

3. USFWS/DWRC should expand its distribution of significant research results to increase the awareness of the important breakthroughs to reduce the damage caused by vertebrate pests. The publications should be in an easily identifiable format, with the name and address of the contact person.

4. With the Agency's concern regarding the environmental impact of the projects and programs, DWRC should make a determination regarding the impact a vertebrate pest eradication campaign might have on the environment.

5. DWRC should investigate the possibility of collaboration under the following projects with the contractors and agencies which have agreements with Office of Agriculture and the Office of Rural and Institutional Development:

   a. Office of Agriculture

      - Collaborative Research Support Programs - to reduce crop losses from vertebrate pests during pre and postharvest time.
        Sorghum/Millet - University of Nebraska
        Beans and Cowpeas - Michigan State University
        Small Ruminants - University of California at Davis
        Peanuts - University of Georgia

      - Storage and Processing of Fruits and Vegetables - University of Idaho to reduce losses of fruits and vegetables

- Agricultural Policy Analysis - Abt Associates
  to identify policies and constraints affecting use of pesticides to reduce vertebrate pest losses

- Farming Systems Support - University of Florida
  to identify areas in farming systems research and extension where vertebrate pest management systems can be promoted.

- International Agricultural Research Centers

  - IRRI - to continue the work to prevent rice losses from rats and birds.

  - CIMMYT - to prevent losses from vertebrate pests in corn, wheat, barley and triticale.

  - IITA - to identify areas in agriculture and cropping systems where vertebrate pest management systems can be utilized to prevent losses.

  - CIAT - to prevent losses from vertebrate pests in beans, forage, cassava, rice and maize.

  - CIP - to prevent losses from vertebrate pests in potatoes.

  - ICRISAT- to prevent losses from vertebrate pests in sorghum, pearl millet, pigeon peas, chickpeas, groundnuts and to identify areas where vertebrate pest management control systems can be introduced in farming systems practices.

  - IFPRI - To identify national policies which could promote vertebrate pest management control systems in the LDCs to reduce losses.

  - ISRAR - To identify areas within national research programs to introduce vertebrate pest management control systems to reduce crop losses and promote national food security.

  - AVRDC - To reduce losses of tomatoes, sweet potatoes, Chinese cabbage, soybeans and mungbeans.

- Soybean Utilization and Research - University of Illinois
  to reduce losses of soybeans.

- Integrated Pest Management and Environmental Protection - new project - to identify areas which can be collaboratively developed to reduce losses from vertebrate and other pests.

- Improved Seed Production and Utilization - Mississippi State University - to identify varieties of grains resistant to bird damage which could be adapted to other environments.

- Postharvest Grain Systems R&D - Kansas State University
  - to develop collaborative programs to reduce grain losses from vertebrate and other pests.

- Technology Development Transfer and Feedback Systems in Agriculture - University of Illinois
  - to use the technology development, transfer and feedback system to disseminate information on vertebrate pest management systems to the farmers.

Office of Rural and Institutional Development

- Employment and Enterprise Policy Analysis and Research - Harvard Institute of International Development
  - to identify and foster policies that will promote vertebrate pest management systems in the LDCs.

- Small Enterprise Approaches to Employment - Michigan State University - to identify and promote small and micro-entrepreneurs who are capable of handling a small business to manufacture and distribute pesticides needed to implement a vertebrate pest control program.

- A.T. International - Appropriate Technology International
  - to identify areas where ATI can promote the development of vertebrate pest control programs in the LDCs.

Other programs

In addition to the above projects and programs, the evaluation team recommends that DWRC investigate with Montana State University the possibility of developing a methodology for controlling rodents and birds through biotechnological innovations.

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Pre/Postharvest Rodent/Bird Control R&D

Project Evaluation

The evaluation team has received the background material provided by the Denver Wildlife Research Center scientists and the Office of Agriculture, Agricultural Production Division project manager. The conclusions and recommendations of the evaluation team are listed below.

I. Goal, Purpose, Outputs and Assumptions

A. Goal

1. Are there serious shortcomings in the project goal statement?

The goal statement in the logical framework and as stated below is too broad and a quantum step would be required to reach the goal by means of the purpose and outputs.

Current Goal Statement "To improve the standard of living in agricultural areas of participating countries by increasing income, employment, agricultural productivity, and food available through the development and sharing of vertebrate pest control technology".

In DWRC's 1983 annual report, the objective of the project is given as

"To increase the available human food supply in developing countries by reducing losses to vertebrate pests in both preharvest and postharvest situations."

The evaluation team finds that the DWRC objective stated above is the goal of the project and can be achieved through the purpose and outputs defined in the logical framework.

2. Are the assumptions for obtaining the goal still valid and are they being adequately addressed?

The assumptions as defined in the logframe are valid to achieve the goal as restated above and which DWRC described as the objectives of the project.

B. Purpose

1. Are there serious short comings in the project purpose statement?

There are no serious short comings in the project purpose and the conditions expected at the end of the project are being achieved.

2. Are the assumptions for obtaining the purpose still valid?

These assumptions are still valid

3. End of project status.

It is expected that by December 31, 1985 when this project terminates, the following will have been achieved:

- Knowledge of crop loss incidence and distribution and damage assessment methodology improvements.
- Increased awareness among crop protection scientists of the significance of vertebrate pest problems, monitored annually.
- On-going evaluations of appropriate control techniques and programs and presentation of recommendation packages adapted to local conditions.
- Program results and recommendations published and available to all sectors.
- Trained persons assuming domestic roles in vertebrate pest control.
- Use of research results in host countries.
- Increased demand for the sharing of information.

The expanded awareness of vertebrate pest problems and their solution will increase the demand for services by the DWRC staff. Other teams of experts who have evaluated the predecessor projects strongly recommended continuing the research, training, technology transfer and networking activities. Assistance such as DWRC provides will be useful as long as the LDCs continue to have significant vertebrate pest control problems that they cannot solve by themselves.

C. Outputs

1. Are there serious short comings in the project output statement?

The outputs are appropriately stated and are being achieved:

DWRC scientists supported activities of field stations and cooperated with other organizations in research and training of mutual interest. Three field programs involving resident U.S. biologists were continued during 1983. These programs were located in Haiti, the Philippines and Bangladesh. The broad goals of these programs are to increase food and to reduce the risk of severe agricultural losses caused by vertebrate pests in developing countries. The specific objectives are to:

- Establish the technical capabilities and support within governments and the agricultural sector to conduct programs in vertebrate pest research and management.

- Develop new and adapt existing, practical, low-cost methods and technology to evaluate and reduce preharvest and postharvest crop losses to vertebrate pests of significant regional importance under local conditions.

- Provide on-site training in research and management methods to reduce losses by vertebrate pests.

Provide training at DWRC and appropriate universities to perfect capabilities of counterparts to conduct programs in vertebrate pest management.

Africa

DWRC worked with FAO's Regional East Africa and West Africa Quelea projects on fluorescent marking techniques, residue analyses for crop protection trials, assistance in graduate research programs, and provided assistance in organizing and participating in a training workshop "Vertebrate Pests of West African Crops" held in Niamey, Niger, together with the Organization for African Unity (OAU) and USAID. DWRC also worked with FAO in defining the status of rodent pests and control in five East African countries. In Kenya, DWRC worked with the Mission in defining, evaluating and recommending control methods to reduce rodent damage to stored grains in Western Kenya..

Latin America

DWRC completely documented the vertebrate pest problem in Haiti. Crop production statistics were gathered and losses to vertebrate pests were described from questionnaire surveys or quantified from actual field assessments. Studies evaluating wrapping material, nets, and chemical repellents were initiated to protect crops from birds. Sustained baiting with warfarin (a method developed in the Philippines) was used to protect rice from rodents. Training and hands-on experience were provided to Vertebrate Pest Laboratory personnel.

Asia

The DWRC project leader and scientists of the National Crop Protection Center (NCPC) in the Philippines continued to research new and improved methods for reducing rodent damage to rice and coconut and evaluate chemical repellents for reducing bird damage to ripening sorghum. Scientists and experts supervised training of several graduate students in vertebrate pest management research and participated in additional workshops and extension programs. The scientists under this project and its predecessors were instrumental in establishing an effective national pest control center for research and extension in association with the University of the Philippines at Los Banos.

The two Bangladeshi graduate students, who received their M.S. degrees at the University of the Philippines at Los Banos in Vertebrate Pest Management, returned to the Vertebrate Pest Research Laboratory (VPRL) in 1982 and became immediately involved in an active research program. Studies were initiated to: 1) quantify wheat yield at harvest following simulated bird damage to the wheat at the time of sprouting; 2) determine the sensitivities of several bird species to chemical repellents and the toxicities of rodenticides to common rodent pests; 3) control damage by rodents in deepwater rice; and 4) determine the agricultural and economic importance of jackals. In addition, a National Rat Control Campaign in major wheat-growing areas was conducted in cooperation with the Bangladesh-German (GTZ) Plant Protection Programme.

National and International Organizations

NCPC/DWRC has cooperated with FAO, IRRI, World Bank and others in offering appropriate vertebrate pest training at Los Banos for LDC trainees funded by these donors. VPRL cooperated with the Directorate of Agricultural Extension Services and the Bangladesh-German Plant Protection Programme in planning, implementing, and funding the National Rat Control Campaign in Wheat in Bangladesh.

Technical advice, traps and rodenticide baits were provided to British Overseas Development Agency, Bangladesh Rice Research Institute (BRRI) to protect experimental deepwater rice plots and to the Diabetes Hospital, Dhaka, in an attempt to control rats that were damaging electrical cables on X-ray equipment.

Studies of rodent populations in Bangali farmers' houses continued as part of a cooperative effort with FAO/BRRI project on postharvest storage losses of paddy at the farm and village level.

During a visit at the Seventh Day Adventist Seminary School at Monosapara, Netrakona District, Bangladesh, DWRC scientists provided technical advice, traps and rodenticides to the school to control porcupine damage in the pineapple gardens.

Training

DWRC has been providing training opportunities for LDC participants from the LDCs. There follows an illustrative listing of the types of training:

Bangladesh -

Mrs. Parvin Sultana began graduate degree studies at Colorado State University, Fort Collins, Colorado in March 1983. She will research pest bird problems and crop protection methods for her expected degree in Vertebrate Pest Management by September 1985.

Dr. Abdul Karim completed his Ph.D. degree at Bowling Green State University (BGSU), Bowling Green, Ohio in August 1983 and returned to the VPRL in September 1983.

Two new scientific officers, Mr. Rajat Kumar Pandit and Mr. Shahabuddin Ahmad, both graduates of Bangladesh Agricultural University (BAU), were appointed to the VPRL in September 1983. Rajat is now enrolled in a M.S. Program at BAU.

Emdadul Haque enrolled in a Ph.D. program in Zoology at Dhaka University and will study Nesokia indica, a rodent pest.

Rodent control training was provided to about 80 Plant Protection Inspectors, Plant Protection Assistants, and Extension Officers in connection with the National Rat Control Campaign in Wheat. About 1,000 other participants received slide/narrative seminar training in agricultural rodent control during 1984.

Under the awareness program in Bangladesh, Radio Broadcasts by project scientists included the following:

- Rat problems and control in deepwater rice
- Rat problems and control in stored grains
- Pest bird problems and control in maize
- Rat problems in stored food and their control
- Vertebrate pest problems in field crops and their control

In addition, the Bengali scientists with degrees in entomology provided the following information for the radio broadcasts:

- Insect problems and control in coconut
- Insect problems and control in pomegranate

Philippines

The popular, 10-month diploma course for crop protection specialists was continued at UPLB. This course has graduated 59 students, including three from other Southeast Asian countries, from 1980 to 1983. Four other agricultural disciplines have also been offered in the same 10-month diploma format to about 100 other students. This concept, devised by NCPC, has fulfilled a need for practical instruction beyond the 4-year curriculum for agricultural workers.

A variety of other informal and formal training also took place under the project. A Burmese agronomist completed a 1-year study tour at IRRI, working with DWRC scientists on rodent problems in rice. One Filipino graduate student completed a nondegree vertebrate pest program at Michigan State and returned to the Philippines to work in crop protection. Three other Filipinos received doctoral degrees in vertebrate pest management at Bowling Green State University and North Carolina State University. Another graduate student at BGSU will complete his Ph.D. soon.

A training package for rodent control in coconut groves was developed, field-tested, and made available to national extension officers. A three-year training program is scheduled to begin in 1985. A one-week training course was offered to NCPC staff to improve office procedures and administrative support techniques.

Assistance was provided to Ms. Paciencia Milan, a doctoral student studying rodents in Philippine coconut. She completed requirements at Bowling Green State University and has returned to Visayas State College of Agriculture.

Project scientists assisted the Philippine Council for Agriculture and Resources Research and Development by contributing to a series "Philippine Recommendations for Rodent Control" to be released in 1985. A rodent biology textbook being produced by NCPC was completed, published and released by the UPLB in 1985.

Project scientists assisted the IRRI in preparation of an illustrated guide for Integrated Pest Management (IPM) in tropical rice which included rodents. In addition, they gave lectures and field demonstrations on other VPM problems during a rice IPM workshop.

Africa

DWRC helped organize and participated in a USAID Regional Food Crop Protection Project and OAU Interafrican Phytosanitary Council-sponsored training conference, entitled "Vertebrate Pests of West African Crops" in Niamey, Niger. The goal of the conference was to bring the latest research results to individuals of each country in the best position to implement pest management. Participants included representatives from Sahelian countries, including crop protection services of Mauritania, Senegal, Gambia, Cape Verde, Guinea-Bissau, Mali, Upper Volta, Niger, Cameroon and Chad. Speakers conducted workshops on the subjects of bird and rodent pests of the Sahel, damage assessment techniques, control methods and strategies at the national and regional level, lethal and nonlethal crop protection, rodent control for small-farm agriculture and in storage, determining movement patterns, environmental concerns, and training and research needs. The proceedings from the workshop are to be published in French and English.

Latin America

Agronomists in Haiti participated in a Rice Seminar at the Mauge Experimental Station in the Artibonite Valley. Project personnel presented the vertebrate pest management portions of the seminar.

DWRC Training Activities

Because of growing recognition of the importance of vertebrate pests to food production and storage in most countries of the world, there is an increasing need for specialists to define, research, and manage these problem species. Recognizing the need for graduate training in the newly emerging field of Vertebrate Pest Management, the Department of Fishery and Wildlife Biology, Colorado State University, has developed a cooperative arrangement with the U.S.

Fish and Wildlife Service's Denver Wildlife Research Center for individuals seeking advanced education in Vertebrate Pest Management and fields related to the control of animal damage. A special effort has been made to address the individual needs of international participants in managing vertebrate pest problems in their home countries. This effort supplements programs presently existing in other universities.

The academic program consists of courses such as:

Principles of Wildlife Management
Wildlife Management Techniques
Vertebrate Pest Management
Wildlife Ecology
Statistics
Wildlife Biology Seminar
Independent Study in Vertebrate Pest Management
Mammalogy
Ornithology
Animal Behavior
Economics of Natural Resources.

During the four years this program has existed, 37 students, including individuals from Malawi, Sudan, Nigeria, Venezuela, Columbia, Nicaragua, Guatemala, Bangladesh and Ethiopia have enrolled.

Project scientists worked with faculty at Bowling Green State University, the University of California at Davis, and University of Wyoming to provide international vertebrate pest control training for students of these universities.

Vertebrate Pest Seminars:

Seminars on vertebrate pest problems and control, illustrated with color slides and narrative were given at BARI, Bangladesh and subregional Agricultural Research Stations, to personnel of the Thana Training and Development Center, and to students and training staff at Agricultural Extension Training Institutes. Approximately 1,000 participants attended these seminars.

Other DWRC Activities

DWRC staff traveled in Asia, the Caribbean, Latin America, Africa, and Europe in conjunction with ongoing field research activities and at the request of FAO and foreign governments through USAID missions or S&T/AGR, to assess vertebrate pest problems, review, evaluate, and coordinate present and future research programs and to present seminars. This travel for 1983/4 involved 614 person-days in 25 countries. The dates, persons involved, countries visited and the purpose of each trip are outlined briefly in Appendices III and IV.

II. Issues to be addressed

A. Was the quality and quantity of the project output adequate for the separate tasks?

The evaluation team has reviewed DWRC reports and determined that each individual task order was given adequate attention to successfully complete the scope of work.

B. What kinds of applied research activities were carried out to resolve rodent and bird problems in LDCs? Describe and characterize these activities.

1. Profiling, Mimicking, and Masking the Flavor of a Selected Rodenticide

Results of the research showed that rats are capable of recognizing the flavor components of strychnine. Moreover, when these components are mixed in proportion to the degree of generalized aversion, a mimic of strychnine is obtained. Although these results are from laboratory tests, we believe that the methods can be effectively applied in the field to improve baiting efficacy.

2. Rodenticide-treated Nest Material to Control Bandicota bengalensis

This is a rodenticide delivery method of placing poison-treated nest material near the burrows for pickup and caching by rats which could prove advantageous even during the dry season when bait acceptance is poor due to grain hoarding in burrows or bait shyness.

3. Determining Trimethacarb Residues in Sorghum and Rice

The research indicated that the amount of chemical on the seed at harvest was far less than the amount shown to inhibit germination; therefore, sprayed seeds could be used as seed stock without reduced germination.

4. Evaluating Experimental Rodenticide in Wild Rats

This was a study of an acute oral, single-dose chemical which produces delayed mortality in the rodents exposed.

5. Use of Bird Scaring Reflection Tape

A reflection tape strung over the top of maturing grain crops susceptible to bird damage was tested in several countries and crops and found successful in repelling birds and reducing damage significantly.

6. Laboratory Trials Testing candidate repellent chemicals on Pest Birds in the Philippines

Two bird repellents were tested for toxicity (LD_{50}) and repellency (R_{50}) on Philippine pest birds. The laboratory results indicated that both methiocarb and trimethacarb warrant preliminary field testing.

7 Estimating Rodent Populations and Damage to Stored Grains

A closed colony of house mice in a wheat storage area was studied to develop methods to estimate rodent numbers and damage to wheat. Water intake and photocell breaks were tested as rodent population estimators. House mice consumed about 20 percent of their body weight per day.

C. Describe the kinds of training provided.

This is covered in paragraph I.C.1., page 4-7 above.

D. What kind of assistance has been given to public and private institutions in LDCs?

Assistance was focused primarily through country and regional public institutions and consisted of direct participation in research studies, discussions, reviews and revisions of research and training plans; coauthorship and editing of research papers and training manuals; and provision of resource materials and/or speakers for local or regional training. Indirectly, much of this activity does assist private institutions and corporations acting in these countries, by creating informed users and improved markets for vertebrate pest control materials and by faciliatating hazard analysis for local registration of such materials, facilitating their availability for use by farmers. The private sector in Bangladesh was included in the national rodent control in wheat campaign by using five local manufacturers to formulate bait materials.

E. Describe a sample of an in-country program carried out under this PASA.

The Philippine Vertebrate Pest Management project based at the National Crop Protection Center (NCPC) in Los Banos was completed under this PASA. It consists primarily of field and laboratory activities aimed toward reducing rodent damage to rice, coconut, and corn, and defining the scope and magnitude of agricultural losses caused by birds. Cooperative studies with NCPC staff provided both new data and increased staff capability for continuing such research

after project completion. Work with graduate students and trainees from the Philippines and other Asian countries, conducted in conjunction with the crop protection graduate program at the University of the Philippines, provided a means to obtain substantial data to advance project objectives and provide professional training for students and trainees. The project biologist stationed in the Philippines interacted frequently with DWRC-based staff to coordinate adjunct research and data analysis related to Philippine and Southeast Asian problems and to establish direct, ongoing working relationships among host country staff, regional trainees, and Denver-based researchers. Scientific and technical publications in national and international journals were coauthored with host-country staff to provide identity for local personnel and host-country institutions as well as to make project findings widely available.

F. Do reports from the project cover the various activities in sufficient detail?

The review team found that the annual reports, trip reports, publications, technical reports and training manuals provided the Agency with sufficient information to make an informed decision on the future direction of this project.

G. Are the financial resources under the project justified in terms of actual accomplishments and outputs?

The financial resources are more than justified in terms of accomplishments and outputs. Since January 1983, AID/S&T has invested only $1,625,000 for research, training, technical assistance and networking at DWRC. In Bangladesh alone the savings through the use of ready-made zinc phosphide bait in standing wheat in 11 primary districts in one season (1983/84) amounted to 5,414 tons or $736,304. Since 1976, when improved techniques were introduced in the Philippines for controlling rat damage in the rice fields, an annual savings of $14.0 million has been realized.

H. Ratio of FY 1984 PASA person-days to project expenditures by project component.

Project Component	Percent	Person-Days	Expenditures
Research	35	764	$192,150
Technology Transfer	35	764	192,150
Problem Solving Assistance	10	218	54,900
Training	10	218	54,900
Networking	10	218	54,000
Total	100	2,182	$549,000

I. Ratio of number of trainees/training to expenditures.

Number of Trainees receiving training at DWRC or in association with DWRC during FY 1984-85 is 32.

Estimated Training Expenditures

16 Individuals	FY 1984 (10%)	= $54,900	Average	$3,431.
16 Individuals	FY 1985 (10%)	= $48,300	Average	3,019
Total		$103,200	Average	$3,225

III. DWRC Capabilities

A. Staff

1. How do the numbers, job classifications, and duties of the DWRC staff compare to the needs of the LDCs?

The numbers, job classifications, and duties of the staff assigned to the project in the International Programs Section were adequate to achieve the project goal and purpose. There were four scientists, one technician and two administrative persons in this section, all of whom were partially funded by this project. In addition, 25 scientists and 12 support staff from other sections of the DWRC were called upon to provide assistance, as required, usually without charge to the project. Several of the DWRC professional staff are fluent in French and Spanish. Because of the limited staff under this project, activities in the categories listed (research, technology transfer, training, and networking) were implemented by all project staff. Comments below summarize overall professional capabilities within the International Programs group at DWRC.

a. Research: Approximately 75 percent of staff are scientists or have primary expertise as research scientists or research technicians. Of this group, about 50 percent have primary orientation toward field research and 50 percent toward laboratory research. Many studies require a multidisciplinary approach; the scientific component was adequate to allow for high-quality, multidisciplinary effort.

b. Technology Transfer: Technology transfer was implemented in conjunction with field research and through cooperative publications of research findings with host-country scientists. Preparation of training manuals or inputs

into locally prepared training materials were also utilized. Numerous requests for information from LDCs, AID Missions, and international organizations were responded to by project scientists. The DWRC library provided an important secondary means of information transfer and contacts with LDC scientists and institutions. The library sent 1025 reprints/photo copies of technical papers in response to requests in the first seven months of 1985. The library activities were not charged to the project.

c. Training: Training was conducted by three principal methods: 1) participation by scientists in formal or informal graduate training programs, 2) local workshops or on-the-job training in conjunction with field research efforts in LDCs, and 3) organized, but informal training programs for LDC personnel visiting DWRC for periods of a few days to several weeks. In the latter category, trainees often worked directly with DWRC scientists not funded under the project at no additional cost to AID.

d. Networking: As a national research institution, DWRC serves as the hub of an international network in vertebrate pest management, resulting in frequent interaction among many of the professional scientists and experts with LDC counterparts. Project personnel made efforts to utilize already established networks and to develop new relationships with the international agriculture research centers and with projects funded by other international donors. The network coordinated by DWRC is composed of more than 700 persons from about 400 organizations. The scientific capabilities at DWRC continue to be well suited to the networking approach.

2. Is the training, job classification and experience of the professional staff adequate to achieve the project purpose?

The four scientists of the International Programs Section have excellent training and extensive overseas experience. The International Program Section of DWRC maintains a permanent research staff composed of wildlife biologists specialized in vertebrate pest ecology and management methods development; other DWRC sections provide laboratory and field researchers in a variety of scientific disciplines and a supporting research group involving statisticians, engineers, and information specialists. Many of these researchers also have overseas experiences. These project scientists, most of whom work across several projects and disciplines, represent a cross section of the DWRC.

The Center currently employs 111 professionals, 75 clerical/technical personnel and an additional 40 temporary personnel to handle seasonal field work. The research is concerned with two primary areas; 1) ecological relationships between wildlife, their habitats and man's needs for land and water and associated resources; and 2) reducing the damage wildlife causes to agriculture, forests, industry, or other areas of human endeavor. The latter is extremely important to the LDCs. In this regard, research in animal damage control includes damage assessment; laboratory and field studies of behavior and ecology of the damaging species; and the development and testing of chemical, physical, or cultural methods for minimizing or eliminating the problem situation. Emphasis is given to insuring that the methods developed are biologically sound, effective, safe, and socio-economically acceptable within the broad context of environmental concerns.

3. Does the use of part-time professional staff result in desirable utilization of resources?

The use of part-time professional staff has made it possible to realize the maximun benefit from S&T/AGR's limited resources. This is made possible by DWRC's policy of maintaining world renown scientists and experts at the Center and partitioning professional scientists' time across several related projects and activities during the year.

4. Has adequate provision been made in the event of unanticipated short- and long-term absences of staff members?

In the event of short- or long-term absences of staff members, the International Programs Section can draw on the expertise of the rest of DWRC, including the field stations to provide needed scientists to implement required work for AID.

B. Facilities

1. Are the facilities adequate?

The DWRC facilities are more than adequate to backstop a program for the LDCs. The headquarters consist of 19 buildings (estimated value of buildings and equipment is $17.8 Million) located on 5 acres of land. In addition, 23 field stations are located in areas remote from Denver. Overseas field stations are provided by host government agencies. Other field stations range from 23 acres at Gainesville, Florida to a two acre station at Laredo, Texas.

2. Who finances the facilities?

Rental costs for DWRC facilities are financed by the U.S. Fish and Wildlife Service. Overhead costs (27 percent) included in project funds are utilized to some degree for facilities rental costs charged to DWRC administration.

3. Are the facilities appropriate for training LDC students?

DWRC facilities are highly appropriate for the types of training provided. For example, LDC students do their course work at U.S. Universities and their research at DWRC or in their home countries. Cooperating universities are Colorado State University, in nearby Fort Collins, University of California at Davis, Bowling Green State University, Bowling Green, Ohio, and University of Wyoming, Laramie, Wyoming.

C. Equipment

1. Is the equipment for research and other activities of the right type and up to date?

The research equipment is more than adequate for the work at the Center. DWRC has the most modern equipment for the type of assistance it provides within its mandate. The research laboratories consist of 14,315 square feet. Its pens and outside storage consists of 4,105 square feet. The total square feet of space at DWRC is 85,870.

2. Is the equipment appropriate for training LDC students?

The equipment maintained at DWRC provides the most modern environment for training. Because the basic research is performed at the Center or field stations, participants can benefit directly by the exposure to methods applicable to problems in their home countries. Animal quarters, experimental facilities and laboratory and field equipment are similar to that which is or could be used in developing countries.

IV. Relevancy of DWRC's Work to LDCs.

A. Are the interests and needs of the missions and regional bureaus in the area of pre/postharvest vertebrate pest control being adequately addressed?

DWRC scientists are responding to the interests and needs of the missions and regional bureaus. For example, in the Philippines rodent damage to rice approached 5.0 % of cut tillers. DWRC scientists developed a baiting technique and trained field

technicians and by 1976 this technique resulted in less than 1.0 % cut tillers and an annual savings of rice valued at $14 million. Rat damage to coconuts is extensive in many of the developing countries. DWRC scientists developed a methodology involving crown baiting a small percentage of palms with anticoagulant rodenticides to solve this problem. This technique resulted in a minimum benefit of $1.28 for every $0.09 invested.

B. Is DWRC research relevant to LDC problems and environment?

The DWRC research results are highly relevant to LDC problems and environments. The project provides a channel through which information and research generated by DWRC scientists working in a specific LDC can be applied to other LDC situations with similar environment.

C. Is the PASA providing adequate useful information to LDCs on rodent and bird damage?

The project serves as a major source of worldwide information concerning the impact of bird and rodent damage on agriculture and on methods and materials for alleviating such damage. Numerous LDC inquiries found in DWRC and AID correspondence/cable files document the utility of such information for LDCs

V. Special AID Benefits

Many benefits are received under this PASA agreement with DWRC that are not charged to the project. Some of the benefits are listed below:

A. Training in connection with degree work.

In this category many of the LDC students are provided use of laboratories, library, statistical and computer services and special guidance from DWRC scientist at a minimal cost to the project.

B. Short-Course Training Sessions to LDC visitors.

C. Technical assistance provided to LDCs, missions, FAO, World Bank and other sponsors.

DWRC responded to requests for assistance outside of the projects. In 1984 these requests totalled 184 and ranged from literature or information on research and crop protection to materials and photographs. From January through August 1985, 125 requests from 34 LDCs were answered.

D. Consultations with foreign Visitors at DWRC.

DWRC receives visitors to the center regularly who are given orientation on the activities and research going on and how they relate to the conditions in their home countries. Their names are placed on an international mailing list for receiving annual reports and other literature and publications appropriate to their VPM interests.

E. Participation of DWRC staff in international workshops and seminars.

In order to maintain the extensive network system established under the predecessor project, it is necessary for DWRC staff to attend and participate in key domestic and international workshops and seminars. This is accomplished with minimal cost to the project.

F. Publications funded by DWRC.

Costs for research publications are shared by the International Programs Section and by the project. Research publications concerning domestic VPM problems are totally funded by DWRC, but directly benefit the International VPM community.

G. Complementary Research.

DWRC has also attempted to optimize limited resources and expertise in vertebrate pest management through cooperative planning and complementary research with both domestic and international organizations. An example has been the collaborative efforts of FAO, DWRC and several governments of African countries to determine migratory patterns of pest birds. This effort was implemented at minimal cost to the project.

H. DWRC Equipment

DWRC field and laboratory equipment used by LDC graduate students and scientists for related vertebrate pest management and control research is estimated at $50,000 per year. The use of this equipment is DWRC's contribution to achieve the purpose and goal of the project.

I. Estimated replacement cost of facilities and equipment

The facilities and equipment available to the Agency at no cost are estimated at $17.8 million, of which $9.0 million is for buildings and $8.8 million for laboratory equipment, computers, vehicles, major office equipment, and animal holding pens.

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MMozynski:8/26/85 REV. 9/05/85

OVERVIEW

DENVER WILDLIFE RESEARCH CENTER INTERNATIONAL ACTIVITIES

BACKGROUND

Since 1967, the U.S. Agency for International Development (AID) has supported developmental research to reduce vertebrate pest damage to agriculture in developing countries under Participating Agency Service Agreements with the U.S. Fish and Wildlife Service's Denver Wildlife Research Center (DWRC). These projects, with worldwide applications, include work on a variety of methods, materials, and control strategies pursued both in Denver and in various field programs. Current field programs supported by AID are located in Joydebpur, Bangladesh, established in 1978, and in Port-au-Prince, Haiti, established in 1980.

PROJECT GOAL

To increase the available human food supply in developing countries by reducing the risk of severe preharvest and postharvest losses to agriculture caused by vertebrate pests. This will be accomplished through safe, effective, and economical control methods appropriate to small farmers and acceptable in the broader context of agricultural development and environmental protection. Self-sustaining, in-country programs are the expected result of the project.

METHODS

- Team approach to problem solving.
- Problem-oriented laboratory research.
- Integrated approach considering all interacting factors in a problem situation.
- In-country programs, including research, training, extension, and institutionalization.
- Timely transfer of research findings to user groups.
- Cooperative linkages with other international organizations and governments.
- Outreach activities from DWRC as requested by AID/Washington, AID Missions or host countries.
- Technical, administrative, and supervisory support from DWRC.

PERSONNEL

Personnel of the Section of International Programs stationed at Denver:

John W. De Grazio	Section Chief - Supervises and coordinates research activities; organizes or participates in outreach activities to control vertebrate pests in AID-designated developing countries.
Donna J. Scott	Section Program Assistant - Manages fiscal activities, travel arrangements, personnel functions, commodity procurement, shipping. Coordinates these and other activities with AID/Washington, AID missions, and international organizations.
Richard L. Bruggers	Biologist - Assists laboratory research in Denver and oversees bird control activities in Asia, Latin America, and Africa.
Lynwood A. Fiedler	Biologist - Assists laboratory research in Denver and oversees rodent control activities in Asia, Latin America, and Africa.
G. Clay Mitchell	Biologist - Assists outreach research and cooperative activities with emphasis on bird and rodent damage problems; responsible for developing comprehensive rodent bibliography.
Annaliese E. Valvano	Editorial Assistant - Performs secretarial duties; edits and prepares manuscripts, reports, and correspondence.
Michael S. Bornstein	Biological Technician - Assists Section personnel with laboratory studies, commodity procurement and shipping, literature searches, analyses, etc.

Personnel of the Section of International Programs stationed overseas:

Joe E. Brooks Bangladesh Agricultural Research Institute, Joydebpur, Bangladesh	Biologist - Manages research and cooperative activities with emphasis on rodent and bird damage problems.
James O. Keith Ministry of Agriculture, Port-au-Prince, Haiti	Biologist - Manages research and cooperative activities with emphasis on rodent and bird damage problems.

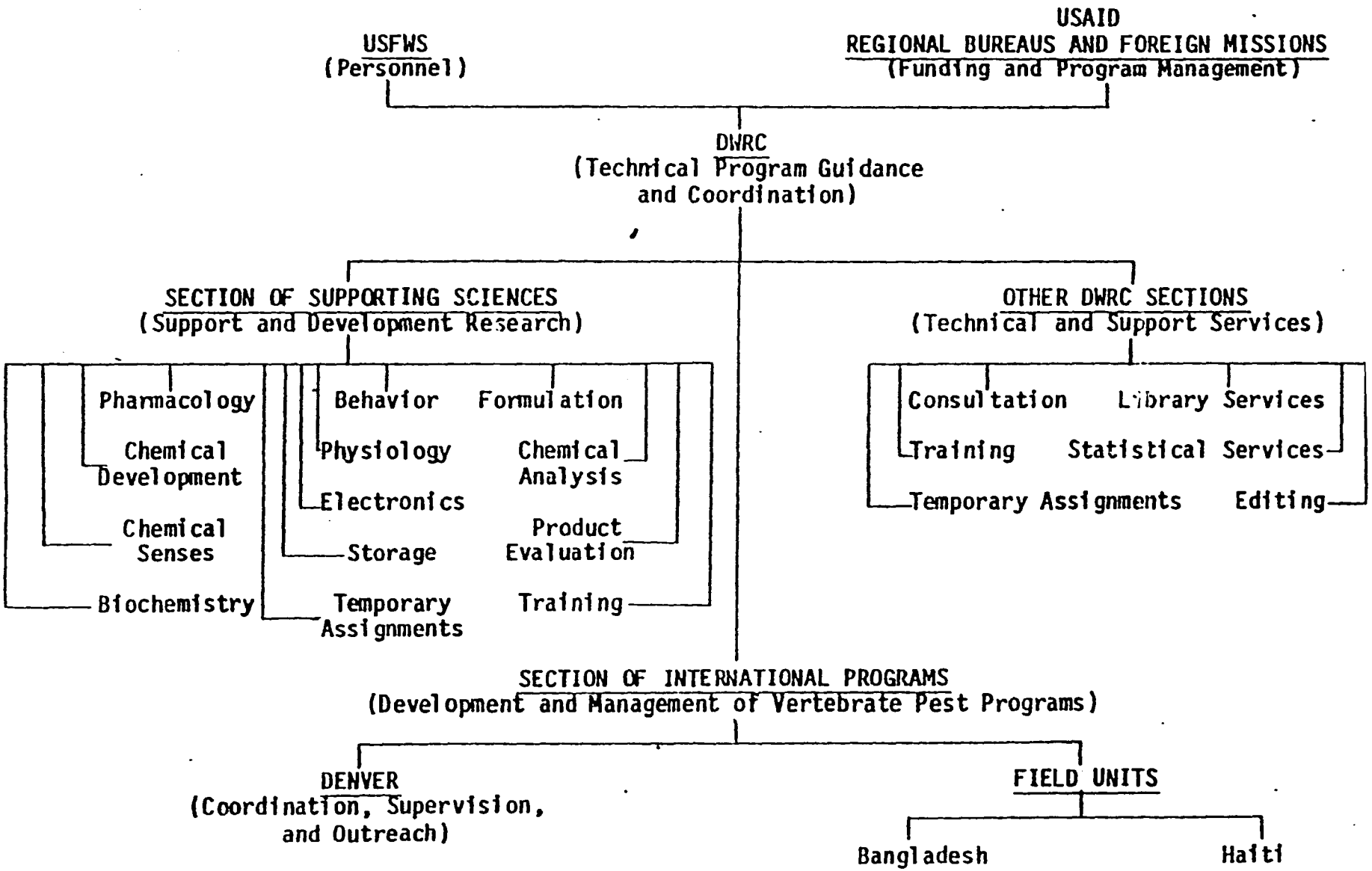
Other DWRC personnel assisting the Section of International Programs:

Section of Supporting Sciences

Roger W. Bullard	Biochemist - Coordinates postharvest food loss research activities in Denver.
	Ten other persons are partially funded by AID to conduct field problem oriented research studies in the laboratory and provide TDY assistance. Expertise covers electronics, pharmacology, physiology, behavior, biochemistry, and chemical analytical services.
Other Sections at DWRC	More than 100 professional and support personnel provide expert assistance to International Programs. Expertise includes fields of administration, terrestrial and marine mammalogy, ornithology, wildlife ecology and management, taxonomy, species abundance and distribution, primate ecology, and statistical, computer, library, and editorial services.

FACILITIES

Bangladesh	Vertebrate pest project building completed in 1980 and consists of office, laboratory, and animal room as a part of the Bangladesh Agricultural Research Institute. Jackal pens and outdoor rodent enclosure completed in 1982. Experimental plots available nearby.
Haiti	Vertebrate pest project building completed and consists of office, laboratory, animal room, conference room, and outside holding pens. Facility is located with the Ministry of Agriculture complex at Damien.
Denver Wildlife Research Center	The DWRC is a major research facility of the U.S. Fish and Wildlife Service. At DWRC, an interdisciplinary team of specialists, using a broad spectrum of sophisticated laboratory equipment and specialized facilities, conduct backup research for field programs. Cost of duplicating this capability at overseas stations would be exorbitant and impractical.


USFWS
(Personnel)
USAID
REGIONAL BUREAUS AND FOREIGN MISSIONS
(Funding and Program Management)
DWRC
(Technical Program Guidance
and Coordination)
SECTION OF SUPPORTING SCIENCES
(Support and Development Research)
Pharmacology
Chemical Development
Chemical Senses
Biochemistry
Behavior
Physiology
Electronics
Storage
Temporary Assignments
Formulation
Chemical Analysis
Product Evaluation
Training
OTHER DWRC SECTIONS
(Technical and Support Services)
Consultation
Training
Temporary Assignments
Library Services
Statistical Services
Editing
SECTION OF INTERNATIONAL PROGRAMS
(Development and Management of Vertebrate Pest Programs)
DENVER
(Coordination, Supervision,
and Outreach)
FIELD UNITS
Bangladesh
Haiti

ESTIMATES OF ECONOMIC LOSSES TO VERTEBRATE PESTS

BANGLADESH	$128 million annual loss of rice to rats $15 million annual loss of wheat to rats
PHILIPPINES	$60 million annual (prior to 1975) loss of rice to rats 30% annual loss of coconuts to rats, representing about $192 million 7% damage, 3% total loss in sugarcane to rats
AFRICA	$100 million annual loss of sorghum and small grains to birds
SUDAN	$15-30 million annual loss of cereals to birds
HAITI AND THE DOMINICAN REPUBLIC	$30 million annual loss of agricultural crops to rodents and birds
LATIN AMERICA	$350 million annual loss of livestock to rabies transmitted by vampire bats

AID/DWRC ACHIEVEMENTS IN REDUCING VERTEBRATE PEST LOSSES

PHILIPPINES

Sustained baiting has been incorporated into the Masagana 99 technology package for participating farmers. Rat damage to rice on these farms (500,000 ha or 1,000,000 effective hectarage) was reduced from 5% to 1%.

Annual surveys by the Bureau of Plant Industries on 2.1 million ha showed rat damage of 3.67% (1971-75) and 0.49% (1976-79). Sustained baiting and training of field technicians contributed to loss reduction amounting to savings of more than $14 million per year since 1976.

Recent trials using anticoagulant rodenticides in coconut crowns increased yield 280%. Cost:benefit ratio of the 3-year program based on actual costs of control and copra production at the end of the 3 years was 1:28. Estimated annual gain for the entire country is $192 million.

Experimental trials using modified sustained baiting with anticoagulant rodenticides in corn reduced damage by 84%. Farmer profits increased $27.40 per ha. For each $1 spent, $7 were returned.

NICARAGUA

Paralytic rabies in livestock caused by vampire bats has been eliminated. Annual benefits to the livestock industry, $2.4 million; annual control program costs, $130,000. For each $1 spent, there was a return of $18.74.

LATIN AMERICA

As a result of AID/DWRC training and extension activities, 13 of 18 countries plagued with vampire bats have self-funded control programs.

COLOMBIA

Experimental trials using crown baiting of anticoagulant rodenticides in 1973 reduced rodent damage to coconuts from 75% to 0%. Based on 1973 prices, it was estimated that treatment of 1 million palm trees would result in an annual $730,000 savings.

SUDAN

Field studies in Sudan and East Africa indicate that effective crop protection can be achieved using the chemical repellent methiocarb at relatively low levels and with economical application techniques. Since 1976, a 1,012-ha wheat farm in Tanzania has experienced less than 5% losses to pest birds during the 3 years in which methiocarb was applied to those parts of the field being damaged. In 1978, when the chemical was not used, birds caused 80% damage to the fields.

BANGLADESH — Experimental trials using zinc phosphide bait cakes to reduce rodent damage to ripening wheat was conducted in one district during the 1981 season. Observed results showed that farmers who used the prepared baits reduced damage to their wheat crop by 71%; the cost:benefit ratio in this study was 1:30. Based on these results, a nationwide control campaign was initiated in January 1983.

HAITI — The Organization for the Development of the Artibonite Valley (ODVA) is responsible for rice production in the valley which has 23,000 ha under cultivation. Haitian counterparts trained 20 ODVA agronomists and several peasant farmers how to apply the sustained baiting method for reducing preharvest rice losses to rodents. As a result, 50 ha of newly transplanted rice were baited with the rodenticide warfarin in 1982. In 1983, the treated area may be increased and comparative studies with zinc phosphide- and warfarin-treated baits will be conducted before making recommendations for large-scale baiting programs.

TRAINING AND INFORMATION TRANSFER ACTIVITIES

TRAINING

Thousands of individuals, including farmers, extension agents, technicians, biologists, veterinarians, administrators, and others concerned with agricultural production, have received both informal and formal training in many aspects of vertebrate pest management. The informal training has taken many forms:

- workshops, demonstrations, and seminars;

- day-to-day interactions between counterpart personnel and resident biologists in all phases of the research process which includes planning, execution, data collection and analyses, reporting, and extension;

- (1) in-country training for either resident or nonresident individuals with a local university (for example, University of the Philippines at Los Banos) on a special problem overseen by and in cooperation with the resident biologist or (2) short diploma courses; and

- short-term study programs in laboratory or field research for individuals from developing countries at DWRC or one of its domestic or international field stations.

The formal training provided through USAID/DWRC Vertebrate Pest Projects has resulted in 35 counterpart personnel from 10 countries receiving graduate training leading to advanced degrees (M.S. or Ph.D.). Most of these individuals have returned to their country and are working in some aspect of agriculture or vertebrate pest management. M.S. or Ph.D. programs in vertebrate pest management are offered at several U.S. universities including Colorado State University, Fort Collins, Colorado, Bowling Green State University, Bowling Green, Ohio, and the University of California at Davis, California. In some instances, thesis research can be accomplished at DWRC or at one of its field stations. In special cases, a nondegree program can be arranged.

INFORMATION TRANSFER

Information transfer has taken many forms and includes workshops, demonstrations, seminars, training manuals, brochures, annual reports, formal publications, media materials, and responding to written requests from interested individuals or agencies worldwide. Information transfer has been particularly successful in association with controlling vampire bats in Latin America, baiting the crowns of coconut trees for rat control in the Philippines, and developing a rodent control campaign against rat damage to wheat in Bangladesh. For example, this latter program included: daily radio spot announcements, newspaper articles, TV coverage, distribution of 375,000 leaflets to school children in the 11 districts, distribution of 75,000 leaflets to farmers, and January 28, 1983 was declared "Kill a Rat" day.

RESEARCH ACCOMPLISHMENTS, CURRENT AND PLANNED ACTIVITIES

Since the project started, accomplishments in research methodology, techniques, and material development have been detailed in Annual Progress Reports and research publications by DWRC personnel and counterparts. Summarized below are some significant research findings obtained during outreach and in-country project activities.

OUTREACH ACTIVITIES FROM DWRC

a. Accomplishments

Developed two methods to control vampire bats that transmit rabies to livestock in Latin America. Local personnel were trained to handle in-country programs. Rabies was eliminated in Nicaragua.

Conducted successful tests to control rat damage to coconuts in Colombia.

Conducted successful test using the repellent methiocarb on ducks damaging emerging rice in Uruguay.

Demonstrated that rhodamine B is a highly effective marker for rodents when used in a grease formulation.

Demonstrated that Microtaggant plastic particles can be incorporated into baits to mark birds and rodents.

Developed a technique for using coded micro paint particles to mass-mark social bird species.

Developed miniaturized radiotelemetry equipment for studying ranges, activity, and long-distance movements of small rodents, birds, and bats.

Developed methods of assessing rodent and bird damage to various agricultural crops.

Developed the technique of using inked tracking tiles to determine rodent activity in relation to crop damage or to evaluate control methods.

Developed standardized laboratory techniques for comparative evaluation of candidate toxicants and repellents on rodent and bird species.

Developed a more effective bird repellent enhancement method by adding taste or color compounds to the formulation.

Developed an inexpensive gas fumigant cartridge for control of burrowing rodents.

Developed biochemical test procedures to determine bird resistance and nutritional characteristics of sorghum varieties.

Developed a computerized cage system for comparing feeding patterns of different rodent species in relation to different rodenticides or bait formulations.

Instigated a new project on postharvest food losses. Basic literature search completed, study plans developed, and laboratory research underway.

b. Current and Planned Activities

Continue to respond to requests by AID and foreign governments or international agencies for technical assistance in defining and resolving vertebrate pest problems.

Provide analytical and radiotelemetry support (as needed) for field programs in developing countries.

Assist in training personnel to use electronic instrumentation and chemical analysis to support field programs.

Continue to assist in field research, evaluation, demonstration, training, and dissemination of information.

Continue problem-oriented, basic, and applied research activities at DWRC laboratories.

Continue to act as liaison between DWRC and field personnel including U.S. and foreign investigators.

Evaluate potential candidate chemicals and bait formulations for field rodent control programs.

Test and evaluate gel and toxic grease formulations for rodent and bird damage control applications.

Explore aspects of the nature of grooming and taste interactions to improve existing control methods for rodents and birds.

Compare food preferences and food neophobia responses in selected rodent species to develop improved baits.

Develop improved avicides and rodenticides through syntheses and chemical structure activity relationships.

Study the use of additive cues to methiocarb formulations in border applications to maturing small grains.

Conduct studies on improving the effectiveness of methiocarb and Avitrol for field application.

Examine aversive components of bird-resistant sorghum extracts and facilitate development of specialized bird-resistant sorghums.

Develop protocols for assessing postharvest losses to vertebrate pests in developing countries; determine current storage practices and management procedures; and develop control strategies.

c. Current and Planned Activities--in Cooperation with the Philippine National Crop Protection Center

Publish a vertebrate pest control manual for use in on-going training curriculum at the University of the Philippines at Los Baños.

Incorporate vertebrate pest control information into an integrated pest management illustrated guide to be published by the International Rice Research Institute.

Produce and publish in the Philippine Council on Agricultural Research and Resource Development (PCARRD) rodent control recommendations for all major crops for use by administrators, teachers, researchers, and extensionists.

Implement a national program for training in rat control in coconut through the Philippine Coconut Research and Development Foundation (PCRDF) and the Philippine Coconut Authority (PCA) extension program.

Continue surveys to evaluate and quantify postharvest pest losses.

PHILIPPINES

a. Accomplishments

Completed national surveys of rodent damage to rice and determined distribution of rodent pests.

Developed effective method of ricefield rodent control through sustained baiting with anticoagulants for use by small farmers. Recommendations were adopted by Government of the Philippines.

Established vertebrate pest control research and training within the National Crop Protection Center and its regional field stations. About 25 graduate students completed thesis work in association with the project.

Reorganized government operational rodent control programs to incorporate improved methods developed by project personnel.

Developed rodent control techniques for coconut and corn damage.

Investigated fumigant cartridge formulations for use in developing countries, and developed a simulated burrow system for evaluating fumigants.

Investigated anticoagulant wax bait formulations for use in small-farm situations.

Developed a nonlethal electric barrier to prevent crop damage by agricultural rodents.

Evaluated high-energy fence chargers for field use in the tropics.

Supported field programs with specialized equipment and technical expertise for radio tracking animals.

Investigated grooming behavior of rodents in relation to the use of acute rodenticides in grease or dust formulations.

Developed analytical techniques for determining warfarin and diphacinone concentrations in plant, soil, and water samples and demonstrated that these chemicals do not accumulate during field baiting.

EAST AFRICA

a. Accomplishments

Demonstrated effective protection of small grain crops from bird damage can be achieved with relatively low levels of methiocarb repellent head sprays in several East African countries.

Compiled information on crop losses and economic impact of bird damage in Sudan and other African countries.

Obtained information on population reduction efforts as practiced by various organizations. It was found that these overall efforts are largely ineffective in reducing damage except in some local areas.

Determined that the most important agricultural rodent pests in Sudan are Arvicanthis spp. and Mastomys spp. They damage sorghum, wheat, groundnuts, and vegetables.

Developed miniature radio transmitters and attachment method for quelea.

Completed laboratory studies on quelea.

Established colonies of Arvicanthis niloticus and conducted laboratory investigations.

Demonstrated in Ethiopia that red-billed quelea (Quelea quelea) can be mass-marked with fluorescent paint particles to obtain information on their migratory movements relative to crop damage patterns.

Demonstrated in Ethiopia the feasibility of using 1.8-g miniature radio transmitters for rapidly locating nesting colonies and understanding local movements of red-billed quelea.

b. Current and Planned Activities

Continue cooperative research efforts with FAO personnel.

BANGLADESH*

a. Accomplishments

Organized Vertebrate Pest Division within Bangladesh Agricultural Research Institute; established cooperative ties with other agencies; assigned counterpart personnel to project.

Established new laboratory, office, and pen facilities.

Held several workshop and training sessions for Government personnel.

Completed national survey of rodent damage to wheat and rice. The countrywide loss to wheat was valued at about $15 million and to rice about $128 million.

Began national survey of vertebrate pest problems on small farms and started pest identification and analysis of their distribution.

Completed preliminary laboratory evaluation of candidate rodenticides and bait formulations.

Conducted a variety of baiting studies in small-farm crops.

Completed studies of burrow systems and behavior of fossorial rodents.

Conducted test trials to determine the most effective method of monitoring field rodent populations including live and snap traps, and tracking tiles.

Cooperated with GTZ and the Government of Bangladesh in a national rodent control campaign in wheat.

Demonstrated that experimental plots of maize can be protected from parakeet (Psittacula krameri) damage with Avitrol.

Determined the toxicity and repellency of several repellents to pest birds and demonstrated the effectiveness of three chemicals as seed dressings on sprouting wheat in experimental and farmers' fields to prevent bird damage.

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*Funded by AID Mission/Dhaka

Initiated studies of post-harvest losses of stored grains to village farmers.

b. Current and Planned Activities

Study effect of intensive trapping on rodent damage to deepwater rice providing information on seasonal changes in reproduction.

Continue national vertebrate pest and crop damage surveys.

Evaluate efficacy of fumigants for field rodent control.

Evaluate use of taste aversion to protect crops from rat damage.

Evaluate sublethal aversion of various rodenticides, and develop means to overcome or minimize these effects.

Develop improved miniature radio transmitters for field programs.

Develop improved rodenticides and formulations.

Evaluate efficacy of lethal and nonlethal barriers to prevent damage caused by rodents.

Determine reproductive patterns of lesser bandicoot rats (Bandicota bengalensis) and study the feasibility of establishing a breeding colony for research use.

Evaluate burrowing, feeding, and grooming behavior of B. bengalensis to facilitate development of systems for control of this species.

Evaluate use of tracking tiles to more accurately determine rodent movement and population densities.

Continue to evaluate chemical repellents as wheat seed treatments to prevent losses by pest birds.

Initiate studies of rodent damage to stored foods in village clusters.

AITI*

. Accomplishments

Organized Vertebrate Pest Project within Haitian Ministry of Agriculture; established cooperative ties with Dominican Republic Ministry of Agriculture including the assignment of counterpart personnel.

Currently funded by AID/Haiti Mission.

Established new laboratory and office building.

Counterparts received training at DWRC.

Assembled initial information on vertebrate pests and associated problems in agriculture in Haiti and the Dominican Republic.

Demonstrated sustained baiting of rodents in rice is feasible in the Artibonite Valley.

Gathered information through the use of radiotelemetry on the biology of the village weaver (Ploceus cucullatus).

Obtained basic information on the use of pesticides in Haiti and the Dominican Republic.

Documented vertebrate pest losses in maturing corn.

b. Current and Planned Activities

Continue to assemble data on important vertebrate pests, crops damaged, and losses and develop comprehensive research plans for specific vertebrate pest damage problems.

Assist the Ministry of Agriculture develop a rodent control program for rice in the Artibonite Valley.

Evaluate control methods for reducing losses to vertebrate pests in maturing corn.

Evaluate bird repellents on maturing sorghum and rice.

Work closely with the Section of Supporting Sciences on postharvest storage losses.

Assist Peace Corps volunteers in specific vertebrate pest damage studies.

PROGRAM DIRECTION FOR THE NEXT 3-5 YEARS

AID's Bureau for Science and Technology (S&T) has indicated a reduction in future funding for calendar year 1985 and beyond.

The Bangladesh Vertebrate Pest Project is funded through fiscal year 1986.

The Vertebrate Pest Project in the Philippines terminated September 1983.

The Haiti Vertebrate Pest Project has been funded for fiscal year 1984; future funding is unknown.

The Project will attempt to secure additional future funding through contacts with AID Missions in developing countries.

SUMMARY

AID FUNDING 1967-1983

FISCAL YEAR	S&T FUNDS	BANGLADESH FUNDS	UTILIZATION FUNDS	LAC FUNDS	TOTAL
1967	22,000				22,000
1968	251,617				251,617
1969	409,509				409,509
1970	449,594				449,594
1971	558,000				558,000
1972	550,000				550,000
1973	478,641		71,359		550,000
1974	373,813		76,187		450,000
1975	411,578		60,000		471,578
1976[a]	485,000		100,000		585,000
1977	439,850		84,000		523,850
1978	480,000	24,356	95,000	10,000	609,356
1979	543,668	164,944		13,000	721,612
1980	613,566	116,000		247,400	976,966
1981	607,434	154,650		175,000	937,084
1982	462,217	167,781		297,937	927,935
1983	566.416	171,253		249,490	987,159
1984	549,000	191,806		200,000[b]	940,806
Total	8,251,903	$990,790	$486,546	$1,192,827	10,922,066

[a] Includes 5th quarter (transition quarter).

[b] Estimated.

1985	482,820
Total	8,734,723

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REDUCTION OF VERTEBRATE PEST CROP LOSSES IN HAITI

Project 598-0584
(FY-1979 to 1983)

Project 521-0078, No. 4
(FY-1984)

Participating Agency Service Agreements

between

Department of State
Agency for International Development

and

Department of the Interior
Fish and Wildlife Service
Denver Wildlife Research Center

James O. Keith

October 1, 1984

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APPENDIX 6 PRINCIPAL VERTEBRATE DAMAGE TO CROPS IN HAITI BASED ON RESPONSES TO QUESTIONNAIRES BY 14 OF 20 AGRICULTURAL DISTRICTS

PROJECT AUTHORIZATION, BUDGET, AND PERSONNEL

The Vertebrate Pest Control (VPC) project originated as a U.S. Agency for International Development (USAID) Bureau for Latin America and the Caribbean (LAC) regional project for Haiti and the Dominican Republic. These countries share the island of Hispaniola and have common problems of crop losses to rodents and birds. A Participating Agency Service Agreement (PASA) between the Agency for International Development and the Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Center (DWRC) was completed in August 1979. In January 1980, a Memorandum of Understanding was signed with both countries, and counterpart staff were assigned to the project. Project headquarters was established in Port-au-Prince, Haiti, and a project biologist from DWRC arrived in Haiti in May 1980.

The project was funded by LAC from August 1979 through December 1982, and project activities were undertaken in both countries. Project funding support was provided exclusively by USAID/Haiti from January 1983 through September 1984, and activities were restricted to Haiti. The original Project 598-0584 terminated in September 1983. Activities during FY-1984 were continued under PDAI (Integrated Agricultural Development Project) No. 521-0078 USAID/Haiti.

Authorization and Budget

August 1979 — Project Paper and Project Authorizaton approved by USAID/LAC/Washington for a 4-year project (No. 598-0584).

PASA and Project Implementation Order/Technical (PIOT) prepared for 4 years with the following budget:

FY-1979	3 months	$ 13,000
FY-1980	12 months	227,811
FY-1981	12 months	244,185
FY-1982	12 months	302,524
FY-1983	3 months*	62,480
		$850,000

*Total of $850,000 expended as of December 1982, 9 months earlier than planned.

January 1983 — Additional funds were allocated by USAID/Haiti to complete last 9 months of FY-1983 under Project 598-0584.

FY-1983 (Jan-Sep)	$200,000

October 1983 — PASA was extended and additional funds were allocated by USAID/Haiti for FY-1984 under Project 521-0078.

FY-1984 (12 months)	$129,200

Total funds allocated: $1,179,200.

Personnel

1. Project Managers

   a. USAID/Haiti

Mr. Jesse M. Trevino	Feb 1980 to May 1983
Mr. Abdul Wahab	May 1983 to Sep 1984

   b. Departement de l'Agriculture, des Ressources Naturelles et du Developpement Rural (DARNDR), Haiti

Mr. Julio Bartholemy	Feb 1980 to Sep 1984

   c. Secretaria de Estado de Agricultura, Departamento de Vida Silvestre, Dominican Republic

S. Marcos Peña	Feb 1980 to Jan 1981
Ing. Ramon Tio	Jan 1981 to Dec 1982

2. Project Staff

   a. Project Biologists, DWRC

Dr. G. Clay Mitchell	May 1980 to Jun 1982
Dr. James O. Keith	Oct 1982 to Sep 1984

   b. Counterpart Staff

      (1) Haiti

Mme. Michele Rimpel, Biologist	May 1980 to Sep 1984
Mr. Jean-Paul Samedy, Agronomist	May 1980 to Sep 1984
Mr. Colbert Zephyrin, Technician	Apr 1983 to Sep 1984
Mme. Irmgard Laroche, Secretary	Aug 1980 to Aug 1981
Mme. Michaelle Burr-Reynaud, Secretary	Aug 1981 to Jul 1982
Mme. Yolene Gaspard	Jan 1983 to Sep 1984
Mr. Daniel Isidore, Trainee Agronomist	Aug 1981 to Sep 1981
Mlle. Claire Marie Normil, Student	Jul 1983 to Aug 1983
Mr. Dimitri Norris, Student	Aug 1983 to Sep 1983

      (2) Dominican Republic

S. Tomas Vargas, Biologist	Feb 1980 to Dec 1982
S. Manuel Gonzales, Biologist	Feb 1980 to Dec 1982

3. Peace Corps Volunteers

Project funds were used to support activities of volunteers in the Dominican Republic.

Mr. Brent Mitchell	Studies of woodpecker damage in cacao
Ms. Kathy Luke	Studies of village weavers

PROJECT DESCRITPION

Introduction

The VPC project addressed problems related to damage by vertebrates with special attention to crops grown on small farms that suffer from disproportionate losses. The project included technical assistance, training, commodities, conferences, and other appropriate activities in vertebrate pest management. Major activities of the project were training host government specialists, developing appropriate, applied research, and demonstrating programs for vertebrate pest management. A major goal of the project was to establish the capability within host governments to independently continue programs of vertebrate pest research and management after project termination.

During the project, emphasis was placed on observing damage situations and evaluating control practices both in farmers' fields and on experiment station plots. This focus led to an understanding of present and future needs of farmers and provided a background for problem solving in actual pest situations. Locating the field headquarters in Haiti was particularly good for this project because of the large number of small farms available for study.

Effective control methods developed by DWRC have been successful in reducing vertebrate pest damage to agricultural crops in the United States and in developing countries, but the diversity and seriousness of vertebrate pest losses on small farms in Hispaniola was a special challenge. Research and technology developed by DWRC scientists in countries with similar crops, pests, and farming practices were extended and adapted to Caribbean conditions.

Technical Assistance

Technical assistance was provided through a PASA between USAID and DWRC. This included long-term services of a technician with expertise in vertebrate pest management stationed in Haiti for the development of a viable field station and for the training of counterpart personnel. Additionally, DWRC provided many person-months of short-term consultants, with specialized expertise such as research planning and evaluation, biometrics, pharmacology/toxicology, vertebrate behavior and physiology, chemical residue analysis, electronics (biotelemetry, remote sensing), and dissemination techniques to assist the resident technician at the field station.

The resident technician, in collaboration with participating country personnel,

1. Acquired an in-depth knowledge of vertebrate pest situations throughout the region.

2. Determined research priorities and progressed toward developing simple, effective, safe, and economically beneficial systems for management of vertebrate pests.

3. Designed and conducted related studies essential to the development of suitable control procedures. These included pest population dynamics, food habits, and behavior of pest species as related to development, evaluation, and safety of existing and proposed control approaches.

4. Determined distribution and extent of vertebrate pest damage in major small-farm crops as affected by various factors (e.g., cropping practices of farmers).

5. Developed census techniques to determine relative population of vertebrate pests before and after application of experimental control procedures.

6. Evaluated traditional control approaches of local farmers and compared them with newer methods for effectiveness, economic benefits, and human and environmental safety.

7. Planned and conducted laboratory and field studies as required for development of vertebrate control methods (including the capture of animals for research purposes).

8. Planned and conducted field studies to evaluate such approaches as chemical agents, mechanical devices, and habitat manipulation as means of alleviating vertebrate damage.

9. Participated in training programs designed to establish an indigenous capability in the area of vertebrate damage control.

10. Designed and initiated an interim control plan for priority problems identified in each participating country.

11. Participated in scientific meetings, as appropriate, to confer or present papers, and carried on technical correspondence with cooperators.

12. Participated in the formulation of long-term planning and strategy.

Short-term DWRC consultants assisted in specific activities:

1. A research planning and evaluation expert cooperated yearly to coordinate research activities between DWRC and the field station.

2. A biometrician, physiologist, and residue chemist assisted in study designs for evaluating traditional and alternative control approaches in special problem areas and in developing national damage assessment programs. The biometrician assisted in damage assessment methods, population indices, and essential experimental design.

3. Technicians on TDY directed considerable, specialized laboratory and field research (APPENDIX 1).

Supporting research in problem areas, where highly sophisticated or specialized equipment and skills were required, was conducted at DWRC.

1. Electonic materials development (biotelemetric transmitters and receivers, field event counters, remote sensing devices).

2. Toxicological studies (oral toxicity, bajt acceptance, evaluation of candidate control agents for efficacy and safety) and chemical residue analyses.

3. Behavioral studies.

4. Consultants also served as a resource for conferences or seminars, assisted in the training of counterparts, and participated in other project activities within the assigned area of the resident technician.

In addition, the support team in Denver assisted and advised in study plan design and in procurement and shipment of required research and office supplies and equipment.

Training

On-the-job training was continuously stressed during the life of the project. Staff received exposure to many theories, tools, and techniques used in vertebrate pest management. Training also included:

1. Presentation at seminars, conferences, workshops, and field demonstrations (APPENDIX 2).

2. Preparation of publications (scientific journals, popular publications, extension-type brochures, and leaflets) and technical reports (APPENDIX 2).

3. Development and implementation of extension programs.

Senior local staff members from both Haiti and the Dominican Republic exchanged visits and also spent 2 to 3 weeks or more in the U.S. at DWRC and other appropriate U.S. research institutions (APPENDIX 3). Basic objectives were to allow these individuals to become familiar with the overall complexities of vertebrate pest control, to become aware of DWRC technical backup capabilities by working in laboratories and in the field with DWRC personnel, and to receive training in areas related to vertebrate control which are not available in the participating countries.

Facilities and Commodities

1. Laboratory - Haiti

   PL-480 funds ($120,000) were made available for construction of an office/laboratory building on the experimental farm at Damien, where the Ministry of Agriculture is located. This building of about 3,500 ft^2 contains three offices, a secretary/reception area, a

conference room, a library, two laboratories, two animal rooms, two storerooms, two lavatories, and a generator shelter. The construction of the building was begun in May 1981 and completed in October 1982. The building is now fully furnished, equipped, and functional.

2. Aviaries - Haiti and Dominican Republic

In FY-1982, project funds were used to complete an aviary at the experimental farm of the Ministry of Agriculture in San Cristobal, Dominican Republic. Pens in this aviary were used to house birds for avian research. In Haiti, a small, temporary pen was built near the office building to hold birds for laboratory studies. In 1984, funds were obligated for construction of a larger, permanent aviary.

3. Vehicles - Haiti and Dominican Republic

Two, four-wheel drive vehicles were purchased for project use in Haiti and one for use in the Dominican Republic. A motorcycle was purchased for project use in Haiti; another motorcycle was purchased for use by Peace Corps cooperators in the Dominican Republic.

4. Equipment - Haiti and Dominican Republic

The following items are examples of equipment purchased with project funds: Emergency generator at laboratory; desks, chairs, cabinets, tables, and files; shelving for library and storage rooms; microscopes, balances, refrigerators, bioassay cages, and a hygrothermograph; typewriter, calculators, slide projector, projection screen, blackboard, lamps, and fans; binoculars, cameras, CB radios, traps, nets, and biotelemetry equipment; books, magazines, and scientific journal subscriptions.

5. Supplies - Haiti

The following goods are examples of supplies purchased for use in Haiti: Chemicals, reagents, pesticides, and feeds; glassware, toxicological supplies, feed dishes, and waterers; stationery and office supplies; baits, bands, markers, tools, and hardware.

PROJECT ACTIVITIES

Specific research and outreach activities undertaken during the project varied somewhat with the problems and situations in each participating country. The general approaches used in these activities were as follows.

1. Identifying principal bird and rodent pests, determining planting schedules for principal crops receiving damage, and identifying the time when damage assessments and crop protection should be undertaken.

2. Developing assessment techniques for rodent and bird damage to principal crops. The ability to measure crop losses was necessary to evaluate effectiveness of candidate control methods and provide an economic base to measure benefits.

3. Determining optimum dosage for principal pest species and environmentally sound application methods for vertebrate pest control chemicals.

4. Cooperating with other agencies to evaluate control practices currently recommended or used by the Ministry of Agriculture and/or farmers. This was necessary to provide agencies and farmers with information on how current practices compared with alternate approaches.

5. Systematic testing of control approaches for use under various pest damage situations. Such approches were either adapted from findings in other countries or devised under local conditions.

6. Conducting field observations and periodic population surveys for several pest species in each region. This information was important to gain an understanding of fluctuating population densities and periodic pest outbreaks.

Objectives for Denver-based personnel during the project period included:

1. Screening and evaluating candidate chemicals for possible field testing against selected pest species.

2. Analyzing basic behavior patterns and physiological functions of selected pest species to provide background information for the development of more effective biological and chemical control approaches.

3. Designing specialized equipment (traps, field recorders, experimental bait formulations, sprayers, cages, etc.) and providing statistical and technical literature assistance.

As project development proceeded, research needs for specific problem situations were identified. The program was one of problem solving through adaptive research and practical application of selected techniques, therefore, considerable attention was placed on developing methods and information for small farmers. Pilot extension activities using proven technologies were supported by training programs, field demonstrations, and workshops.

SUMMARY OF ACCOMPLISHMENTS

1. Compiled data on crop production within each of the agricultural districts in Haiti. This enabled the determination of where crops susceptible to vertebrate damage are grown and where fieldwork should be conducted.

2. Compiled data on crop phenology in both mountain and valley zones. This showed in which months damage could be expected in susceptible crops within both zones. Data were generally applicable throughout Hispaniola.

3. Conducted questionnaire surveys of vertebrate damage to crops in each agricultural district of Haiti. This provided a subjective assessment by agronomists in each district of the scope and severity of vertebrate pest damage. It also indicated where problems might be the greatest and allowed priorities for work to be established.

4. Conducted countrywide assessments of village weaver abundance and damage in ricefields in Haiti and the Dominican Republic.

5. Conducted seven laboratory trials with birds to determine lethal and repellent levels of selected chemicals.

6. Conducted six laboratory trials with rats to establish lethal levels of toxicants and relative acceptance of different baits.

7. Conducted 30 field assessments of timing, intensity, and conditions of bird and rat damage to crops throughout Haiti (APPENDIX 4, section A).

8. Conducted 24 field trials for the development of techniques to reduce damage by birds and rats to various crops in different areas (APPENDIX 4, section B).

9. Conducted eight demonstrations for district agronomists and private volunteer organizations of methods to reduce crop damage by birds and rats. Prepared an extension brochure for rat control in rice (APPENDIX 4, section C).

10. Cooperated for 4 years with staff of DARNDR and Texas A&M University (PDAI project) in the protection of experimental crops on the experimental farm at Damien.

11. Conducted year-long investigations of the reproduction, habits, and local movements of village weavers, Hispaniolan woodpeckers, roof rats, and Norway rats in Haiti to help understand how the animal's behavior is related to damage patterns in crops and what approaches are most feasible to reduce their damages to crops.

12. Investigated the kinds of crops grown on 18 small farms in the Cul-de-Sac Plain near Port-au-Prince and the season, intensity, and ways to control damage by vertebrates.

13. Initiated strategies to reduce losses of crops and stored products on small peasant farms through scheduling of periodic activities to remove rats and repel birds throughout each year.

14. Constructed and equipped an office/laboratory facility at Damien. This facility is now called the Laboratoire des Vertebres and will be the center for continued vertebrate pest research and management in Haiti.

Results of technical activities and accomplishments are documented in reports and publications listed in APPENDIX 5, and are available either through DWRC or the Laboratoire des Vertebres, DARNDR, Damien, Haiti.

PROJECT EVALUATIONS

The VPC project was evaluated twice during its existence. The first team was brought together in May 1982 to evaluate accomplishements during the first 2 years of the project. The team visited in the Dominican Republic for several days and in Haiti for about 2 weeks. Names of team members and their findings and recommendations were published by Jackson et al. (1982; APPENDIX 5). It was concluded that the project should be continue and funded by USAID Missions in Haiti and the Dominican Republic rather than by the USAID Bureau for Latin America and the Caribbean.

In November 1983, an evaluation team was brought to Haiti to review progress of the PDAI project No. 521-0078 and make recommendations for future direction and emphasis for the project. This team was asked to also review the VPC project and to consider funding for that project during FY-1984 under PDAI if objectives of the two activities were compatible. The team report included an evaluation of the VPC project an recommended its funding under PDAI during FY-1984 (Martin et al., 1983; APPENDIX 5)

CURRENT STATUS OF VERTEBRATE PEST CONTROL TECHNOLOGY IN HISPANIOLA

Considerable progress was made during the 4 years of this project in identifying the kinds of crops damaged by vertebrates in Haiti and the Dominican Republic (APPENDIX 6). Damage is common in most crops throughout the island of Hispaniola, and crop losses frequently cause serious hardships to peasant farmers.

Rats cause at least some damage to most crops and can seriously damage corn, rice, cacao, sugarcane, root crops, and fruits in certain areas each year. Damage is neither constant nor uniform in occurrence and intensity. For instance, the degree of rat damage to rice can differ markedly within Haiti and particularly among the Artibonite Valley, Fond des Negres, and Les Cayes. Similarly, rat damage to corn on the experimental farm at Damien and in the Cul-de-Sac Plain has varied greatly between areas and years. The reasons for these differences are not clearly understood, but they must be related to changes either in rat abundance or in rat food preferences.

Regardless of these variations in damage levels, losses to rats often reduce profits by $50 to $200/ha. Such losses can be largely reduced by rat control. The average cost of rat control is about $10/ha. Consequently, farmers can recover between $5 to $20 for each $1 spent for reducing losses to rats. The system of sustained baiting with anticoagulant poisons is most efficient and economical, especially where rat pressure on crops differs over time. Sustained baiting requires that poison bait be kept constantly available to rats. If many rats are

present and bait consumption is high, additional bait stations are set out and maintained. As rat numbers decline, bait stations are removed and less bait is used. This system results in an economical use of bait, because the number of rats present determines how much bait is used which ensures minimal costs with adequate control. Sustained baiting should be practiced with each planting of annual crops. Farmers should not wait for serious damage to occur before beginning rat control.

Rat control is an integral step in crop protection; as such, it must be accepted as a necessary cost of crop production. Farmers must have sufficient funds to practice rat control with each crop they plant. Often such funds are not available, and means are needed to provide the cash for rat control by loans farmers receive for raising crops. Returns can be great, and rat control should be encouraged.

Damage by birds can be as important as damage by rats, but it is a more difficult problem for farmers to control. Losses usually are severe only locally, but when damage occurs, it can be considerable. Each farmer must assess the potential for bird damage to his crops and develop plans to reduce such losses accordingly. As with rats, losses to birds should be prevented before they occur. Once birds begin feeding on crops, it is difficult to keep them out of the fields.

Repellents and other crop protection practices should be used to reduce bird damage rather than killing birds with poisons. Birds are highly mobile. Using poisons, the farmer faces the impossible task of eliminating large numbers of birds over a large area, just to protect his crops. Ample evidence exists from many areas of the world that poisoning birds seldom reduces crop losses. In addition, Haitian peasants eat birds, and poisoning birds presents a real hazard to humans. This threat in itself is sufficient to justify prohibiting the use of poisons as a means of reducing crop damage by birds.

Adequate means exist for farmers to protect their crops from birds, but the job is more complicated than controlling rat damage. Techniques must be carefully selected based on bird species, crops, and the situation involved, and farmers must expect to expend more effort. Where bird damage is high, crop losses can be as high as 50%, therefore, farmers can expect large returns from their efforts.

Village weavers feed on rice, sorghum, and corn from 2 weeks after flowering until harvest. Grassquits feed on rice and sorghum only during the first 2 weeks after flowering, but will feed on millet until harvest. Woodpeckers damage corn from the time the ears begin to form until kernels harden. They also attack sugarcane, cacao, coconuts, and fruits over prolonged periods and, in the aggregate, may cause more damage than any other species.

Netting can be used to cover crops and exclude birds, but it is costly ($0.10/m^2$). For most farmers these costs are prohibitive, but netting becomes economical when protecting small areas of rice seedbeds, seedlings, and nursery crops. Crop experiments are expensive and are sometimes conducted when heavy bird damage can be expected. Protection of

experimental crops with netting often can be justified because netting is durable and can be used for many years. Chemical bird repellents are expensive ($35/ha), and, to be effective, they must be applied before birds begin feeding in rice and sorghum fields. Usually, severe bird damage is not predictable, and farmers seldom are willing to use repellents as an insurance measure. Where damage by village weavers and grassquits can be expected to reduce rice and sorghum yields by more than 25%, the use of bird repellents becomes economical and should be encouraged.

Chemical repellents are effective and economical to protect newly planted seeds from vertebrate pests. Use of methiocarb should be encouraged as a seed treatment to protect corn seed from rats, rice seed from birds, and sorghum seed from lizards.

Individual ears of corn and heads of sorghum can be covered with fine-mesh netting to prevent losses to birds. Costs of materials are not prohibitive because wrappers can be used many times. However, labor requirements are intensive, and the decision to wrap each ear must be made by each farmer. In areas where woodpeckers and village weavers damage 50% or more of corn ears, the use of wrappers can provide considerable benefits.

Traps and mist nets can be used to remove village weavers that are damaging isolated crops. The costs incurred have not been established, but, again, labor is the principal investment. Traps and nets can be used over many cropping seasons. As with poisons, it is difficult to protect crops by trapping and removing birds if a high bird population exists. Where small numbers (100-200) of birds are attacking local crops, trapping can be quite effective in reducing crop losses.

At Damien, damage by woodpeckers to experimental corn has been effectively reduced by using bright red, plastic flagging. Strips, 2.5 to 7.5 cm wide and approximately 30 cm long can either be tied to corn stalks or slit and slipped over corn ears. Red is the most effective color in repelling woodpeckers. Red flagging may evoke a behavioral response related to that caused by the red head of these woodpeckers, but these relationships are poorly understood. Red flagging does not repel village weavers or other pest species from corn. The intense damage by woodpeckers that can occur in cacao also seems to be reduced by hanging red flagging in cacao trees, but this technique has not been sufficiently evaluated.

Farmers in the Artibonite Valley lay tape (from audio recording cassettes) over their rice to protect it from birds. A similar tape (bird-scaring reflection tape) is now being tested to repel birds from grainfields. It is wider and stronger than cassette tape, and is silver on one side and red on the other. Tests in other countries suggest it can sometimes be effective in repelling birds when suspended just above crops. More information will soon be available on the value of this technique under different use conditions.

During project activities, it became evident that in addition to techniques to protect individual crops, a program was needed to protect

small peasant farms from losses to rats and birds throughout the year. Most Haitian farmers own small farms on which many different crops are grown annually. Some crops are mixed, and some are alternated on the same plots, but at different seasons. Annual crops are planted in fields, while perennial crops are grown along field borders or in small stands of bushes or trees. Since crops are grown year-round, farmers face continuous pressure from vertebrate pests. A program is being developed for use on small farms that will schedule different activities throughout the year to protect seeds, annual crops, coconuts, coffee, cacao, fruits, and stored products from rats and birds. Peasant farmers and their families constitute 80% of the Haitian population, and this small-farm program will be the most important contribution made to increasing crop yields in Haiti through vertebrate pest control.

Thus, in the aggregate, many methods have been developed to help farmers reduce losses to vertebrate pests. A principal job now remaining is to further test and perfect techniques and to demonstrate their use to extension agronomists and farmers. This will require that an aggressive research and extension program be continued by the ministries in Haiti and the Dominican Republic.

The VPC project has established the physical capabilities needed for vertebrate pest research and extension in Haiti. A fully equipped laboratory/office complex exists to support such activities within DARNDR, and Haitian and Dominican agronomists and biologists can rely on the continued technical advice of the DWRC in the future. Economical and logistic1 support must be provided by DARNDR to maintain a dynamic and effective program. PL-480 funds will be needed by DARNDR to complement local appropriations and ensure the economic viability of vertebrate pest management in Haiti during the next decade. In the Dominican Republic, national funds seem adequate to support continued activity in vertebrate pest management.

Counterpart staff in DARNDR, Haiti and the Departamento de Vida Silvestre, Dominican Republic have been with the project since its inception. They have become familiar with vertebrate pest damage and the control methods currently available. Their activities on the job during the past 4 years have taught them how to assess vertebrate damage to different crops and how to test and develop effective methods for protecting crops. Conducting laboratory and field studies has provided experience in the use of scientific methods in experimentation and compilation and analysis of data. They have benefited from training at DWRC and from exposure to the diverse scientific disciplines of the Denver staff at DWRC or on TDY in Haiti and the Dominican Republic. Formal and on-the-job training have provided them with knowledge of vertebrate pest management and theories of toxicology, population regulation, and animal ecology, behavior, and reproduction.

DARNDR is fortunate to have intelligent, highly qualified, and well trained personnel with whom to continue a program in vertebrate pest management in Haiti through the Laboratoire des Vertebres at Damien. However, DARNDR must receive funds from some source to reestablish original salary levels for this staff. Staff salaries have been reduced

by one-half or more during the last several years. Current salaries are inadequate and inequitable for scientists with such a high degree of dedication, education, training, and job seniority. If salaries are not increased, staff of the Laboratoire des Vertebres may be forced to seek other employment outside of DARNDR. Conduct of a program in vertebrate pest management is impossible in Haiti without the current staff. Training was the most important accomplishment of the VPC project, and existing facilities, equipment, and funding will be of little use without trained personnel.

CONSIDERATION OF FUTURE NEEDS

One objective of the VPC project was to develop safe, effective, and economical methods that are appropriate for use on small farms to protect crops from vertebrate pests. These methods also had to be compatible with the broader goals of agricultural development and environmental protection in Hispaniola. Given the wide diversity of ecological conditions under which vertebrate damage occurs in Hispaniola and the variety of crops and animals involved (APPENDIX 6), it is unrealistic to expect development of methods for each specific crop/pest situation within a period of 4 years. Several cropping seasons are needed to test techniques for each crop/pest combination; about 50 such combinations have been identified. In addition, time is needed for development of damage assessment procedures before efficacy of control methods can be evaluated. After the project was started, another objective was incorporated; USAID/Haiti stressed the need to include extension activities to ensure the proven methods were made available to farmers. This work greatly increased the scope and time requirements of the project.

Only about one-third of the identified pest/damage situations were studied during the life of the project. These were situations where greatest losses occurred countrywide, but they also were the situations (e.g., rat damage in rice) where the most information existed from work done elsewhere. The remaining problems probably will require considerably greater effort, time, and creativity to resolve.

Another objective of the VPC project was to develop the capabilities within host countries to continue vertebrate pest research and management in the future. In vertebrate pest management, as in all aspects of agricultural production, new knowledge and technology, changes in crops and farming practices, and development of new crop varieties necessitate a continuing research effort to provide farmers with currently effective tools. The job of managing pests is a continuing one, and capabilities must be available for continued research to improve management practices.

Often the philosophy was expressed within USAID that after 4 years of training the capabilities of host government staffs should be adequately developed to enable them to continue without further technical assistance. This is akin to expecting a graduate from a 4-year college to independently administer a complex program in biology or agriculture. In 4 years, few people can master an area of science sufficiently to enable them to conduct a broad, comprehensive program without further technical

assistance. In Haiti especially, institutional support is neither adequate nor consistent enough to enable sustained operation of a VPC program. Funds allocated are inadequate to pay staff salaries, and little money exists for operational expenses. The Minister of Agriculture and his staff have been replaced three times in just over 2 years, and there has not been any consistancy in either priorities, program direction, or support. Personnel are insecure, poorly paid, confused as to how they can meet their goals, and disappointed over the lack of challenge, stimulation, and accomplishments in their job.

Maintenance of existing staff and laboratory/office complex is the first requirement for continued VPC activities. Operation funds must also be provided to support the program and to conduct research and extension activities. Finally, continued training and moral support must be provided to enable the full development of the staff's potential to conduct a VPC program.

It is highly advisable that USAID/Haiti ensure the continued presence of foreign technical assistance in vertebrate pest control research and extension during the next 4-5 years. This can best be done by incorporating VPC activities into a new USAID/DWRC project. A considerable investment has already been made toward developing the capability for this work, which is greatly needed in Haiti. If additional efforts are not made, current accomplishments may be lost, and Haiti again will be without the ability to address these problems.

Provisions for VPC activities can be made within the framework of other projects. Projects to meet many types of goals can logically include a VPC component. A project to develop overall capabilities in plant protection might be the most appropriate for continued VPC work. Such a project is extremely relevant as DARNDR does not now have the capability to assist farmers with problems of insects, nematodes, diseases, weeds, and other pests that attack or compete with crops. Vertebrates are some of those other pests, and they could logically be included in a comprehensive plant protection project.

RECOMMENDATIONS

1. USAID/Haiti should encourage DARNDR to determine their needs in the plant protection area and to submit a request for a project to help develop those capabilities. This project should include a VPC component, and planning for the project should begin immediately. It will require 12-18 months to implement a new project. USAID/Haiti should provide for some interim activities to maintain continuity and support for the VPC program in DARNDR, as recommended in paragraphs 2, 3, and 4 below.

2. USAID/Haiti should facilitate continued relations between the VPC staff in DARNDR and DWRC during the next 12-18 months. This can be accomplished by encouraging DARNDR to request short-term technical assistance from DWRC in specific program areas where additional assistance and training is required. TDY's by DWRC staff would be essential to maintain morale and program interest in DARNDR.

3. USAID/Haiti should establish an awareness in DARNDR administrators that VPC activities are essential to the achievement of maximum agricultural production in Haiti. In the traditional agriculture now practiced, vertebrates cause a considerable loss in crops. With the introduction of new plant varieties such as corn and sorghum, damage by vertebrates will increase. Experience already gained has clearly demonstrated that benefits from new varieties cannot be fully realized unless crops are protected from rats and birds (pers. comm. Robert Cheaney, Texas A&M University). It is essential that commitments be made within DARNDR to support a program in VPC so that farmers have effective and economical methods to protect their crops from rats and birds now and in the future.

(APPENDIX 1)

TDY'S BY DWRC STAFF TO HAITI

Jun 1980	Mr. Jean Bourassa, Electronic Specialist. Use of radiotelemetry.
Dec 1980	Dr. Richard Engeman, Statistician. Design of sampling for damage assessment.
Jan 1981	Mr. Donald Zielesch, Administrative Officer. Fiscal management.
May 1981	Mr. John De Grazio, Chief, Section of International Programs. Project planning and administration.
Jun-Jul 1981	Mr. David Hayes, Laboratory Technician. Survey of rodent damage to rice and corn.
Aug-Oct 1981	Dr. James Keith, Biologist. Field studies of village weavers.
Aug 1981	Dr. Richard Bruggers, Biologist. Radio-tracking of village weavers.
May 1982	Mr. John De Grazio and Dr. James Keith. Project evaluation and planning.
Jul 1982	Dr. Clay Mitchell, Biologist. Project supervision.
Aug 1982	Dr. James Keith, Biologist. Project supervision.
Mar-Apr 1983	Dr. Mike Fall, Biologist. Rat control concepts and techniques.
Apr 1983	Dr. Richard Bruggers, Biologist. Bird repellents and crop protection.
Jun-Jul 1984	Mr. Lynwood Fiedler, Biologist. Small farm survey.
Aug 1984	Mr. David Hayes, Laboratory Technician. Laboratory development and animal maintenance.
Sep 1984	Dr. Peter Savarie, Pharmacologist. Laboratory toxicological studies.
Sep 1984	Dr. James Keith, Biologist. Prepare termination report.

ASSISTANCE BY CONSULTANT

May-Jun 1983	Dr. Chad Roberts, Biologist, Oscar Larson & Associates (consultants). Woodpecker biology and crop protection. Dr. Roberts' work was arranged and funded by PDAI (Project No. 521-0078, No. 4), but his time was spent with VPC staff.

(APPENDIX 2)

MEETINGS AND PUBLICATIONS

Meetings

Jean-Paul Samedy represented Haiti at a Seminar on Caribbean Pesticide Management; Bridgetown, Barbados; November 1980.

James Keith attended the Annual Meeting of the Pacific Seabird Group; Honolulu, Hawaii; December 1982.

James Keith participated in the XVIth International Congress of Game Biologists; Strbske Pleso, Czechoslovakia; October 1983.

Jean-Paul Samedy attended the IXth Latin American Congress of Zoology; Arequipa, Peru; October 1983.

Jean-Paul Samedy participated in a Symposium on Rice Culture; Maugé, Artibonite Valley, Haiti; February 1984.

Publications

Bruggers, R. L., P. Sultana, J. E. Brooks, L. A. Fiedler, M. Rimpel, S. Manikowski, N. Shivanarayan, N. Santhaiah, and I. Okuno. 1984. Preliminary investigations of the effectiveness of trimethacarb as a bird repellent in developing countries. Pp. 192-203 in Proc. 11th Vertebr. Pest Conf., Sacramento, California.

Engeman, R. M., J.-P. Samedy, M. S. Bornstein, and G. C. Mitchell. In press. A comparison of bird damage among eleven varieties of corn in Haiti. J. Agric. Univ. P. R.

Keith, J. O. 1982. Feral animals - the problem and some management considerations. Paper presented at the Annual Meeting of the Pacific Seabird Group; Honolulu, Hawaii; December 1982. Abstract in Pacific Seabird Group Bulletin 9(2):74.

Keith, J. O. 1983. Brown pelicans - can they survive? Oceanus 26(1):62-67.

Keith, J. O. In press. A historical perspective of pesticide-wildlife relationships. Paper presented at the XVIth International Congress of Game Biologists; Strbske Pleso, Czechoslovakia; October 1983.

Samedy, J. P. 1980. Pesticide use in Haiti. Paper presented at a Seminar on Caribbean Pesticide Management; Bridgetown, Barbados; November 1980.

Samedy, J. P. 1983. Vertebrate pest problems in Haiti and control methods to reduce crop losses. Paper presented at IXth Latin American Congress of Zoology; Arequipa, Peru; October 1983.

(APPENDIX 3)

TRAINING

Michele Rimpel, Jean-Paul Samedy, Jesse Trevino, and Clay Mitchell traveled to the Dominican Republic to meet with counterparts and attend training seminar given by Jean Bourassa, Electronics Specialist on TDY from DWRC; June 1980.

Tomas Vargas and Manuel Gonzalez were at the Denver Wildlife Research Center for Training; August 1980.

Julio Bartholemy and Clay Mitchell traveled to the Dominican Republic to view pest problems and work with counterpart staff; November 1980.

Tomas Vargas traveled to Haiti to work with Richard Engeman, Statistician on TDY from DWRC; December 1980.

Michele Rimpel attended course at Kansas State University, Agricultural Research Methodology; June-July 1981.

Michele Rimpel and Irmgard Laroche were at the Denver Wildlife Research Center for training; July-August 1981.

Julio Bartholemy spent 2 weeks at the Denver Wildlife Research Center to consult with staff and view programs and activities; August 1981.

Jean-Paul Samedy spent 2 weeks training at the Denver Wildlife Research Center; January 1982.

(APPENDIX 4)

FIELD TRIALS CONDUCTED BY VERTEBRATE PEST CONTROL PROJECT

A. Damage Assessments

Rats in rice - Artibonite Valley

Deseaux	Apr-Aug 1981
Mauge	Mar-May 1982
Trois Bornes	Aug-Oct 1982
Trois Bornes	Jan-Apr 1983

Rats in corn

Damien	Jul 1981; Dec 1981; Nov 1982; Feb 1983
Les Cayes	Jul 1982
Fond des Negres	Jul 1983
Cul-de-Sac	Aug 1983

Rats in cacao

Fond des Negres	Mar 1983; Jul 1983

Village weavers in corn

Damien	Dec 1981; Feb 1983; Apr 1983
Les Cayes	Jul 1982
Cul-de-Sac	Aug 1983

Village weavers in rice

Artibonite Valley	Aug 1981; Apr 1982

Village weavers in sorghum

Damien	Feb 1982; Feb 1983

Woodpeckers in corn

Les Cayes	Jul 1982; May 1983
Damien	Nov 1982; Apr 1983; Aug 1983

Woodpeckers in cacao

Fond des Negres	Mar-Apr 1983; Apr-Jul 1983
Grd Riv. du Nord	Nov-Dec 1983

(APPENDIX 4)(cont'd)

B. Development of Control Methods

Rat control in rice

Trial to establish efficacy and benefits of sustained baiting (Deseaux)
Trial to compare efficacy of chemicals
Two demonstrations to farmers of techniques and benefits

Rat control in corn

Four trials (two trials in hybrid corn, two trials in native corn) to establish efficacy of sustained baiting

Two trials to compare bait forumation and bait station

Protection of crops from village weavers

Three trials in sorghum
Four trials in rice
Three trials in corn

Protection of corn from woodpeckers - four trials

C. Extension

Cooperation with the Organization for the Development of the Artibonite Valley (ODVA). Demonstration of rat control in rice with sustained baiting; Jul-Sep 1982.

Cooperation with ODVA. Two extension programs for rat control in rice with farmers conducting their program; Jul 1983.

Cooperation with Districts. Fond des Negres District: rat and woodpecker control in cacao and corn. Port-au-Prince District: work on small farms.

Cooperation with private volunteer organizations. Mennonite Economic Development Associates: woodpecker damage in cacao. Mission for Christ: rat and village weaver damage in rice.

(APPENDIX 5)

DOCUMENTATION

Bruggers, R. L. 1980. Annual Report. Vertebrate Damage Control Research in Agriculture. Denver Wildlife Research Center. 111 pp.

Bruggers, R. L. 1981. Annual Report. Vertebrate Damage Control Research in Agriculture. Denver Wildlife Research Center. 92 pp.

Bruggers, R. L. 1982. Annual Report. Vertebrate Damage Control Research in Agriculture. Denver Wildlife Research Center. 99 pp.

Bruggers, R. L. 1983. Annual Report. Vertebrate Damage Control Research in Agriculture. Denver Wildlife Research Center. 121 pp.

Bruggers, R. L., P. Sultana, J. E. Brooks, L. A. Fiedler, M. Rimpel, S. Manikowski, N. Shivanarayan, N. Santhaiah, and I. Okuno. 1984. Preliminary investigations of the effectiveness of trimethacarb as a bird repellent in developing countries. Pp. 192-203 in Proc. 11th Vertebr. Pest Conf., Sacramento, California.

Denver Wildlife Research Center. Trip reports on TDY assignments in Haiti:

Name	Date	Assignment
DWRC Staff		
Bourassa, J. B.	Jun 1980	Radiotelemetry
Bruggers, R. L.	Aug 1981	Radio-tracking birds
Bruggers, R. L.	Apr 1983	Bird repellents
De Grazio, J. W.	May 1981	Project planning
De Grazio, J. W.	May 1982	Project evaluation
Engeman, R. M.	Dec 1981	Statistical sampling
Fall, M. F.	Mar 1983	Rat studies
Fiedler, L. A.	Jun 1984	Small farm study
Hayes, D. J.	Jun-Jul 1981	Rodent survey
Hayes, D. J.	Aug 1984	Laboratory development
Keith, J. O.	Aug-Oct 1981	Bird studies
Keith, J. O.	May 1982	Project evaluation
Keith, J. O.	Aug 1982	Project supervision
Keith, J. O.	Sep 1984	Termination report
Mitchell, G. C.	Jul 1982	Project supervision
Savarie, P. J.	Sep 1984	Toxicology
Zielesch, D. W.	Jan 1981	Administration
Consultant - Oscar Larson & Associates		
Roberts, C.	May-Jun 1983	Woodpecker biology

(APPENDIX 5) (cont'd)

Engeman, R. M., J.-P. Samedy, M. S. Bornstein, and G. C. Mitchell. In press. A comparison of bird damage among eleven varieties of corn in Haiti. J. Agric. Univ. P. R.

Jackson, W. B., D. R. Drga, J. W. De Grazio, and J. O. Keith. 1982. Evaluation of Project 598-0584, Reduction of Vertebrate Pest Crop Losses. May 1982. On file at Denver Wildlife Research Center.

Keith, J. O. 1983. Vertebrate Pest Control Project No. 598-0584. Accomplishments and proposals for future work. Unpublished rpeort. On file at Laboratoire des Vertebres, Damien, Haiti. July 13, 1983. 9 pp. and attachments.

Laboratoire des Vertebres. October 1982 to August 1984. Monthly reports. Vertebrate Pest Control Project. DARNDR, Damien, Haiti.

Laboratoire des Vertebres. 1984. Rat control in rice - an extension brochure. DARNDR, Damien, Haiti. 9 pp.

Martin, F. W., R. C. Kite, G. C. Jackson, and L. R. Frederick. 1983. Evaluation of the research and extension component of the Integrated Agricultural Development Project No. 521-0078. USAID/Port-au-Prince, Haiti.

Mitchell, B., and R. L. Bruggers. In press. Aspects of woodpecker ecology and damage to cacao in the Dominican Republic. Trop. Pest Manage.

Mitchell, G. C. 1982. Vertebrate Pest Control Project NO. 598-0584. Report of Activities. Port-au-Prince, Haiti. May 14, 1982. 11 pp.

Mitchell, G. C. 1984. In preparation. Annual Report. Vertebrate Damage Control Research in Agriculture. Denver Wildlife Research Center.

Roberts, R. C. 1983. Avian crop damage control in Haiti and the Dominican Republic - An application of integrated pest control practices. Oscar Larson and Associates. Eureka, CA 95501. 55 pp.

Samedy, J. P. 1980. Pesticide use in Haiti. Paper presented at Seminar, Caribbean Pesticide Management, Bridgetown, Barbados. On file at Laboratoire des Vertebres, DARNDR, Damien, Haiti.

Samedy, J. P. 1981. Analyse economique du systeme d'appâts continue á base de warfarin dans les rizieres: Deseaux (O.D.V.A.). Unpublished report. On file at Laboratoire des Vertebres, DARNDR, Damien, Haiti.

(APPENDIX 5) (cont'd)

Samedy, J. P. 1983. Vertebrate pest problems in Haiti and control methods to reduce crop losses. Paper presented at IXth Latin American Congress of Zoology. Arequipa, Peru. On file at Laboratoire des Vertebres, DARNDR, Damien, Haiti.

Samedy, J. P. 1984. Concept de la recherche applequeé au controle des vertebres nuisibles á l'agriculture. Approche de la question des procedures de controle en matiere de protection des plantes (rats et oiseaux déprédateurs de la culture du riz). Paper presented at Rice Symposium Maugé, Artibonite Valley, Haiti. February 1984. On file at Laboratoire des Vertebres, DARNDR, Damien, Haiti.

Samedy, J. P. 1984. Studies of methods to reduce crop losses to vertebrate pests on small farms in the Cul-de-Sac Plain, Haiti. Unpublished report. 16 pp. On file at Laboratoire des Vertebres, DARNDR, Damien, Haiti.

Scimetrics International. 1982. Field evaluation of the rodenticide VIZON in Haiti. P. O. Box 513, Conifer, Colorado 80433. 27 pp.

(APPENDIX 6)

PRINCIPAL VERTEBRATE DAMAGE TO CROPS IN HAITI BASED ON RESPONSES TO QUESTIONNAIRES BY 14 OF 20 AGRICULTURAL DISTRICTS

Crops	No. districts with crops	Districts (%) with heavy damage	Months of heaviest damage	% districts reporting damage by vertebrate pests[a]							
				Rat	Dog	VW	WP	PK	CR	GF	GQ
Corn	14	100	Apr-Jul	100	86	57	93	64	93	0	0
Rice	12	83	Jun-Dec	92	0	100	0	17	33	0	17
Sorghum	13	85	May-Jun/Dec-Jan	77	0	85	23	69	31	15	15
Coffee	8	50	Sep-Dec	100	0	0	13	0	0	0	0
Cacao	5	80	Aug-Nov	100	0	0	60	0	20	0	0
Sugarcane	14	57	Jan-Dec	100	0	0	86	7	0	0	0
Sweet potato	13	46	Nov-Apr	100	0	0	0	0	8	8	0
Manioc	10	50	Dec-Apr	100	0	0	0	0	10	0	0
Coconut	8	25	Jan-Dec	25	0	0	100	13	63	0	0
Peanuts	9	78	Jan-Dec	100	56	11	11	11	44	0	0
Peas	13	62	Dec-Feb	92	8	31	8	38	31	8	0
Fruits	9	11	Jan-Dec	89	22	11	56	33	44	0	0
Others	13	31	Jan-Dec	100	2	0	23	0	8	0	0

[a] VW = Village weaver (Ploceus cucullatus).
WP = Hispaniolan woodpecker (Melanerpes striatus).
PK = Hispaniolan parakeet (Aratinga chloroptera).
CR = Crows (Corvus spp.).
GF = Guinea-fowl (Numida meleagris).
GQ = Grassquits (Tiaris olivacea).

International travel for technical assistance projects by USAID/USFWS-DWRC personnel during 1983.

Date	Name	Location	Purpose of Visit
15 Feb-13 Mar	R. L. Bruggers	Philippines, Kenya, Tanzania, Senegal	Philippines: Organize field trials and and set up laboratory tests for trimethacarb on bird pest species. East Africa: Discuss cooperative work with FAO Quelea Project personnel. East and West Africa: Discuss with authors their contribution to the quelea book.
15 Mar-2 Apr	D. J. Scott	Philippines	Provide office management guidance, discuss administrative procedures with project leader, and gain better understanding of interactions among DWRC and USAID-funded overseas project, host government, and USAID.
20 Mar-2 Apr	M. W. Fall	Haiti	Assist project leader in fieldwork, review data, and assist planning future project activities.
23 Mar-29 Apr	J. W. De Grazio	Pakistan, Bangladesh, Philippines	Pakistan: Develop two preliminary proposals on vertebrate pest problems and solutions for possible implementation into the USAID/Pakistan-sponsored Agriculture Production, Distribution, and Storage (APDS) Project. Bangladesh and Philippines: Review research and administrative activities at USAID/DWRC projects.

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Date	Name	Location	Purpose of Visit
26 Mar-15 Apr	J. E. Brooks	Pakistan	Assist in developing two preliminary proposals on vertebrate pest problems and solutions for possible implementation into the USAID/Pakistan-sponsored Agriculture Production, Distribution, and Storage (APDS) Project.
20 Apr-1 May	R. L. Bruggers	Haiti	Initiate trials to protect newly sown seeds from pest birds. Conduct surveys for bird and rat damage.
19 May-1 Jun	R. L. Bruggers	England, Kenya	England: Discuss rodent bibliography and bird pest problems with Tolworth and Worplesdon Laboratory. Discuss bird and rodent repellents with Sphere Laboratories. Represent USAID/DWRC in FAO Quelea Project 4th Annual Technical Meeting and make tentative plans for cooperative research for 1984.
5-9 Sep	L. A. Fiedler	Indonesia	Observe crop protection planning activities.
7 Sep-7 Oct	P. J. Savarie	Bangladesh, Philippines	Assist with laboratory evaluation of new rodenticides; evaluate status of rodenticides used; and plan future toxicological tests (Bangladesh). Assist in developing collaborative studies with NCPC (Philippines).

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Date	Name	Location	Purpose of Visit
17-25 Sep	J. W. De Grazio, M. W. Fall	Niger	Present four papers at USAID/OAU Inter-african Phytosanitary Council Training Conference "Vertebrate Pests of West African Crops."
9-15 Oct	D. J. Elias	Peru	Attend 9th Latin American Zoology Congress and chair symposium "Economic Zoology and Vertebrates as Pests of Agriculture."

Appendix III
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International travel for technical assistance projects by USAID/USFWS-DWRC personnel during 1984.

Date	Name	Location	Purpose of trip
8-31 Jan	R. L. Bruggers	Niger, Upper Volta, Kenya, Italy	Assist UNDP/FAO Regional Quelea Project personnel in eastern Africa to mark large numbers of quelea with fluorescent markers and plan future cooperative work. Discuss quelea book chapters with authors.
13 Mar-12 Apr	R. L. Bruggers	Bangladesh, Nepal, Philippines	Bangladesh: Assist project leader in study design and fieldwork. Nepal: Assess present status of vertebrate pest management. Philippines: Discuss present and organize future cooperative bird damage research studies with NCPC staff.
30 Mar-5 May	L. A. Fiedler	Philippines, Sri Lanka, Maldives, Italy	Philippines: Assist NCPC personnel in planning and implementing rodent control in coconut extension and evaluation program. Sri Lanka: Discuss vertebrate pest problems with FAO personnel. Maldives: Upon request by FAO, study rodent problem in coconuts and design control program. Italy: Briefing sessions with FAO personnel on vertebrate pest problems in the Maldives.
29 May-8 Jun	J. E. Brooks	Nepal	Survey vertebrate pest damage on small farms. Present seminars. Write project proposal.

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Date	Name	Location	Purpose of trip
30 May-15 Jun	R. L. Bruggers	Nepal	Survey vertebrate pest damage on small farms. Present seminars. Write project proposals.
31 May-13 Jun	J. W. De Grazio	Pakistan, Bangladesh	Pakistan: Prepare draft scope of work and budget for possible assistance in vertebrate pest control. Bangladesh: Review project and plan future research and activities.
18 Jun-6 Jul	L. A. Fiedler	Haiti	Conduct small-farm surveys to assess damage by rodents and birds.
10-26 Jul	J. W. De Grazio	Ecuador, Galapagos Islands, Costa Rica	Ecuador, Galapagos Islands: Discuss ver-vertebrate pest problems on islands and mainland. Costa Rica: Discuss vertebrate pest damage to agricultural crops and livestock. Initiate test on tree-duck damage to emerging rice.
16 Jul-3 Aug	G. C. Mitchell	Zimbabwe	At the request of National Parks and Wildlife Management Department, assist in evaluating trimethacarb as a bird repellent to maturing wheat.
1-22 Aug	D. J. Hayes	Haiti	Set up laboratory and capture animals for training purposes.
27 Aug-20 Sep	L. A. Fiedler	Ecuador, Honduras	Discuss vertebrate pest damage problems in agricultural crops on the mainland of Equador and the Galapagos Islands with USAID/Quito personnel. Recommend methods for feral animal control. Honduras: Recommend bird and rodent control methods in rice and corn.

Date	Name	Location	Purpose of trip
10-28 Sep	J. O. Keith	Haiti	Prepare final report on the Vertebrate Pest Control project.
11-28 Sep	P. J. Savarie	Haiti	Provide technical assistance and instruct personnel in laboratory techniques.
1-16 Oct	R. W. Bullard	El Salvador	Evaluate vertebrate pest control and grain storage problems in El Salvador and make recommendations.
27 Oct-19 Nov	D. L. Otis	Kenya, Tanzania, Sudan	FAO consultancy with Project RAF/81/023 to determine techniques for aerially assessing areas of cultivated land and distribution of crops, and estimating bird damage.
29 Oct-12 Dec	L. A. Fiedler	Ethiopia, Somalia, Kenya, Tanzania, Zimbabwe, Italy	FAO consultancy to evaluate rodent problems in eastern Africa. Brief FAO personnel in Rome on findings.
5 Nov-2 Dec	R. L. Bruggers	Sudan, Kenya	Sudan: Discuss DWRC participation in bird damage control. Kenya: Participate in FAO-sponsored Technical Meeting on quelea research and management in eastern Africa. Organize cooperative field trials with FAO to evaluate the bird repellent trimethacarb and a bird-scaring reflection tape.
1-30 Dec	M. V. Garrison	Philippines	At request of Director, NCPC, assist NCPC personnel in study design and toxicity and repellency tests of avicides.

Appendix IV
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Requests to DWRC for assistance during 1983. This table does not include requests to DWRC biologists stationed at field stations in Haiti, the Philippines, and Bangladesh.

Type of request or activity	Months												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Information on International Programs	2	2	6	2	0	3	0	1	1	2	1	1	21
Literature or information on research and crop protection methods	6	14	12	22	7	18	13	4	3	19	9	7	134
Graduate school inquiries	1	4	2	0	0	1	4	0	0	0	3	2	17
Workshops/symposia/conferences	11	9	1	1	0	4	0	1	3	1	0	0	31
Materials/photographs	2	2	3	2	0	1	2	0	0	0	1	0	13
TDY's/project requests	0	1	3	2	2	5	2	2	1	0	2	4	24
Hiring possibilities	0	1	2	0	0	2	0	0	0	1	0	0	6
Visits or visitors to DWRC	0	0	1	0	4	5	4	2	0	0	8	0	24
Funding	0	0	0	0	0	0	1	0	1	1	1	0	4
TOTAL	22	33	30	29	13	39	26	10	9	24	25	14	274

Originating countries:

Jan Egypt, Switzerland, Thailand, Haiti, Tanzania, Argentina, Canada, Mexico, Uruguay, Venezuela, Colombia, USA, Peru, Brazil, Chile.

Feb Argentina, USA, Panama, Ethiopia, Colombia, Somalia, Nicaragua, Denmark, Venezuela, Dominican Republic, India, Costa Rica, Pakistan, Mexico, Canada.

Mar Dominican Republic, Haiti, Panama, Indonesia, Ethiopia, Sudan, Guatemala, Peru, Uruguay, Zaire, USA, Mexico, Somalia, Kenya, Italy, Papua New Guinea, Central African Republic, Morocco, New Zealand, Canada.

Apr Uruguay, Argentina, New Zealand, Guyana, USA, Guatemala, Pakistan, Bangladesh, Nigeria, Indonesia, Costa Rica, Panama, Colombia, Italy, Bolivia, Peru, Canada, Malaysia.

May Philippines, Tanzania, USA, Cape Verde, Mali, Bangladesh, Italy, Kenya.

Jun Zambia, Kenya, Cape Verde, Cameroon, Sudan, Ethiopia, Pakistan, Costa Rica, Italy, England, Tanzania, Bangladesh, Thailand, Uganda, India, Egypt, Guyana, USA, Peru, New Zealand.

Jul USA, Australia, India, Honduras, Nicaragua, Egypt, Germany, Sierra Leone, Mali, Tanzania, Uruguay, Ethiopia, Sudan, England.

Aug Puerto Rico, USA, Tanzania, Ethiopia, India, Botswana, Latin America, Kenya, Sudan.

Sep USA, Tanzania, India, Pakistan, Yemen, Costa Rica, Uruguay, Niger.

Oct Thailand, Canada, India, South Africa, USA, Italy, Ecuador, Guinea Bissau, Niger, Fiji, England, Mali, Morocco, Liberia, Australia, Chile, Venezuela, Peru, Argentina, Uruguay.

Nov USA, Guinea Bissau, Liberia, Italy, Tanzania, Zimbabwe, Costa Rica, Switzerland, Israel, Brazil

Dec Upper Volta, Uruguay, USA, Ethiopia, Qatar, Israel, Costa Rica, El Salvador, Tanzania Indonesia, Malawi, Mexico, Peru, Colombia.

Requests to DWRC for assistance during 1984. This table does not include requests to DWRC biologists stationed at field stations in Haiti and Bangladesh.

Type of request or activity	Months												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Information on International Programs	2	1	1	0	0	0	0	1	2	2	0	2	11
Literature or information on research and crop protection methods	12	9	8	5	4	4	4	8	3	10	5	5	77
Graduate school inquiries	2	0	0	0	0	0	0	1	0	0	0	0	3
Workshops/symposia/conferences	0	0	0	0	0	0	0	1	0	0	0	0	1
Materials/photographs	0	0	0	0	2	2	3	0	0	0	0	3	10
IDY's/visits/project requests	4	4	5	5	4	2	6	6	0	5	5	3	49
Hiring possibilities	0	1	2	0	1	0	0	2	1	0	0	0	7
International or visitors to DWRC	0	0	4	7	1	2	2	4	1	4	0	1	26
Funding	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	20	15	20	17	12	10	15	23	7	21	10	14	184

Originating countries:

Jan Argentina, Australia, Brazil, Costa Rica, Egypt, El Salvador, India, Jamaica, Kenya, Mexico, Morocco, Niger, South Africa, Sudan, USA, Upper Volta.

Feb Australia, Bolivia, Cameroon, Costa Rica, Guatemala, Honduras, India, Italy, Ivory Coast, Mali, Mexico, Peru, Tanzania, USA, Upper Volta.

Mar Bangladesh, Brazil, Ecuador, France, Haiti, Honduras, India, Italy, Kenya, Mexico, Puerto Rico, Tanzania, USA, Vietnam, Virgin Islands, Zambia, Zimbabwe.

Apr Grenada, Guatemala, India, Nepal, Philippines, Poland, Somalia, Sri Lanka (Maldives), USA, Zimbabwe.

May Australia, Bangladesh, France, Ireland, Kenya, Nepal, Pakistan, Philippines, Switzerland, USA.

Jun Bangladesh, Chile, Haiti, Kenya, Nepal, Pakistan, Philippines, United Kingdom, USA, Venezuela.

Jul East Africa, West Africa, Australia, Bangladesh, Costa Rica, Ecuador (Galapagos), France, Honduras, Indonesia, Montserrat, Pakistan, Philippines, USA, Venezuela, Zimbabwe.

Aug South Africa, Bangladesh, Canada, Costa Rica, Ecuador, Egypt, Germany, Haiti, Honduras, India, Israel, Japan, Kenya, Philippines, Sri Lanka (Maldives), USA, Venezuela.

Sep Brazil, France, Philippines, Sri Lanka, Tanzania.

Oct Argentina, Bangladesh, Colombia, Ecuador, Guatemala, Indonesia, Malaysia, Morocco, Nepal, Nicaragua, Pakistan, Philippines, Sri Lanka, Switzerland, USA, Venezuela, Zimbabwe.

Nov Barbados, Ethiopia, Morocco, Kenya, Senegal, Somalia, Spain, Sudan, Tanzania.

Dec Costa Rica, Ethiopia, Haiti, Iran, Kenya, Malawi, Nigeria, Sudan.

Appendix VI

ESTIMATED REPLACEMENT COSTS
DENVER FACILITIES AND EQUIPMENT

Building	$ 9,000,000
Major laboratory equipment	5,000,000
Computers, printers, etc.	500,000
Vehicles, boats, etc.	300,000
Major office equipment	1,000,000
Library holdings	1,000,000
Outside animal holding pens and parking areas	1,000,000
Total	$17,800,000

DENVER WILDLIFE RESEARCH CENTER
RESEARCH PUBLICATIONS OF INTERNATIONAL PROGRAMS

1. Alfonso, P. J., and J. P. Sumangil. 1970. Control of ricefield rats, Chapter 15. Pages 204-211 in Rice Production Manual. University of the Philippines, College of Agriculture.

2. Alviola, P. L. III, F. F. Sanchez, and E. A. Benigno. 1973. Notes on the feeding habits of three species of Philippine weavers of the genus Lonchura. Kalikasan (Philipp. J. Biol.) 2:149-153.

3. Barbehenn, K. R., J. P. Sumangil, J. L. Libay, and M. W. Fall. 1972. Distribution of agricultural rodent pests in the Philippines. Proc. Pest Control Counc. Philipp. 3:58-59.

4. Barbehenn, K. R., J. P. Sumangil, and J. L. Libay. 1973. Summary of Philippine rodents collected from February 1969, through December 1971. Rodent Research Center, College, Laguna, Philippines. 7 pp.

5. Barbehenn, K. R., J. P. Sumangil, and J. L. Libay. 1973. Rodents of the Philippine croplands. Philipp. Agric. 56:217-242.

6. Bullard, R. W., and R. D. Thompson. 1977. Efficacy and safety of the systemic method of vampire bat control. Interciencia 2(3):149-152.

7. Benigno, E. A. 1972. Estimating population parameters of the ricefield rat (Rattus rattus mindanensis Mearns). Unpublished M.S. Thesis, University of the Philippines at Los Baños. 49 pp.

8. Besser, J. F., J. W. De Grazio, and K. H. Larson. 1970. The dickcissel--a problem in ripening grains in Latin America. Proc. 5th Bird Control Semin., Bowling Green, Ohio, 5:141-143.

9. Bullard, R. W. 1970. Variation of chemical concentration in surface-coated and tableted grain baits. J. Wildl. Manage. 34:925-929.

10. Bullard, R. W., G. Holguin, and J. E. Peterson. 1975. Determination of chlorophacinone and diphenadione residues in biological materials. J. Agric. Food Chem. 23(1):72-74.

11. Bullard, R. W., J. E. Peterson, and G. Holguin. 1971. Determination of chlorophacinone in blood plasma by gas-liquid chromatography or UV spectrophotometry. 27th Annu. Southwest Reg. Meet. Am. Chem. Soc., San Antonio, Texas, 27:14. (Abstr.)

12. Bullard, R. W., and S. A. Shumake. 1973. Food temperature preference response of Desmodus rotundus. J. Mammal. 54(1):299-302.

13. Bullard, R. W., S. A. Shumake, and G. Holguin. 1972. Fingerprinting rat preputial gland exudate. 28th Annu. Southwest Reg. Meet. Am. Chem. Soc., Baton Rouge, Louisiana, 28:20. (Abstr.)

14. Bullard, R. W., R. D. Thompson, and S. A. Shumake. 1972. Response of vampire bats (Desmodus rotundus) to olfactory stimuli. 3rd Annu. N. Am. Symp. on Bat Res., San Diego, California. (Abstr.)

15. Burns, R. J. 1970. Twin vampire bats born in captivity. J. Mammal. 51:391-392.

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A-1 Bruggers, R. L. 1980. The situation of grain-eating birds in Somalia. Proc. 9th Vertebr. Pest Conf., Fresno, California, 9:5-16.

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