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RESEARCH REVIEW REPORT

December 1979

- I. PROJECT TITLE Control of Vertebrate Pests
- II. PROJECT NUMBER 931-0473
- CONTRACT NUMBER PASA/ID/TAB-473-67
- III. PURPOSE AND RATIONALE FOR TEAM EVALUATION
- The objective of this review is to carry out a comprehensive examination of the planning, organization, operation, budgeting and research components of the USAID PASA/ID/TAB 473-1-67 with the Denver Wildlife Research Center (DWRC), USDI. The applied research covering field surveys, studies, testing, and basic research will be reviewed and evaluated with socio-economic studies, technical service, training, and information distribution taken into consideration.
- The ultimate intent of the Pest Management Research Program is to develop safe, effective, and economical pest control methods that can be adapted and utilized under social and economic conditions existing in developing countries. These methods need to be practical for small farm systems yet based on sound agricultural development principles. In order to be most effective the techniques must in the final analysis be self sustaining in the LDC's.
- IV. COMPOSITION OF TEAM
- William D. Fitzwater, Director
bioLOGIC consultants, Chairman
- Dr. Robert E. Gray, Special
Assistant to the Deputy Director of
Tech. Assistance, Office of
International Cooperation &
Development, USDA
- King L. Lovinger, Director of the
Information Division of Animal and
Plant Health Inspection Service, USDA

- b. Continue to assist in field research, evaluation, demonstration, training, and dissemination of information.
- c. Continue problem-oriented, basic, and applied research activities at DWRC laboratories.
- d. Continue to act as liaison between DWRC and field personnel including both U. S. and foreign investigators.

B. Philippines

1. MAJOR ACCOMPLISHMENTS

- a. National surveys of rodent damage to rice completed and distribution of rodent pests determined.
- b. Effective method of ricefield rodent control through sustained baiting with anticoagulants developed for small farmers. These recommendations were adopted by Government of the Philippines.
- c. Vertebrate pest control research and training established and institutionalized within the National Crop Protection Center and its regional field stations. More than 20 graduate students completed thesis work in association with the project.
- d. Government operational rodent control programs reorganized to incorporate improved methods developed by project personnel.

2. CURRENT AND PLANNED RESEARCH ACTIVITIES

- a. Evaluate and adapt approaches for reducing the rodent damage to rice, corn, coconuts, and sugarcane. Project is to serve as intermediate field laboratory for worldwide rodent research activities.
- b. Studies underway to determine chemical residues in plants, soil, and water following sustained anticoagulant baiting.
- c. Continue development of vertebrate pest management graduate program to include local and foreign students.
- d. New research in progress to enhance effectiveness of field programs includes:
 - (1) Evaluation of new or improved rodenticides and bait formulations.
 - (2) Use of marking agents and radio-telemetry to determine movements of

rodents and birds. (3) Evaluation of border marshlands harboring dense rodent populations to understand and prevent major rat outbreaks. (4) Evaluation of bird damage to small grains and development of control methods.

C. Sudan

1. MAJOR ACCOMPLISHMENTS

- a. Obtained information on indirect (i.e., population reduction) bird control efforts as practiced by various organizations. It was found that these efforts are largely ineffective in reducing damage and not economical.
- b. Initial field trials in three East African countries indicate that effective protection of small grain crops from bird damage can be achieved with relatively low levels of methiocarb repellent head sprays.
- c. Information on crop losses and economic impact of bird damage in Sudan and other African countries has been compiled.
- d. The most important agricultural rodent pests in Sudan are Arvicanthi spp. and Mastomys spp. They damage sorghum, wheat, groundnuts, and vegetables.

2. CURRENT AND PLANNED RESEARCH STUDIES

- a. Conduct intensive field studies with methiocarb on small grains being damaged by Quelea including: (1) Evaluation of best method of head spray treatment; strip, spot, or edge. (2) Initiate village pilot project to evaluate use of methiocarb head sprays for protecting sorghum.
- b. Conduct questionnaire survey to more clearly define vertebrate pest damage problems in Sudanese agriculture.
- c. Evaluate the use of nesting material for delivering toxicants to nesting birds near areas with chronic damage.
- d. Evaluate candidate chemicals and bait formulations for potential use in field rodent control programs.
- e. Assist East African countries and international organizations in establishing a research information network.

D. Bangladesh*

1. MAJOR ACCOMPLISHMENTS

- a. Vertebrate Pest Division organized within Bangladesh Agricultural Research Institute (BARI), cooperative ties with other agencies established, and counterpart personnel selected.
- b. New laboratory and office facility designed and functional.
- c. Workshop and training sessions held for BARI and other Government personnel.
- d. National survey of rodent damage to wheat completed in 1979. The countrywide field loss was 12% valued at about \$15 million.
- e. National survey of vertebrate pest problems on small farms. Pest identification and distribution initiated.

2. CURRENT AND PLANNED RESEARCH ACTIVITIES

- a. Laboratory evaluation of candidate rodenticides and bait formulations.
- b. Baiting studies in small-farm crops being implemented.
- c. Studies of burrow systems and behavior of fossorial rodents.
- d. Test trials to discern the most effective method of monitoring field rodent populations; includes live and snap traps, and tracking tiles.
- e. Study effect of intensive trapping on rodent damage to deep-water rice. It will also provide information on seasonal changes in reproduction.
- f. Continue national vertebrate pest and crop damage surveys.

*Funded by AID Mission/Dacca

E. Haiti*

1. MAJOR ACCOMPLISHMENTS

- a. Four-year PASA negotiated with and approved by AID Latin America/Caribbean Bureau (LAC)
- b. Initial information on vertebrate pests and associated problems in agriculture has been assembled.

2. CURRENT AND PLANNED RESEARCH ACTIVITIES

- a. Project will address vertebrate pest problems in small-farm agriculture of the Caribbean region. Initial activities to include: (1) Establishment of laboratory and office facility. (2) Establishment of cooperative ties with Haitian and other Caribbean organizations and hiring of counterpart personnel. (3) Compiling of baseline data on important vertebrate pests, crops damaged, and losses incurred. (4) Planning of comprehensive research and training program.

B. TDY Activities

TDY activities from the DWRC have become an increasingly important part of the project. Short term functions include evaluations, cooperative studies with host-country scientists, training, liaison/coordination with international research organizations, etc. Non-scheduled trips are requested by AID/Washington, AID Mission, Regional Bureaus, or individual countries. Due to the limited staff of the Section of International Programs--and the frequent need for quick response to TDY requests--other DWRC biologists or consultants may be utilized to fulfill these functions. In 1978, DWRC staff and consultants spent 435 man-days in 24 countries.

At some time in the near future it may be advisable to conduct a cost-benefits and/or priority-need evaluation of DWRC TDY activities (total picture) vs. established program activities. This is because the increasing trend of TDY will make this function a significant budget item, while the fact that much TDY is unscheduled makes budget proposal justification difficult, if not impossible.

C. Management and Administrative Functions of DWRC & AID

The project is physically located at the Denver Federal Center in Denver, Colorado. The Center is administered by Clyde J. Jones, Director of the Denver Wildlife Research Center, Fish

*Funded by LAC/AID/Washington

and Wildlife, U. S. Department of the Interior. Direct management of the project is under John W. DeGrazio, Chief, of International Programs. Mr. DeGrazio's salary is paid by both FWS (24%) and AID (76%). He has staff of 4 in Denver and 5 in 4 overseas field stations. DWRC also payroll's members of other branches to support the activities of International Programs. The complete breakdown of staff persons and salary distribution of DWRC personnel for FY-80 by pay periods is listed below:

<u>International Programs</u>	<u>DSB</u>	<u>CARIBBEAN</u>	<u>BANGLADESH</u>	<u>FWS</u>
DeGrazio	7.0	14.0		5.0
Scott	14.0	12.0		
Fall	26.0			
Valvano		13.0	13.0	
Bruggers	18.5	6.5		
Fiedler	26.0			
Garrison	26.0			
Bohl	26.0			
Biologist (Vacant - Sudan)	4.0			
Poche			26.0	
Mitchell		26.0		
Technician (Vacant - Denver)		<u>13.0</u>	<u>12.0</u>	
Subtotal	147.5	84.5	51.0	5.0
<u>Supporting Sciences</u>				
Thompson	13.0			13.0
Kolz	13.0			13.0
Savarie	6.6		13.0	6.4
Johns	13.0			13.0
Bullard	13.0			13.0

Shumake	19.6			6.4
Elias	13.0			13.0
Crane	19.6			6.4
Kilburn	19.6			6.4
Riebe	13.0			13.0
Technician (Vacant)	13.0		12.0	
Technician (Vacant)	_____	<u>6.5</u>	_____	<u>18.5</u>
Subtotal	123.8	19.5	25.0	122.1
TOTAL	271.3	104.0	76.0	127.1
Person-Years	10.4	4.0	2.9	4.9

Dr. John W. Walker provifes the necessary liaison for management and administrative requirements of AID.

D. Problem Oriented Research at DWRC

1. SIGNIFICANCE TO AID OBJECTIVES

Vertebrate pests play a major role in limiting agricultural production in developing countries and often have greatest impact on the poorest farmers in marginal agricultural areas. Chronic losses caused by these animals remove a substantial part of agricultural production in any areas before crops are harvested. Hence, a sizable percentage of production investments and agricultural labor are devoted simply to feeding pests. Many species, in addition to reducing production, damage stored foods and are important vectors of a variety of diseases. Failure to protect crops from vertebrate depredation means that many of the new agricultural technologies available to farmers in developing countries do not realize their full potential for improving yields. Minor investments in laboratory and field research and in training of indigenous counterpart control specialists can result in development of practical control methods suited to local needs along with the development and strengthening of country institutions to support active implementation programs.

Results of previous work by Denver biologists in developing countries--particularly in the case of control of rat damage to rice and coconuts, vampire bat damage to cattle, and control of bird damage to emergent grains--have shown that the potential for tremendous savings exists as a result of the development of new control techniques.

The successful institutionalization of field research, training, and implementation in several of the countries where AID-funded programs have been carried out have far-reaching, long-term impact in preparing these countries to respond to local vertebrate pest problems on a continuing basis. The value of such program benefits have not been fully expressed in economic terms but nonetheless form an important aspect of fulfilling the goals of AID-funded research. For example, in the Philippines, training local and other Asian personnel from farmers to scientists (about 3,000 in 1975) is an important part of the project. Counterpart personnel have played an increasing role in training, in development of control techniques, and in outreach activities into other Asian countries. This has been accomplished with only one or two DWRC biologists with assistance of the backup team in Denver.

2. RELATION TO EXISTING KNOWLEDGE

Little information on vertebrate pest biology and control from developing countries has been recorded in technical literature. Most of the scientific and para-scientific literature on rat control, for example, relates to work on one species--the Norwayrat--in stable, temperate, urban situations. Attempts to copy the control methods and research procedures used on this species have actually retarded progress on agricultural rodent control in tropical regions because major ecological and behavioral differences exist. DWRC scientists, through work on AID-funded projects, have played an important role in evaluating and synthesizing existing scientific literature on animal damage control and have helped to make a variety of publications and current information available to cooperators in developing countries. The results of research by Denver biologists and their cooperators have been reported in more than 200 technical publications during the past 8 years. Research summaries are widely distributed in regular annual progress reports and include both field and laboratory phases. These reports and publications have been an important function in providing research models and new ways of viewing vertebrate pest

problems to worldwide contacts. They have also resulted in a better understanding of local agricultural problems by indigenous local scientists and agriculturists.

3. RELATION TO OTHER RESEARCH

The need for increased food production has led to increased emphasis on crop protection research by international organizations and by many of the developing countries. The Denver Center maintains active cooperation with the agricultural research programs of numerous international organizations and country institutions and has carefully coordinated its programs to avoid duplication and focus on areas of greatest need. Cooperative efforts have been carried out in conjunction with FAO, PAHO, CIAT, IRRI, WHO, and various programs in individual countries. In addition, the Denver Center and its field programs have served as training sites for personnel from these organizations. Utilization of techniques developed by DWRC has been assisted or carried out by several international organizations, thus greatly increasing the impact and dissemination of the results of AID-funded research.

E. Dissemination of and Utilization by LDC's and AID Missions of the Knowledge and Skills Developed from this Project

DWRC researchers have published more than 200 papers relating to animal damage control in developing nations. Efforts are made to include cooperating host country researchers as co-authors as a means of increasing publication and distribution of technical papers within impact countries. Likewise, cooperating foreign institutions and scientists are encouraged and assisted in publishing collateral work independently.

DWRC researchers also prepare routine progress reports on all studies, annual reports, and summaries of management implications upon completion. Reports (as well as technical papers) are published in professional journals and widely distributed to cooperators and colleagues concerned with animal damage control problems throughout the world.

The above assures good dissemination of information to scientists and agricultural administrators involved or interested in animal damage control. However, this scientific specialty does not exist in many LDC's and AID missions. Moreover, policy and decision-making officials in LDC's may be totally unaware that they have animal damage control problems.

Such scientists and administrators will not tend to read the professional journals that publish DWRC reports and technical papers, nor attend the meetings where they are presented. Thus LDC's and AID Missions that need DWRC help may not be aware of its availability.

True, DWRC reports may be circulated to such individuals and organizations due to their position of authority. But, in such cases reports may be viewed as just one more highly technical, long (the 1978 annual report runs 129 pages) item in the constant flow of daily paperwork.

Where reports are scanned, their application to this LDC or Mission may be missed since they tend to be specific in terms of pest (type of rat), crop, country, and local problem. There are, of course, exceptions (i.e. - a publication on rodents in tropical rice), but they tend to be long on detail and highly technical--which discourages reading by officials who do not have a scientific background in this area.

There is, therefore, a need for short, interesting publications and audio-visuals (i.e. - slide shows) of a general and not overly technical nature. This material would be widely circulated and used to acquaint foreign agricultural and AID Mission officials with the functions performed and services offered by DWRC.

Similar materials should be produced to categorize and explain animal damage problems in a dramatic, general, short-but-interesting manner (i.e. - rat damage in field crops). Emphasis would be on costs of damage and benefits of control.

Such materials would help LDC and Mission officials identify their animal damage problems, get them thinking along newer, more creative and effective control lines, and increase the utilization of DWRC and its research.

F. Damage Assessment

Assessment of crop damage is important from the standpoint of evaluating the effect of particular control methods in field trials and, in some situations, may be useful in developing the statistics on the impact of pest damage in a particular country or region. Specialized techniques are required for different types of information and must be designed to fit particular crops or cropping patterns. Considerable progress has been made in developing index surveys for rodent damage in transplanted rice and bird damage to corn.

G. Evaluation of Current Control Methods

Many countries have extensive government programs using control approaches of dubious value from the standpoint of crop protection. Similarly, most farmers suffering damage problems make some effort to prevent or reduce damage. Often, a serious evaluation of these practices must be made in cooperation with indigenous personnel or institutions to convince them that adequate crop protection is not being achieved through local programs. A principal difficulty in many countries (including the United States) is that vertebrate pest control practices are directed at killing large numbers of animals without regard to the damage that they cause, and sometimes without regard to the cost/benefit relationships of a particular approach.

Development and evaluation of practical delivery systems will be an important aspect of research in all problems addressed by this project. Among the principal approaches to be researched are baiting methods for birds and rodents and application of repellents to seeds, growing plants, or maturing grains. Such work requires a cooperative effort of pharmacologists, field biologists, behaviorists, and engineers and is an area in which the Denver Center has made important advances for a variety of specific problems.

Need: Evaluations of control methods in use by LDC's is an important consideration for the future. Ways must be devised to selectively deliver chemicals or other control materials to target species in problem situations.

H. Toxicological Evaluation

A variety of rodenticides, avicides, repellents, and other chemical control agents are available commercially or as candidate materials having potential for United States registration. Most of these materials, despite their availability in many foreign countries, have not been adequately evaluated toxicologically or pharmacologically on major pest species.

Need: Such evaluations on principal pest rodents and birds are an important preliminary aspect, and involve evaluation of candidate materials likely to be useful and commercially available in foreign markets. In certain cases, specific formulations for these materials may need to be developed and evaluated.

I. Chemical Development

Because most control chemicals and devices are developed by private industry and directed toward temperate urban markets, some tropical pest situations, particularly those involving agricultural rodents, may require selected

development of specific chemicals not currently considered of economic importance by private industry. On a selective basis, preliminary work on chemical development will be undertaken by this project in cooperation with other international organizations such as WHO and FAO. Such chemicals will be required to support vertebrate control programs in cases where rodent population develop genetic resistance to existing anticoagulant rodenticides.

Need: The development of analytical techniques is an essential aspect of vertebrate control methods research. These techniques are required to assess environmental persistence and degradation and to determine potential hazards for nontarget species. The development and evaluation of select chemicals which have select modes of action will be further investigated.

J. Analytical Techniques (Cost-Benefit Analysis)

While difficult to measure in an area with as diverse ramifications as vertebrate pest control, present economic realities demand that some cost-benefit effects be measured.

Estimates of this ratio have been obtained from some completed projects:

1. PHILIPPINES: Rat damage to rice reduced on 500,000 ha from 5% to 1%, saving farmers \$50 million annually. Individual studies have indicated the cost:benefit ratio for rat control can range from 1:18 on corn (Bukidan), 1:40 coconut (Mindoro), 1:68 rice (Mindoro) to 1:90 (Pangasinan).
2. NICARAGUA: Paralytic rabies eliminated. Annual benefits to livestock industry \$2.4 million. Cost:benefit ratio 1:19.
3. COLOMBIA: Rat damage to coconuts reduced 100%. Cost:benefit ratio 1:75.

K. Pest Behavioral and Physiology Analysis

In many cases, virtually no biological information is available on the principle species in developing countries. Pest rodents in particular have flexible behavior, and important behavior parameters may vary under different environmental situations. In the course of this project, colonies of selected species from developing countries are being assembled at regional field stations or at Denver and subjected to comparative analyses of important behavioral and physiological parameters. Behavior analyses will also be used under laboratory and semifield conditions to evaluate candidate control materials and delivery systems.

Need: Such information is critically important to direct the development of control methods or materials and to understand the extent to which control approaches may be generalized from one species to another.

L. Protection of Stored Grain

Although considerable effort has been devoted to reduction of storage losses to rats and birds by both government and private industry in the United States, little effort has been made to extend technological gains to developing country situations. In practice, such losses in the tropical regions are generally unrecognized and difficult to determine because of rapid turnover of grain stores. Storage losses may be most intense on farms and small community facilities directly affecting the income and available food of the poorest farmers. The Denver Center has carried out only limited work on grain storage problems in the United States.

Need: Efforts should be made to gain preliminary information about developing country rural problems and to assess the degree with which existing technology may be applied.

M. Adaptive Research and Field Evaluation

To approach practically in most operational situations, methods must undergo detailed field evaluation in specific problem areas and, in some cases, must be adapted to fit the particular circumstances of unique farming practices, capabilities of local plant protection organizations or farmers, or behavior of local pest species. Such field trials are also useful in encouraging regional cooperation among developing country institutions, in training foreign cooperators to carry out such evaluations on a continuing basis, and in developing cooperative research networks that can tie the vertebrate pest control efforts of developing country agencies to a coordinated approach for the effective use of new technology. Although some methods adaptation must usually be made for each specific situation, the Denver Center team has developed basic approaches for carrying out field evaluations of vertebrate pest control techniques in most major types of crop situations encountered in developing countries. Local and regional training and institutionalization of this field evaluation capability in each region would permit continuing cooperation on the extension of U. S. technology to these areas after the withdrawal of U. S. biologists. Resident field projects currently exist in the Philippines, Sudan, Bangladesh, and Haiti.

Need: Such evaluations form an important part of this project and are viewed as a necessary step in the process of bringing particular control methods to operational status.

N. Engineering Application

The Denver Center maintains an electronics laboratory and has a staff engineer who is a particularly important member of the control methods development team. Development of better techniques of field recording of rodent activity, particularly for the evaluation of rodenticide delivery systems, is required and such efforts will be continued under this project. In addition, adaptation of a sublethal electric barrier designed and developed by our group will be pursued to fit specific rodent damage situations in Asia, Africa, and Latin America.

Need: Continuing development of methodology for biotelemetry studies of selected species and other remote sensing applications.

O. Environmental Assessment

Most developing countries, at present, devote little attention to the potential environmental impacts of current control methods. In many cases, highly toxic persistent chemicals, particularly organochlorine insecticides, are used haphazardly for pest control, often with detrimental effects to other wildlife and potentially endangering humans who consume treated food. Candidate control methods which have potential for developing countries will be evaluated in terms of their selectivity for target organisms, primary and secondary hazards to associated nontarget species, and potential for producing hazardous or intolerable residues in human food. Such investigations would develop information according to guidelines of AID's comprehensive environmental impact statement and adhere to U. S. Fish and Wildlife Service and EPA environmental policies.

A recently announced shift of the National Fish and Wildlife Laboratory, physically located in the Field Museum of Natural History, Washington, D. C., under the administrative aegis of DWRC will augment ecological assessments of the projects activities in the future.

Need: This project will help cooperators to understand the undesirable environmental aspects of such approaches (which are usually ineffectived in protecting crops) to vertebrate pest control.

P. Evaluate External Factors

The major project setting - i.e. the need (a) to gain a better understanding of the magnitude and causes of food production losses due to vertebrate pests and (b) to design and implement programs to substantially reduce these losses - has not changed. If there has been any significant change, it has been for additional emphasis to be given to the food loss field - both by AID policy and directives and by recipient Government interest. In a number of cases - such as in the Philippines - vertebrate pest control has been made an integral part of the development strategy for small farmers. As additional experience and knowledge is gained by both host country agencies and by the DWRC personnel effectively and economically controlling the major pests causing losses, it can be expected that the program will become even more important. The critical mass of knowledge and experience is being generated upon which major control programs may be based.

Q. MEASURE OUTPUTS

The field accomplishments of DWRC are discussed in detail under section A: Outreach of In-country Programs and need not be repeated here. However, the laboratory aspects were not included in this discussion and thus are enumerated below:

1. OUTREACH AND IN-COUNTRY PROGRAMS

a. Major Accomplishments

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

Determined that DRC 4575 has the potential for use as an acute rodenticide.

Developed an automated computer system for determining daily feeding patterns of rats.

Demonstrated that microtaggant plastic particles can be used to mark baits and topically mark birds and rodents.

b. Current and Planned Work

Continue rodenticide development

Provide analytical and radio telemetry support as needed for field programs in developing countries.