PD-ABC-425

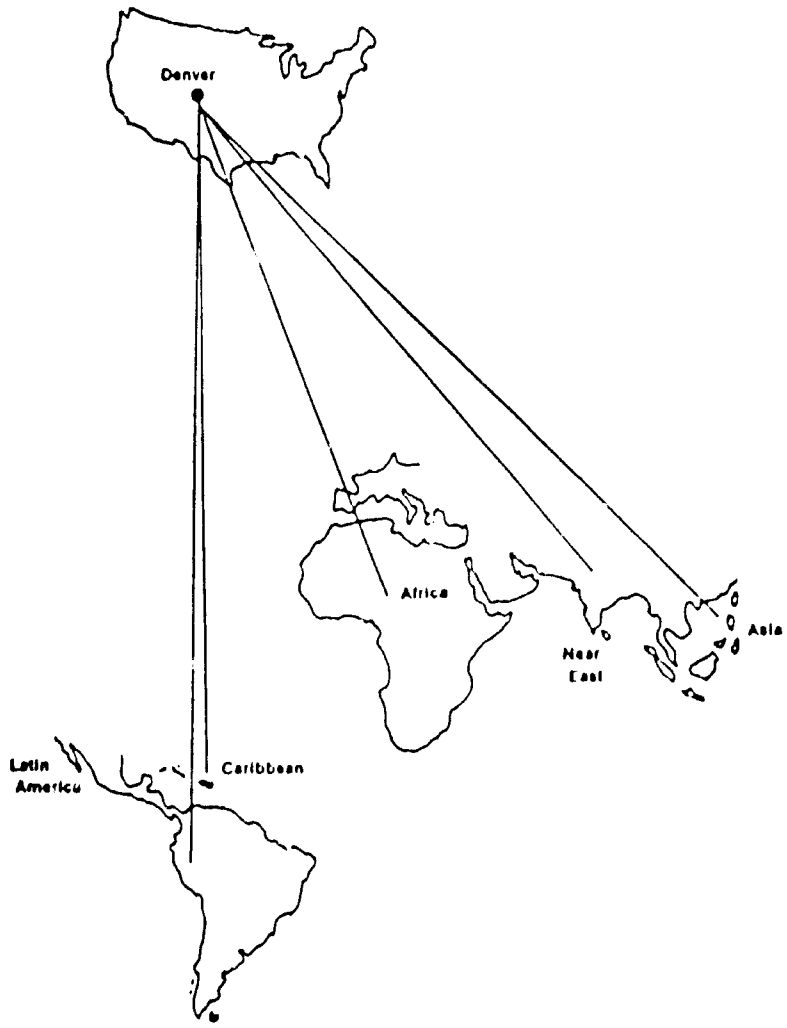
DENVER WILDLIFE RESEARCH CENTER

INTERNATIONAL PROGRAMS RESEARCH SECTION

VERTEBRATE PEST MANAGEMENT IN AGRICULTURE

OUTREACH PROGRAM—FY 1990

PROBLEM SOLVING RESEARCH TECHNOLOGY TRANSFER EXTENSION
TRAINING CONSULTANCIES DOCUMENTATION



U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH
INSPECTION SERVICE
SCIENCE AND TECHNOLOGY

U.S. AGENCY FOR INTERNATIONAL
DEVELOPMENT

United States Department of Agriculture

Animal and Plant Health Inspection Service

Science and Technology

Denver Wildlife Research Cente
Building 16, P.O. Box 25266
Denver Federal Center
Denver, CO 80225-0266

OUTREACH ACTIVITIES

International Programs Research Section

November 1990

This document is a compilation of trip reports resulting from international requests for Denver Wildlife Research Center (DWRC) technical assistance in vertebrate pest management. During Fiscal Year 1990, DWRC staff facilitated travel of 13 individuals and 25 consultancies to the following countries in Africa, Asia, Europe, La'in America, and South America to assess vertebrate pest problems; to conduct, review, evaluate, and coordinate present and future activities; to participate in training workshops; and to present technical seminars.

Argentina	Indonesia	Philippines
Bahamas, The	Italy	Senegal
Bangladesh	Malaysia	Uruguay
Chad	Morocco	Yemen, Republic of
Guinea-Bissau	Pakistan	

These consultancies were at the request of the Africa Emergency Locust and Grasshopper Assistance Program (AELGA), International Rice Research Institute (IRRI), Food and Agriculture Organization (FAO) of the United Nations, U.S. Agency for International Development (USAID), USAID missions, USAID/Washington, and foreign governments. These consultancies had a diverse range of topics including large-scale rodent control demonstrations; rodent, jackal, and wild boar population monitoring studies; problem assessment and project planning of pest birds; training and research on the impact of locust sprays on the environment and nontarget wildlife; specific training in techniques of radiotracking wild animals; chemical residue analysis of pesticides; and statistical analysis of data.

Richard L. Bruggers
Chief, International Programs Research Section

FY-90 TRIP REPORTS

CONTENTS

Trip Reports*

Keith, J. O. 1989. Environmental effects of insecticides used in locust control. Trip Report No. 2--Senegal. 3 pp. and 4 attachments.

Fiedler, L. A. 1989. Trip Report--Bangladesh. 4 pp.

LaVoie, G. K. 1989. Trip Report--Chad and Guinea-Bissau. 10 pp.

Wilson, J. 1989. Trip Report--Chad. 57 pp.

Timm, R. M. 1989. Trip Report--Bangladesh. 7 pp. and 3 appendices.

Bruggers, R. L. 1989. Trip Report--Chad, Italy, and Morocco. 7 pp.

Keith, K. O. 1989. Trip Report--Morocco. 4 pp. and 3 attachments.

Knowlton, F. F. 1990. A review of predator research in Bangladesh. Trip Report--Bangladesh. 17 pp.

Fiedler, L. A. 1990. Bird pests in Argentina and Uruguay--project planning. Trip Report--Uruguay and Agentina. 18 pp. and 4 appendices.

Groninger, N. P. 1990. Computer assistance and training. Trip Report--Hawaii, Bangladesh, and Pakistan. 10 pp. and 4 attachments.

Bruggers, R. L. and M. W. Fall. 1990. Program activities, progress, and future action plans for cooperative Denver Wildlife Research Center projects in Bangladesh and Pakistan. Trip Report--Bangladesh and Pakistan. 9 pp. and 5 attachments.

Fiedler, L. A. 1990. Trip Report--Italy, Malaysia, Indonesia, and the Philippines. 4 pp. and 1 appendix.

LaVoie, G. K. 1990. Trip Report--Chad. 7 pp. and 1 appendix.

Keith, J. O. 1990. Environmental pesticide project. Trip Report--Morocco. 5 pp. and 4 attachments.

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* Mr. John E. McConnell left the DWRC on May 2, 1990, to begin a 1-year assignment as Project Coordinator in Morocco.

Dr. J. Juan Spillett arrived in Chad on July 3, 1990, as project leader of the new field station in Chad.

FY-90 TRIP REPORTS (Continued)

Gillis, J. N. 1990 Chemical analyses of pesticides. Trip Report--Morocco. 6 pp.

LaVoie, G. K. 1990. An assessment of the rodent problems in the Republic of Yemen. Trip Report--Yemen. 10 pp. and 4 appendices.

Kolz, A. L. and R. L. Phillips. Environmental pesticide project--wildlife telemetry training. 1990. Trip Report--Morocco. 7 pp.

Keith, J. O. 1990. Predator control to protect nesting Bahama parrots. Trip Report--The Bahamas. 9 pp.

Fiedler, L. A. 1990 Rodent pests in Guinea-Bissau. Trip Report--Guinea-Bissau. 10 pp.

L. A. Fiedler and M. W. Fall. 1990. IRRI Expert Panel Meeting on rodent pests in rice, Los Baños, Philippines, and DWRC Hilo Field Station consultation. Trip Report--The Philippines. 6 pp. and 2 appendices.

NOTE: Trip reports are on file at the International Programs Research Section, DWRC.

TRIP REPORT*

Environmental Effects of Insecticides Used in Locust Control**

SENEGAL

September 11-October 13, 1989

by

James O. Keith
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Denver Wildlife Research Center
Science and Technology
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
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Unpublished Report

November 30, 1989

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* This project was conducted with funds contributed to the U.S. Department of Agriculture/Animal and Plant Health Inspection Service/Science and Technology, Denver Wildlife Research Center by the U.S. Agency for International Development with support from the African Bureau and the Africa Emergency Locust and Grasshopper Assistance Project.

** Details of this cooperative international research program and the accomplishments of earlier fieldwork in July and August are presented in a trip report dated September 14, 1989, available from the International Programs Research Section, Denver Wildlife Research Center.

Itinerary

September 11-12	Travel from Denver, Colorado, to Dakar, Senegal
September 13	Travel from Dakar to Richard Toll, Senegal
September 14 - October 7	In Richard Toll
October 8	Travel from Richard Toll to Dakar
October 9-10	In Dakar
October 11-13	Travel from Dakar, Senegal, to Denver, Colorado

OBJECTIVE

To complete studies in Senegal of the impact on birds of insecticides used to control African migratory locusts and grasshoppers.

ACCOMPLISHMENTS

Insecticides applied for locust control have not been evaluated for ecological and nontarget effects under the conditions of their use in Africa. As locust control is continental in scope and large areas and amounts of insecticides are involved, environmental effects of treatments need to be assessed. Such research was initiated in Senegal during June, July, and August 1989 by an international team of scientists with expertise in diverse aspects of aquatic and terrestrial biology. Pretreatment data were obtained on experimental plots prior to treatments; insecticides were applied to plots in early September. Background information and details of pretreatment activities are available in an earlier trip report--SENEGAL, June 27-September 3, 1989--available from the Denver Wildlife Research Center.

In July and August, pretreatment information was obtained on the kinds and numbers of birds occurring on the five study plots. Five weekly counts on six transects (Attachment 2) were taken in each plot. In addition, golden sparrows, buffalo weavers, and singing bush larks were collected to determine foods they were eating and normal cholinesterase (ChE) levels in their brains. It was anticipated that both food habits and ChE levels of birds would be affected by insecticide treatments.

Insecticides were applied to experimental plots between September 5-11. Two plots (see Attachment 1) were treated with fenitrothion (A, at 500 g, and B, at 1,000 g/ha) and two were treated with chlorpyrifos (D, at 240 g, and E, at 480 g/ha). Plot C was not treated and served as a control. A 12- to 14-person search team walked through each plot twice, once at 24 hours and again at 48 hours after treatments. The fenitrothion (1,000 g/ha) plot also was searched at 3 and 6 days posttreatment. Searchers walked 20 m apart and covered a swath about 250-m x 2-km during each search. The area searched was about 25% of the central 1,000 x 2,000-m study area of each plot (see Attachment 2). A few dead and debilitated birds were found (Attachment 3).

Bird counts were resumed on September 12. The first count on each plot was made about 1 week after it was treated. Four weekly counts were taken on each of the treated and control plots. Considerable changes occurred in bird abundance on plots due to normal movements of birds between late July and early October. Numbers of golden sparrows, which were the most abundant birds on plots in July, decreased dramatically during August and September. Buffalo weaver numbers also decreased, largely before spray applications. Following treatments, numbers of singing bush larks decreased on all plots, including the control plot, as young birds fledged and larks left the study area. Other species, such as the woodchat shrike, gradually increased on all plots during August and September.

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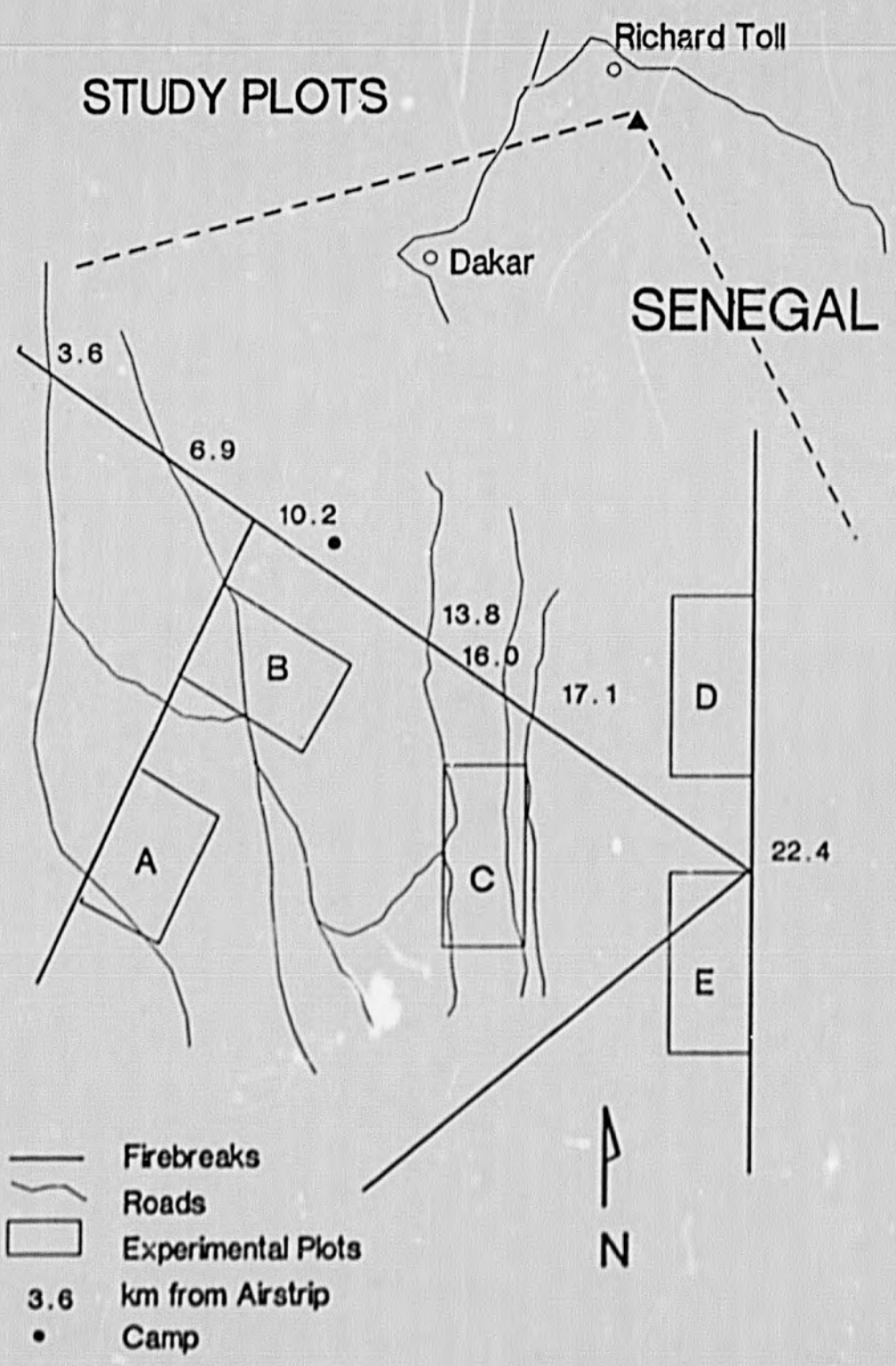
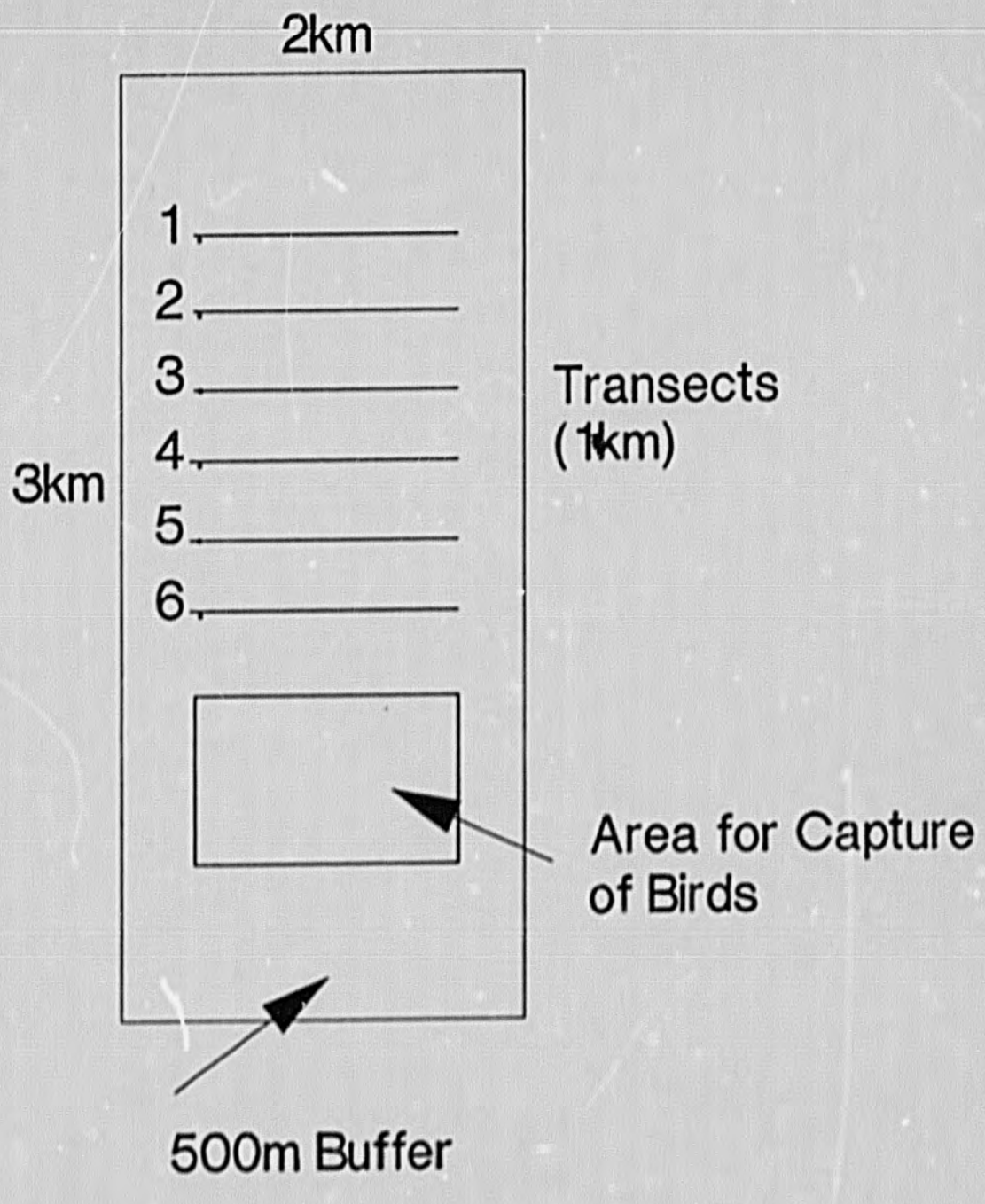
Changes in the abundance of other species appeared related to treatments (Attachment 4). Thorough compilation and analysis will be required of all data to determine which changes were real and which were related to treatments. Preliminary compilations of bird counts obtained by Dr. Keith suggest that the total number of individuals of the abundant species residing on plots were affected (comparing the last pretreatment count with the average of the four posttreatment counts). Totals of these collective species showed a reduction of about 45% on plots treated with 1,000 g/ha of fenitrothion and 480 g/ha of chlorpyrifos. Reductions in total bird numbers ranged from 17-32% on other plots, including the control plot. Reductions in bird abundance probably resulted from both normal movements and those in response to reduced food supplies following decimation of invertebrate biomass by the insecticides applied to plots.

Posttreatment collections of live birds were made during September to obtain gizzards for food habits analyses and brains for ChE determinations. Sampling was done for some species collected pretreatment, for species killed or debilitated by treatments, and for other species that were subjected to exposure but remained abundant on treated plots. Identification of insects found in stomachs and traps is continuing in order to document changes in foods eaten by birds and in invertebrate biomass after treatments. ChE analyses are being conducted at the University of Dakar and should be completed in November.

After bird count data are analyzed, food habits are determined, and ChE analyses are completed, a comprehensive report of results will be prepared. Our report will be included with those of other scientists to give a broad consideration of the ecological ramifications of fenitrothion and chlorpyrifos used to control locusts and grasshoppers in the specific ecosystems studied in northern Senegal. Results cannot be used to predict the consequences of such uses in other areas under different ecological conditions. Additional studies and evaluations will be required in other areas before questions about the environmental costs of locust and grasshopper control throughout Africa can be resolved.


STUDY PLOTS
Richard Toll
Dakar
SENEGAL
3.6
6.9
10.2
13.8
16.0
17.1
22.4
A
B
C
D
E
N
Firebreaks
Roads
Experimental Plots
3.6 km from Airstrip
Camp

LAYOUT OF STUDY PLOTS



Dead (D) and Debilitated (d) Birds Found on Plots[a]

Species	Plot treatments[b]			
	F-500	F-1,000	C-240	C-480
Button Quail	-	2(d)	1(d)	-
White-throated Bee-eater	-	-	-	1(d)
Abyssinian Roller	1(d)	1(d)	-	3(D)
Hoopoe	1(D)	2(d)	-	-
Singing Bush Lark	1(D)	2(D)	-	1(D)
Tree Pipit	-	1(d)	-	-
Woodchat Shrike	-	2(d)	-	-
Cricket Warbler	-	1(d)	-	-

[a] Fledglings of the long-tailed beautiful sunbird (2), buffalo weaver (1), singing bush lark (28), rose-grey dove (1), and Tchagra (1) were captured during searches. It was not clear if these birds were debilitated or simply flightless. ChE levels will be analyzed in dove, lark, and weaver brains. No dead or debilitated birds were found on Plot C (control).

[b] Treatments were fenitrothion at 500 g/ha (F-500) and 1,000 g/ha (F-1,000); chlorpyrifos at 240 g/ha (C-240) and 480 g/ha (C-480).

Partial Compilation of the Most Common Bird Species Counted on Study Plots Before (Last Pretreatment Count) and After (Average of the Four Posttreatment Counts) Spraying*

Species	Plots and Periods									
	F-500		F-1,000		Control		C-240		C-480	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Namaqua Dove	3	7	9	2	14	5	3	7	15	11
Laughing Dove	12	8	3	1	7	4	4	3	8	7
Rose-grey Dove	21	12	2	9	10	29	9	14	171	27
Vinaceous Dove	7	10	1	2	2	6	3	7	26	13
Blue-naped Mousebird	-	4	-	-	2	3	5	9	9	12
White-throated Bee-eater	-	5	1	6	2	16	6	7	6	10
Abyssinian Roller	17	7	1	13	10	23	22	20	13	22
Singing Bush Lark	69	10	74	20	123	30	93	70	84	29
Chestnut-backed Finch Lark	-	-	3	0.5	4	1	31	31	-	2
Woodchat Shrike	4	18	6	8	11	10	11	9	5	11
Blue-eared Glossy Starling	3	3	3	0.3	5	3	4	4	4	0.4
Chestnut-bellied Starling	12	9	7	5	12	13	4	6	15	11
Black Bush Robin	5	5	-	0.3	1	3	1	4	2	2
Fantail Warbler	12	10	4	4	5	1	1	1	1	0.3
Long-tailed Beautiful Sunbird	4	4	-	-	3	0.5	2	4	2	2
Buffalo Weaver	22	18	49	18	50	47	54	13	149	108
Golden Sparrow	491	166	293	98	841	92	555	103	263	177
Totals (except sparrows)	191	130	163	89	261	194	253	209	510	268
% Change	-32		-45		-26		-17		-47	

* Numbers are for counts on only three of the six transects on each plot.

TRIP REPORT*

BANGLADESH

September 21-October 24, 1989

Lynwood A. Fiedler

Wildlife Biologist (Research)

International Programs Research Section

Denver Wildlife Research Center

USDA/APHIS/S&T

P.O. Box 25266

Denver, Colorado 80225-0266 USA

Unpublished Report

January 10, 1990

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* This research was conducted with funds contributed to the Animal and Plant Health Inspection Service/Science and Technology/Denver Wildlife Research Center by the U.S. Agency for International Development Mission to Bangladesh through the Project "Agricultural Research II Vertebrate Pest Management Component" PASA IBD-0051-P-IF-2252-05.

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ITINERARY

Date	Location	Activity
September 21-22	Denver, Colorado, to London, England	Travel
September 23-24	London	Layover
September 25-26	London to Dhaka, Bangladesh	Travel
September 26-October 20	Dhaka and vicinity	Assisted the USAID/DWRC Vertebrate Pest Section in implementing the Rodent Control Research and Demonstration Field Study.
October 20-21	Dhaka to London	Travel
October 22-23	London	Layover
October 24-25	London to Denver, Colorado	Travel

OBJECTIVES AND SUMMARY

The purpose of this trip was to assist the Bangladesh Vertebrate Pest Section (VPS) in implementing a field research/demonstration project on preharvest rat control in rice. Two sites were selected, one at Ishurdi and the other at Comilla. I worked with Dr. Parvin Sultana, Bangladesh counterpart in charge of this study, at the Comilla site. The Comilla study site, like the Ishurdi study site, consisted of 48 x 1-km^2 blocks consisting of 2 x 24-km transects. In each transect, blocks were randomly selected to compare the effectiveness of two rodenticides and three user groups against no rat control. Either zinc phosphide bait or Phostoxin[R] [1] tablets were used by either an individual farmer, a farmer representative, or VPS staff. Training sessions were held with each participating farmer and farmer representative group. Participants in each group were instructed to follow the same rat control procedure using either the zinc phosphide bait cakes or Phostoxin tablets. The training was organized with the cooperation of local extension service personnel. Visual aids were planned, developed, and used in five training sessions, and three more sessions were scheduled after my departure.

BACKGROUND

The field work carried out during my stay in Bangladesh is part of the VPS work unit "Developing a strategy for extending rodent control technology to the Bangladeshi farmer." The results of more than 10 years of field research are being used to develop a cost effective and environmentally acceptable strategy for controlling preharvest rat damage in rice and wheat in Bangladesh. The strategy being tested consists of initiating rat control soon after the annual monsoon rains and subsequent flooding, a time when rat populations are low due to natural mortality caused by floods. Secondly, using a rodenticide applied directly to rat burrows in affected fields limits nontarget effects and reduces costs. This study will test whether zinc phosphide bait cakes or Phostoxin tablets should be recommended as the rodenticide of choice. Thirdly, this study will provide some answers as to who should implement the strategy--farmers themselves (Are they competent and willing to follow the recommendations?) or farmer representatives (since they work for several farmers and are experienced in crop protection activities). Rodent control implemented by farmers and farmer representative groups will be compared to that conducted by VPS professionals, which theoretically would represent an optimal rat control effort. To compare results from each of the three treatment groups (farmers, farmer representatives, and professionals), rat damage in treated fields will be estimated by counting pre- and posttreatment active rat burrows. Conclusions from this work will be used to formulate specific recommendations for rat control in rice fields.

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

ACTIVITIES

My assistance in the implementation of the Comilla field demonstration involved primarily setting up the scheduled training sessions, planning training activities, developing visual aids, and participating in five training sessions. The work in Ishurdi, which involved fewer farmers, was largely completed before my arrival. A flip chart was developed that contained 19 poster drawings with Bangladeshi titles and captions and included topics such as (1) a background of rat control fundamentals directly related to rat control in rice, (2) the purpose of the study, (3) procedures to complete, (4) rodenticide safety, and (5) proper disposal instructions.

Five of eight scheduled training sessions were completed prior to my departure. Sessions were well organized and well attended, largely due to the preplanning by Dr. Sultana with the local extension office in Comilla. Sessions included a presentation by Dr. Sultana using the flip chart, followed by a question-and-answer period. Interest among farmers and farmer representatives appeared high, judged by the number of questions and the length of the discussion. Immediately after each training session, rodenticide was distributed to registered participants who signed for the chemical.

Results will be evaluated by an extension specialist and will include rat damage assessments and farmer surveys, designed to identify major social, economic, and technical constraints. Dr. Robert Timm, Superintendent and Extension Wildlife Specialist, Hopland Field Station, California, assisted the VPS in these evaluations between November 18 and December 15, 1989.

CONTACTS AND ACKNOWLEDGMENTS

U.S. Agency for International Development (USAID)/Dhaka

Mr. Phil Warren, Chief, Agricultural and Rural Development (ARD)
Dr. Ray Morton, Program Officer, ARD

Bangladesh Agricultural Research Institute (BARI)/Vertebrate Pest Section (VPS)

Dr. Michael Jaeger, Project Leader
Mr. Emdadul Haque, Senior Scientific Officer
Mr. Rajat Pandit, Scientific Officer
Dr. Parvin Sultana, Senior Scientific Officer

Bangladesh Rice Research Institute (BRRI)

Dr. Jerry McIntosh, International Rice Research Institute (IRRI) Adviser

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TRIP REPORT*

BANGLADESH

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ACTIVITIES

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Mr. Rajat Pandit, Scientific Officer
Dr. Parvin Sultana, Senior Scientific Officer

Bangladesh Rice Research Institute (BRRI)

Dr. Jerry McIntosh, International Rice Research Institute (IRRI) Adviser

TRIP REPORT*

CHAD and GUINEA-BISSAU

October 8-November 12, 1989

G. Keith LaVoie
Wildlife Biologist (Research)

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Animal and Plant Health Inspection Service
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Unpublished Report

January 10, 1990

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* This project was conducted with funds contributed to the Animal and Plant Health Inspection Service/Science and Technology, Denver Wildlife Research Center through the Office of International Cooperation and Development (OICD), USDA, by the U.S. Agency for International Development/Bissau under the Project "Vertebrate Pest Management Systems R&D," PASA DAN-4173-X-AG-6001.

ITINERARY

Date	Location	Activity
October 8-11	Denver, Colorado, to Chad, Africa	Travel
October 12-18	Chad	Field work to initiate a rodent density monitoring program. Briefings with USAID and Crop Protection.
October 19-20	Chad to Guinea-Bissau	Travel
October 21-November 11	Guinea-Bissau	Briefings with USAID/USDA and Crop Protection and surveys of field rodents.
November 12	Guinea-Bissau to Denver, CO	Travel

OBJECTIVES AND ABSTRACT

The objective of the Chad portion of the TDY was to provide initial field assistance in Chad to Dr. John Wilson, Research Director, Centre for Biological Population Management, Queensland University of Technology, Brisbane, Australia, who was on sabbatical at the Denver Wildlife Research Center (DWRC). Dr. Wilson initiated a rodent population monitoring program near N'Gouri. Briefings were held with the U.S. Agency for International Development (USAID)/Chad and Ministry of Agriculture (MOA)/Chad to facilitate occupancy of office, laboratory, and housing accommodations upon the arrival of DWRC biologist and family.

The objective of the consultancy to Guinea-Bissau was to evaluate the pest status of rodents in agriculture and to train a counterpart in rodent pest research and control techniques, specifically: (1) to collect and identify rodents from the four agricultural zones, (2) to conduct rodent damage surveys in major crops which were at a vulnerable growth stage during the consultancy, and (3) to train a counterpart in trapping, rodent pest behavior, and control techniques applicable to Guinea-Bissau. These objectives were only partially accomplished during this consultancy.

CHAD

Activities

I accompanied Dr. John Wilson to N'Gouri to familiarize him with the areas I had previously surveyed to determine rodent species and evaluate rodenticides. I assisted him in the selection of permanent sampling points for the initiation of a long-term rodent density monitoring program in irrigated and dryland agricultural areas near N'Gouri. This monitoring program will continue for the duration of the project if, after a trial period, it provides scientifically acceptable data and is logistically feasible. These data will be the basis on which fluctuations in rodent population densities will be evaluated. Discussions were also held with the USAID representative, Agricultural Development Officer and Administrative Officer, the MOA Director General, and Director of Plant Protection and counterpart Crop Protection personnel regarding the arrival times and physical accommodations for the DWRC biologist in early 1990. Discussions with Mr. Kurt Fuller and Ms. Jeri Pennu led to a better understanding of what could be expected of AID/Chad's contract supply agent, Development Management Systems (DMS), and what would be required of DWRC to initiate and maintain a rodent research project in Chad.

GUINEA-BISSAU

Background

This was the third consultancy to Guinea-Bissau by Denver Wildlife Research Center biologists. The first consultancy by Dr. Richard Bruggers (Bruggers, 1986) was completed on August 25, 1986, and explored the

possible needs and opportunities for technical assistance. A second consultancy by Dr. Bruggers (1987) was an assessment of bird pests in Guinea-Bissau.

Guinea-Bissau is a small country (36,260 km^2) consisting of a low coastal plain, rising gradually to savanna in the east. The climate is tropical. The agricultural rodent pest situation in Guinea-Bissau has never been assessed. The objectives of my consultancy were to: (1) survey and identify rodents pests from the four agricultural zones, (2) conduct rodent damage surveys in major crops if they were at a vulnerable stage during the consultancy, and (3) initiate counterpart training in rodent pest behavior, trapping, and applicable management techniques. Only partial completion of these objectives was achieved. Transportation problems and limited specimen collection areas because of trap theft and disturbance significantly reduced the sampling areas and trap nights; we were able to use only about half (50) of our available traps on any one night, so that in case of theft we could continue surveys with the remaining traps. I should like to note, however, that these limitations are not unique to Guinea-Bissau but are shared in varying degrees with other developing nations.

Results

Rodent surveys: We conducted rodent surveys in agricultural Zone 1 (east central) and Zone 3 (coastal), Figure 1. A 5-day trip to survey Babaque Island in Zone 4 was unproductive because of transport problems. Trap bait used in all trapping activities described below was dried fish.

Zone 1: Near Bula, two sites in harvested vegetable fields, totaling about 1.5 ha, were trapped on successive nights for 1 night each. Traps (48/site) were set in grids: 10 m between 6 lines of 10 traps each with traps spaced 10 m apart. A total of 96 trap nights produced 8 specimens (8% trap success) consisting of two species of *Mastomys erythroleucus* and *Mastomys natalensis* and two specimens of *Mus* sp.

Zone 3: In the Catio area of Zone 3, a trapping survey of swamp rice produced 6 specimens of *M. natalensis* in 24 trap nights. Traps were set on dikes and uncultivated areas near the rice fields and spaced at least 10 m apart, but in no particular pattern in approximately a 1-ha area. Very limited trapping in upland rice produced 6 specimens, 3 of each *M. erythroleucus* and *M. natalensis* in 6 trap nights. Traps were placed in this upland rice field where evidence of rodent activity was found.

Near Caboxanque, also in Zone 3, we caught 14 *M. erythroleucus* and *M. natalensis* in swamp rice fields in 2 nights of trapping (39 trap nights and 36% trap success) in an area of less than 1 ha. In this area, we also trapped 2 consecutive nights in vegetable fields encompassing about 0.5 ha. On the first night, 48 traps in the vegetable fields caught 10 *M. erythroleucus* and *M. natalensis*, while during the second night in the same field, 25 traps captured only

3 *M. natalensis*, a 12% trap success. About 50% of the traps in these vegetable fields were found sprung each morning, and some captured rodents had been eaten while in the traps; tracks near the traps indicated that a cat of some type had disturbed the traps. The results of these trapping surveys are summarized in Table 1.

Table 1. Guinea-Bissau rodent surveys, October-November 1989.

			Captures				
Zone	Location	Crop	*Mastomys erythroleucus*	*Mastomys natalensis*	*Mus* sp.	Trap nights	% success
1	Bula	Vegetables	1	2		48	6
		Vegetables		3	2	48	11
3	Catio	Swamp rice		6		24	25
		Upland rice	3	3		6	100
	Caboxanque	Swamp rice		9		19	47
		Vegetables	4	6		48	21
		Swamp rice	2	3		20	25
		Vegetables	3			25	12
4	Babaque*						
		Totals	13	32	2	238	20

* Transport for personnel and supplies unavailable.

Note: In Bula and Catio, 12 trap nights in two grains storage buildings resulted in the capture of 4 *Rattus rattus*.

According to Crop Protection personnel and farmers, another apparently significant rodent pest, particularly to peanuts, is the ground squirrel (*Euxerus erythropus*). This squirrel is primarily a forest dwelling species, but causes damage to small plots of peanuts and other crops that are grown near the roads in these forested areas. During the course of this consultancy, we drove about 850 km; approximately 350 km of this was in Zone 3 through forested areas on unimproved roads going to and from Catio and Caboxanque. This squirrel was visible on at least half of the forested roads we traveled. In those areas, road counts of this squirrel ranged from 5 to 11 animals per km. We did observe some damage to peanuts and a few burrows in peanut fields. We did not conduct any damage estimates due to lack of a reliable method to estimate ground squirrel damage to peanut crops; however, characteristics of damage by several other

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vertebrate pests and damage assessments to peanuts in Pakistan are described by Brooks et al. (1988), Fiedler (1988), and Hussain et al. (1989). A similar study should be conducted for this ground squirrel and other vertebrate pest damage to peanuts in Guinea-Bissau. It appeared that about ≤1% of the mature peanuts were eaten or cached by ground squirrels and <1 percent of the peanut vines were destroyed by the burrowing activities of these squirrels in the two fields we examined. Traps were set for 1 night in a peanut field where fresh squirrel feeding and burrowing activities were found, but no squirrels were captured, probably because of the abundance of available peanuts.

Other mammalian pests observed, which reportedly cause significant but sporadic crop damage, were monkeys and wild boar. Monkeys were observed on several occasions on the road in bands ranging from 10 to 50 animals in Zone 3, the major fruit production area of Guinea-Bissau. I also saw a wild boar (*Sus scrofa*) that had been trapped and killed the previous night and that had reportedly been damaging crops in the area.

Zone 4: The giant rat (probably *Cricetomys* sp.) is reportedly abundant on the Island of Babaque. We were unable to trap any of them while on the island because a vehicle was not available to transport traps and personnel. Farmers and Crop Protection personnel on the island claim that the giant rats are the primary rodent pest to rice and vegetable crops on the island.

Rodent damage assessments: I was not able to assess rodent damage because the swamp rice was still in the vegetative growth stage and upland rice and vegetables previously had been harvested. Although peanuts were being harvested, I know of no statistically reliable method to estimate rodent damage to peanut crops. Based on my experience in other west African countries and Asia, it is reasonable to assume that in areas of high rodent density, such as those sampled in Zone 3, up to about 3% of the standing crops can be lost to rodents. However, the 3% loss estimate in vegetable crops is conservative, since vegetable crop losses are more difficult to estimate because damaged seedlings are often replaced by the farmer. In other west African countries, I have noted losses to vegetable crops ranging from about 4% to 50%, depending on the times of damage and replacement costs of seedlings.

Initiation of counterpart training: Mr. Alfesene Balde accompanied me throughout this consultancy. He received "hands-on" instructions in rodent identification, population assessment, trapping techniques, and specimen preparation. We discussed the use and hazards associated with chemical control, specifically the anticoagulant warfarin. We agreed, since rodents are utilized as a food source by many Guineans, that mechanical removal methods would be the most appropriate techniques of rodent control in Guinea-Bissau. These methods would certainly include trapping and possibly habitat manipulation, such as clearing of vegetation in and near crops.

Conclusions

In the two zones surveyed, only *M. erythroleucus* and *M. natalensis* were trapped in rice fields. This was true of both swamp rice and upland rice; however, we sampled for only 6 trap nights in one small upland rice field. These same species were also found in all vegetable fields trapped in both zones. Two specimens of *Mus* sp. were also trapped in one vegetable field in Zone 1. Based on very limited surveys in both zones, it appears that *Rattus rattus* is the dominant pest species in storage facilities. However, we found droppings of a size consistent with those of *Mastomys* spp. also in those storage facilities.

Rodent densities in Zone 3 averaged 37% trap success in rice and 18% trap success in harvested vegetable fields, compared to 8% trap success in harvested vegetable fields in Zone 1. Experience in other countries has shown that a trap success of greater than 10% indicates a high rodent density. Reports by Crop Protection personnel indicate the rodent densities appear to peak in January. While this may be the case, it is also possible that rodents are just more visible because of decreased vegetation for food and harborage during the cool months of January and February. Population peaks and increased visibility of rodents have been noted under late postharvest conditions in other countries (LaVoie, 1988; Poulet, 1985; Swink et al., 1972).

Control measures are often initiated at this period because rodents are numerous and farmers are usually available after harvest to assist in rodent reduction programs. It should be noted, however, that although these campaigns often produce spectacular reductions in rodent numbers, they usually have little effect in reducing rodent damage to crops the following growing season. This is because there is usually an annual natural decline in rodent numbers beginning about this time, which continues until crops and natural vegetation become more abundant the following rainy season. Because rodent species usually have high reproductive rates and strategies to meet environmental conditions, their populations can increase to, and often exceed, the available forage and harborage during the growing season. Thus, it is usually neither economically productive nor biologically sound to conduct control operations at this time of year.

Based on my observations and reports by farmers and Crop Protection personnel, the ground squirrel appears to be a significant pest to peanuts, at least in Zone 3. Surveys to verify the economic impact of this species on crops are needed.

We also observed about 10 bands of monkeys, consisting of from about 10 to more than 50 individuals, and one wild boar on or near the roads we traveled in Zone 3. Again, farmers and Crop Protection personnel related sporadic, yet very significant, crop damage, particularly to peanuts, from these animals. Although this type of damage (i.e., sporadic) is difficult to control, it should investigated.

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The development of a simple, effective rodent trap that could be made by farmers from local materials at a nominal cost appears to be the first step in implementing a safe, economical, culturally acceptable rodent damage control program. I think that a trap design based on the principle of the Bal-Chatri raptor trap (i.e., numerous thin monofilament snares) may meet these requirements. My experience in development of methods to reduce rodent damage to electrical wires and cables shows that rodents have great difficulty in severing wires that are less than 0.5 mm in diameter.

Recommendations:

Guinea-Bissau is a very small country struggling to achieve self-sufficiency in food production. My observations indicated some significant losses of grains, peanuts, and vegetables to rodents occur. This country has no history of rodent control, other than the utilization of rodents in the Guinean diet. The harvesting of rodents for food may reduce crop damage if a sufficient number of rodents are removed at a time when the crops are vulnerable to damage. However, the use of rodents as a food source also limits the methods available for rodent control. Thus, the following recommendations are made based on these observations and considerations.

Immediate needs:

1. Training of Crop Protection personnel in vertebrate pest research and control methods is the most pressing and basic need. Training ideally should be accomplished with a small amount of applied research and an aggressive training package, consisting of a series of instructions and practical in-country exercises in the areas of rodent identification, biology, behavior, and control techniques suited to cultural conditions in Guinea-Bissau. This training will require at least one consultancy in FY 1990.

2. Mr. Alfesene Balde, my counterpart, completed the Vertebrate Pest Management Course in Ft. Collins, Colorado, in 1989 and received additional instruction during this consultancy. He should continue collecting and preparing specimens from Zones 2 and 4 and additional areas in Zones 1 and 3. The supplies needed for collection and preparation of specimens were left in his care following the completion of this consultancy. He should also make damage assessments of various crops at appropriate times utilizing the knowledge and reference materials acquired this past year.

Long-term needs:

1. One individual in Crop Protection should be assigned to head a functional, applied research and control Vertebrate Pest Management Unit. This Unit should consist of at least two individuals with at least undergraduate degrees in biological sciences and should be able to draw on the expertise of other Crop Protection personnel, as needed.

The Unit should be responsible for all control and research activities related to field and storage situations where vertebrate pests are a significant economic factor. The individual selected to head this Unit should receive graduate training in vertebrate pest management. Two institutions offering such training are Colorado State University in Fort Collins, Colorado, or Utah State University in Logan, Utah. This training would insure that a qualified individual, capable of directing training, research, and vertebrate control operations in a safe and effective manner is in charge when the period of USAID/USDA technical assistance is terminated.

2. At the minimum, a mechanism needs to be established so that the current Crop Protection Unit and any future Vertebrate Pest Management Unit has access to scientific literature, periodic technical assistance and training, purchase of necessary materials and supplies, and attendance at appropriate international vertebrate pest conferences. For example, attendance by Crop Protection Unit scientists at the upcoming California Vertebrate Pest Conference, March 6-8, 1990, would be beneficial.

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TRIP REPORT*

CHAD

October 11-November 9, 1989

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This report is divided into four sections:

Section 1 summarizes plans for population monitoring of rodents in two subregions of the Sahel.

Section 2 briefly indicates a strong need for effective control measures to prevent massive outbreaks of rodents in the Sahel such as occurred in 1986.

Section 3 outlines the philosophy of the project, the long-term aims, and describes the protocols to be followed throughout the project.

Section 4 outlines specific activities undertaken during the October-November 1989 visit and how these relate to the long-term aims of the project.

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Rodent Pest Management Research and Control in West Africa

1.0. Abstract

The objectives of this consultancy were to select and document two habitat areas typical of Sahelian agriculture systems and within these areas (a) select sites for establishing long-term rodent population monitoring, (b) begin implementing rodent monitoring to establish its feasibility, (c) initiate bait acceptability trials, and (d) train counterpart scientists in identification trapping, autopsy, and data collection methods.

Population monitoring will be undertaken in two subregions that are typical of the highly dissected agricultural regions of the Sahel. The subregions chosen (N'Gouri and Abéché) will allow both the methodology and the results to be extrapolated to similar areas throughout the region with minimum modification. A third subregion (in the south) could be added at a later stage. The two subregions represent the major Sahelian agricultural environments: N'Gouri--intensive, small quadi farming with isolated dune farming; and Abéché--isolated, large quadi farming and extensive dune farming. The availability of shelter, suitable breeding space, and food in each area will dictate the amplitude of fluctuations in the rodent population cycle. To be successful, a predictive model must correlate environmental attributes with rodent population dynamics. In order to understand these organism-environment interactions, it is necessary to understand the agricultural environments within which these animals exist.

Final site selection for the monitoring phase of the project will be undertaken during the pilot survey along with initial trapping to test the methodology. Following this survey, regular monitoring of selected sites will be undertaken on 1 night per month (N'Gouri) and on 1 night every 2 months (Abéché) for the duration of the project.

2.0. Background

In 1986, when several Sahelian nations declared national disasters due to massive outbreaks of rodents, the Agency for International Development (AID)/Washington was hampered in providing assistance due to the lack of knowledge of the species concerned, as well as population dynamics and effective control measures. Short-term technical assistance was provided by vertebrate pest management specialists of the U.S. Department of Agriculture (USDA)/Animal and Plant Health Inspection Service (APHIS)/ Denver Wildlife Research Center (DWRC), but even these scientists could do little more in the field than determine rodent species and predict future population trends. In addition, technical arguments ensued over appropriate rodenticides. Since rodent problems continue to occur in the Sahel, it is essential to conduct sufficient research into rodent biology and control methods to permit national crop protection decision-makers to deal with

chronic annual fluctuations, to forecast periodic rodent irruptions, and to begin control campaigns using proven methods at the proper time. The objectives of the technical assistance requested here are to: (a) begin to determine the life cycles of the major rodents pests of the Sahel; (b) begin to evaluate the efficacy and appropriateness of alternate control methods; and (c) begin to prepare training materials on rodent biology and control for use by the National Crop Protection Services.

The DWRC has been asked to implement a rodent research project with support from USAID to accomplish these objectives. DWRC has recruited a Project Leader to be based in Chad sometime in early 1990. During the interim period, DWRC will provide short-term technical assistance to the Ministry of Agriculture (MOA) to begin rodent population monitoring. The activities in this trip report describe a pilot survey to determine the feasibility of one kind of rodent population monitoring system that could be established.

3.0. Rationale

3.1. Introduction

Plagues of rodents cause serious economic damage in African agricultural systems. The gravity of the problem has been noted in the internal publications of the DWRC from 1976 to the present.

Generally, outbreaks occur on some type of "ecological island", i.e., an area of favorable habitat surrounded by a habitat type less favorable to the species, e.g., in quadis and old-dune grain crops. In many regions, the agricultural landscape contains an abundance of permanent refuges (hedgerows, grasslands, etc.) in close proximity to the cropped area. The dune/quadi system gives rise to a highly dissected landscape and, hence, a fragmented cropping system. The close proximity of the refuges results in a high risk of crop damage. At first glance, these refuges may appear small (i.e., insignificant) and homogeneous, but consideration of (a) the reproductive capacity of rodents and (b) the subtle environmental prompts for the onset of breeding shows that, in many cases, first impressions can be misleading (see Appendix 1). The identification and specific use made of these refuge areas is of paramount importance in that populations existing within these localized areas may then be attacked at a time when they are most vulnerable, i.e., when they are not breeding and are under physiological stress due to low food supply and adverse environmental conditions. In most agricultural areas, it is important to realize that the refuges are usually well-defined and separate from the cropped area.

A typical Sahelian landscape is highly dissected by both new- and old-dunes interspersed with quadis. It is important to note that rodent population fluctuations within the quadi system appears to be independent of the fluctuations that occur in the old-dune grain farming areas. *Arvicanthis niloticus* and *Mastomys* sp. are responsible for damage in the quadi system while *Gerbillus andersoni* and *Jaculus jaculus* are the major problem in the dune crops.

It is possible that the environmental conditions that prompt an eruption in the quadi system also give rise to high population densities of rodents in the dune system, but current data suggest that there is no interaction between the species of the two systems.

3.2. Aims

This rodent research project is designed to satisfy three practical aims:

(a) To provide an understanding of rodent population fluctuations in two agricultural systems, namely, old dune farming and interdune depression farming. Both of these agricultural systems need to be investigated as it is likely that the determinants of rodent dynamics in the two systems will differ significantly.

(b) To develop an early warning system of potential crop damage so that crop damage can be minimized. A predictive model is required so that, if in a particular year control action is necessary, it can be applied at the appropriate time--well in advance of the problem getting out-of-hand.

(c) To assess the economic impact of rodent populations within both agricultural systems and to develop and introduce safe, effective, economically feasible and culturally acceptable population control techniques.

Obviously, the second and third aims are a product of the first, and it is only with a thorough understanding of the ecology of the rodent populations that effective prediction and control (of both chronic and acute infestations) may be achieved.

3.3. Population Monitoring Study Description

The aspects of the population monitoring study of this project address the dynamics of the quadi and old-dune systems independently, but the design is such that it will detect interaction between the two systems during periods of high population density or large-scale dispersal.

The study will be undertaken in several subregions that are typical of the highly dissected agricultural regions of the Sahel. This will, hopefully, allow both the methodology and the results to be extrapolated to similar areas throughout the region with the minimum of modification.

3.3.1. Extensive Removal Trapping

Extensive removal trapping will be undertaken in all major habitat types adjacent to crops as well as in the crops themselves. This approach will provide:

- species diversity and distribution on the basis of habitat type
- temporal changes in habitat utilization
- an index of abundance
- population age structure
- reproductive viability of the population
- possible correlates of abundance and structure with agricultural practice and environmental conditions
- an historical database on which an early warning system for potential crop damage can be developed
- food habits and possible seasonal correlates

This current consultancy was considered as a pilot survey to identify the major habitat types and the utilization of these habitats by rodents. This survey identified possible sub-regions to consider for the subsequent monitoring program. Concurrent with this activity, trials to determine an appropriate trap-bait for the monitoring study were implemented. Habitat attributes of the region were also documented--especially the type and extent of refuges within and adjacent to the cultivated areas.

Final site selection for the monitoring phase of the project will be undertaken during the pilot survey along with initial trapping to test the methodology. Following this survey, regular monitoring of selected sites will be undertaken on 1 night per month (N'Gouri) and on 1 night every 2 months (Abéché) for the duration of the project.

(1) Quadi Systems

Quadi systems were chosen that cover the various habitat attributes documented in the pilot survey. Where possible, in each of the quadi systems, six trapping transects should be located, as in Figure 1. Each interior and margin transect will consist of 25 large break-back traps, laid 10 m apart. Each exterior transect should consist of 25 pairs of Can't Miss®[1] snap traps (1 large rat and 1 small mouse traps, separated by 1 m), laid 10 m apart. The use of small traps in the interior and margin transects is not practical (see Section 4.4). This design will allow for the capture of the major pest species. The "exterior" transects should be at least 20-50 m from the margin of the cultivated areas. Bait type will be determined by the results of the pilot study.

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

This transect design is optimal for quadis that are small (less than 10 ha), intensively cultivated and surrounded by hedgerows that can act as permanent refuges. In situations where quadis possess a different configuration, such as long dry creek beds with no hedgerows and a patchy distribution of cultivation, an alternative design will be required. In these latter situations, two transects should be placed in cultivated areas--preferably one in vegetables and one in grain crops. Two transects should be placed at the margin of the cultivated area in margin refuges (if they exist) and two transects should be placed in the closest exterior habitats that are not subject to flooding.

Trapping should be undertaken on 1 night per month (N'Gouri) and one 1 night every 3-4 months (Abéché) for the duration of the study. Interior and margin traps should be opened in the morning and collected early the next morning. The exterior traps should be opcned in the late afternoon and collected early the next morning to avoid animals that graze the exterior of the quadis by day. This trapping procedure is necessary to cater for the various diurnal and crepuscular activity cycles of the three pest species.

Data collected from each animal should include:

- location
- trap type
- species
- sex
- sexual condition
- head-body length
- weight

A sample data sheet and the coding protocol is given in Appendix 3.

Museum specimens, including skull and pelage should be collected for any animal of doubtful taxonomic status. The stomach contents of rodents decompose rapidly in hot conditions; therefore, it is necessary to use only animals that have been dead for less than 1 hour for stomach contents analysis. Each month, approximately 20 of each of the two dominant species should be trapped at a location near the one of the monitoring sites. Animals for stomach contents analysis should not be trapped at the monitoring sites as the additional capture effort may significantly reduce the population. Fifty to 100 traps should be laid in the habitat where there is the highest probability of capture. Traps should be checked every hour until the required number of animals are collected.

(2) Old Dune Systems

Grain fields should be chosen in each subregion on the basis of adjacent habitat types and refuge proximity. The fields should be chosen, where possible, so that they are interspersed between the monitored quadis. The *G. andersoni* present in the region are known to be colonial and, as the agricultural practices of the area create very little soil disturbance, gerbil colonies persist in the same location for years. Refuge habitats are unimportant for these animals and the aim of the monitoring program in the dunes is to document population processes in relatively sedentary populations and to correlate these with agricultural practices and climate.

Twenty-five small traps should be used, placed 10 m apart. At each site (location), two transects should be placed in crops and two in native grassland. The sites (locations) should be chosen on evidence of long-term gerbil activity. Data collected will be as for the quadi system.

3.3.2. Habitat Attributes

At each of the trapping sites, habitat attributes such as vegetation cover, dominant species, vegetation structure, agricultural practice and climatic data during the trapping period should be documented. This will allow for possible correlates with rodent population processes such as onset of breeding, juvenile mortality, etc. Subregional rainfall data should be collected, if possible.

3.3.3. Intensive Live Trapping

Intensive live trapping should be undertaken in the critical habitats identified by the extensive studies. This aspect of the study will provide:

- patterns of movement between critical habitats, that is, habitats where breeding may occur or those that are used as refuges during vulnerable phases of the population cycle
- rates of population increase
- information on specific habitat attributes conducive to reproduction, survival, and dispersal

It will be necessary to document <u>at least</u> one complete population cycle via the removal trapping studies before critical habitats can be identified and, hence, the live-trapping studies would not commence until Year 2 or 3 of the project.

When the live-trapping phase begins, each animal trapped should be individually marked and released. This study will identify

the timing and extent of colonization and dispersal processes and, hence, will provide information essential to the design of efficient control procedures.

3.3.4. Ancillary Studies

(1) Concurrent with the removal trapping, "bait-take" stations should be deployed adjacent to each site. Five substrates will be used, including material from the major crops of the area. The consumption of these substrates (corrected for population density) will give an indication of substrate acceptability during the various phases of the population cycle. If a dietary switch is evident, this study may give an early indication of the direction that future control programs should take. This is only intended to be a pilot study.

(2) During the removal trapping phase, chemical and nonchemical control methods will also be developed--including the evaluation of potential toxicants. Specific details of this study will be outlined in subsequent documents.

4.0. Specific Activities Undertaken during the October-November 1989 Consultancy

4.1. Objectives of Population Monitoring Consultancy

(a) Document habitat types within a typical Sahelian agricultural system.

(b) Select two subregions containing the above.

(c) Inspect each subregion for possible study sites.

(d) Select study sites for the long-term monitoring program.

(e) Implement the initial monitoring of selected sites in one subregion.

(f) Undertake trials to determine a satisfactory bait type.

(g) Introduce counterpart and cooperators to the concept and operation of the project.

(h) Train counterparts and cooperators in:

(1) trapping techniques
(2) rodent identification
(3) autopsy techniques
(4) documentation of habitat attributes
(5) use of data coding sheets

4.2. Selection of Subregions

Population monitoring will be undertaken in two subregions that are typical of the highly dissected agricultural regions of the Sahel. The subregions chosen (N'Gouri and Abéché) will allow both the methodology and the results to be extrapolated to similar areas throughout the region with minimum modification. A third subregion (in the south) could be added at a later stage. The two subregions represent the major Sahelian agricultural environments: N'Gouri--intensive, small quadi farming with isolated dune farming; and Abéché--isolated, large quadi farming and extensive dune farming. The availability of shelter, suitable breeding space, and food in each area will dictate the amplitude of fluctuations in the rodent population cycle. To be successful, a predictive model must correlate environmental attributes with rodent population dynamics. In order to understand these organism-environment interactions, it is necessary to understand the agricultural environments within which these animals exist.

4.2.1. The N'Gouri Subregion

The first subregion to be studied is the N'Gouri area, some 230 km northeast of N'Djamena. The topography and agricultural practices of this area are representative of a large part of the Sahel with both quadi and old dune farming being undertaken in the area.

There are approximately 700 quadis in the area, but only 300 are currently being exploited. The remainder are unsuitable for cultivation due to either (1) the presence of high concentrations of soil salts and/or (2) the water table is too deep for exploitation by the shadouf. The shadouf, a simple yet effective device for raising water, cannot be operated economically with water table depths greater than 6-7 m. The use of motor pumps will allow additional quadis (to the north) to be exploited in the near future.

In general, the elevation of the dunes (and hence, the interdune depressions) increases in both a northern and easterly direction from Lake Chad. In the N'Gouri area, this results in exploitable quadis being confined to a band from N'Gouri, southeast through Njigidada (Fig. 2). To the north and east of this band, the depth of the water table increases rapidly, making the use of the shadouf impractical. South of this band, high soil salt levels preclude agriculture.

Meteorological data for N'Gouri are given in Table 1. The annual rainfall is low, with monthly effective rainfall (that is, rainfall corrected for evapotranspiration) being negative for most of the year. Agriculture in the quadis relies entirely on irrigation from groundwater originating from the Lake Chad area some 30 km southwest of N'Gouri. Agriculture on the dunes relies on heavy storms of short duration to provide the necessary moisture for growth.

The clay soils of the quadis within the exploited area are all derived from ancient lake sediments and so are uniform throughout the area. It is unlikely, therefore, that soil characteristics will be a factor limiting rodent distribution.

The productivity of the quadis varies greatly, depending on farmer efficiency and water supply. A guide to the productivity of several of the efficiently managed quadis is given in Table 2. The main crops of the area are cassava, onions, eggplant, and okra with lesser plantings of tomatoes, cucumbers, and sorghum.

The villages in the area depend entirely on the production from the quadis (and adjacent millet) both for food and to generate cash for necessities that cannot be produced in the area. No estimates are available for the area planted to millet, but the average yield from a millet field is in the vicinity of 700-750 kg/ha.

The agricultural practices of the area are simple and performed entirely by manual labor. Most farming families own both a quadi section and a millet field and, hence, have to divide their labor between the two. This means that at certain periods of the year when labor is required in the millet fields, the quadis are neglected. A typical agricultural cycle is shown in Table 3. It is apparent that both the food supply and shelter for rodents in the quadis fluctuates greatly throughout the agricultural cycle. The monthly monitoring phase of the project will correlate rodent population fluctuations with attributes of the agricultural cycle.

4.2.2. The Abéché Subregion

The second subregion under study is the Abéché area, 750 km northeast of N'Djamena. In the N'Gouri area, the quadis take the form of interdune depressions that were originally derived from clay sediments from ancient Lake Chad and, hence, are small, numerous, and scattered among short, steep dunes, giving rise to a highly fragmented dune/interdune depression landscape. In contrast, the quadis of the Abéché area are very long, continuous dry creek beds that meander through highly weathered dunes that have combined to form an undulating dune plain. There are far fewer quadis in the Abéché area, and the region is predominantly a dune plain dissected by a few isolated creek beds with very large catchment areas (some extend into Sudan). Weathered rocky outcrops are interspersed between the dunes, providing a rodent habitat unique to this area.

In Abéché, the centers of the quadis flood each wet season, whereas in N'Gouri, the quadis rarely flood (one in 10-15 years). Quadis will be flooded for periods of 2-7 days at various intervals between late July and mid-September, depending on the intensity and frequency of the rainfall. The

difference between N'Gouri and Abéché with respect to quadi flooding occurs despite similar rainfall patterns (Tables 1 and 4) and is due to the different form that the quadis take in each area. In Abéché, AFRICARE has constructed barrages in several quadis to spread the floodwaters, thus allowing a greater surface area to be cultivated on residual soil moisture. Because of the regular flooding, less than 15% of quadi gardens have hedgerows, and the gardens are separated by large tracts of uncultivated land, whereas in N'Gouri, almost the entire quadi is cultivated. In terms of rodent habitat, the quadis of the two areas are entirely different. Habitat stability is also different, with the hedgerows and uncultivated interior sections of N'Gouri quadis providing a stable habitat with good cover. Abéché quadi habitats are nowhere near as stable, due to regular flooding--here, the most stable habitats are the quadi fringes which do not have the cover from hedgerows.

Only a few of the vegetables in Abéché quadis are irrigated, and all other agriculture relies on residual moisture from the wet season. Large quantities of sorghum are cultivated in the quadis on residual moisture.

The main agricultural pursuit in the Abéché area is dune farming of millet and sorghum. Dune farming is extensive with over 125,000 ha of grain planted each year within the prefecture. The average yield of sorghum and millet is 850 kg/ha and 600 kg/ha respectively. Quadi vegetable farming in Abéché is secondary and is often neglected, as farming families tend to live in the dune fields near their grain crops and may have to travel 30 km for periods of the year in order to tend to the quadis.

Table 5 gives an indication of quadi production, the main crops being sorghum, garlic, onions, and tomatoes. The total quadi area cultivated (7,500 ha) is small compared to the cultivated dune area; however, the quadis are extremely important as they are the sole vegetable source for the villages of the area. Quadis are cultivated to a greater extend in "drought" years when grain crops fail. The typical agricultural cycle of the area is given in Table 6. There are marked differences in both food supply and cover available to rodents at various times of the year between the N'Gouri (Table 3) and Abéché quadis.

A comparison of the two subregions is given in Table 7. Considered together, these two subregions represent the major agricultural systems of the Sahel. As dune farming is so important in this area, the monitoring study will place more emphasis on dune sites rather than quadi sites. The reverse is true in N'Gouri.

4.3. Site Selection

The major habitat types identified in the two subregions are:

(a) hedgerows around quadis (N'Gouri and Abéché)
(b) quadi crops (N'Gouri and Abéché)
(c) noncultivated weedy areas within the quadis (N'Gouri and Abéché)
(d) sabbal at the interface of the dunes and the quadis (N'Gouri)
(e) millet stubble on dunes (N'Gouri and Abéché)
(f) native grassland--grazed and ungrazed (N'Gouri and Abéché)
(g) rocky outcrops in dunes (Abéché)
(h) dense shrub cover at the interface of the dunes and the quadis (Abéché)

Quadis and dune systems within each subregion were inspected to (a) identify the major habitat types and the utilization of these habitats by rodents and (b) to identify the major agricultural practices within each subregion.

From the quadis inspected, eight were selected in the N'Gouri area and three in the Abéché area as sites to be monitored for rodent activity on a monthly basis (N'Gouri) and a bimonthly basis (Abéché). The monitoring sites were chosen so as to encompass:

(a) the geographical range of the cultivated quadis in the subregion;
(b) the range of quadi productivity within the subregion;
(c) various combinations of the habitat types available in each subregion;
(d) the range of rodent infestations reported in recent years (from light to very heavy; transient to chronic).

From the dune systems inspected, two were chosen in the N'Gouri area and five in the Abéché area as monitoring sites. The emphasis of the monitoring program reflects the agricultural practices of the two areas. In N'Gouri, the emphasis will be on quadis (8 quadis, 2 dunes) while in Abéché, the emphasis will be on dune systems (5 dunes, 3 quadis).

4.3.1. Site Selection--N'Gouri

Sixteen quadis were inspected (Fig. 2):

(1) Mangalma
(2) Boui
(3) Binam
(4) Molori
(5) Molo
(6) Kalingouri
(7) Asankadori
(8) Broudou
(9) Ngarfari

(10) Ygra
(11) Kaya
(12) Tomasy North
(13) Tomasy South
(14) Madi
(15) Ngoural
(16) Dibinintchi

The eight quadis selected as monthly monitoring sites to satisfy the criteria of Section 2.3. were:

Fig. 2, Ref. 3:

(3) Binam
(9) Ngarfari
(8) Broudou
(10) Ygra
(4) Molori
(2) Boui
(16) Dibinintchi
(7) Asankadori

Detailed site descriptions of these eight quadis are given in Appendix 2.

The two dune sites monitored were at Binam and Ygra, near Tomasy North. These sites were selected on the basis of *G. andersoni* activity. The trapping transects at these sites have not been marked; only the general area of rodent activity has been noted. Detailed marking of the transects and detailed site descriptions will have to be undertaken during the next visit.

4.3.2. Site Selection--Abéché

Note: Only general locations for sites have been chosen in the Abéché area. Specific site locations need to be chosen during the next visit. The counterpart, Mr. Yacoub, is fully aware of the criteria that need to be satisfied at the specific sites. Maps of the Abéché area are not available at present (reasons of internal security).

Seven quadi areas were considered in the Abéché area:

(1) Bitea (Amouch)
(2) Bitea (Marchout)
(3) Bitea (Amgantoura)
(4) Sabbar
(5) Koutoul
(6) Tarbaka
(7) Matar

The three quadi locations chosen for monthly monitoring were:

(1) Koutoul (close to village)
(2) Koutoul (3-4 km from village)
(3) Bitea (Marchout)

Nine dune systems were considered:

(1) Djerwa
(2) Abugudan
(3) Arkou
(4) Goz-torbaka
(5) Kakara
(6) Artilo
(7) Tire
(8) Aboundrova
(9) Folokote

The five dune systems chosen for monthly monitoring are:

(1) Abugudan
(2) Artilo
(3) Kakara
(4) Djerwa east
(5) Djerwa west

4.4. Bait Selection

Trials to determine a suitable bait for the long-term monitoring study were undertaken in the Mangalma area (Fig. 2, Quadi 1) 30 km southwest of N'Gouri. This area contained all of the habitat types encountered in the preliminary inspection of the 16 quadis and dune systems in the N'Gouri area.

Baits for inclusion in the trials were selected on the basis of previous work with the proviso that they must be available locally throughout the year. Baits chosen for the trials were:

(a) Corrugated cardboard soaked with locally produced crude peanut oil

(b) Corrugated cardboard soaked with linseed oil

(c) Cassava--fresh

It was originally envisaged that potato would be included in the trials as a "wet" bait, but potato was not available at N'Gouri. Trials were undertaken in seven habitats to determine if rodents in particular habitats exhibited different "preferences" due to habituation to local foods. The habitats chosen were:

(a) Hedgerows adjacent to dense clumps of sabbal and quadi crops

(b) Quadi crops--sorghum, okra, cassava, and tomato

(c) Sabbal adjacent to native grassland

(d) Native grassland (mainly *Eragrostis* spp.)

(e) Millet stubble adjacent to dense clumps of sabbal

(f) Hedgerows adjacent to millet and dense weeds (in quadi) in a previously cultivated area

(g) Weeds of cultivation (mainly grasses) adjacent to millet stubble

These seven habitats represent the major habitats in the vicinity of the cultivated quadis.

In each habitat, 72 pairs of Can't Miss® snap traps (1 large rat and 1 small mouse traps, separated by 1 m) were laid along a line transect with 5 m between each pair of traps. The pairs of traps were baited sequentially with the three baits, resulting in a bait sequence of ... bait 1, bait 2, bait 3, bait 1, bait 2 ... etc.

This sequence resulted in 24 trap pairs of each bait type in each transect. In total, 1,008 traps were laid (504 large, 504 small).

Traps were laid in the early afternoon and collected early the next morning. The following data were collected for each successful capture: species, sex, trap type (large, small), and bait type. In addition, the number of traps of each type that were ineffective (sprung, lost, etc.) was recorded.

The distribution of captures within each habitat is shown in Table 8. A total of 106 animals were captured--58 *A. niloticus* and 45 *G. andersoni*, together with two other unidentified species of rodents and one unidentified species of ground squirrel.

As expected from previous studies in the area, the two dominant species have partitioned the available habitats, with *A. niloticus* utilizing the hedgerows (79% of *A. niloticus* captures) and the interior of the quadis (17% of *A. niloticus* captures) while the *G. andersoni* utilize the native grassland and millet stubble outside the quadis (80% of *G. andersoni* captures). For each species, equal numbers of males and females were trapped ($P_{0.05}$). The remainder of this report considers only the two dominant species--*A. niloticus* and *G. andersoni*.

The distribution of captures within each habitat based on trap type is given in Table 9. Ninety-one percent (91%) of all *A. niloticus* captures occurred in large traps while 55% of *G. andersoni* captures occurred in large traps. This last result is somewhat misleading due

to the high percentage of small traps that were ineffective (that is, sprung or lost). *G. andersoni* captures, when expressed as the number of captures per effective trap, show that the majority of captures occurred in small traps. The percentage of large traps that were ineffective is well within acceptable limits; however, this is not the case for the small traps. The extremely high percentage of ineffective small traps renders them useless for a long-term monitoring study. Only large traps will be used in the quadis where the majority of captures are expected to be *A. niloticus* (see Table 8) and both large and small traps will be used outside the quadis where the majority of captures are expected to be *G. andersoni*. The use of only large traps inside the quadi should not present too much of a problem as *G. andersoni* will still be captured in large traps (Table 9) thus enabling an index of abundance and population structure to be constructed for these areas. It should be noted, however, that the indices for *G. andersoni* inside the quadis will not be as precise as those generated outside the quadis where both large and small traps will be used.

It is apparent (Table 8) that the exterior habitats are most important for *G. andersoni*.

The high percentage of ineffective small traps was due to

(a) *A. niloticus* activity--many small traps were eaten or dragged into burrow entrances.

(b) Activity of crickets and dung beetles.

Larger animals, such as goats, sheep, and camels were not responsible for the sprung traps in the exterior transects, as the traps were either laid and collected while these animals were absent or farmers were hired to keep animals away from the trapping area.

There was no interaction ($P_{0.05}$) between the number of ineffective traps and bait type. As the number of sprung traps was equally distributed among the three bait types, no data correction is required for "within transect" comparisons.

Table 10 shows that, for *A. niloticus*, the total number of captures for each bait type was similar ($P_{0.05}$). For each bait type, there was no bias ($P_{0.05}$) towards a particular sex. Also, bait type did not exert any significant ($P_{0.05}$) effect on the overall capture rate in any of the three major habitat groups (Table 11). Similarly, Table 12 shows that, for *G. andersoni*, the total number of captures for each bait type was similar ($P_{0.05}$). For peanut oil and cassava, there was no bias ($P_{0.05}$) towards a particular sex; however, significantly more females than males were captured with linseed oil. Bait type did not exert any significant effect ($P_{0.05}$) on the overall capture rate in the three major habitat groups.

In summary, the three baits tested were equivalent in all of the major habitat types likely to be encountered in the monitoring study. Corrugated cardboard soaked in crude peanut oil will be used in the monthly monitoring study. The advantages of this particular bait are that it is available locally throughout the year and is easy to prepare and use in the field.

4.5. Initial Monitoring--N'Gouri

Initial monitoring was undertaken at the eight selected quadis in the N'Gouri area. Only very limited data analysis is possible at this stage as it is the month by month trends that will describe the status, structure, and trajectory of the populations in the various habitats.

Tables 13a and 13b show that the selected quadis cover the spectrum of infestation levels expected within the area, from heavy infestation (Binam, population index for the interior of 62.8/100 traps) to very light (Ngarfari, population index for the interior of 12.5/100 traps). In all quadis, *A. niloticus* was the most dominant rodent in the interior while *G. andersoni* was dominant in most of the exterior habitats. These data support the distribution data gathered during the bait trials where it was shown that the hedgerows are an important refuge habitat for *A. niloticus*.

The variability in capture rate for the exterior habitats reflects the suitability of these habitats at this particular time of the year. Exterior habitats were chosen to cover the entire range of habitats available--from heavily grazed areas with very little cover to ungrazed, densely vegetated areas. The monitoring program will allow the importance of these habitats during the various phases of the population cycle to be ranked for each species.

Table 14 (A) shows that the *A. niloticus* populations contained a high proportion of juveniles (immatures)--both male and female. Very few animals were pregnant (determined by autopsy) with only 0.26 of the mature female stratum (that is, the stratum that is physiologically capable of becoming pregnant) actually being pregnant. The high proportion of juveniles suggests that the breeding season is either just beginning or just ending. Without monthly trends in population structure, it is not possible to be definite; however, Table 14 (B) suggests that the breeding season has just commenced as the size and weight of both the juvenile and mature strata have relatively low standard deviations. If the breeding season were nearing its end, a larger size and weight range would be expected, reflecting the entry of various cohorts into the population over the breeding season.

At this time, the point is debatable, and monitoring over the next 2 to 3 months will document changes in population structure and resolve the question.

Table 14 (B) shows that there is a clear demarkation in both the size and weight of the immature and mature strata (both males and females). All males over 90 g were mature, and all but 3 of 15 males of HB 130 mm and over were mature. Similarly, all females over 85 g were mature, and all but 3 of 34 females of HB 130 mm were mature. The data show that weight is a more reliable indicator of sexual maturity than head-body length.

The situation with *G. andersoni* is similar and the population is only trickle breeding at present with the majority of females being sexually immature. The morphological demarkation between sexual strata is not as definite with this species, probably because the sample size in all but the immature female stratum is too small for any real analysis of population structure to be undertaken. Sample sizes will be increased when the dune monitoring sites are implemented in the near future.

A database program has been written to handle the monthly monitoring data, and the data from this trip has been entered. A printout of the capture data is given in Appendix 3.

4.6. Project Promotion

The concept and operation of the project was discussed with the following local authorities and organizations:

N'Djamena

Director General, Ministry of Agriculture
Director, Crop Protection Service, Ministry of Agriculture
U.S. Agency for International Development

N'Gouri

Sub-prefect
Chief of ORT, hydrologist and agronomist
Chief of SODELAC

Abéché

Prefect adjoint
Assistant Director, ONDR
Chief of Sector, ONDR
AFRICARE--Chief of Project, hydrologist and agronomist

4.7. Acknowledgments

The activities undertaken during this visit are the result of a team effort and could not have been achieved without the enthusiastic and diligent assistance of:

Mr. Abdelwahib Yacoub
Mr. Djimtoide Baoral
Mr. Maila Dourbaga

To these people, I give my warmest thanks.

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Table 1. Meteorological Data--N'Gouri, 1988 (Source: ORT N'Gouri).

Month	Decade	Rain (mm)	Evapotranspiration (calc. Penman mm/decade)	°C T_{min}	T_{max}	T_{av}
Jan	1	0	39	12	26	19
	2	0	47	12	28	20
	3	0	62	14	32	23
Feb	1	0	56	14	32	23
	2	0	53	14	29	22
	3	0	58	17	35	26
Mar	1	0	67	22	42	32
	2	0	61	20	36	28
	3	0	69	21	38	30
Apr	1	0	61	23	41	32
	2	0	66	25	45	35
	3	0	70	26	44	36
May	1	0	67	26	41	34
	2	0	71	26	44	35
	3	0.2	68	28	43	35
Jun	1	4.3	66	27	42	35
	2	0	63	28	43	35
	3	15.2	54	26	40	33
Jul	1	0.9	65	26	39	33
	2	17.0	51	24	34	29
	3	122.9	63	24	34	29
Aug	1	42.9	46	23	32	28
	2	45.7	52	23	33	28
	3	76.1	61	25	33	30
Sep	1	35.2	56	24	35	31
	2	0	60	24	37	30
	3	24.6	51	22	36	29
Oct	1	1.2	61	18	37	28
	2	0	60	20	37	29
	3	0	68	16	36	26
Nov	1	0	53	17	36	26
	2	0	53	17	35	26
	3	0	47	16	36	26
Dec	1	0	48	16	36	27
	2	0	42	13	31	22
	3	0	47	12	27	20
Total		386				

Table 2. Productivity of selected quadis in the N'Gouri area: October 1988-September 1989.

Crop	Quadi: Boui			Quadi: Molori		
	Surface area (ares)	Yield (kg/are)	Production (kg)	Surface area (ares)	Yield (kg/are)	Production (kg)
Cassava	450.00	400	180,000	60.00	200	12,000
Okra	365.96	300	109,788	43.56	150	6,534
Onion	163.48	150	24,522	93.66	150	14,049
Eggplant	1.50	100	150	23.73	350	8,306
Tomato	2.81	100	281	41.17	300	12,351
Pepper	2.33	30	70	11.75	70	823
Cucumber	-	-	-	-	-	-
Sorghum	-	-	-	31.33	50	1,567
Wheat	75.82	9	682	92.82	22.5	2,088
Potato	3.52	7	25	6.20	100	620

Crop	Quadi: Ygra			Quadi: Mangalma		
	Surface area (ares)	Yield (kg/are)	Production (kg)	Surface area (ares)	Yield (kg/are)	Production (kg)
Cassava	-	-	-	125.00	300	37,500
Okra	2.24	*	*	156.00	200	31,200
Onion	13.78	100	1,378	82.20	150	12,330
Eggplant	5.25	150	787.5	11.50	150	1,725
Tomato	6.00	100	600	4.15	50	208
Pepper	0.90	30	27	3.70	50	185
Cucumber	6.34	200	1,268	0.20	*	*
Sorghum	26.30	25	662.5	164.00	30	4,920
Wheat	27.72	20	554.4	89.00	25	2,225
Potato	-	-	-	-	-	-

* No estimate available.

Source: ORT N'Gouri

Table 3. Typical agricultural cycle in the N'Gouri area.

Month	Dune	Quadi
Oct	Harvest millet; leave stubble standing	No activity; quadi covered in weeds (mainly grasses). Late October: harvest mature sorghum--cut at the base, remove heads, and use stubble for animal feed. Remove weeds in portions to be planted.
Nov	No activity	Remove weeds and prepare quadi for planting. Weeds are placed in heaps to compost. Late November: plant onions, eggplant. Start to irrigate.
Dec	No activity	Plant tomatoes, onions, eggplant, peppers, and wheat. Harvest any early eggplant.
Jan	No activity	As for December: plant and harvest. Harvest cassava at Boui and Mangalma.
Feb	No activity	Plant cassava at Mangalma, Molori, and Boui. Continue planting and harvesting vegetables. The only weeds present at this stage are small shrubs in the noncultivated area of the quadi.
Mar	No activity	Harvest wheat--pull out entire plant and leave to dry on ground. Remove stems in late March for animal feed. Plant okra and onions.
Apr	No activity	No activity
May	No activity	Plant okra. Harvest cassava--pull out entire plant and leave the stems to mulch. May plant a special small variety of millet.

Table 3. Typical agricultural cycle in the N'Gouri area (Continued).

Month	Dune	Quadi
June	Prepare fields, eradicate weeds. Plant millet in anticipation of first rain in late June/early July. Ground is essentially weed free.	Very little activity. Harvest special variety of millet. Plant cassava at Mangalma and Boui. Rest of quadi is neglected. Harvest any okra that is present. Some farmers (not many) may plant sorghum. At this stage, most crops have been harvested--stubble and stems from vegetables are left to mulch.
July	Continue planting millet. Cultivate weeds each week--very few weeds present.	Very little activity. Plant sorghum and more okra. At this stage, the remainder of the quadi is covered in mulch.
Aug	Cultivate weeds--by late August, the millet has shaded out the weeds.	No activity. Quadi is full of weeds.
Sep	Late September: Harvest any early millet for own consumption (usually only a small amount).	Resume some work: begin to remove weeds. At this stage, most of the quadi is full of weeds.

Table 4. Rainfall data--Abéché, 1988 (Source: AFRICARE, Abéché).

	mm	Annual rainfall (mm)	
January-April	0.0		
May	17.5	1984	100
June	16.4	1985	331
July	41.6	1986	357
August	250.9	1987	140
September	67.0	1988	518
October	29.3	1989	422
November-December	0.0		
Total	422.7		

Table 5. Quadi productivity--Abéché, 1988 (Source: AFRICARE, Abéché).

Crop	ha planted	mean yield (t/ha)
Sorghum	2,500	1.25
Garlic	2,200	5
Onions	1,500	22
Pepper	100	4
Okra	200	?
Tomatoes	1,000	2
Potatoes	trace	?*

* Crop recently introduced to the area.

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Table 6. Typical agricultural cycle in the Abéché area.

Month	Dune	Quadi
Oct	Sorghum and millet in full head and opening. Very few weeds. Some cucumbers and wild melon planted among grain. Harvest peanuts.	Planting: tomatoes, onions, garlic, radishes, lettuce, beets, peppers. Plant sorghum (only on clay soils). Very few weeds in cultivated area, but cultivated areas are surrounded by weeds.
Nov	Harvest any ripe heads (very few). Leave stubble standing. Very few weeds (mainly grasses).	Continue planting.
Dec	Harvest millet and sorghum.	Neglected; may be some very small planting of vegetables. Harvest potatoes (compost stems) and replant potatoes.
Jan	Stubble standing. Graze livestock in fields.	Sorghum is maturing. Some small plantings of garlic and onions. Continue harvesting and replanting potatoes.
Feb	As for January.	Harvest sorghum. Leave stubble standing.
Mar-May	Remove stubble for market. Livestock in fields.	Plant onions. Remove sorghum stubble for market. Very hot and dry--most of quadi is bare ground. Dried off weeds present outside the cultivated areas.
June	Prepare fields for millet planting. A small number of farmers may also hoe out the old millet and sorghum rootstock, but not many.	Quadi starts to flow intermittently. Only the main bed floods at this stage. Cultivated areas are mainly bare ground.
July	Prepare ground and plant millet on first moisture. A small amount of peanut is planted. Many farmers plant sesame and hibiscus in with the millet.	Neglected; by late July, quadi is flooding intermittently for between 2 and 7 days. Weed growth--due to rain--mainly grasses and sedges.

Table 6. Typical agricultural cycle in the Abéché area (Continued).

Month	Dune	Quadi
Aug	Cultivate out weeds or replant if moisture was insufficient for a good strike on first planting. Plant sorghum and perhaps a small amount of millet.	As for July.
Sep	Plant sorghum.	As for July until mid-September. Sedges flower in September/October.

Table 7. Comparison of the N'Gouri and Abéché areas.

Feature	N'Gouri	Abéché
Topography	Highly fragmented dune/ interdune depression system	Less fragmented--undulating duneplain dissected by dry creek beds
Primary agriculture	Quadi farming (vegetables)	Dune farming (millet and sorghum)
Secondary agriculture	Dune farming millet	Quadi farming vegetables and sorghum
Quadis	- small - numerous - entire quadi farmed - all surrounded by hedges - all crops rely on irrigation (shadouf) - all clay-based soils - small water catchment area (rely on groundwater flow from the Lake Chad area) - flood only occasionally	- large - few - only small portions are farmed - less than 15% surrounded by hedges - no irrigation except for some varieties of vegetables, other agriculture dependent on residual soil moisture - some clay and some sandy soils - large water catchment areas (some extend into Sudan) - flood each wet season
Dunes	- steep, isolated - isolated millet plantings separated by extensive native grasslands	- weathered, continuous (duneplain) - extensive millet and sorghum plantings and a small quantity of peanuts

Table 8. Distribution of captures within each habitat.

Habitat	*Arvicanthis niloticus* Male	Female	Total	*Gerbillus andersoni* Male	Female	Total	Other	Total
Hedge: dense sabbal/crops	8	18	26	-	-	-	1	27
Hedge: millet stubble/dense weed cover (unfarmed)	9	11	20	1	2	3	-	23
Millet stubble/ weeds of cultivation	-	1	1	1	-	1	1	3
Millet stubble/ sparse sabbal	-	-	0	4	5	9	-	9
Sabbal/native grassland	2	-	2	10	9	19	1	22
Native grassland/ sparse sabbal	-	-	0	2	6	8	-	8
Crops: sorghum, tomato, cassava	5	4	9	2	3	5	-	14

Table 9. Distribution of captures based on trap type.

Habitat	Large traps			Small traps		
	Arvicanthis niloticus	*Gerbillus andersoni*	% ineffective	*Arvicanthis niloticus*	*Gerbillus andersoni*	% ineffective
Hedge: dense sabbal/crops	22	0	7	4	0	35
Hedge: millet stubble/dense weed cover (unfarmed)	19	2	8	1	1	96
Millet stubble/ weeds of cultivation	1	1	0	0	0	40
Millet stubble/ sparse sabbal	0	4	1	0	5	50
Sabbal/native grassland	2	13	1	0	6	66
Native grassland/ sparse sabbal	0	3	0	0	5	32
Crops: sorghum, tomato, cassava	9	2	0	0	3	58

Table 10. Distribution of captures of *Arvicanthis niloticus* based on bait type.

Habitat	Peanut oil			Cassava			Linseed oil		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Hedge: dense sabbal/ crops	4	5	9	2	6	8	2	7	9
Hedge: millet stubble/ dense weed cover (unfarmed)	5	2	7	2	4	6	2	5	7
Millet stubble/weeds of cultivation	0	0	0	0	1	1	0	0	0
Millet stubble/sparse sabbal	0	0	0	0	0	0	0	0	0
Sabbal/native grassland	0	0	0	0	0	0	2	0	2
Native grassland/sparse sabbal	0	0	0	0	0	0	0	0	0
Crops: sorghum, tomato cassava	0	1	1	3	0	3	2	3	5
TOTAL	9	8	17	7	11	18	8	15	23

Table 11. Distribution of captures based on bait type for the three major habitat groups.

(A) *Arvicanthis niloticus*

Habitat group	Peanut oil			Cassava			Linseed oil		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Hedgerows	9	7	16	4	10	14	4	12	16
Interior of quadis	0	1	1	3	1	4	2	3	5
Exterior of quadis	0	0	0	0	0	0	2	0	2

(B) *Gerbillus andersoni*

Habitat group	Peanut oil			Cassava			Linseed oil		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Hedgerows	0	2	2	1	0	1	0	0	0
Interior of quadis	1	1	2	2	0	2	0	2	2
Exterior of quadis	7	8	15	6	4	10	3	8	11

Table 12. Distribution of captures of *Gerbillus andersoni* based on bait type.

Habitat	Peanut oil			Cassava			Linseed oil		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Hedge: dense sabbal/ crops	0	0	0	0	0	0	0	0	0
Hedge: millet stubble/ dense weed cover (unfarmed)	0	2	2	1	0	1	0	0	0
Millet stubble/weeds of cultivation	0	0	0	1	0	1	0	0	0
Millet stubble/sparse sabbal	2	3	5	1	1	2	1	1	2
Sabbal/native grassland	4	2	6	4	2	6	2	5	7
Native grassland/sparse sabbal	1	3	4	1	1	2	0	2	2
Crops: sorghum, tomato cassava	1	1	2	1	0	1	0	2	2
TOTAL	8	11	19	9	4	13	3	10	13

Table 13a. Abundance of rodents--N'Gouri, October 1989.

	Population Index (No. Captures/100 Effective Traps)															
Quadi	Binam				Ngarfari				Broudou				Ygra			
Species[1] / Transect[2]	A	G	O	Tot	A	G	O	Tot	A	G	O	Tot	A	G	O	Tot
NC	47.6	28.6	19.0	95.2	39.1	0	0	39.1	8	20	0	28	8.7	4.3	0	13.0
NI	33.3	0	5.6	38.9	*	*	*	*	*	*	*	*	8.3	0	0	8.3
CC	52.3	14.3	4.8	71.4	0	0	0	0	5.9	0	0	5.9	17.4	13.0	0	30.4
CI	33.3	5.6	0	38.9	0	0	0	0	20	0	8	28	0	4.2	0	4.2
Total interior	42.3	12.8	7.7	62.8	12.5	0	0	12.5	11.9	7.5	3	22.4	8.5	4.3	0	12.8
CE	0	2.2	0	2.2	0	0	0	0	4	0	0	4	0	2.3	0	2.3
NE	2.6	2.6	0	5.2	0	0	0	0	5.9	5.9	0	11.8	2.2	2.2	0	4.4
Total exterior	1.2	2.4	0	3.6	0	0	0	0	4.8	2.4	0	7.2	1.1	2.2	0	3.3
Total site	21.1	7.5	3.7	32.3	5.6	0	0	5.6	7.9	4.6	1.3	13.8	4.9	3.3	0	8.2

[1] Species A: *Arvicanthis niloticus*
G: *Gerbillus andersoni*
O: Other sp. or unknown (eaten)

[2] Transect NC: Noncultivated margin
NI: Noncultivated interior
CC: Cultivated margin
CI: Cultivated interior
CE: Cultivated exterior
NE: Noncultivated

* No estimate

Table 13b. Abundance of rodents--N'Gouri, October 1989.

	Population Index (No. Captures/100 Effective Traps)															
Quadi	Molori				Boui				Dibinintchi				Asankadori			
Species[1] / Transect[2]	A	G	O	Tot	A	G	O	Tot	A	G	O	Tot	A	G	O	Tot
NC	8.7	0	0	8.7	22.2	11.1	5.6	38.9	60	0	0	60	50	0	0	50
NI	26.7	0	6.7	33.4	15	15	0	30	32	0	0	32	4.3	0	0	4.3
CC	37.5	4.2	0	41.7	15.8	10.5	0	26.3	50	0	0	50	70.8	8.3	0	79.1
CI	0	0	0	0	12.5	0	0	12.5	34.8	0	0	34.8	8.3	4.2	0	12.5
Total interior	17.9	1.2	1.2	20.3	16	8.6	1.2	25.8	44.3	0	0	44.3	33.6	3.2	0	36.8
CE	0	6.3	0	6.3	0	13.9	0	13.9	4.1	0	0	4.1	0	0	0	0
NE	0	6.4	0	6.4	4.2	4.2	0	8.4	0	4.7	2.3	7.0	0	2.3	0	2.3
Total exterior	0	6.3	0	6.3	1.7	10	0	11.7	2.2	2.2	1.1	5.5	0	1.1	0	1.1
Total site	8.4	3.9	0.6	12.9	9.9	9.2	0.7	19.8	23.8	1.1	0.5	25.4	17.1	2.1	0	19.2

Species A: *Arvicanthis niloticus*
G: *Gerbillus andersoni*
O: Other sp. or unknown (eaten)

[2] Transect NC: Noncultivated margin
NI: Noncultivated interior
CC: Cultivated margin
CI: Cultivated interior
CE: Cultivated exterior
NE: Noncultivated exterior

Table 14. Population structure of rodents--N'Gouri, October 1989.

(A) Sexual condition (determined by autopsy)

Species	P_F	P_mM	P_FM	$P_{MF}P$	P_FP
Arvicanthis niloticus	0.53	0.68	0.63	0.40	0.26
Gerbillus andersoni	0.61	0.56	0.21	0.50	0.11

P_F: Proportion of females captured
P_mM: Proportion of mature males
P_FM: Proportion of females mature
$P_{MF}P$: Proportion of mature females pregnant
P_FP: Proportion of females pregnant

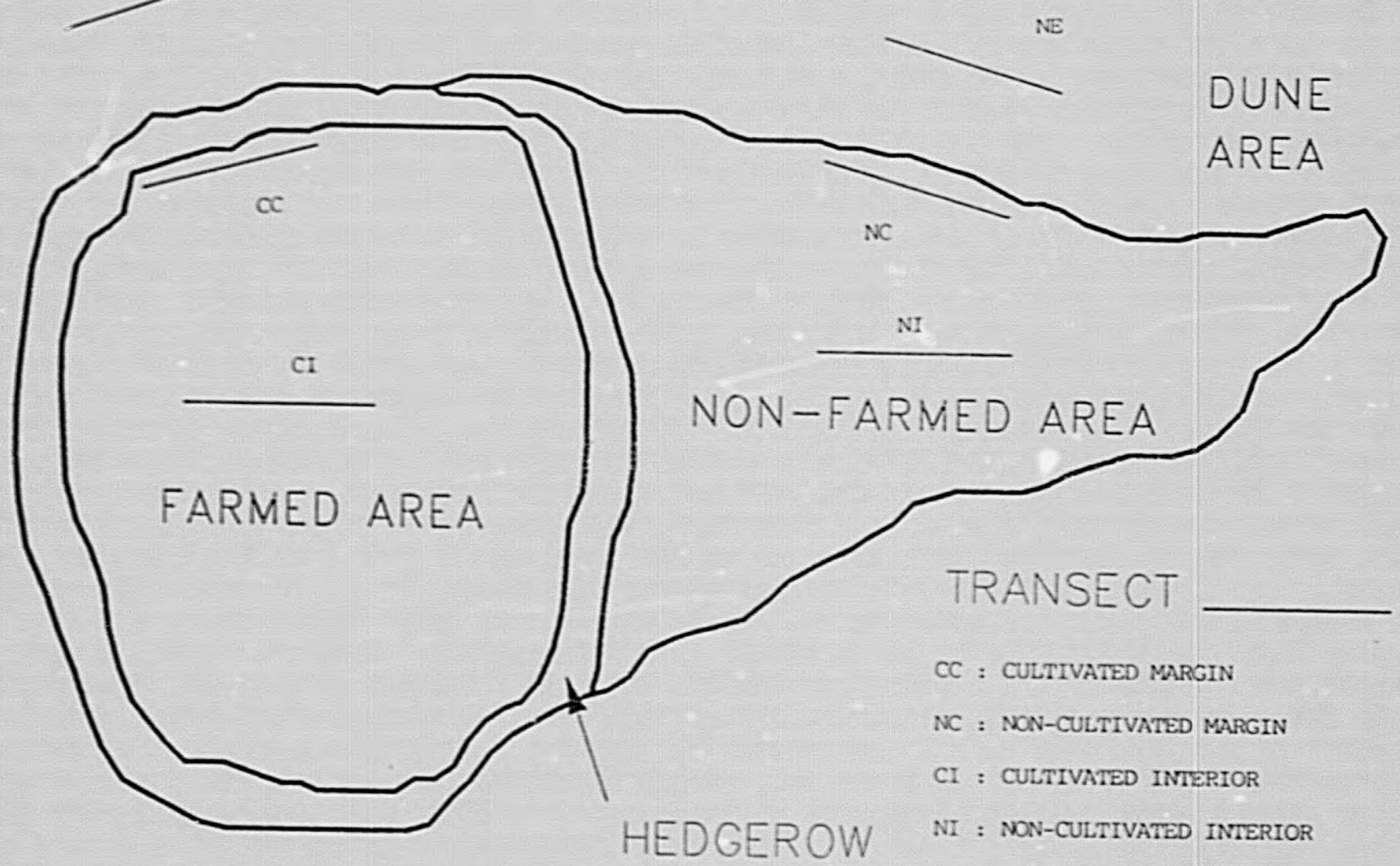
(B) Morphological structure*

(i) *Arvicanthis niloticus*	Immature males	Mature males	Immature females	Mature females
Head-body length (mm)	109±17	148±15	117±12	146±13
Weight (g)	46±23	127±27	62±22	111±16
n	18	15	23	34

(ii) *Gerbillus andersoni*	Immature males	Mature males	Immature females	Mature females
Head-body length (mm)	107±19	129±18	95±17	143±10
Weight (g)	38±16	72±20	38±21	106±29
n	7	7	21	4

* Mean ±S.D.

FIGURE 1
QUADI SHOWING TRANSECT POSITIONS



CC : CULTIVATED MARGIN

NC : NON-CULTIVATED MARGIN

CI : CULTIVATED INTERIOR

NI : NON-CULTIVATED INTERIOR

CE: CULTIVATED EXTERIOR

NE: NON-CULTIVATED EXTERIOR

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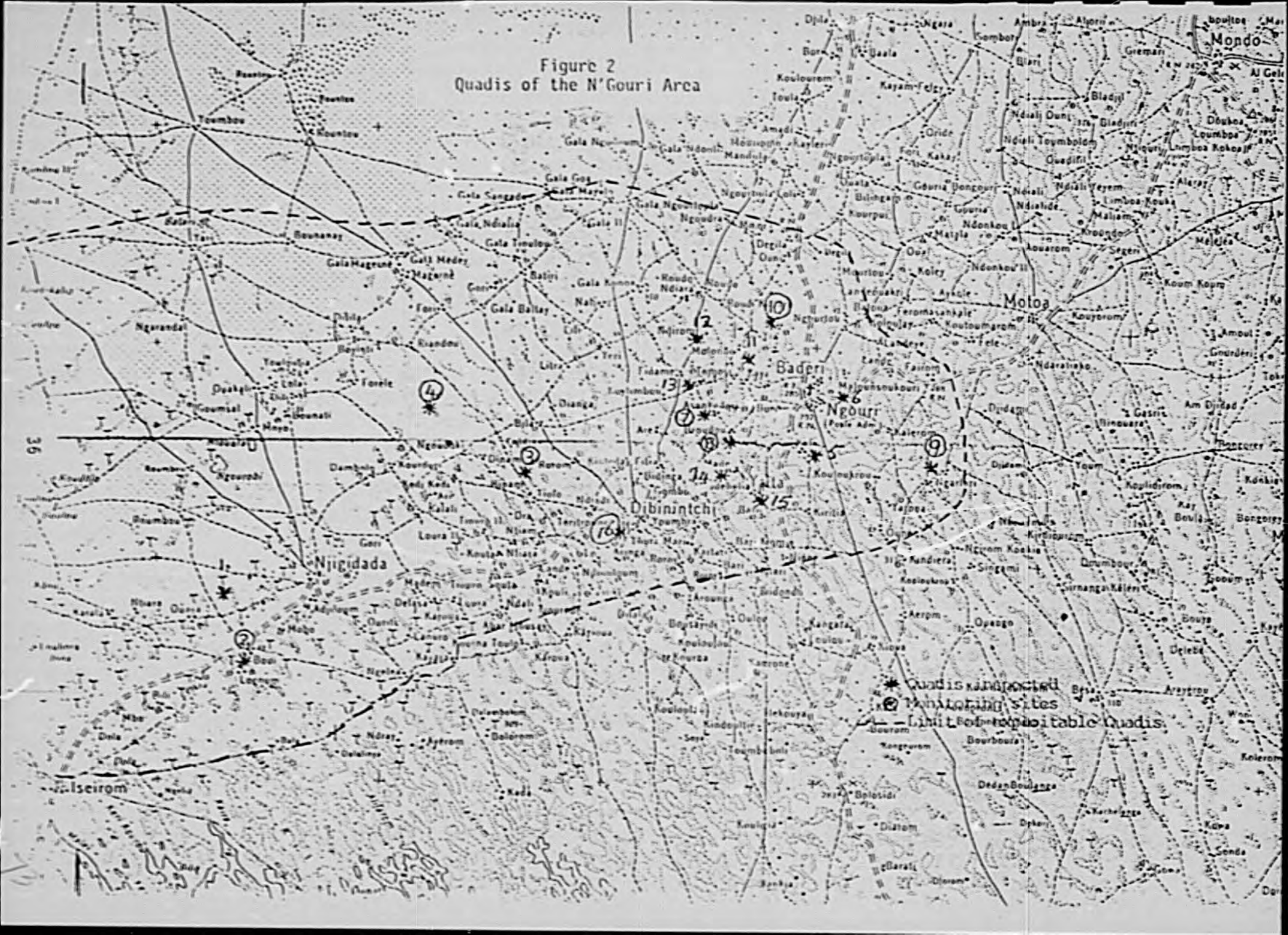
Figure 2
Quadis of the N'Gouri Area



APPENDIX 1

Rodent Life-History Strategies and Population Fluctuations

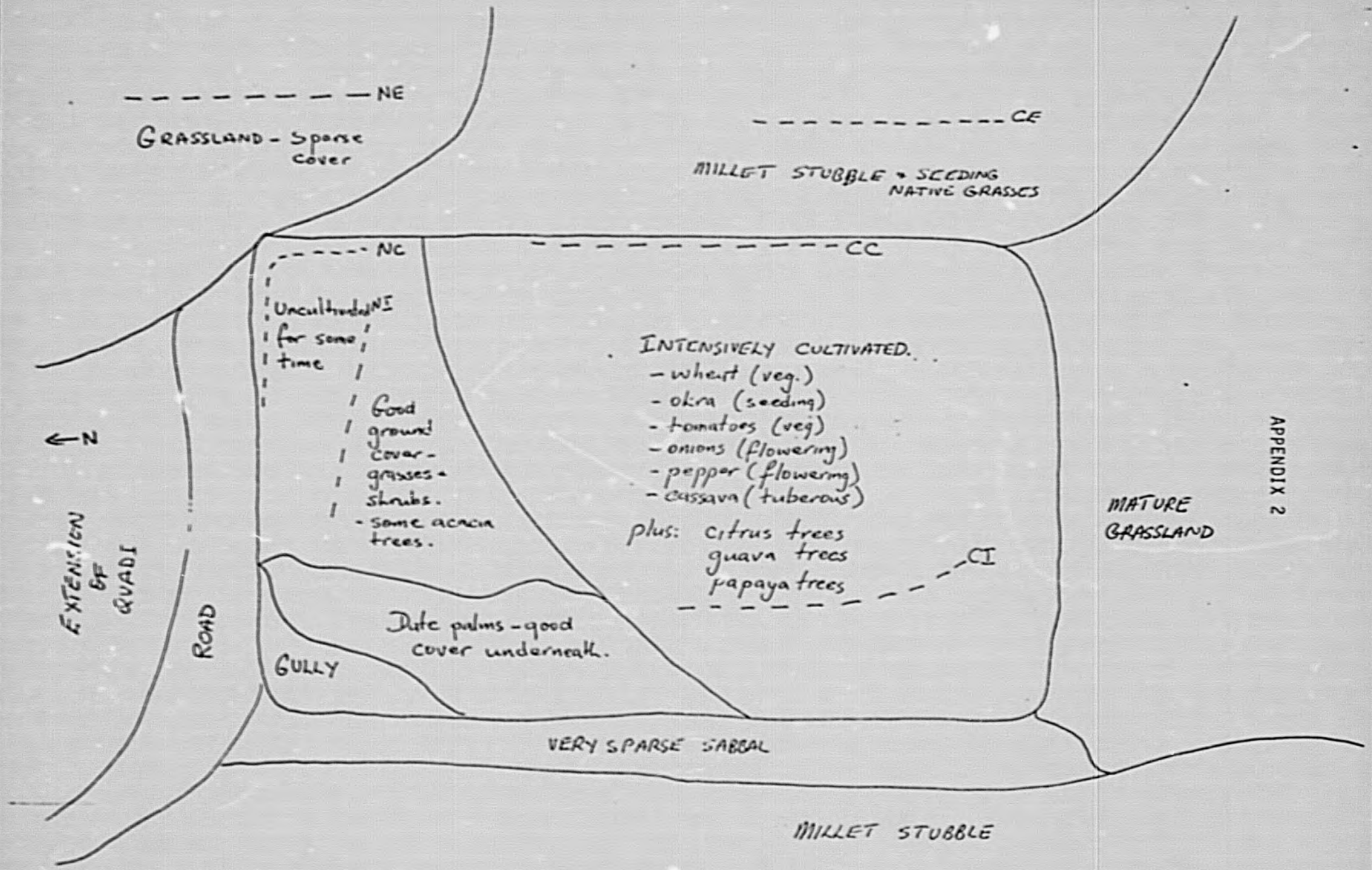
Reproductive characteristics such as polyoestrus breeding, post-partum oestrus, large litter size, short gestation period and a young age at sexual maturity result in populations that track continuously changing environments and quickly respond to any favourable change. In addition, many species "trickle" breed during times of stress and "protect" the most reproductively viable stratum of residual populations by temporarily elevating these animals in the social hierarchy. These remarkable reproductive traits combine to produce a very adaptable animal with an extremely effective life-history strategy.

It is important to note that environmental factors act on population processes e.g. birth rate, death rate and not on individuals. Many studies have shown that the most important process giving rise to year by year fluctuations in rodent population density is the degree of expression of fecundity. Population regulation appears to act through a complex of extrinsic and intrinsic factors, the latter tends to determine the potential of the breeding cycle (and is fixed) whereas the former dictates the expression of this potential and varies from year to year.

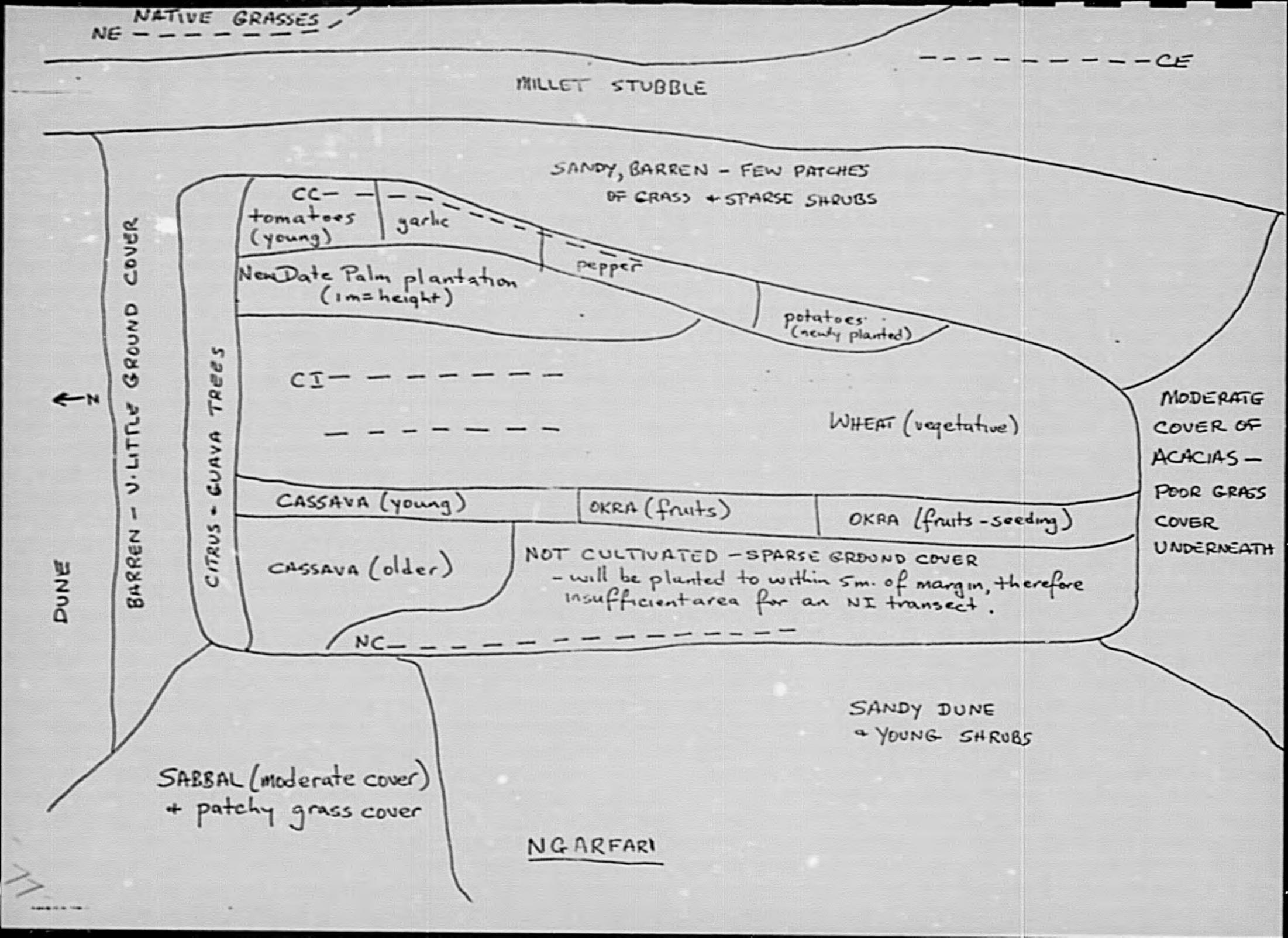
Climatic factors are considered the most important of the external factors and hypotheses based on soil-moisture, rainfall, food supply (via plant growth or production of plant hormones) and temperature have been advanced. Rainfall is most favoured and is used as an integrating factor (i.e. a factor synchronising reproduction to food supply and habitat attributes such as shelter). In this sense, rainfall can be considered the ultimate factor (e.g. regulating food production) whilst food production itself can be considered the proximate factor.

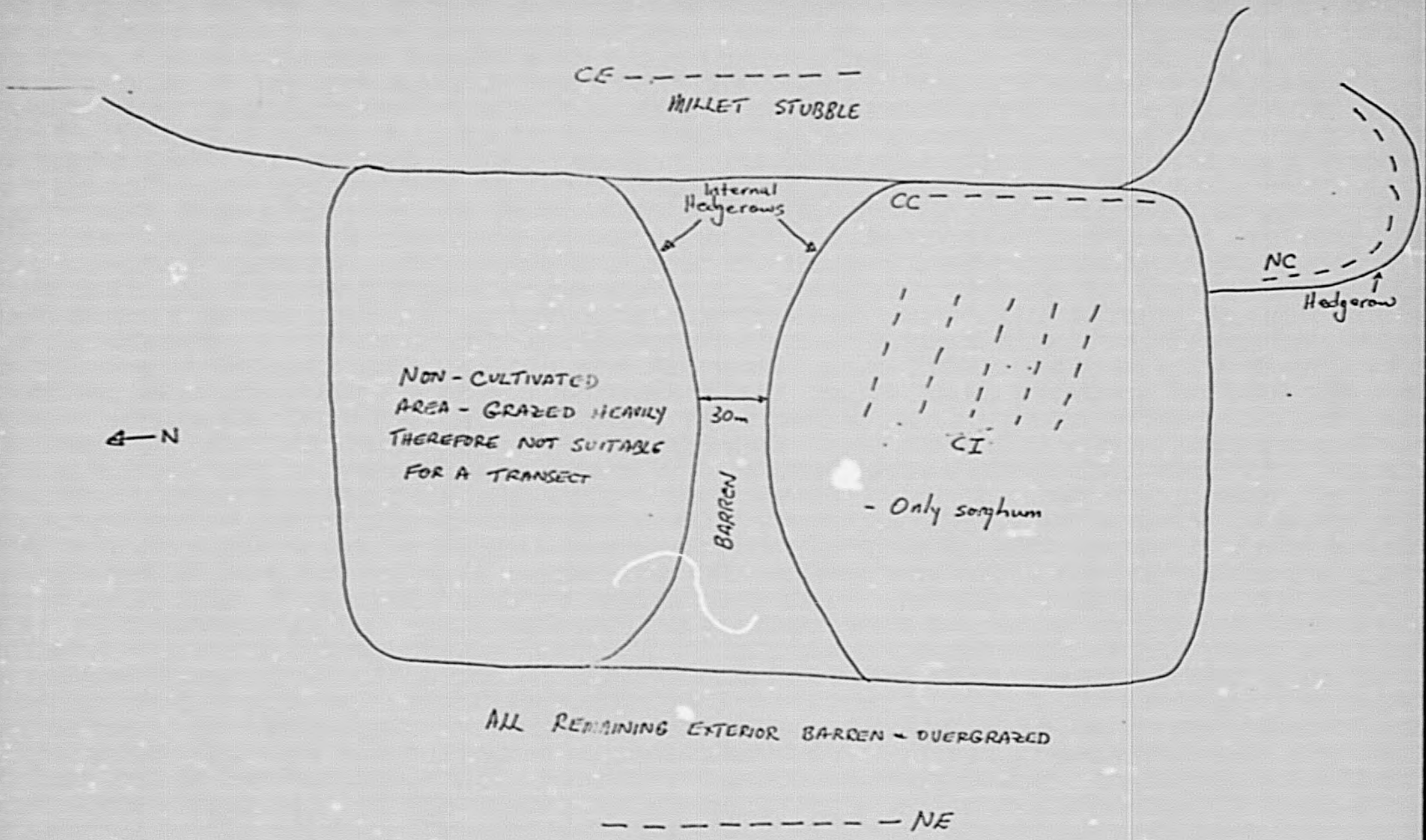
The problem in using an ultimate factor is that it cannot account for the differences in microclimate that exist at the individual site level. Hence most models that rely solely on "distant" or ultimate factors like rainfall do not performed well in the long-term. The proximate factors affecting reproduction will vary enormously throughout a region depending on local conditions such as soil-type, local rainfall, soil-seed reserves, water shedding/collecting characteristics and agricultural practices.

All of the external factors regulating population density have associated limits that must be exceeded before a prompt is issued. A "problem" year is one where the limits of the various factors are exceeded in synchrony. These limits are not usually exceeded at the same "real time" throughout a region and therefore to predict a regional event as well as localised eruptions (which is the aim of the exercise), the data must give an appreciation of the variation in these factors throughout the region. For this reason an extensive (i.e. sub-regional) monitoring study is suggested.

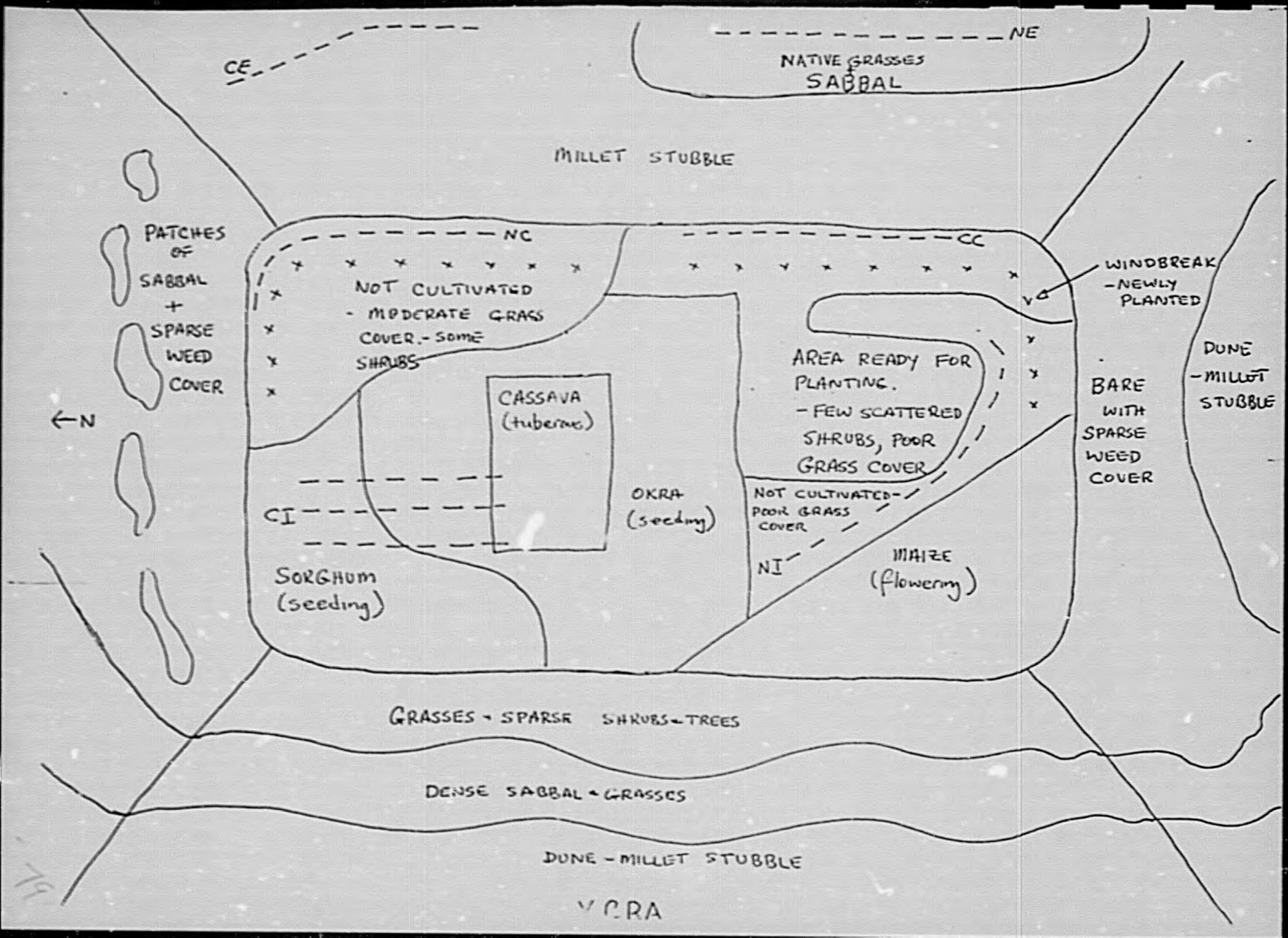

NE
GRASSLAND - Sparse cover
CE
MILLET STUBBLE + SEEDING NATIVE GRASSES
NC
CC
Uncultivated for some time
NI
Good ground cover - grasses + shrubs. - some acacia trees.
INTENSIVELY CULTIVATED.
- wheat (veg.)
- okra (seeding)
- tomatoes (veg)
- onions (flowering)
- pepper (flowering)
- cassava (tuberous)
plus: citrus trees
guava trees
papaya trees
CI
MATURE GRASSLAND
N
EXTENSION OF QUADI
ROAD
Date palms - good cover underneath.
GULLY
VERY SPARSE SABBAL
MILLET STUBBLE

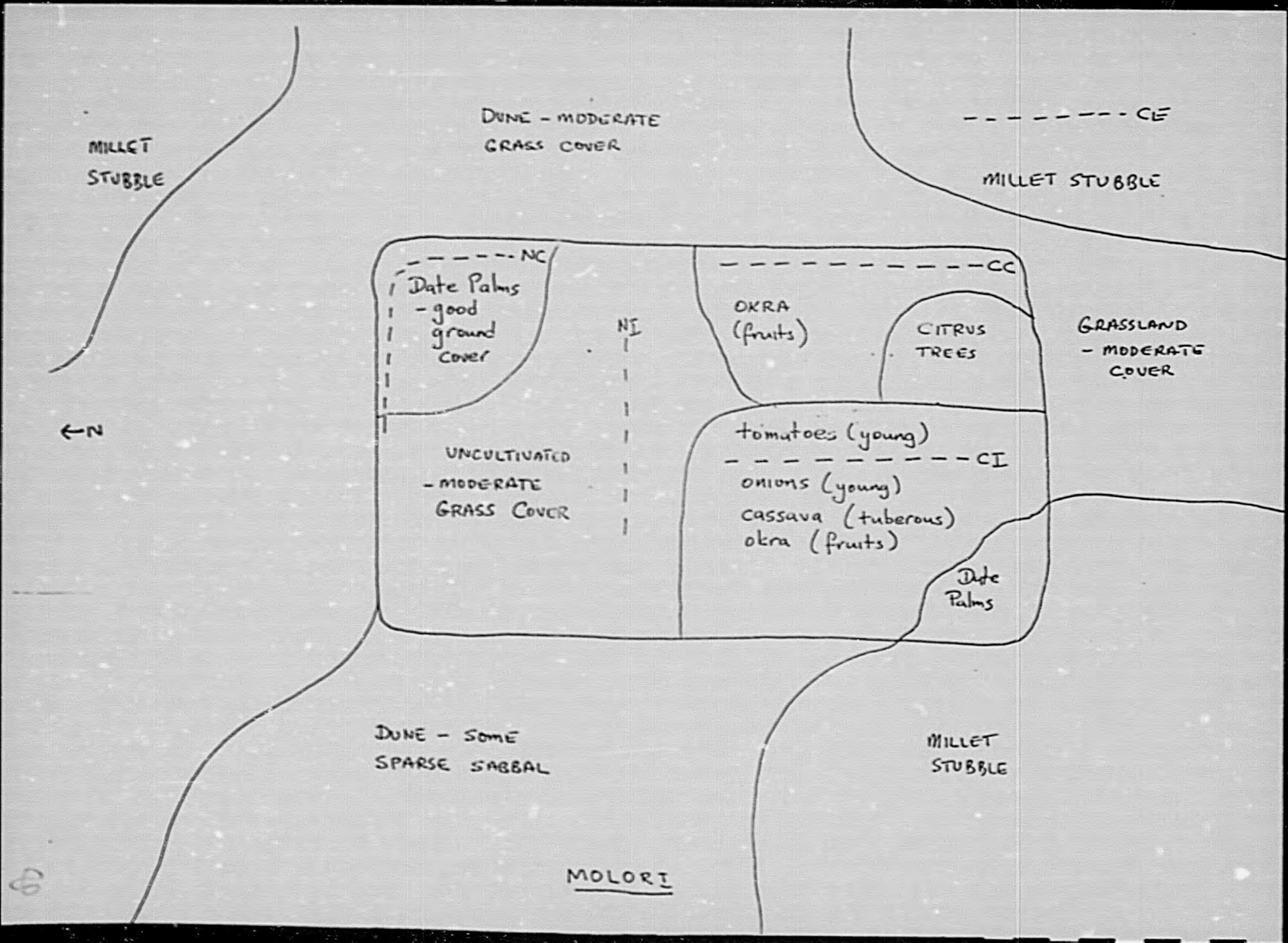
BINAM

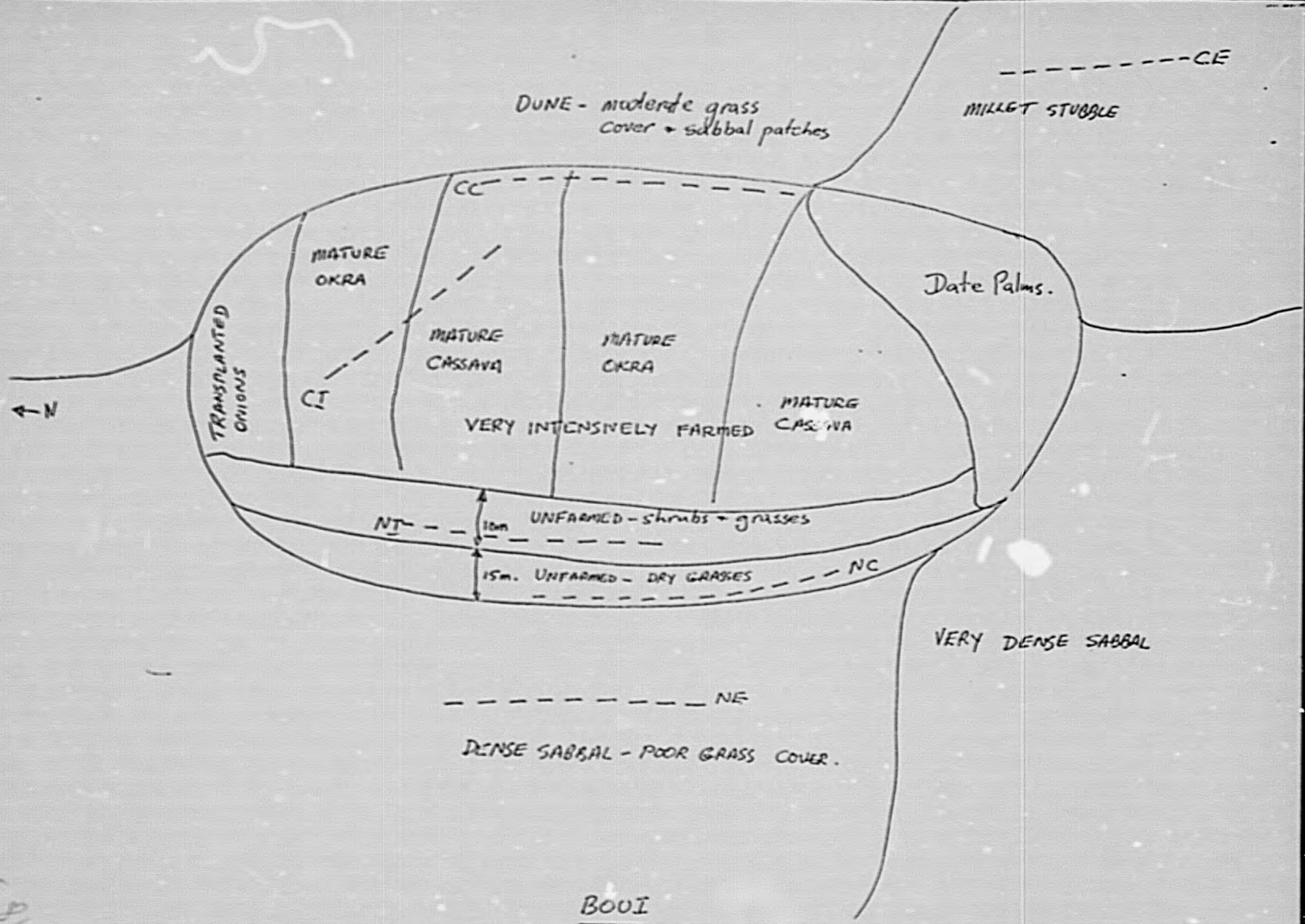

NATIVE GRASSES
NE
CE
MILLET STUBBLE
SANDY, BARREN - FEW PATCHES OF GRASS + SPARSE SHRUBS
CC
tomatoes (young)
garlic
pepper
New Date Palm plantation (1m = height)
potatoes (newly planted)
CI
WHEAT (vegetative)
MODERATE COVER OF ACACIAS - POOR GRASS COVER UNDERNEATH
CASSAVA (young)
OKRA (fruits)
OKRA (fruits - seeding)
CASSAVA (older)
NOT CULTIVATED - SPARSE GROUND COVER - will be planted to within 5m. of margin, therefore insufficient area for an NI transect.
NC
N
DUNE
BARREN - V. LITTLE GROUND COVER
CITRUS + GUAVA TREES
SANDY DUNE + YOUNG SHRUBS
SABBAL (moderate cover) + patchy grass cover
NGARFARI


CE
MILLET STUBBLE
Internal Hedgerows
CC
NC
Hedgerow
NON-CULTIVATED AREA - GRAZED HEAVILY THEREFORE NOT SUITABLE FOR A TRANSECT
30m
BARREN
CI
- Only sorghum
N
ALL REMAINING EXTERIOR BARREN - OVERGRAZED
NE

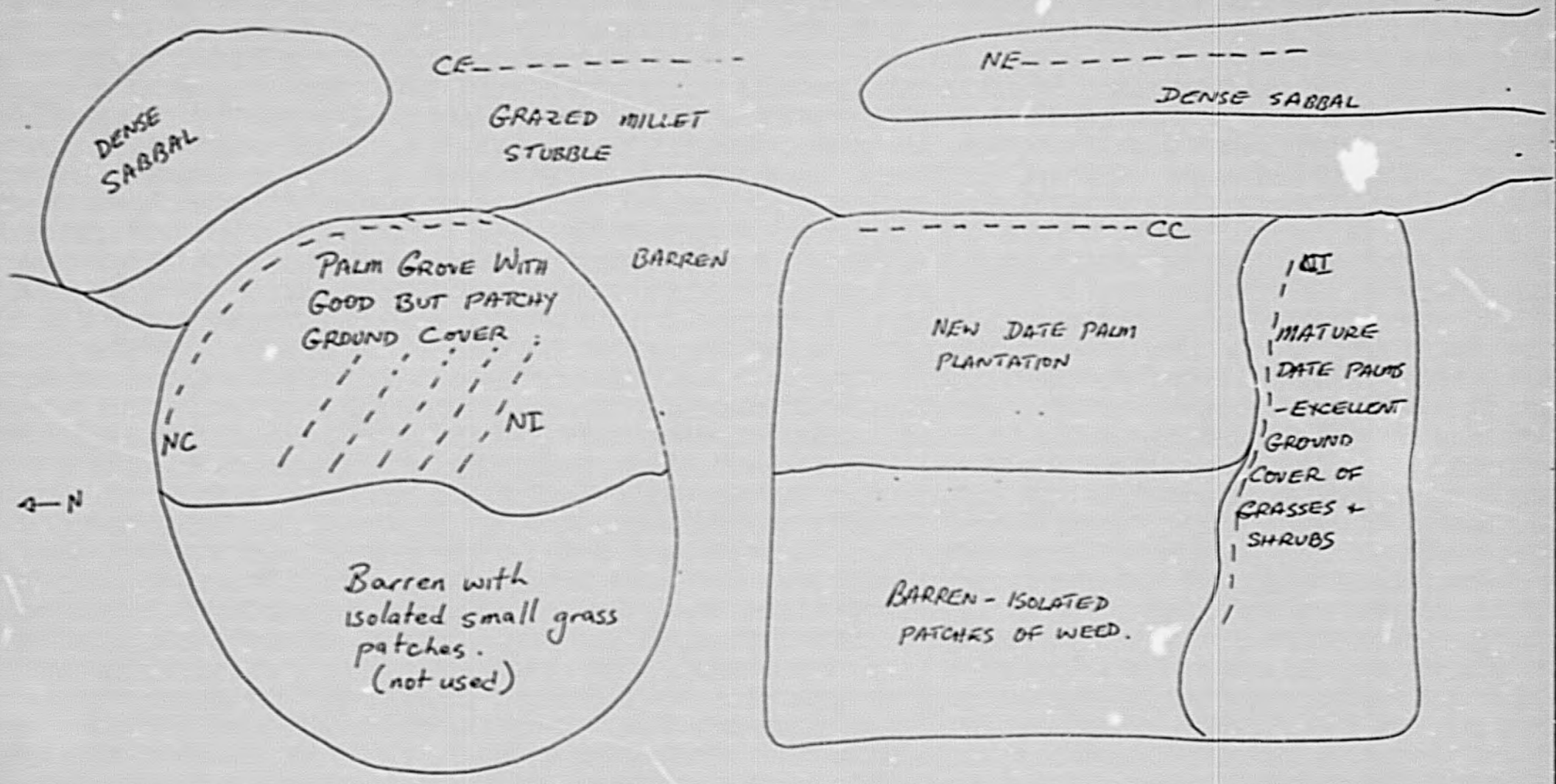
BROUDOU


CE
NE
NATIVE GRASSES
SABBAL
MILLET STUBBLE
PATCHES OF SABBAL + SPARSE WEED COVER
←N
NC
CC
NOT CULTIVATED - MODERATE GRASS COVER - SOME SHRUBS
WINDBREAK - NEWLY PLANTED
AREA READY FOR PLANTING. - FEW SCATTERED SHRUBS, POOR GRASS COVER
DUNE - MILLET STUBBLE
BARE WITH SPARSE WEED COVER
CASSAVA (tuberne)
OKRA (seedny)
CI
NOT CULTIVATED - POOR GRASS COVER
NI
MAIZE (flowerny)
SORGHUM (seeding)
GRASSES + SPARSE SHRUBS + TREES
DENSE SABBAL + GRASSES
DUNE - MILLET STUBBLE
YCRA


MILLET STUBBLE
DUNE - MODERATE GRASS COVER
CE
MILLET STUBBLE
NC
Date Palms - good ground cover
NI
CC
OKRA (fruits)
CITRUS TREES
GRASSLAND - MODERATE COVER
←N
UNCULTIVATED - MODERATE GRASS COVER
tomatoes (young)
CI
onions (young)
cassava (tuberous)
okra (fruits)
Date Palms
DUNE - SOME SPARSE SABBAL
MILLET STUBBLE
MOLORI

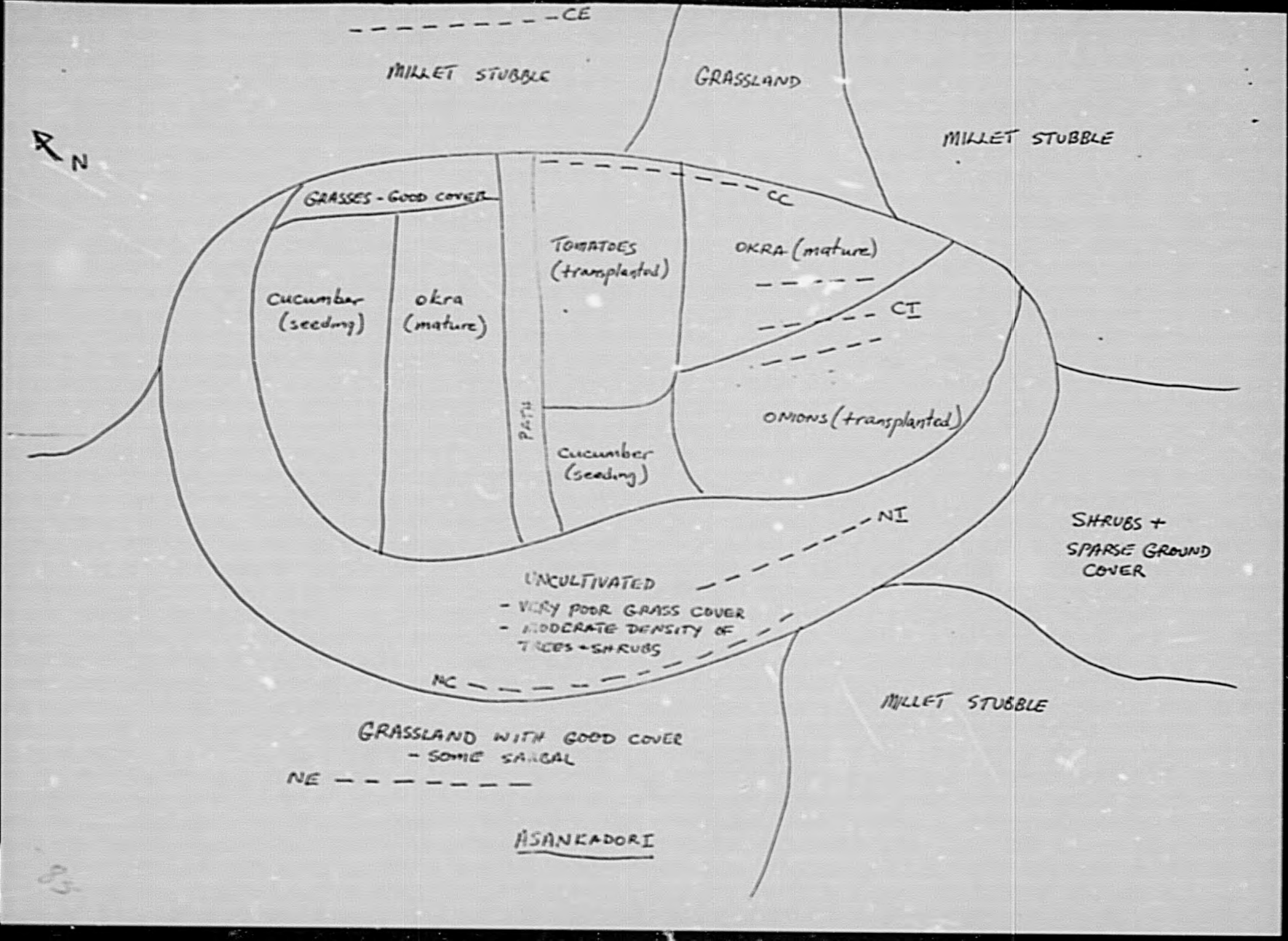

CE
DUNE - moderate grass cover + sabbal patches
MILLET STUBBLE
CC
MATURE OKRA
Date Palms.
TRANSPLANTED ONIONS
MATURE CASSAVA
MATURE OKRA
CI
MATURE CASSAVA
VERY INTENSIVELY FARMED
N
NI
10m
UNFARMED - shrubs + grasses
15m. UNFARMED - DRY GRASSES
NC
VERY DENSE SABBAL
NE
DENSE SABBAL - POOR GRASS COVER.

BOUI



COMPLETELY DENUDED BY OVERGRAZING

DIBININITCHI


CE
MILLET STUBBLE
GRASSLAND
MILLET STUBBLE
N
GRASSES - GOOD COVER
CC
TOMATOES (transplanted)
OKRA (mature)
Cucumber (seeding)
okra (mature)
CI
PATH
ONIONS (transplanted)
Cucumber (seeding)
NI
SHRUBS + SPARSE GROUND COVER
UNCULTIVATED
- VERY POOR GRASS COVER
- MODERATE DENSITY OF TREES + SHRUBS
NC
MILLET STUBBLE
GRASSLAND WITH GOOD COVER
- SOME SARGAL
NE
ASANKADORI

APPENDIX 3

Data Sheet and Coding Protocol

Location:

CC: Cultivated margin
NC: Noncultivated margin
CI: Cultivated interior
NI: Noncultivated interior
CE: Cultivated exterior
NE: Noncultivated exterior

Species:

U: Unknown (only part of animal present)
A: *Arvicanthis niloticus*
G: *Gerbillus andersoni*
M: *Mastomys* sp.
#1,2, etc.: Unknown--skin and skull forwarded for identification along with ear length and foot length.

Add more as necessary--maximum, two characters.

Head-body: (mm) to nearest 5 mm (U = unknown)
Tail: (mm) to nearest 5 mm (U = unknown)

Sex: U = unknown
11 = male, immature (testes abdominal)
12 = male, mature (testes scrotal)
21 = female, immature (vagina imperforate)
22 = female, mature (vagina perforate) [by autopsy]
23 = pregnant
1U = male, unknown condition
2U = female, unknown condition

Weight: (g) to nearest 5 g for animals over 100 g
to nearest 2.5 g for animals under 100 g
Record as U (unknown) if animal has been eaten to any significant extent.

APPENDIX 3 - (Continued)

Size of Embryo:

1. Early-term: small, but producing a discernable distention of the uterine horn
2. Mid-term: an obvious distention of the uterine horn but no fetal features apparent.
3. Late-term: large, fetal form apparent

N.B. If embryo is only a "spot" in the uterine horn producing no discernable distention, assume that the animal is NOT pregnant as resorption of very early embryos is possible.

% Seed)
% Vegetable) Stomach content analysis
% Other)

If a specific transect is not laid for any reason, a data sheet must be completed with "no traps laid" and the reason inserted in the comments section.

If no animals are trapped in a specific transect, a data sheet must be completed with "no animals trapped" inserted in the comments section.

In short, a separate data sheet must be completed for each transect of each site, regardless of whether traps were laid or animals were caught.

SAMPLE ONLY

DATE: 25/OCT/1989			AREA: Ngouri							WEATHER: fine/clear		
TRIP NO: 1			SITE: BINAM							TIME OUT: 1500		
OPERATOR: YACOUB			LOCATION: NC							TIME IN: 0810		
BAIT: Peanut oil			NO. TRAPS SET: 25				NO. INEFFECT: 4			NO. EFFECTIVE: 21		
ANIMAL NO:	1	2	3	4	5	6	7	8				
SPECIES:	A	G	#1	G	G	A	A	G				
HEAD-BODY:	U	115	150	U	135	150	130	120				
TAIL:	U	150	140	U	150	110	110	165				
SEX:	10	21	22	U	12	23	10	21				
EAR:												
FOOT:												
WT:	U	U	110	U	60	90	65	50				
~~EVISC. WT:~~												
NO. EMB:						8						
SIZE EMB:						1						
% SEED:												
% VEG:												
%OTHER:												

COMMENTS: #1 Unknown (large gerbillus sp.) - labelled specimen #1

ON DBASE: / /19 BY VERIFIED: 26/OCT/1989 BY Joh SHEET: 1/

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Record#	TRIP	AREA	SITE	LOC	SP	H_B	TAIL	SEX	WEIGHT	NO_EMB	SIZE_EMB	EFF_TRAPS
1	01	N	YG	CI	G	100	120	U	U			24
2	01	N	YG	NE	A	90	91	11	30			46
3	01	N	YG	NE	G	110	130	21	40			46
4	01	N	YG	CC	A	120	90	U	U			23
5	01	N	YG	CC	G	130	180	12	60			23
6	01	N	YG	CC	A	145	130	12	140			23
7	01	N	YG	CC	A	145	130	23	120	6	1	23
8	01	N	YG	CC	A	160	130	12	150			23
9	01	N	YG	CC	G	90	120	21	25			23
10	01	N	YG	CC	G	110	170	21	70			23
11	01	N	YG	NI	A	110	110	21	40			24
12	01	N	YG	NI	A	120	120	12	85			24
13	01	N	YG	NC	A	140	112	23	95	9	1	23
14	01	N	YG	NC	G	100	125	21	30			23
15	01	N	YG	NC	A	160	120	12	130			23
16	01	N	YG	CE	G	57	60	21	30			43
17	01	N	DI	CE	A	130	120	21	75	8	1	49
18	01	N	DI	CE	A	U	U	U	U			49
19	01	N	DI	CI	A	160	140	23	120	14	1	23
20	01	N	DI	CI	A	170	120	12	155			23
21	01	N	DI	CI	A	150	135	22	120			23
22	01	N	DI	CI	A	140	135	11	80			23
23	01	N	DI	CI	A	150	130	20	110			23
24	01	N	DI	CI	A	150	135	22	110			23
25	01	N	DI	CI	A	170	125	12	115			23
26	01	N	DI	CI	A	U	U	U	U			23
27	01	N	DI	NI	A	190	160	22	145			25
28	01	N	DI	NI	A	160	100	20	U			25
29	01	N	DI	NI	A	150	120	22	U			25
30	01	N	DI	NI	A	U	U	U	U			25
31	01	N	DI	NI	A	U	U	12	U			25
32	01	N	DI	NI	A	120	105	21	45			25
33	01	N	DI	NI	A	135	100	11	U			25
34	01	N	DI	NI	A	100	95	11	25			25
35	01	N	DI	NC	A	170	135	12	U			25
36	01	N	DI	NC	A	140	U	U	U			25
37	01	N	DI	NC	A	180	115	12	U			25
38	01	N	DI	NC	A	170	U	12	U			25
39	01	N	DI	NC	A	180	U	12	150			25
40	01	N	DI	NC	A	170	135	12	145			25
41	01	N	DI	NC	A	140	113	22	U			25
42	01	N	DI	NC	A	145	125	11	70			25
43	01	N	DI	NC	A	170	125	22	115			25
44	01	N	DI	NC	A	170	125	20	U			25
45	01	N	DI	NC	A	170	120	12	U			25
46	01	N	DI	NC	A	160	145	22	105			25
47	01	N	DI	NC	A	145	120	11	75			25
48	01	N	DI	NC	A	160	140	22	120			25
49	01	N	DI	NE	G	95	110	21	22			43
50	01	N	DI	NE	G	110	140	12	40			43
51	01	N	DI	NE	M	70	70	11	10			43
52	01	N	DI	CC	A	130	130	11	85			24
53	01	N	DI	CC	A	140	135	23	90	10	1	24
54	01	N	DI	CC	A	150	130	23	110	8	1	24
55	01	N	DI	CC	A	150	140	23	115	12	1	24
56	01	N	DI	CC	A	110	100	11	35			24
57	01	N	DI	CC	A	130	100	11	60			24
58	01	N	DI	CC	A	130	130	21	80			24
59	01	N	DI	CC	A	140	130	22	120			24
60	01	N	DI	CC	A	130	125	U	60			24

61	01	N	DI	CC	A	110	110	11	50			24
62	01	N	DI	CC	A	120	120	12	70			24
63	01	N	DI	CC	A	U	U	U	U			24
64	01	N	DI	NC	A	170	125	12	115			25
65	01	N	BO	NE	G	160	170	12	110			24
66	01	N	BO	NE	A	140	140	22	85			24
67	01	N	BO	CC	G	110	160	21	50			19
68	01	N	BO	CC	A	130	130	23	80	6	1	19
69	01	N	BO	CC	A	140	130	12	140			19
70	01	N	BO	CC	A1	160	175	12	125			19
71	01	N	BO	CC	A	135	125	22	95			19
72	01	N	BO	CI	A	150	130	12	140			24
73	01	N	BO	CI	A	150	130	12	120			24
74	01	N	BO	CI	A	110	110	11	80			24
75	01	N	BO	NI	A	150	130	12	155			20
76	01	N	BO	NI	A	130	130	12	140			20
77	01	N	BO	NI	A	130	130	12	85			20
78	01	N	BO	NI	G	140	150	23	110	3	1	20
79	01	N	BO	NI	G	130	180	12	80			20
80	01	N	BO	NI	G	130	175	23	70	11	1	20
81	01	N	BO	NC	U	U	U	U	U			18
82	01	N	BO	NC	A1	140	180	12	110			18
83	01	N	BO	NC	A	130	120	12	100			18
84	01	N	BO	NC	A	160	140	12	160			18
85	01	N	BO	NC	G	130	165	12	60			18
86	01	N	BO	NC	A	U	U	U	U			18
87	01	N	BO	NC	A	140	120	22	105			18
88	01	N	BO	CE	G	150	180	23	140	3	1	36
89	01	N	BO	CE	G	120	140	11	50			36
90	01	N	BO	CC	G	120	140	21	60			36
91	01	N	BO	CC	G	80	120	21	20			36
92	01	N	BO	CE	G	U	U	U	U			36
93	01	N	AB	NE	G	90	110	21	25			42
94	01	N	AB	NC	A	U	U	U	U			24
95	01	N	AB	NC	A	130	120	22	80			24
96	01	N	AB	NC	A	120	130	23	80	6	1	24
97	01	N	AB	NC	A	130	100	23	70	6	1	24
98	01	N	AB	NC	A	150	140	12	110			24
99	01	N	AB	NC	A	130	120	12	U			24
100	01	N	AB	NC	A	100	100	11	30			24
101	01	N	AB	NC	A	95	90	11	30			24
102	01	N	AB	NC	A	140	120	22	70			24
103	01	N	AB	NC	A	130	130	22	80			24
104	01	N	AB	NC	A	95	90	21	30			24
105	01	N	AB	NC	A	90	90	11	30			24
106	01	N	AB	NI	A	130	140	23	110	6	1	23
107	01	N	AB	CI	G	110	160	21	45			24
108	01	N	AB	CI	A	140	150	12	105			24
109	01	N	AB	CI	A	170	155	23	130	4	1	24
110	01	N	AB	CE								NC
111	01	N	AB	CC	G	150	170	23	105	4	1	25
112	01	N	AB	CC	A	140	130	12	95			25
113	01	N	AB	CC	G	135	140	U	U			25
114	01	N	AB	CC	A	150	140	23	110	6	1	25
115	01	N	AB	CC	A	U	U	U	U			25
116	01	N	AB	CC	A	150	U	12	160			25
117	01	N	AB	CC	A	120	125	21	85			25
118	01	N	AB	CC	A	140	145	22	130			25
119	01	N	AB	CC	A	130	140	22	100	6	1	25
120	01	N	AB	CC	A	90	95	11	25			25

121	01	N	AS	CC	A	140	135	12	95			25
122	01	N	AS	CC	A	U	U	U	U			25
123	01	N	AS	CC	A	150	125	12	90			24
124	01	N	AS	CC	A	150	140	12	135			24
125	01	N	AS	CC	A	140	120	12	80			24
126	01	N	AS	CC	A	120	120	21	85			24
127	01	N	AS	CC	A	130	125	22	70			24
128	01	N	AS	CC	A	130	130	23	80	4	1	24
129	01	N	AS	CC	A	140	150	22	135			24
130	01	N	BR	NI								NL
131	01	N	BR	NE					-.			34
132	01	N	BR	NE	G	80	110	11	20			34
133	01	N	BR	NE	A	130	130	22	110			34
134	01	N	BR	NE	A	130	130	22	70			34
135	01	N	BR	CE	A	130	130	21	85			50
136	01	N	BR	CE	A	90	90	21	20			50
137	01	N	BR	CC	A	130	130	23	90	4	1	17
138	01	N	BR	NC	G	80	125	21	20			25
139	01	N	BR	NC	G	120	140	U	U			25
140	01	N	BR	NC	G	120	170	12	60			25
141	01	N	BR	NC	G	90	140	21	25			25
142	01	N	BR	NC	G	90	140	21	30			25
143	01	N	BR	NC	A	130	125	21	75			25
144	01	N	BR	NC	A	120	125	21	80			25
145	01	N	BR	CI	A	110	110	11	60			25
146	01	N	BR	CI	M	90	90	21	20			25
147	01	N	BR	CI	A	155	130	23	115	5	1	25
148	01	N	BR	CI	A	150	U	22	115			25
149	01	N	BR	CI	A	130	120	11	65			25
150	01	N	BR	CI	U	120	140	20	48			25
151	01	N	BR	CI	A	115	110	11	60			25
152	01	N	MO	CI								NC
153	01	N	MO	NI	U	U	U	U	U			15
154	01	N	MO	NI	A	160	140	12	170			15
155	01	N	MO	NI	A	140	130	22	100			15
156	01	N	MO	NI	A	160	130	22	115			15
157	01	N	MO	NI	A	U	U	U	U			15
158	01	N	MO	CC	A	U	140	U	U			24
159	01	N	MO	CC	A	U	U	U	U			24
160	01	N	MO	CC	A	110	120	21	50			24
161	01	N	MO	CC	A	140	140	22	145			24
162	01	N	MO	CC	A	U	U	12	U			24
163	01	N	MO	CC	A	140	130	U	90			24
164	01	N	MO	CC	A	100	120	21	60			24
165	01	N	MO	CC	G	140	130	21	85			24
166	01	N	MO	CC	A	130	100	U	U			24
167	01	N	MO	CC	A	90	110	21	35			24
168	01	N	MO	NC	A	150	170	12	110			23
169	01	N	MO	NC	A	120	130	21	85			23
170	01	N	MO	CC	G	100	120	12	U			48
171	01	N	MO	CE	G	80	115	21	U			48
172	01	N	MO	CE	G	70	100	11	U			48
173	01	N	MO	NE	G	90	120	21	30			47
174	01	N	MO	NE	G	90	115	22	25			47
175	01	N	MO	NE	G	85	130	11	15			47
176	01	N	NG	NI								NL
177	01	N	NG	CI								NC
178	01	N	NG	NC	A	110	120	21	70			23
179	01	N	NG	NC	A	120	110	21	60			23
180	01	N	NG	NC	A	U	U	U	U			23

181	01	N	NG	NC	A	U	U	U	U				23
182	01	N	NG	NC	A	U	U	U	U				23
183	01	N	NG	NC	A	U	U	U	U				23
184	01	N	NG	NC	A	U	U	U	U				23
185	01	N	NG	NC	A	U	U	U	U				23
186	01	N	NG	NC	A	U	U	U	U				23
187	01	N	NG	CC									NC
188	01	N	NG	CE									NC
189	01	N	NG	NE									NC
190	01	N	BI	NC	U	U	U	U	U				21
191	01	N	BI	NC	U	U	U	U	U				21
192	01	N	BI	NC	U	U	U	U	U				21
193	01	N	BI	NC	U	U	U	U	U				21
194	01	N	BI	NC	A	U	U	U	U				21
195	01	N	BI	NC	A	U	U	U	U				21
196	01	N	BI	NC	A	U	U	U	U				21
197	01	N	BI	NC	A	U	U	U	U				21
198	01	N	BI	NC	A	U	U	U	U				21
199	01	N	BI	NC	A	U	U	U	U				21
200	01	N	BI	NC	A	130	120	11	75				21
201	01	N	BI	NC	G	100	140	11	40				21
202	01	N	BI	NC	A	U	U	U	U				21
203	01	N	BI	NC	G	115	150	21	U				21
204	01	N	BI	NC	H	150	140	22	110				21
205	01	N	BI	NC	G	U	U	U	U				21
206	01	N	BI	NC	G	135	150	12	60				21
207	01	N	BI	NC	A	150	110	23	90	B		1	21
208	01	N	BI	NC	A	130	110	10	65				21
209	01	N	BI	NC	G	120	165	21	50				21
210	01	N	BI	NI	U	U	U	U	U				18
211	01	N	BI	NI	A	100	100	11	40				18
212	01	N	BI	NI	A	150	130	12	125				18
213	01	N	BI	NI	A	135	100	U	50				18
214	01	N	BI	NI	A	140	130	12	100				18
215	01	N	BI	NI	A	U	U	U	U				18
216	01	N	BI	NI	A	120	120	U	60				18
217	01	N	BI	CI	A	130	135	U	55				18
218	01	N	BI	CI	A	150	130	22	120				18
219	01	N	BI	CI	A	140	170	12	140				18
220	01	N	BI	CI	A	150	160	12	160				18
221	01	N	BI	CI	A	125	135	21	110				18
222	01	N	BI	CI	A	100	100	21	25				18
223	01	N	BI	CI	G	100	140	U	40				18
224	01	N	BI	CC	A	U	U	U	U				21
225	01	N	BI	CC	A	U	U	U	U				21
226	01	N	BI	CC	A	U	U	U	U				21
227	01	N	BI	CC	A	U	U	U	U				21
228	01	N	BI	CC	A	U	U	U	U				21
229	01	N	BI	CC	A	U	U	U	U				21
230	01	N	BI	CC	A	U	U	U	U				21
231	01	N	BI	CC	A	U	U	U	U				21
232	01	N	BI	CC	A	U	U	U	U				21
233	01	N	BI	CC	U	U	U	U	U				21
234	01	N	BI	CC	A	130	U	U	U				21
235	01	N	BI	CC	A	110	100	21	80				21
236	01	N	BI	CC	G	130	U	11	55				21
237	01	N	BI	CC	G	U	115	11	U				21
238	01	N	BI	CC	G	120	150	11	45				21
239	01	N	BI	CE	G	80	100	21	15				45
240	01	N	BI	NE	G	90	115	21	30				38
241	01	N	BI	NE	A	120	110	21	45				38
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APPENDIX 4

CHAD -- REPORT OF VISIT

October 11-November 9, 1989

SUPPLEMENT

John Wilson

November 1989

ACCOMMODATIONS

N'Gouri:

A compound has been rented on a long-term basis for storage of equipment and project office. Rent is 17,500 CFA per month and 2 months' rent has been paid (from October 14).

A small, portable refrigerator (propane/12-v DC) is required, as there is no electricity.

N'Djamena:

The counterpart has obtained suitable office/laboratory space from the Ministry of Agriculture, and renovations will commence as soon as funds are transferred to Chad.

Abéché:

Discussions with the temporary Chief of Project--AFRICARE suggest that the AFRICARE guest house may be available for use by project staff while in Abéché. An equipment storage area may also be available. These arrangements should be formalized as soon as possible. Reservations well in advance are recommended.

FINANCIAL

At present, the project has no funds available for operating expenses other than the salary and traveling allowances for the counterpart. This presents a problem for the counterpart in that he has no means of preparing for trips to N'Gouri and Abéché. The expected modification of the PASA transferring funds to the Mission will resolve this problem.

EQUIPMENT

The following equipment (not readily available in Chad, or very expensive) is required:

3 pair dissecting scissors
1 mechanical counter
1 IBM compatible computer and printer for the laboratory/office
2 racks of rodent cages
5 gals. methanol or ethanol for specimens
wire, thread, and needles for specimen preparation
disposable gloves
1 stereo zoom microscope for stomach contents analysis

A cassette recorder has been left with the counterpart for field use.

PERSONNEL

All personnel worked extremely well together and cooperated in a team effort. All learned trapping, autopsy, and data collection techniques very quickly and were diligent in their work. Initially, the hours worked presented a problem for the cooperators, but this was quickly overcome. They may discuss overtime payment with the DG, Agriculture, but all were told that the project would not be responsible for any overtime.

In light of the above, it would provide an incentive if the cooperators could stay at the AFRICARE guest house with other project staff while in Abéché--if the guest house is available.

TRAVEL

Abéché should be monitored every 3 months. Travel can be by vehicle or air. During the wet season (one or two trips per year), air travel would be required. For the trips by air, the possible use of an AFRICARE vehicle and driver should be canvassed. This possibility should be formalized with AFRICARE as soon as possible.

TIMETABLE

N'Gouri should be monitored each month. The timetable of activities is as follows:

Day	Morning	Afternoon
1	Travel to N'Gouri	Set up camp
2	Lay interior traps--Quadis 1&2	Lay exterior traps--Quadis 1&2 Lay traps-Dune 1
3	Collect traps	
4	Lay interior traps--Quadis 3&4	Lay exterior traps--Quadis 3&4 Lay traps--Dune 2
5	Collect traps	
6	Lay interior traps--Quadis 5&6	Lay exterior traps--Quadis 5&6 Lay traps--Dune 3
7	Collect traps	Lay traps for stomach contents analysis
8	Lay interior traps--Quadis 7&8	Lay exterior traps--Quadis 7&8
9	Collect traps	Pack up camp
10	Travel to N'Djamena	

Abéché should be monitored about every 3 months. The timetable of activities is as follows:

Day	Morning	Afternoon
1&2	Travel to Abéché	
3	Lay traps at Quadis 1&2	
4	Collect traps	
5	Lay traps at Quadi 3 & Dune 1	
6	Collect traps	
7	Lay traps at Dunes 2&3	Lay traps for stomach contents analysis
8	Collect traps	
9	Lay traps at Dunes 4&5	
10	Collect traps	
11&12	Travel to N'Djamena	

This timetable is excessive in its time allocation. After one or two trips, the normal trip duration could be shortened by at least 2 days.

FUTURE ACTIVITIES

Next trip:

N'Gouri - Select specific dune sites and implement initial monitoring. This will add 3 days to the normal N'Gouri timetable.

Abéché - Select specific dune and quadi sites and implement initial monitoring. This will add 4 days to the normal Abéché timetable.

When biologist arrives:

Instruct personnel in stomach contents analysis and implement trapping to collect the required number of animals.

TRIP REPORT*

BANGLADESH

November 18-December 15, 1989

by

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Purpose

The purposes of this trip were: 1) to assist Department of Agricultural Extension personnel in creating and implementing a tool to survey Bangladesh farmers regarding current rodent and rodent control perceptions, efforts, and needs; and 2) to make recommendations regarding future program directions for the Vertebrate Pest research effort in Bangladesh.

Introduction

USAID funds created and have supported a Vertebrate Pest Research unit in Bangladesh since 1978, when the first Denver Wildlife Research Center personnel arrived. A comprehensive description of the project's efforts and accomplishments can be found in the recent report by Marko, Jackson, and Ahmad (1989). Concurrent with these efforts, the West German government was involved in extension efforts to promote rat control in Bangladesh agriculture through multi-media campaigns beginning in 1983. These campaigns are described in a publication by Adhikarya and Posamentier (1987).

Given the type and extent of past efforts in vertebrate damage control in agriculture, there appeared to remain significant problems in farmers' ability to control rat damage to various crops throughout Bangladesh. A much-needed survey to determine farmers' current attitudes and practices regarding rodent control was envisioned by Dr. Michael M. Jaeger and his colleagues in the Vertebrate Pest Section. Need for such a survey had been recognized in the early 1980s by Adhikarya and Posamentier (1987), but time and resource restraints prohibited their conducting such work prior to initiating the national rat campaigns.

Current plans of DWRC and USAID are for Dr. Jaeger to terminate his work in Bangladesh in the fall of 1990, but for DWRC presence to continue for the next two years in the form of short-term consultancies. Absence of a full-time DWRC advisor to the Vertebrate Pest Section raises potential questions about future program continuity as well as timely responsiveness of DWRC or USAID personnel to critical research needs (e.g. research support activities available through DWRC such as bait quality control testing, residue analysis).

Accomplishments and Recommendations

A summary calendar of activities during my time in Bangladesh is attached as Appendix 1.

1) Survey of Bangladesh Farmers

A comprehensive questionnaire for use in interviewing farmers throughout Bangladesh was developed with the assistance of project personnel (Appendix 2). It was field-tested at sites near Comilla (12 farmers) and near Manikganj (36 farmers). The initial data we obtained pointed to specific program needs in extension education as well as in pesticide regulation and enforcement. Additionally, aspects lacking in previous rodent control

efforts were noted.

Recommendations were made to Mr. S. Sarker, who is primarily responsible for data collection under the supervision of Dr. M. M. Jaeger, regarding adequate sample size, statistical reliability of data, interviewing strategy, and data interpretation.

Specific recommendations were as follows:

a) that Mr. Sarker compile a data set from the interviews of the 36 farmers interviewed in the Manikganj area. Further, that these data be tabulated and evaluated for variability to predict needed sample sizes, insofar as possible, for other study sites throughout the country.

b) that a statistician experienced in data analysis of such surveys as are typically employed by social scientists be consulted regarding data adequacy and appropriate statistical tests, using this data set of 36 interviews.

c) that remaining changes be made and the questionnaire be finalized as soon as possible, so that the interview process can proceed without delay. In this way, variability of responses that might result from change of season or farmers' changing activities will be minimized.

d) that appropriate needs and directions for extension and research work, as revealed by the data, be summarized in writing by Mr. Sarker in cooperation with Dr. Jaeger and with other BARI/Vertebrate Pest Section personnel.

2) Future Directions for DWRC/USAID Efforts

A large part of the success of past and current vertebrate pest research in Bangladesh is the direct result of the continued presence of DWRC personnel. Program continuity has been maintained, certain data needs have been identified and met, and a number of Bangladesh students have received training as scientists at home and abroad through the completion of Master's and Ph.D. programs (see Marko et al 1989). These personnel will soon be reaching a number that constitutes a "critical mass" of scientists with interests and capabilities in the vertebrate pest research area.

Continued ability of USAID to fund graduate-level training for Bangladesh scientists in American or other institutions is critical for maintenance and growth of the needed research capability. Recent restriction of the period of such overseas studies to a maximum of 3 years for a doctoral degree is unrealistic. This time restriction also devalues the potential and real educational experiences that can accrue from such investments in young scientists. Such study programs should be for a minimum of 4, if not 5 years for Ph.D. programs.

For continuity of the vertebrate pest research effort to be maintained, I offer the following recommendations:

a) that a permanent DWRC staff member be continued until at least the end of 1992, when both of the two Bangladesh students now pursuing Ph.D. degrees in the U.S. will have completed their studies and returned as staff members of the BARI/Vertebrate Pest Section.

b) that all possible efforts be made to support Divisional status for the Vertebrate Section, thereby separating it from its current administrative oversight by the Entomology Department of BARI; and that this new unit be headed by a scientist with a doctorate who has a proven record of research including both the areas of mammals (rodents, specifically) and birds; and that adequate funds be allocated to support this group of scientists in field as well as laboratory work. This should include funding for two or more additional Scientific Officers as support personnel, as appropriate.

c) that funds be continued to support short-term consultancies involving individuals who have significant expertise in specific areas of vertebrate damage control, as well as those who have extensive experience in establishing workable vertebrate control programs and strategies in developing countries within those nations' social and political contexts.

3) Specific Rat Control Needs and Directions

Recommended Strategy and Materials

The strategy for aiming rat control at the lesser bandicoot rat, **Bandicota bengalensis**, in rice fields during September-October appears appropriate and potentially very cost-effective. Control at this time, when the population is low and beginning to increase, will involve relatively little labor by farmers or others and will utilize only small amounts of pesticide as opposed to control efforts undertaken at later times during the cropping season. Such control practices, if successfully undertaken, have potential benefits in terms of saving pre-harvest rice and pre-harvest wheat, as well as reducing rodent damage to stored grains through overall reduction of rat numbers.

Once current survey efforts are completed and data summarized, better understanding of farmers' rodent control practices and perceptions will be possible. It is anticipated that a significant effort will be necessary to motivate farmers to initiate control early in the season, prior to the time they typically recognize significant rat damage to be occurring. In fact, there is ample evidence from past experiences in Bangladesh to suggest it may be quite difficult to institute an efficacious rodent control program through usual methods of extension and training of farmers. Studies currently in progress, being conducted by Sultana and Jaeger, are designed to compare efficacy of rat control conducted by trained farmers to control efforts performed by other persons specifically hired and trained to conduct control in farmers' fields. Based on such information, a decision should be reached whether to place primary future emphasis on training of farmers, or whether rodent control efforts should be focused on establishment of a cadre of trained government employees whose task would be to conduct control at the appropriate time and in the recommended manner. It appears that the former strategy (e.g. extension training of

farmers in rat control) has been assumed to be the appropriate approach for many years; yet, the latter strategy has several obvious advantages. Among these are that if properly managed, it virtually assures that control would be conducted at the optimum time of year; that pesticides would be correctly used, thus reducing hazards to non-target species; and that area-wide control could be conducted without reliance on the farmers' ability to cooperate, coordinate, or even participate. I recommend that a consultant with experience in developing the infrastructure for such a control program be utilized in the near future to assist officials of the Bangladesh government in determining the proper direction for future efforts.

Assuming the current emphasis to train farmers to do their own rat control is continued, efforts should proceed to:

a) Provide a mechanism for making ready-to-use rat baits and/or burrow fumigants available in the local marketplace to farmers at a suitable cost. Such efforts could be first piloted in one or two districts, and then a successful strategy expanded to other areas. The ideal situation would be to have the following materials available to farmers:

i) ready-to-use Zinc Phosphide baits, formulated at 2% active ingredient, and packaged with specific use instructions. This product can be the mainstay of September-October control efforts, but its use should not be repeated more often than once every 6 months because of the potential for bait shyness and resulting loss of effectiveness. Potential exists for this formulated product to be manufactured within Bangladesh, if proper facilities and safeguards can be implemented to ensure quality control of baits as well as safe working conditions for persons handling the zinc phosphide and formulated product during manufacture and packaging. It is likely that a formulation could be utilized that would maintain adequate shelf life of up to 1 year, if packaged properly.

ii) a ready-to-use single-dose anticoagulant bait, formulated to be weather-proof and packaged with specific use instructions. This could be used instead of the Zinc Phosphide product, or it could be used as a follow-up treatment to kill bait-shy individuals or those not accepting the Zinc Phosphide formulation for other reasons. Research conducted by Sultana and her colleagues has established that products such as ICI's Klerat®[1] formulation (active ingredient: brodifacoum) are highly efficacious when burrows of B. bengalensis are baited, and that no significant environmental hazard is apparent. While a multiple-dose anticoagulant could also serve this purpose, it would likely be less cost-effective because more bait would be needed per rat, and its efficacy would be poorer if many other food items in the environment compete with the bait.

iii) a ready-to-use burrow fumigant, such as aluminum phosphide, be available to farmers and be packaged with specific use instructions. This could be used as a follow-up to a toxic bait application, or it could be substituted for baits in those situations where a high prevalence of competing food items tends to reduce bait acceptance and therefore limits control efficacy.

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[1] Reference to trade names does not imply U.S. Government endorsement.

b) Implement a pilot extension training program, concurrent with improved availability of rodent baits and/or fumigants, that would include a motivational component as well as training of extension workers and farmers in the specific methodologies of applying such rodenticides for maximum efficacy and safety. Extension personnel and farmers should be trained to recognize rat infestations through early detection and survey of fields in September (or immediately following peak high water levels), according to geographic area and local conditions), to treat burrows with appropriate toxicants, and to evaluate the effectiveness of their treatments and re-treat as necessary to achieve adequate levels of control.

I wish to emphasize the importance that a clear decision be reached whether control efforts are to rely primarily on training of farmers vs. creation of a governmental entity that will hire persons to perform rat control. Such a decision must involve participants from all of the involved agencies and departments, and whatever decision is reached should be fully supported and adequately backed by funds for training and implementation.

4) Current Pesticide Concerns

The current situation, in which powdered unformulated Zinc Phosphide is being packaged and sold in the marketplace apparently throughout Bangladesh, is untenable and potentially hazardous to human health as well as to non-target species in the environment. Further, it has resulted in poor levels of control effectiveness. Farmers surveyed in November and December remarked on problems of lack of specific use instructions, poor bait acceptance, and hazards to non-target species. A technical assay of such Zinc Phosphide products was conducted in May 1989 by DWRC staff in the U.S., revealing that the level of active ingredient in these products varied between an estimated 1% and 96%. Within one single brand of product, the a.i. was found to range from 12% to 44%. This, coupled with the lack of specific instructions on toxicant packets being sold, makes it virtually impossible for a farmer or any individual to correctly and effectively formulate and apply baits. If the level of active ingredient in the final bait is too low, rats will ingest sub-lethal doses and will likely develop bait shyness that may persist 6 to 12 months or longer. If the level of active ingredient is too high, rats will likely reject the bait entirely, leaving it available in the environment for other species to ingest, or as a contaminant. Farmers reported non-target kills of poultry, cats, and dogs. In the U.S., Zinc Phosphide is regarded as a "Restricted Use Pesticide" and is available only for use by Certified Pesticide Applicators. To allow its continued sale in a concentrate form to Bangladesh farmers is an invitation to poisoning of children, livestock, and non-target wildlife, while it does little or nothing to solve the rat damage problem. Once properly formulated, readymade baits can be manufactured. Zinc phosphide should remain the most appropriate choice for agricultural rat control.

A mechanism needs to be developed and implemented that will prevent a situation such as the current one, involving the sale of unformulated Zinc Phosphide to farmers, from developing and continuing. Clearly, better communication is needed among several groups, including those researchers working on vertebrate control in the field, and those in the Department of Agricultural Extension responsible for pesticide registration and public

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safety involving pesticide formulation, distribution, and use. I wrote a letter to Dr. M. M. Rahman, Executive Vice President of the Bangladesh Agricultural Research Council (BARC) emphasizing this point immediately before my departure (Appendix 3).

5) Trapping and Trap Availability

While most farmers report using one or more types of traps in rat control. it appears that traps are used primarily in and around houses to control rodents at these locations, rather than in the fields. Research by Jaeger and his colleagues have shown that **B. Bengalensis** is quite difficult to trap, in comparison to other species present. Therefore, it does not appear that efforts to promote more intensive trapping efforts by farmers would be effective in reducing overall rat damage to field crops, unless new traps and trapping techniques are developed that are successful against lesser bandicoot rats. It is possible, however, that increased availability of affordable traps could allow farmers and their families to be more effective in controlling Rattus and other species (e.g. house shrews, see below) that may cause damage to stored foods ad other household goods. Traps of a size that would be effective against roof rats (**Rattus rattus**), house mice (**Mus musculus**), and house shrews (**Suncus murinus**) could be effectively employed. Further, because of the relatively low cost of labor in Bangladesh and the availability of children or others who might conduct trapping in and around homes and villages, increased trap use might prove quite cost-effective in reducing such damage.

During my last day in Bangladesh, I chanced to learn that the Mennonite Central Committee personnel in Dhaka are in the process of developing a local industry to manufacture and sell rat traps, and apparently are well-along in this effort. It might be quite productive for persons in the Vertebrate Pest Section to be in contact with the Mennonite administrators in Dhaka (Rollin Rheimheimer and Mark Nord) to facilitate cooperation and coordination of both groups' efforts.

6) House Shrews

Farmers we surveyed consistently reported the presence of house shrews (**Suncus murinus**) in and around houses and villages. Further, they reported frequent occurrence of damage from this species, including consumption and contamination of foodstuffs, damage to eggs, and predation on young chicks. It appears that little is known about this species and its activities. Study of house shrews, their damage, and the potential for their control could be quite valuable as well as interesting. If their predation on eggs and chicks is in fact as frequent as the farmers reported, house shrews may be having a significant economic impact on rural households throughout the country.

7) Emphasis of Rat Control Campaigns

A minor component of the 1983 and 1984 national rat campaigns, namely, contests for collection of rat tails, has been perpetuated and continues to

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utilize time and effort of staff within the Dept. of Agricultural Extension. Originally conceived and implemented as a tool to promote awareness of and participation in rat control, this concept has now apparently become somewhat institutionalized as a bounty system in which those persons in local areas who submit the largest number of tails are awarded prizes and recognition. Such a bounty system does little to promote ecologically sound rodent control practices, in that it does not reward those who conduct control early in the season when rat numbers are low. Instead, it rewards those who control later, after significant damage to crops has occurred. Thus, such a system may in some sense actually promote rat damage, in that it rewards those who have the largest numbers of rats. In addition, many of the tails turned in may be from species other than the most damaging species **B. bengalensis**. It is always difficult to devise a bounty system that does not suffer from some forms of misrepresentation or fraud. This program uses valuable time and energy which could be better directed toward other aspects of promoting rodent control; further, farmers showed essentially no interest in the contest. It should be discontinued.

8) Future Extension-Research Emphases

Failure of major aspects of the nationwide rat control strategy, as devised in the early 1980s, to be carried forward in a effective, productive manner points to the need for continual re-assessment and evaluation of program goals and accomplishments. It is also clear that for any educational or extension program to be effective, it must be based on actual needs and perceptions of the end-users. The current survey of farmers will provide important base-line data for measuring future changes in rodent control practices and attitudes. Continued research effort will be needed to measure changes in behavior, as well as to define problems and propose appropriate solutions. Future extension work, then, will require research support in order for its effectiveness to continue.

Benefits will be obtained from improving and formalizing interactions between the Vertebrate Pest Section, the Department of Agricultural Extension, and those working within the Bangladesh Rice Research Institute (BRRI). Improvement in communication among scientists and extension workers in these units will facilitate identification of problems in vertebrate damage control and will speed their solution.

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Appendix 1

Calendar of Activities

18-21 November	Travel from Hopland, CA / San Francisco / Bangkok to Dhaka, Bangladesh
21 November	Met with Dr. Michael Jaeger regarding scope of project and consultancy assignment
22 November	Met with USAID project director W. Phil Warren, American Embassy. Toured Vertebrate Pest Laboratory and office facilities at BARI (Bangladesh Agricultural Research Institute), Joydebpur Met with Dr. Parvin Sultana, Senior Scientific Officer, BARI, and Mr. Santosh Sarker, Senior Instructor, Dept. of Agricultural Extension, at Dhaka, regarding survey of farmers
23 November	American Holiday - Thanksgiving
24 November	Weekend
25 November	Traveled to study site at Comilla with M. Jaeger and S. Sarker; inspected field sites; began field testing of questions to be asked of farmers regarding rodent control.
26 November	With M. Jaeger and S. Sarker, developed first draft of farmers questionnaire; typed questionnaire; continued field testing of questions and further revisions based on farmers' responses; further discussed questionnaire with M. Jaeger, P. Sultana, and S. Sarker
27 November	Field-tested revised questionnaire with farmers in Comilla district; discussed rodent control with district Dept. of Agricultural Extension officials; further modified questionnaire and drafted study's objectives
28 November	Returned to Dhaka; field-tested questionnaire with farmers in deep-water rice areas during return trip; entered revised version of questionnaire onto computer at Bangladesh Agricultural Research Council (BARC) office, Dhaka
29 November	National day of work stoppage (hartal): Reviewed project study plans and previous research reports
30 November	Continued review of study plans; met with M. Jaeger and S. Sarker regarding sampling methodology for farmer interviews
1-2 December	Weekend

3 December	Reviewed publication by GTZ regarding national rodent control campaigns of 1983 and 1984; met with M. Jaeger regarding project and interview progress
4 December	Continued review of GTZ publication and other project materials
5 December	Discussed sampling strategy with S. Sarker and M. Jaeger; installed PFS:Professional Write word processing software onto IBM computer at Vertebrate Pest Lab, Joydebpur; loaded and modified questionnaire on computer
6 December	Met with Mr. M. Huq, Director, Plant Protection Wing, Dept. of Agricultural Extension, Dhaka; began field testing of revised questionnaire at study site near Manikganj with S. Sarker
7 December	Continued field testing of questionnaire at Manikganj
8 December	Weekend
9 December	Continued field testing of questionnaire at Manikganj; participated in discussion of rodent control project and work plans with Dr. Bruce Currey, Human Resources Development Specialist, Winrock International; M. Jaeger, S. Sarker, P. Sultana, project consultants for Economics and Social Anthropology, as well as other project personnel
10 December	Revised questionnaire on computer at BARI, Joydebpur; discussed vertebrate control research needs and rat project in particular with Dr. M. A. Karim, head of Division of Entomology and Vertebrate Section, BARI; began work on Trip Report and continued summarization of farmers survey data
11 December	Further revised questionnaire utilizing comments of B. Currey, on computer at Vertebrate Pest Lab, Joydebpur; continued work on Trip Report
12 December	Compiled and reviewed questionnaire data; discussed potential questionnaire changed with M. Jaeger and S. Sarker
13 December	Exit interview with W. Phil Warren, USAID; met with M. Jaeger and S. Sarker regarding further questionnaire modifications, data analysis, and interpretation
14 December	Met with M. Huq, M. Jaeger, S. Sarker, and other Dept. of Agricultural Extension personnel regarding concerns about pesticide safety and use by farmers, and need for additional rodenticide availability
14-15 December	Travel from Dhaka, Bangladesh to Bangkok / San Francisco / Hopland, CA

RODENT CONTROL QUESTIONNAIRE DRAFT 13 DEC '89

Interview Number:_____
Date:_____

Preselected Location Coordinates:_____
Name of Nearest Village:_____
Name of Farmer:_____

Give the farmer the following information:

"We are studying damage caused by rats throughout Bangladesh. Because you, as a farmer, are most likely to have good information about damage caused by rats, we would like to ask you some questions about your experience. Please answer the questions as truthfully as you can. In that way, we will have the best possible information about rats and rat damage. This will help us to plan the most effective controls for farmers such as yourself to use in future years."

1. What crops do you grow at this location during the year?
   ___ T. Aman ___ wheat ___ sugar cane ___ onion
   ___ B. Aman ___ potato ___ jute
   ___ aus ___ pulses ___ vegetables
   ___ boro(IRRI) ___ mustard ___ other:_____

2. What is your <u>most</u> important pest problem, insects, rodents, or plant diseases?
   ___ insects ___ rodents ___ plant diseases

3. What is your second most important pest problem?
   ___ insects ___ rodents ___ plant diseases

4. Do you have rodents (rats) in your fields? ___yes ___no

5. Do you have rats in and around your house? ___yes ___no

6. When are the rats most numerous in the house?
   ___ after harvest of aus ___ during the rainy season
   ___ after harvest of boro ___ during winter
   ___ after harvest of Aman

7. Do you have house shrews in your house? ___yes ___no

8. Do the house shrews cause damage?
   ___ yes
   ___ no (Skip to Question # 10)

9. What kind of damage do they cause?
   ___ eat or damage foods in house/kitchen
   ___ kill young chickens
   ___ damage eggs
   ___ contaminate foods, etc. with droppings
   ___ Other:_____

10. What types of rats do you have in and near the house?
    ___ large rats
      ___ living in burrows
      ___ living in the ceiling
      ___ living in trees
      ___ living in storage areas
    ___ small rats
      ___ living in burrows
      ___ living in the ceiling
      ___ living in trees
      ___ living in storage areas

11. In your house(s), what types of things do the rats damage?

___ rice ___ boxes ___ Other:_____
___ pulses ___ cloth/clothing
___ wheat ___ books
___ cloth ___ structure of house

12. In your house(s), how much damage from rats occurs in a year?
food grains _____ mds clothes Tk_____ Other:_____

13. What types of rats do you have in the fields?

___ large rats
___ living in burrows
___ not living in burrows

___ small rats
___ living in burrows
___ not living in burrows

14. What crops are most heavily damaged by rodents? (Give 1st & 2nd)

___ T. Aman ___ wheat ___ sugar cane ___ onion
___ B. Aman ___ potato ___ jute
___ aus ___ pulses ___ vegetables
___ boro(IRRI) ___ mustard ___ other:_____

15. What is your usual yield of your most important crops?

T. Aman	_____ mds/ac	wheat	_____ mds/ac
B. Aman	_____ mds/ac	sugar cane	_____ mds/ac
aus	_____ mds/ac	pulses	_____ mds/ac
boro(IRRI)	_____ mds/ac	mustard	_____ mds/ac
	Other:_____		_____ mds/ac

16. When do you believe the greatest amount of rat damage occurs? (indicate 1st and 2nd)

Rice & Wheat Field
___ pre-ripening
___ ripening
___ harvesting

House: all crops
___ inside house
___ outside house
___ trees & vines

17. How much of your crop is lost annually, because of rats?

T. Aman	_____ mds/ac	wheat	_____ mds/ac
B. Aman	_____ mds/ac	sugar cane	_____ mds/ac
aus	_____ mds/ac	pulses	_____ mds/ac
boro(IRRI)	_____ mds/ac	mustard	_____ mds/ac
	Other:_____		_____ mds/ac

18. When do you first see rats in the field?

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T. Aman	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
B. Aman	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
aus	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
boro	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
wheat	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
mustard	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
pulses	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
_____	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )

19. In the last year, when did you control rats in the house?

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

20. What types of control did you use in the house?

Poison	Traps	Flooding Burrows	Digging Burrows	Electric Devices	Burrow Fumigation	Other: _____
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

21. Have you done any rat control in the last year in the field?
___ yes ___ no

If yes, when and where?

	Poison	Traps	Flooding Burrows	Digging Burrows	Electric Devices	Burrow Fumigation	Other: _____
Canals, dikes*	[]	[]	[]	[]	[]	[]	[]
T. Aman	[]	[]	[]	[]	[]	[]	[]
B. Aman	[]	[]	[]	[]	[]	[]	[]
aus	[]	[]	[]	[]	[]	[]	[]
boro	[]	[]	[]	[]	[]	[]	[]
wheat	[]	[]	[]	[]	[]	[]	[]
potato	[]	[]	[]	[]	[]	[]	[]
pulses	[]	[]	[]	[]	[]	[]	[]
mustard	[]	[]	[]	[]	[]	[]	[]
sugar cane	[]	[]	[]	[]	[]	[]	[]
jute	[]	[]	[]	[]	[]	[]	[]
veget.	[]	[]	[]	[]	[]	[]	[]
Other:_____	[]	[]	[]	[]	[]	[]	[]

*includes areas outside crop fields

22. Estimate the number bait placements, trap-nights, burrows treated, etc. as appropriate within the last year.

	Placements of Poison	Trap-Nights	Burrow Systems Flooded	Burrow Systems Dug Up	# Burrows # Electric Devices	Burrows Fumigated	Other: _____
In & near house	___	___	___	___	___	___	___
Canals, dikes*	___	___	___	___	___	___	___
T. Aman	___	___	___	___	___	___	___
B. Aman	___	___	___	___	___	___	___
aus	___	___	___	___	___	___	___
boro	___	___	___	___	___	___	___
wheat	___	___	___	___	___	___	___
potato	___	___	___	___	___	___	___
pulses	___	___	___	___	___	___	___
mustard	___	___	___	___	___	___	___
sugar cane	___	___	___	___	___	___	___
jute	___	___	___	___	___	___	___
veget.	___	___	___	___	___	___	___
Other:_____	___	___	___	___	___	___	___

*includes areas outside crop fields

23. If you have not controlled rats in canals, dikes, etc., why not?
___ rats are not numerous enough to justify control
___ do not have time available
___ do not know techniques for controlling rats in field
___ Other:_____

24. How much money do you spend each year controlling insect or rodent pests?

crop:	T. Aman	B. Aman	aus	boro (IRRI)	wheat	veget.	in house	_____
insects	Tk_____	_____	_____	_____	_____	_____	_____	_____
rodents	Tk_____	_____	_____	_____	_____	_____	_____	_____

25. If poison bait has been used, what kind?
kind: ___ powder ___ unformulated cake
___ cake, formulated (ready-to-use)
brand name, if known:_____

26. If traps have been used, what kind?
kind: ___ snap trap ( ) number
___ bamboo trap ( )
___ wooden trap ( )
___ Other trap:_____( )

27. Do you use traps in the field?
___ yes ___ no

28. If electric devices have been used, what kind?
___ electric fence ___ in burrows
___ Other:_____

29. If fumigants have been used in burrows, what kind?
___ aluminum phosphide
___ Other:_____

30. Which method do you think works best in the fields?
___ poison bait
___ traps
___ digging burrows
___ flooding burrows
___ electric devices
Why? _____

31. When do you begin to control rodents in your crops?
___ when the rats are first seen
___ when damage begins
___ when serious damage has occurred

32. When do you begin control in your house?
___ when the rats are first seen
___ when damage begins
___ when serious damage has occurred

33. When do you begin control in rice?
___ at tillering
___ at booting
___ at ripening
___ do not control in rice

in wheat?
___ at tillering
___ at booting
___ at ripening
___ do not control in wheat

___ other:_____

34. Who does the rat control in the crop fields?
___ yourself ___ daughter ___ father or mother
___ wife ___ son ___ Other:_____
___ hired labor ___ brother

35. Who does the rat control in the house?
___ yourself ___ daughter ___ father or mother
___ wife ___ son ___ Other:_____
___ hired labor ___ brother

--- If no poisons have been used, skip to question # 51 ---

36. How often is rat poison available to you?
___ always available
___ sometimes available
___ seldom available
___ not available

37. Are there instructions on the poison package for its use?
___ yes
___ no (Skip to Question # 39)

38. Did you read the written instructions on the package?
___ yes
___ no

39. What are your other sources of information of how to use the poisons?
___ insecticide dealer
___ canvasser/poison seller or promoter
___ UPK office
___ block supervisor
___ other farmers
___ Other:_____

40. Which instructions did you follow, if any?
___ written instructions on package
___ instructions given by canvasser or seller
___ Other: _____

41. Are the instructions...
___ very useful
___ partially useful
___ not useful

42. Do the instructions suggest types of food materials to use in making bait?
___ yes
___ no

43. Do the instructions give the <u>quantity</u> of foods to be used when making poison bait?
___ yes
___ no

44. Did you mix the poison with food to make bait?
___ yes
___ no

If yes, describe how you mixed it (i.e. ground together, not ground together into paste):

45. <u>What</u> kinds, and <u>how much</u> food do you mix with the poison?

		<u>amount</u>
___	rice	_____
___	wheat flour	_____
___	fried rice	_____
___	dried fish	_____
___	biscuit	_____
___	Other: _____	_____

46. Do you place the poison bait...
___ inside the rat burrows
___ immediately outside the rat burrows
___ in the rat trails or runways
___ other locations:_____

47. In general, do you believe the poison works effectively?
___ yes, it always works effectively
___ it works well if the rats eat the bait
___ it sometimes works well
___ it does not usually work well

48. Do the rats eat the poison bait?
___ always eaten
___ sometimes eaten
___ not eaten

49. Have you found rats that have been killed by the poison?
___ yes
___ no

50. Have you ever found other animals that have been killed by the poison baits?
___ yes
___ no
If yes, what kinds of animals and how many?
___ chickens (____)
___ dogs (____)
___ cats (____)
___ Other: _____ (____)

51. In the house, do you have cats?
___ yes How many? (____)
___ no (Skip to Question # 54)

52. Do cats kill...
___ small rats
___ large rats
___ house shrews
___ none of the above

53. Do you think the cats are effective in reducing the damage caused by rats?
___ yes, very effective
___ partially effective
___ not effective

54. Have you seen any of the following animals in this area?

	Are they numerous?		
___ jackals	___ many	___ some	___ few
___ mongoose	___ many	___ some	___ few
___ jungle cat	___ many	___ some	___ few
___ snakes	___ many	___ some	___ few
___ birds of prey ------	___ many	___ some	___ few
___ dog	___ many	___ some	___ few
___ civet cat	___ many	___ some	___ few

55. Do you believe any of these animals kill rats?

___ jackals	___ seen	___ not seen
___ mongoose	___ seen	___ not seen
___ jungle cat	___ seen	___ not seen
___ snakes	___ seen	___ not seen
___ birds of prey ----------	___ seen	___ not seen
___ dog	___ seen	___ not seen
___ civet cat	___ seen	___ not seen

56. What do you believe these animals generally eat?
jackals:_____
mongoose:_____
jungle cat:_____
snakes:_____
birds of prey ( ):_____
dog:_____
civet cat:_____

57. Where do you get information about rat control?
___ radio
___ television
___ newspaper
___ Krishi Khata
___ meetings: society and other
___ campaign posters & leaflets
___ block supervisor
___ UPK Office
___ insecticide dealers
___ canvassers
___ Other:_____

58. Which of these sources do you want?
___ radio
___ television
___ newspaper
___ Krishi Khata
___ meetings: society and other
___ campaign posters & leaflets
___ block supervisor
___ UPK Office
___ insecticide dealers
___ canvassers
___ Other:_____

59. Have you ever heard about the national rat control campaigns?
___ yes
___ no (Skip to Question # 62)

60. If yes, from what source?
___ radio
___ television
___ newspaper
___ Krishi Khata
___ meetings: society and other
___ campaign posters & leaflets
___ block supervisor
___ UPK Office

61. What did you do after you heard about the rat control campaign?
___ checked fields for rats
___ poisoned rats
___ trapped rats
___ took other control measures:_____
___ went to talk with block supervisor
___ did nothing different
___ Other:_____

62. Did you receive any training in rat control?
___ yes
___ no (Skip to Question # 64)

63. Received training from...
___ block supervisor
___ UPK officer
___ Society meeting
___ Other:_____

64. Would you like to have more training in rat control?
___ yes
___ no

65. Who do you believe is responsible for rat control?
___ the government
___ the farmer
___ both the government and the farmer

66. In your opinion, which is the most needed for effective rat control?
___ a program that gives prizes for the most rat tails collected
___ effective rat poisons available in the market
___ a program that pays money for rat tails collected

67. If you could buy in the market a very effective rat poison, how much would you pay for a package that would kill ten rats?
___ Tk 1
___ Tk 5
___ Tk 10
___ Tk 20
___ more than Tk 20

68. Do you think rats move from one field to another? ___ yes ___ no
Do you think rats move from house to field? ___ yes ___ no
Do you think rats move from field to house? ___ yes ___ no
Do you think rats move from roads to fields? ___ yes ___ no

69. Do you control rats by yourself, or do you control cooperatively with other farmers who have fields near you, at the same time?
___ cooperatively
___ individually

70. Do you think rat control is more effective when done by all farmers in an area, or when done by each farmer individually?
___ cooperatively, by all farmers
___ individually

71. What are the problems that prevent you from working cooperatively with other farmers?

72. How many members are there in your family?
(____) total (____)adult male (____)adult female (____)children

How many family members work in your fields?
(____) total (____)adult male (____)adult female (____)children

Do you have any permanent hired laborers?
___ yes If yes, number: (____)
___ no

73. How many acres do your farm?
(____) total acres farmed
(____) acres owned
(____) acres taken in (leased or rented from others)
(____) acres given out (leased or rented to others)

74. Do you have any religious bindings that prohibit killing rats?
___ yes
___ no

75. What languages can you read?

___ Bengali
___ English
___ Other: _____
___ none

76. What is your level of education?

___ none
___ Primary
___ Secondary
___ Higher Secondary
___ University

77. What is your occupation?

___ completely service
___ partially farming
___ service and farming
___ farming only
___ Other:_____

78. What is your age: _____

"Thank you for taking time to answer these questions. The information you have given will be important in developing better ways to help farmers like you control rats successfully."

14 December 1989

Dr. M. M. Rahman, Executive Vice President
Bangladesh Agricultural Research Council
Dhaka, Bangladesh

Dear Dr. Rahman:

I regret that my schedule in Bangladesh did not permit me to meet with you personally prior to my return to the United States. By means of this letter, I want to inform you in brief concerning some of my findings from my consultancy here during the past three weeks.

It is clear that vertebrate pest problems and their ultimate solution are of importance to Bangladesh and its people. I am pleased to see the results of ongoing efforts to build a research capability at BARI in this area, and you can be justifiably proud of some of the fine work coming from this unit. I hope that in the future scientists such as Dr. Parvin Sultana and her colleagues will continue close cooperation and linkage with the Denver Wildlife Research Center and other agencies in the U.S. and elsewhere that and involved in solving similar vertebrate problems. The level of present cooperation is excellent, and I believe all persons involved are hopeful it will continue after permanently-assigned American scientists are no longer present in the unit.

Current survey studies of farmers are bringing to light problems with availability of good-quality rodenticides in a ready-to-use form. Many farmers now report they are purchasing and using zinc phosphide concentrates, which are difficult for them to mix and use effectively. Such products also are creating potential and real hazards to non-target animals and presumably to children. I am concerned that this problem needs immediate attention.

It is clear that problems regarding rat damage to crops in Bangladesh are, like many other vertebrate pest problems, complex in nature. These situations do not lend themselves to easy and quick solutions, but involve years of dedicated research on notonly the biology of the pest species, but also on the best way to implement solutions. For this reason, I find the current efforts to determine farmers' attitudes toward rats, rat damage, and rat control to be most useful. These findings should provide a strong basis on which to expand the current extension efforts in rodent control. It appears that the country's extension staff is available and willing to be of continuing assistance in helping farmers and others solve the rat damage problem. While other avenues of implementing developing technologies may also be found, I believe the extension personnel should be utilized as fully as possible in future rodent control efforts. With continuing training of block supervisors and others, extension will be able to help farmers make significant improvements in control effectiveness.

I will be preparing a final report on my trip, to be submitted shortly to USAID. I have asked Dr. Michael Jaeger to see that a copy of this report is made available to you. In the meantime, should you wish to discuss any of these issues at more depth, please feel free to contact Dr. Jaeger.

Sincerely,

Robert M. Timm

Robert M. Timm, Ph.D.
Consultant to USAID/Rodent Control

TRIP REPORT*

CHAD, ROME, and MOROCCO

November 20-December 8, 1989

Richard L. Bruggers
Chief, International Programs Research Section

Denver Wildlife Research Center
Science and Technology
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
P.O. Box 25266
Denver, CO 80225-0266 USA

Unpublished Report

January 10, 1990

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* This work was conducted with funds contributed to the Animal and Plant Health Inspection Service/Science and Technology/Denver Wildlife Research Center by the U.S. Agency for International Development under the Project "Vertebrate Pest Management Systems R&D," PASA DAN-4173-X-AG-6001.

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ITINERARY

Date	Location	Activity
November 20-23	Denver, Colorado, to Chad, Africa	Travel
November 23-28	N'Djamena, Chad	Discuss implementation activities and budget considerations for the rodent research project PASA with AID/N'Djamena.
November 29	Chad to Rome, Italy	Travel
November 30-December 1	Rome	Discuss DWRC cooperation in FAO vertebrate pest activities and specifically Uruguay and Argentina bird pest projects.
December 2	Rome to Casablanca, Morocco	Travel
December 3-7	Casablanca, Agadir, Guilemine, Rabat	Discuss implementation and budget considerations for the environmental monitoring PASA with AID/Rabat. Visit possible field study sites.
December 8	Casablanca to Denver, Colorado	Travel

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OBJECTIVES AND ABSTRACT

This TDY had the following objectives: (1) in Chad, to meet U.S. Agency for International Development (AID) and Ministry of Agriculture (MOA)/ Crop Protection Service (CPS) officials with whom the Denver Wildlife Research Center (DWRC) will be working to implement the Rodent Control Research Project and sort out Project-related budget concerns; (2) in Rome, to discuss with Food and Agriculture Organization (FAO) officials DWRC's possible involvement in a 1-year Technical Cooperative Program (TCP) project during 1990 in Uruguay and Argentina aimed at designing a longer-term subregional bird pest research and management project; and (3) in Morocco, to discuss with USAID and MOA/Plant Protection Service officials DWRC's implementation during 1990 of a 2-year Participating Agency Service Agreement (PASA) for research and training of Moroccan scientists on evaluating the impact on the environment and nontarget wildlife of locust control sprays. All objectives were met.

ACTIVITIES

Chad

Background

In 1986, several Sahelian nations declared national disasters due to massive rodent outbreaks. Effective assistance was hampered due to a lack of ecological and management knowledge of the species concerned and effective control measures. The U.S. Department of Agriculture (USDA)/ Animal and Plant Health Inspection Service (APHIS)/DWRC provided several man-months of technical assistance consultancies between May and November 1986 to five of these Sahelian counties. These consultancies primarily identified species, assessed damage, and provided training in rodenticide use. As a result of this outbreak and the general inability of USAID and other donor organizations to respond in a coordinated, unified, effective manner, and because chronic rodent damage occurs and large-scale irruptions will continue periodically, AID/Washington, AID/N'Djamena, the Chad MOA/CPS and DWRC/International Programs Research Section (IPRS) have worked to implement a rodent research project in the Sahel. This project will be based in Chad, initially at least for 2 years, and will have the general objectives of (a) determining the life cycles of the major rodent pests, (b) evaluating the efficacy and appropriateness of various control methods, and (c) providing training in rodent research and management techniques to the CPS.

During the interim period between project design (1987), funding (1989), and actual project implementation with the arrival of the Project Leader

(expected to be about April 1990), DWRC has implemented several technical assistance and project organizational consultancies:

Mr. Keith LaVoie, Wildlife Biologist	Mar 27-Apr 28, 1988
Mr. Lynwood Fiedler, Wildlife Biologist	Apr 23-May 12, 1989
Mr. Keith LaVoie and Dr. John Wilson*	Oct 8-Nov 9, 1989
Dr. Richard Bruggers, Supervisory Wildlife Biologist and Chief, IPRS	Nov 20-29, 1989

These consultancies were intended to establish the basic research design as well as address the logistic concerns necessary to enable the new Project Leader to begin working effectively upon arrival. Trip reports summarizing the activities during these TDY's are on file at DWRC.

Current TDY

The great majority of time during this 1-week TDY was spent addressing budget concerns with Mr. Kurt Fuller, Project Agricultural Development Officer (ADO). A budget was developed that delineated funds in the PASA for use by the project in Chad. As currently written, all PASA funds were obligated to USDA/DWRC, with none available to AID/N'Djamena for such things as costs for housing, laboratory and office rehabilitation, and local project support. In addition, time was spent with the AID/N'Djamena Comptroller (Mr. Ernest Harding), the Executive Officer (Ms. Jeri Pennu), and the Development Management Systems (DMS) Chief of Party (Mr. Kevin Guild) to obtain realistic costs for housing, furniture, vehicles, and appliances. The budget items were revised accordingly. AID/N'Djamena will now request AID/AFTR (Mr. J. Gaudet) to revise the funding arrangement, extend the PASA beyond December 1990, and provide a funding cite provided to AID/N'Djamena so that additional research and logistic preparatory activities can get underway.

Miscellaneous Notes:

(1) IBM or IBM-compatible computers apparently can be purchased (instead of the WANG system that everyone in AID/N'Djamena uses). To expedite the purchase process, DWRC will provide computer specifications and justification to AID/N'Djamena.

(2) The next DWRC TDY should be in April 1990 and, if possible, coincide with the arrival of the Project Leader to help get him installed, visit study sites, and explain research activities.

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* Research Director, Centre for Biological Population Management, Queensland University of Technology, Brisbane, Australia.

(3) When AID/N'Djamena is given a funding cite, the following will occur in order to facilitate an effective installation by the Project Leader:

(a) Office space at CPS will be rehabilitated and furnished.

(b) All furniture, household appliances, and a computer will be ordered. Arrival time at the post can vary considerably, but items should be delivered in N'Djamena between 4-9 months after ordered.

(4) An apartment in the AID/N'Djamena compound will be available (if necessary) for the Project Leader's use for 1-2 months until he chooses his house and it is furnished.

(5) CARE projects in the area of N'Gouri (Cheddra, northeast of N'Gouri, and Nokon, northwest) have rodent problems in vegetables grown in quadis. These areas could be available for small-scale rodenticide evaluation trials. CARE also is interested in advice on bird damage to rice in Bongor and frog damage in nursery tree seedling plantations. These problems need to be better defined.

(6) Peugeot and Toyota vehicles for personal use can be bought new locally (and be available within 2 weeks) and easily resold at end of the duty tour. April/May is also the normal personnel turnover period, so the Project Leader should be able to find a used vehicle at a reasonable price if he chooses.

Food and Agriculture Organization, Rome

En route from Chad to Morocco, I spent 3 days at FAO Headquarters. The main purpose of this visit was to clarify DWRC's potential role in helping FAO implement a TCP project on bird pest management in Argentina or Uruguay. FAO already has funded this project, which is seen as a preliminary activity to better understand the bird pest situation in these countries and develop recommendations as to future work needs and directions. As things now stand, DWRC may conduct a 4-week consultancy in January-February 1990 to these countries to work with appropriate government counterpart individuals of both countries to: (1) clarify TCP project objectives, (2) confirm and/or identify followup consultancies, (3) develop terms of references, dates, and names of appropriate individuals for them, and (4) generally develop a specific plan of action for the duration of the project.

DWRC is very pleased that this project has been funded and that DWRC may be asked to provide some technical expertise. DWRC worked on bird pest problems in these countries in the early 1970's, had a field station in Colombia between 1970 and 1975, consulted again to Uruguay in March 1985, and most recently has served on the graduate programs at Colorado State University, Fort Collins, of scientists from both countries.

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Morocco

In Morocco, I met up with Dr. James Keith, Project Leader for DWRC's environmental monitoring research and training activity. This project will provide both training and research opportunities to Moroccan scientists in monitoring the impact on the environment and nontarget wildlife of locust control pesticides. The project will be conducted on a TDY basis over an approximate 1-year period beginning about March 1990 and using a number of short-term consultants (primarily from DWRC) with expertise in analytical residue chemistry, cholinesterase analysis, radiotelemetry, and capture techniques and population assessment of birds, small mammals, and insects (project description on file at DWRC). Dr. Keith was in Morocco for a 3-week period to begin making arrangements for implementing the project activities.

During my stay, Dr. Keith, Mr. Joe Kitts (AID/Rabat Locust Coordinator), and I (a) looked at potential study sites between Agadir and Guilemine, (b) revised the PASA budget, (c) worked out some preliminary implementation logistics, (d) checked some previously purchased equipment, (e) met some of the Moroccan and USAID personnel that will be involved in this activity, and (f) visited the MOA chemistry and residue laboratory (where study samples will be analyzed) in Casablanca. The logistical concerns to conducting this project are truly formidable, and the successful accomplishment of this project will require the cooperation and patience of all involved. Nonetheless, it should be an interesting and valuable training and research activity.

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PRINCIPAL CONTACTS AND ACKNOWLEDGMENTS

CHAD

AID/N'Djamena

Dr. Bernie Wilder, USAID Representative
Mr. Kurt Fuller, Agricultural Development Officer
Mr. Ernest Harding, Comptroller
Mr. Jean-Patrick René, Automated Data Processing Specialist
Ms. Jeri Pennu, Executive Officer
Mr. Abdelwahib Yacoub, Administrative Assistant and Rodent Research Assistant

U.S. Department of State

Ms. Pauline Martin, Registered Nurse

Development Management Systems (DMS)

Mr. Kevin Guild, Chief of Party

CARE International

Mr. Guy Stallworthy, Coordinator

Ministry of Agriculture, Crop Protection Service

Mr. Djimtoide Baoral, Plant Protection Officer
Mr. Maila Dourbaga, Plant Protection Officer

Agricultural Cooperative Development International (ACDI)

Ms. Ann Whitlock, Project Assistant/Africa--Fruit and Vegetable Marketing

MOROCCO

Ministry of Agriculture, Plant Protection Department

Mr. Hassan Moumadi, Director, Department of Protection of Agriculture
Mr. Ben Helima, Program Leader, Locusts (Agadir)
Mr. Ahmed Monhim, Entomologist

Rabat

Ms. Malika Bounfour, Entomologist

Casablanca Residue Laboratory

Mr. El-Maati Ben Azzouz, Chemist
Mr. Mostafa Tarhy, Chemist

AID/Rabat

Mr. Ron Stryker, Agricultural Development Officer
Mr. Joe Kitts, Locust Coordinator
Ms. Christine Faschini, Regional Contracts Office

FAO, ROME

AGP, Plant Production Division

Mr. Vandergraf, Chief, Plant Protection Bulletin
Mr. Hafaroui, Rodent Coordinator
Mr. Delas Casas, Rodent Coordinator
Dr. Laurie McCullock, Locust Project Coordinator

Ms. Ilona deBorghei, Editor, Plant Protection

AGO, County Project Officers

Mr. Bensousan, Uruguay
Mr. Trabulsi, Sierra Leonne
Ms. Vallet, Uganda
Dr. Elliott, Zambia, Zimbabwe
Dr. Hughes, Bhutan

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TRIP REPORT*

MOROCCO

November 27-December 16, 1989

James O. Keith
Wildlife Research Biologist

International Programs Research Section
Denver Wildlife Research Center
Science and Technology
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
P.O. Box 25266
Denver, CO 80225-0266 USA

Unpublished Report

January 24, 1990

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ITINERARY

Date	Location
November 27-28	Travel from Denver, Colorado, to Rabat, Morocco
November 29-December 1	In Rabat
December 2-5	Travel from Rabat to Agadir, Guelmim, and return
December 6-15	In Rabat
December 16	Travel from Rabat to Denver, Colorado

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ACCOMPLISHMENTS

In Rabat between November 29 and December 1, 1989, I reviewed all project documents and with Joe Kitts, U.S. Agency for International Development (USAID)/Agricultural Development Officer (ADO), revised and resolved details concerned with scope of work, budget, procurement of supplies and equipment, relations with the Government of Morocco, and plans to hire a resident coordinator in Morocco for the project.

Between December 2 and 5, Richard Bruggers, Joe Kitts and I, traveled to Aït Melloul to meet staff at the Ministry of Agriculture's Desert Locust Control Center where our project will be centered. We scouted the area between Agadir and Guelmim for a study site and concluded the search should begin with an aerial reconnaissance as it would be much more time and cost efficient. This activity will be planned early in 1990.

On December 6 and 7, I worked with Richard Bruggers and Joe Kitts to prepare final versions of the PIO/T, PIO/C, and PASA.

On December 8, Mrs. Malika Bounfour, Joe Kitts, Richard Bruggers, and I drove to Casablanca to visit with staff at the Ministry of Agriculture's Pesticide Residue Laboratory. As our first training session will be at the laboratory, we wanted to ensure that all necessary equipment and supplies were available or had been ordered.

During the last week in Rabat, I met with Ministry of Agriculture biologists to review plans for training sessions and research. We resolved possible conflicts between holidays, vacations, work schedules, and proposed project activities. The content of training sessions was discussed to ensure that needs of biologists were met. Consideration was given to the location of possible study areas. Biologists agreed that training sessions should be scheduled in 1990, but strongly recommended that experimental studies be delayed until 1991 during February and March, which is the rainy season in southern Morocco. They suggested that habitats would be more productive at that time, which would allow a better evaluation of pesticide effects on the environment. Biologists stated that some classes in English would help them attain greater benefits from training sessions and asked if support for English classes could be obtained.

Later, Joe Kitts and I met with Abdelaziz Arifi, Director, Plant Protection Department; Rachid Lahtar, Deputy Director; Moha Layid, Commandant and Deputy Director of Locust Control in Morocco; and the Moroccan biologists. I briefly described our studies in Senegal during 1989 in which the environmental effects of fenitrothion and chlorpyrifos were evaluated. We reviewed results of the meeting held by the biologists, including our conclusions and recommendations. The administrators asked a few questions, made some recommendations, and urged us to continue with plans to begin the project in 1990.

Outlines for each of the five training sessions were completed after obtaining input from Moroccan biologists and administrators. These brief plans will be used by DWRC personnel prepare their detailed presentations

for each session. Attachment 1 contains the outlines for training sessions. A schedule of activities during a typical training session is shown in Attachment 2.

FUTURE ACTIVITIES

Equipment and supplies needed for training courses had not been ordered by mid-December. Procurement will involve bid solicitation and will require several months. For this reason, it was decided to delay training sessions until May 1990 to ensure all necessary materials are in Morocco before the project is initiated. This delay also will result in changing the season during which experimental studies are conducted. Research on study plots now will be scheduled during the rainy season in February and March 1991. A revised schedule for project activities is given in Attachment 3.

A study area should be selected before training sessions begin in May. All sessions except chemistry will be conducted from a camp on the study area. Thereby, all information gathered during training will contribute to our ecological knowledge of the study sites. Arrangements will be made to have James Keith, Ahmed Boughdad and Abderrahim El Hani travel to Aït Melloul in early April to select a study area. If possible, an initial survey will be made by helicopter, as aerial reconnaissance would make this task much less time-consuming.

Planning for the experimental treatment of study plots with malathion and dichlorvos will continue, but final design of the experiment must await selection of a study area. For instance, bird counts on transects will be used to monitor bird numbers before and after treatment. The length of transects will be determined by how many birds are seen on transects. Transects will be shorter or longer depending on bird densities. If long transects are necessary, larger plots will be required. If counts vary considerably between transects, greater numbers of transects will be needed. These features of experimental design can not be determined until the study area is selected and preliminary bird count data are obtained. The required plot size will influence the number of treatments and replications that can be used.

CONTACTS AND ACKNOWLEDGEMENTS

AID/Rabat

Mr. Ron Stryker, Agricultural Development Officer
Mr. Joe Kitts, Locust Coordinator
Ms. Christine Faschini, Regional Contract Officer

Government of Morocco

Moha Layid	Commandant, Deputy Director of Locust Control
Abdelaziz Arifi	Director, Crop Protection Department
Rachid Lahtar	Deputy Director
Ahmed Elharmouchi	Head, Pesticide Registration (Phytopharmacien)
Ahmed Boughdad	Head, Coordination (Entomologist)
(Vacant)	Head, Pest Surveys and Control Methods
Mohamed Akchati	Phytopharmacien
Ahmed Baou	Entomologist
Malika Bounfour	Entomologist--Acarologist
(Vacant)	Head, Control of Major Pests
El Hassan Arroub	Mammalogist
Abderrahim El Hani	Ornithologist
Mohamed Daia	Chemist
El Maâte Benazzouz	Director, Casablanca Residue Laboratory
Mostafa Tarhy	Chemist
Thymi Ben Halima	Director, Locust Control Center, Aït Melloul
Mohamed Mohim	Entomologist
Abdelghani Bovaichi	Entomologist
Hassan Moumadi	Director, DPA, Guelmim

Attachment 1

TRAINING SESSION 1

Subject: Collection of samples for determination of cholinesterase (ChE) and pesticide residues. Analysis of samples to determine ChE levels.

Instructor: James Keith

Dates: May 1990

Itinerary:

Days 1-3	Travel - Denver to Agadir.
Days 4-8	Preparation - Aït Melloul and camp.
Days 9-14	Collection of field samples.
Days 15-18	Analysis of cholinesterase samples in Aït Melloul.
Days 19-21	Travel - Agadir to Denver.

Attendees: To be determined.

Objective of Training: To teach Moroccan field scientists how to collect, record, package, and preserve samples for ChE and pesticide residue analyses, and how to analyze samples for ChE contents.

Outline of Session:

Guidelines for maintaining a journal of field activities.

Theory and concepts on the collection and use of ChE and residue data.

Trapping of small birds and mammals for tissue collection.

Use of catalog for recording the biological status of animals captured and samples obtained.

Blood sampling techniques.

Washing of birds to recover surface deposits of pesticides.

Necropsy of birds and mammals, and removal of samples from carcasses.

Preparation, packaging, labeling, and preservation of samples for ChE analysis.

Dosing birds to provide tissues with several levels of ChE inhibition.

Preservation and labeling of gastrointestinal contents for food habits analysis.

Techniques for collecting soil, vegetation, water, fishes, and invertebrates for residue analysis.

Technique for spiking samples with known amounts of pesticides.

Preparation, packaging, labeling, and preservation of samples for residue analysis.

Laboratory analysis of samples for ChE content.

References needed:

1. Selected papers on biochemistry of ChE.
2. Description of methodology for ChE analysis.
3. Examples of organophosphate (OP) effects on ChE levels and mortality.
4. Selected papers on deposits and persistence of OP residues.
5. Papers describing the toxicological activity of OP insecticides.

Equipment and Supplies:

1. Kimwipes, plastic bags, paper towels, paper bags, aluminum foil, filter papers, compass, tape rule.
2. Notebooks, pencils, pens, marking pens, flagging.
3. Glass tubes for filter papers, scissors for vegetation samples, dissection tools (mammal skulls), vials for crop contents, labels, extraction bottles.
4. Ice chest, mist nets and poles, mammal traps, field centrifuge, blood sampling equipment.
5. Liquid nitrogen (dewar flask), ethanol, spiking and dosing solutions (one insecticide).
6. Backpacks (day packs).
7. Spectrophotometer (Model used will determine size of cuvettes); 1 each.
8. Cuvettes to fit above; 2,000 each.
9. Potter-Elvehjem grinder with matching large and small grinding vessels and grinding stems (for tissues weighing about 1.0 g); 1 each.
10. Eppendorf micropipeters (automatic), 20 μl and 100 μl sizes; 1 each.
11. Eppendorf pipeter tips; 2000
12. Ceramic blood scoops; 4 each.
13. Vortex - Genie agitator, small size; 1 each.
14. Stop watches; 2 each.
15. Thermometer, air, in °C; 1 each.
16. Pipeters with auto-bulbs, 10 ml; 6 each.
17. Balance, 0.1 g; 1 each.
18. Balance, 0.0001 g; 1 each.
19. Bottles, plastic, squirt; 4 each.
20. Tooth picks; 2,000 each (for stirring).
21. Bottles, amber, 1 litre; 6 each (for storing solvents).
22. Kimwipes; 12 boxes.

23. Paper towels; 12 packages.
24. Weighing boats; 100 each.
25. Detergent; 1 bottle.
26. Dewar flask, wide mouth, 18-20 litre capacity; 1 each.
27. Vials, 20 ml, suitable for use in liquid nitrogen; 1,000 each.
28. Labels for vials, suitable for use in liquid nitrogen; 1,000 each.
29. Refrigerator; 1 each.
30. Freezer; 1 each.

Chemicals:

1. DTNB; 5,5′-Dithiobis-(2-nitrobenzoic acid); 2 g.

2. ACTHI; Acetyl thiocholine iodide; 20 g (keep refrigerated).

3. Trizma Base (mol. wt. - 121.1); 250 g.

4. Trizma HCl (mol. st. - 158); 100 g.

5. Twice distilled water or deionized water; 25 liters.

6. Liquid nitrogen will be needed. 15 liters to fill dewar flask, fill twice - 30 liters.

Items 1-4 available from:

Sigma Chemical Company
P.O. Box 14508
St. Louis, MO 63178

TRAINING SESSION 2

Subject: Chemical analyses for organophosphate insecticide residues.

Instructor: John Gillis

Dates: May 1990

Itinerary:

Days 1-3	Travel - Denver to Casablanca.
Days 4-11	Methods development and verification.
Days 12-14	Visit study area to pick up samples.
Days 15-18	Analysis of field samples.
Days 19-21	Travel - Casablanca to Denver.

Attendees: Mr. Mostafa Tarhy and technicians

Objective of Training: To ensure that equipment, supplies, methods and staff capabilities at the Casablanca Residue Laboratory are adequate to provide information on organophosphate residues in field samples needed to support ecotoxicological investigations.

Outline of Session:

Week 1:

Gas Chromatograph Operation
Preparation of Pesticide Standards
GC Analysis of Pesticide Standards
Optimize Chromatographic Conditions
Analysis of Formulations/Tank Mixes Used in Study
Sample Receipt and Storage
Sample Tracking

Week 2:

Method Development - Pesticide Residues in Vegetation
- Extraction of Representative Vegetation Samples
- Gas Chromatographic Analysis of Vegetation Samples
- Recovery of Pesticides from Vegetation Samples

Method Development - Pesticide Residues in Soils
- Extraction of Representative Soil Samples
- Gas Chromatographic Analysis of Soil Samples
- Recovery of Pesticides from Soil Samples

Limit of Detection for Vegetation and Soil Samples
Linear Range for Quantification of Pesticide Residues

Week 3:

Method Development - Pesticide Residues in Locusts
- Extraction of Representative Locust Samples
- Gas Chromatographic Analysis of Locust Samples
- Recovery of Pesticides from Locust Samples

Limit of Detection for Locust Samples

Extraction and Analysis of Bird/Mammal Samples
Analysis of Bird Crop Samples
Analysis of Bird Tissue Samples
Analysis of Mammal Tissue Samples
Limit of Detection for Bird/Mammal Samples

Equipment and Supplies:

1. Two Varian Model 3400 gas Chromatographs with ECD and FPD or NPD detectors.
2. Replacement parts for gas chromatographs -
   Septa, injection port inserts, injection port, detectors, columns and hardware used to connect columns.
3. Fume hood, steam bath, device for nitrogen - forced evaporation, tissue grinder, centrifuge, solvent distiller and lab vacuum system.
4. Distilled/deionized water, stock or availability of acetonitrile, acetone, sodium chloride and methanol.
5. Graduated test tubes (10-25 ml).
   Luer - lock syringes with 45 μm filters.
6. EPA Standards for fenitrothion and chlorpyrifos.
   Samples of spray formulations used in locust control.

TRAINING SESSION 3

Subject: The use of radiotelemetry in ecotoxicological studies.

Instructors: Lawrence Kolz and Robert Phillips

Dates: June 1990

Itinerary:

Days 1-3	Travel - Denver to Agadir.
Days 4-8	Preparation at camp.
Days 9-12	Electronics, equipment and maintenance.
Days 13-18	Capture of animals, attachment of radios and radio tracking.
Days 19-21	Travel - Agadir to Denver.

Attendees: To be determined.

Objective of Training: To train Moroccan scientists in methods of capturing birds and mammals, attaching radios to animals, and tracking animals to determine their response to treatments of their habitats with pesticides.

Outline of Session: In the mornings of Days 9-12, Lawrence Kolz will teach the principles of radiotelemetry theory and illustrate the operation, maintenance, and capabilities of equipment. Earlier in his visit, he will offer training in the installation and field use of radio beacons and later will train the Aït Melloul Locust Center electronic technicians in the maintenance and repair of general radio equipment. Robert Phillips will begin his trapping on Day 9 to obtain animals for monitoring by radiotelemetry. The class will assist with attaching radios on animals as he captures them. After Day 13, groups of workers will find and describe the location of certain animals each day and follow their activity. Maps of animal movements will be updated each day and at the end of the session, measurements will be made of the area used by animals during the study.

References Needed:

1. Training manuals for radiotelemetry.
2. Selected publications on the use of radiotelemetry on wild animals in scientific studies.
3. Technique papers on capturing larger mammals and birds.

Equipment and Supplies:

1. Radio transmitters for a variety of animals.
2. Radio receivers, batteries and/or chargers.
3. Hand-held and helicopter antennas.
4. Traps for mammals, mist nets and poles for capturing birds, trap bait, bands for marking birds and mammals.
5. Backpacks for carrying traps, day packs.
6. Anesthetics and equipment for handling animals.
7. Electronic equipment.

TRAINING SESSION 4

Subject: Population assessment of birds, mammals, and invertebrates.

Instructors:

1. Jon Heisterberg - bird studies
2. G. Keith LaVoie - mammals
3. - invertebrates

Dates: July 1990

Itinerary:

Days 1-3	Travel - Denver to Agadir.
Days 4-8	Preparation at Camp.
Days 9-18	Training in population assessment.
Days 19-21	Travel - Agadir to Denver.

Attendees: To be determined.

Objective of Training: To train Moroccan field scientists the methods used to assess the population biology of birds, mammals and invertebrates exposed to pesticides.

Outline of Session:

Concurrent training in birds, mammals and invertebrates will be conducted during this session.

Birds - Several days will be spent on bird identification by sight and calls. Theory and various methods for assessing numbers will be discussed. When birds are known, counts on transects in study plots will begin. Each morning, counts will be taken during 3 or 4 hours after sunrise. Later in the day, mist nets will be used to capture birds away from the study area to determine their foods. Gizzard counts will be analyzed with the assistance of entomologists. Students will be taught how to prepare museum specimens. Discussion and techniques will be used to describe how reproductive success of birds can be evaluated. Methods for quantitating feeding behavior and unique habits of some birds will be illustrated and discussed. The known effects of organophosphate insecticides on bird abundance, foods, reproductive behavior, care of young, and physiological functions will be described.

References Needed:

1. Handbooks of toxicity data.
2. Reviews of malathion and dichlorvos effects on birds.
3. Bird identification handbooks.
4. Selected papers on bird ecotoxicology.

Equipment and Supplies

1. Binoculars, day packs, spray paint, flagging, light rope, stakes.
2. Notebooks, pencils, pens, compilation paper.
3. Mist nets and poles, dissection kits, small vials, labels and ethanol for holding and preserving gizzard contents, sorting dishes for food identification.
4. Taxidermy supplies for museum skin preparations.

Mammals - Trap lines will be set for small and medium size mammals using both snap and live traps. At night, mist nets will be set to catch bats. Animals caught will be identified and data recorded on sex, age, and body and breeding condition. They will be marked with ear tags, bands, or by other methods and released. Off of study plots, animals will be caught for necropsy to obtain stomachs for food habits analyses and skins for preparing museum specimens. Food habit studies will concentrate on insectivores (shrews, hedgehogs, bats) and those that eat some insects in their diet (rodents). Feces will be collected and foods identified. Discussions will be held on the known effects on mammals from organophosphate insecticides, including direct acute toxicity, mortality, food restriction, and secondary toxicity.

References Needed:

1. Handbooks of toxicity data.
2. Review of malathion and dichlorvos effects on mammals.
3. Mammal identification guides.
4. Selected papers on mammal ecotoxicology.

Equipment and Supplies

1. Snap traps, live traps (rodents and larger mammals) leg hold traps, trap stakes, hammer, bait.
2. Backpacks for traps and daypacks.
3. Notebooks, pencils, pens, compilation paper.
4. Dissection kits, vials, labels, ethanol, taxidermy supplies, sorting dishes.
5. Mist nets, poles, light rope, stakes.

Invertebrates - Sampling of invertebrate populations will be done with a variety of traps (light traps, pit fall traps, sticky traps, and sweep nets to define the abundance and kinds of different insects, spiders, termites, etc. Traps will be placed at permanent locations so that information collected throughout the study will be comparable. Invertebrates caught will be identified, sorted, counted, and preserved. Entomologists will help in identifying the invertebrate foods of birds and mammals. Special attention will be given to sampling for food organisms so that reductions in foods can be quantitated if they occur after treatments. Likewise, invertebrates of importance in the biocontrol of locusts will receive special attention in

sampling. The concept of biocontrol and the role of parasites and predators (including vertebrates) will be discussed. The important of invertebrates in vertebrate food chains and the effects of insect control on the availability of energy to vertebrates will be examined. Special attention will be given to evaluating the effect of the experimental insecticides on honey bees. Farmers maintain hives throughout southwestern Morocco.

References Needed:

1. Invertebrate identification guides, handbooks of insect toxicity data.
2. Selected papers on biological control, bird foods and the benefits of birds in controlling pests.
3. Selected papers on ecological disruptions caused by insecticide use to control pests.
4. Papers on the benefits of pest control with insecticides.
5. Presentations of the IPM concept.

Equipment and Supplies:

1. Notebooks, pencils, pens, insect diversity forms, back packs
2. Sticky traps, pit fall traps, light traps, sweep nets etc., formaldehyde for traps.
3. Ethanol, vials in assorted sizes, labels, pins, insect collection boxes, sorting dishes and trays.

TRAINING SESSION 5

Subject: Experimental design, statistical analyses, and the use of the computer.

Instructor: Richard Engeman

Date: September 1990

Itinerary:

Days 1-3	Travel - Denver to Agadir.
Days 4-8	Preparation at Aït Melloul and camp.
Days 9-12	Experimental design and sampling (camp).
Days 13-18	Compilation and analysis of data (Aït Melloul).
Days 19-21	Travel - Agadir to Denver.

Attendees: To be determined.

Objective of Training: To provide Moroccan scientists with the concepts of experimental design and sampling used in research and to train them in the statistical analysis of data using computers.

Outline of Session: On the study area, count data for birds and plants will be obtained and used to show sampling variation. Based on this information, calculations will be made on a lap-top computer to determine numbers of counts needed to provide reliable results. Findings will be used to decide on the size of study plots and the number of treatment replications needed to sample changes caused by insecticide applications. At Aït Melloul, data obtained during environmental monitoring will be entered into a P.C. computer and analyzed using standard statistical methods. Moroccan participants will each be provided the opportunity to solve problems using both the lap-top and P.C. computers. Training should enhance their ability to conceptualize and plan investigations and to analyze findings.

References Needed:

1. Texts on experimental design and sampling.
2. Texts on statistical analysis.
3. Scientific papers illustrating the practical application of methods presented in the training session.

Equipment and Supplies:

1. Calculators for each trainee.
2. A lap-top computer.
3. A P.C. computer.
4. Statistical programs.
5. Extra discs.
6. Computer accessories.
7. Printer paper.

Attachment 2

General description of activities during a field training session.

Day	Day of week	Activities	
		U.S. trainers	GOM trainees
1	Monday	Travel	-
2	Tuesday	"	-
3	Wednesday	"	-
4	Thursday	Preparation	-
5	Friday	"	-
6	Saturday	"	-
7	Sunday	"	-
8	Monday	"	Travel
9	Tuesday	Training	Training
10	Wednesday	"	"
11	Thursday	"	"
12	Friday	"	"
13	Saturday	"	"
14	Sunday	"	"
15	Monday	"	"
16	Tuesday	"	"
17	Wednesday	"	"
18	Thursday	"	"
19	Friday	Travel	Travel
20	Saturday	"	-
21	Sunday	"	-

Attachment 3

Tentative Schedule

1990

April	Selection of study area
May	Training - ChE and Chemistry
June	Training - radiotelemetry
July	Training - population assessment
August	Skill development
September	Training - statistics and computers
October	Skill development

1991

February-March	Research - experimental application of insecticides to study plots

TRIP REPORT*

A Review of Predator Research in Bangladesh

January 15-February 17, 1990

Frederick F. Knowlton, Leader

Ecological and Behavioral Applications Project

Denver Wildlife Research Center

USDA/APHIS/S&T

Utah State University

Logan, Utah 84322-5295

U.S.A.

Unpublished Report

April 26, 1990

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Purpose

Objectives of this effort were to meet with Bangladesh Scientific Officers and the Denver Wildlife Research Center (DWRC) Project Leader, Dr. Michael Jaeger, in the Vertebrate Pest Section (VPS) of the Bangladesh Agricultural Research Institute (BARI) to (1) review the background and current research effort related to the effects golden jackals (*Canis aureus*) have upon Bangladesh agricultural production, (2) make recommendations regarding the jackal research program, and (3) instruct Bangladesh scientific officers with regard to some current predator research techniques and procedures.

Background

In 1978, USAID initiated a project with DWRC (then USDI Fish and Wildlife Service, but administratively transferred to USDA Animal and Plant Health inspection Service in 1985) to assist in developing a VPS within BARI. The major objectives of this project were to train Bangladesh scientific officers and initiate research programs related to (1) assessing the problems vertebrate wildlife caused to Bangladesh farmers and (2) developing products and techniques to mitigate those problems. Most of the effort has been directed toward reducing losses of grains caused by rodents, in both storage and field situations (Sultana and Jaeger 1989a).

In the mid-1980's, some attention was directed toward studying golden jackals (Brooks *et al.* 1985, Poché *et al.* 1987). Three documents are particularly relevant: (1) a survey of 1,110 Bangladesh farmers that suggests substantial losses caused by jackals, particularly to livestock, sugarcane, and some fruits (Haque *et al.* 1984); (2) a report indicating that jackals might be responsible for a 20-25% production loss of sugarcane (Haque *et al.* 1985); and (3) a report suggesting jackals might appreciably reduce rodent damage to maturing wheat by preying upon the rodents responsible for the damage (Sultana and Jaeger 1989b). The VPS is currently contemplating increased emphasis upon the role of jackals in Bangladesh agriculture and is seeking advice and suggestions related to the direction and nature of those efforts.

I visited Bangladesh briefly in 1980 and have some familiarity with the earlier work. During my recent visit, I worked closely with Mr. Rajat K. Pandit, who will be coordinating and conducting much of the Bangladesh jackal research effort.

Activities

Efforts during this consultancy were directed in the following five major areas:

1. Conducting extensive discussions with Mr. Pandit and Dr. Jaeger regarding current understandings of the interactions between jackals and agricultural production, jackal biology, and Bangladesh agricultural practices.

2. Analyzing existing data sets related to jackal research efforts.

3. Providing Mr. Pandit and Dr. P. Sultana an initial familiarization with the Project microcomputer and computer programs LOTUS 1-2-3 and WordPerfect.

4. Demonstrating several research procedures and techniques to Mr. Pandit, including trapping and handling jackals, radio-instrumenting jackals and jungle cats (*Felis chaus*) (two video tape recording sessions covering these aspects were completed and left for future reference), and using radiotelemetry equipment.

5. Working with Mr. Pandit on a draft outline for a scientific publication on the relative responsiveness of jackals to broadcast howls.

Comments

Despite a very high human density (1,500 people/mi^2), Bangladesh is primarily rural with small to medium-size carnivores surprisingly common. Civets (*Viverra zibetha* and *Viverricula indica*), jungle cats, and jackals are living in close proximity to people. Survival of these species apparently is contingent upon maintaining a nocturnal activity pattern to minimize contact with people and having adequate cover to avoid detection or evade capture during the day. The latter appears to be provided primarily by agricultural crops such as sugarcane, wheat, pineapple, jute, and perhaps rice. If verified through scientific scrutiny, this could become a very useful tool for manipulating jackal populations to reduce depredations.

Jackals are common throughout Bangladesh, with estimates of density as high as 4-6 per km^2 in some areas. Farmers kill some, but initial impressions suggest that, with the removal techniques currently available, they do not have a substantial impact on jackal numbers, unless jackals become especially vulnerable during certain seasons of the year (e.g., when cover becomes depleted at harvest times or during periods of flooding).

Previous reports concerning jackal depredations on agricultural crops (Haque *et al.* 1984, 1985) indicate depredations on poultry, goats, ducks, sugarcane, and melons are common. The methodology used in acquiring data for their extensive study, however, was less precise than might be desired for making sound management decisions. The reported damage of 20-25% of the sugarcane near Sripur by jackals (Haque *et al.* 1985) was estimated on the basis of a very small sample and seems unrealistic when the abundance of sugarcane, the density of canes, and the density of jackals are taken into account.

On the other hand, via a model of preharvest losses of wheat, Sultana and Jaeger (1989b) suggest that jackals may substantially reduce losses of wheat by preying upon the two species of bandicoot rats (*Bandicota bengalensis* and *Bandicota indica*) that cause much of the losses. Historically, many biologists have dismissed the role of predators in

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regulating populations of prey species, especially rodents. However, evidence is currently accumulating that suggests predators may substantially impact prey populations in some situations. Several instances (Knowlton 1976, Kie *et al.* 1979, Connolly 1978) coyote (*Canis latrans*) predation on young deer (*Odocoileus virginianus* and *Odocoileus hemionus*) and pronghorn (*Antilocapra americana*) apparently limited populations to lower densities than might be expected in their absence. Similarly, predation on young and adult hares (*Lepus californicus* and *Lepus americanus*) appears to be implicated as a causal agent in the cyclic abundance of those species. (Trostel *et al.* 1987; Stoddart and Knowlton, unpubl. data). Sultana and Jaeger (1989b) only discuss the situation of rodent populations in wheat, claiming the rats congregate in ripening wheat because it is the primary suitable forage for them during the spring and that the rats become especially vulnerable during their wheat-harvesting frenzies. They also claim that following the winter-spring harvest of sugarcane, there is relatively little alternate daytime escape cover for jackals except areas planted to wheat. As a result, jackals concentrate in the wheat at a time when the rats are concentrated in relatively small areas and are vulnerable because of their preoccupation with storing grain. The Sultana and Jaeger model will remain an hypothesis about grain-rodent-jackal interactions until scientific tests validate or refute it. It does, however, suggest one potential benefit of jackals to the farmers of Bangladesh. Clarification of the jackals' role with regard to regulating populations of rodents should precede any large-scale jackal control programs.

Recommendations

1. Jackals are the most common medium-size carnivore in Bangladesh. Their size, abundance, and place in the trophic system puts them in conflict with several aspects of agricultural production. On the other hand, they may help to mitigate some agricultural problems associated with rodents. Although problems caused by jackals are certainly secondary to those caused by rodents, their impacts may be substantial. It is important that the research program that has been initiated be strengthened to objectively assess the situation before demands for depredation relief compromise such analyses and safe and effective damage reduction strategies can be developed.

2. Jackal research efforts should be coordinated and directed toward identifying and resolving problems that jackals cause in relation to Bangladesh agricultural production. There are a multitude of questions of biological interest; but at this point, many do not have clear relevance toward clarifying the "net" economic impact of jackals on Bangladesh farmers, nor are there any indications they might help resolve some of the problems jackals are currently known to cause. A suggested research program is appended.

3. The first priority of the research program should be a better description of the types and temporal distribution of damage caused by jackals. Current efforts related to randomized, monthly interviews with farmers in the areas around Sripur seem particularly well

designed and should provide a detailed understanding of livestock losses over an annual period. On the basis of the data already collected, it appears that the intensity of sampling needs to be increased. Inclusion of questions related to animal husbandry practices in the interviews could provide important insights for developing depredation control practices (see Recommendation 8, below). Eventually additional studies of this type will be needed to provide agricultural damage assessments under circumstances existing in other parts of Bangladesh.

4. The assessment of damage to sugarcane warrants special attention. One means of improving the quality of data might be to enlist the assistance of cane farmers to "collect" all damaged stalks from selected fields at harvest time. In instances where farmers remove damaged stalks before harvest, the collection needs to encompass that period as well. The damaged stalks could then be inspected by research personnel, enumerated by cause (rat, jackal, trampling, etc.), and comparisons made with estimates of the number of stalks harvested from the same fields.

   Because the sugarcane harvest extends over a 3-month period and jackals appear to use sugarcane as "escape cover," jackals probably concentrate in the remaining cane as the harvest progresses. As a result, damage may increase in intensity as the amount of cane remaining diminishes. Thus it is important to distribute damage assessments throughout the sugarcane harvest season.

5. Additional efforts to develop jackal census procedures are not warranted at this time. Many of the immediate questions facing the jackal research program do not depend upon accurate estimates of jackal abundance and developing such capabilities would require an inordinate commitment of resources. Work on other canids, especially coyotes, suggests that <u>indices</u> of abundance are more practical than absolute estimates, but most of them require constraints in data collection to reduce variability in results (Knowlton, unpubl. report). The amount of human activity and the abundance of domestic dogs probably precludes the use of scat deposition rates (Davison 1980) or artificial scent stations (Linhart and Knowlton 1967, Roughton and Sweeny 1982) as indices of jackal abundance in Bangladesh. Jackal responses to broadcast howls is another possibility but preliminary analyses of data already collected identified many factors contributing to variations in response rates. Modification of data collection procedures will be needed before the technique will be suitable as an index of jackal abundance. Analyses of the existing data on responsiveness of jackals to broadcast howls should be completed as soon as practical, and Mr. Pandit should prepare a manuscript on this subject for publication.

6. The current radiotelemetry study should continue, with the number of instrumented jackals increased to more than 15. Data collection should be modified to encompass two objectives: (1) determining the daytime resting cover used by jackals (and possibly jungle cats) throughout the year and (2) assessing sizes of territories used by

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jackals in Bangladesh. The first objective will provide insights for developing depredation control strategies, and the second, a basis for anticipating numbers of jackals and needed distributions of depredation control efforts. One goal requires telemetry locations during the day, and the other, repeated locations throughout night-time periods.

7. The most complex question facing the jackal research program relates to the role jackals potentially play in reducing damage to wheat by feeding on rodents, particularly the two species of bandicoot rats. The loss of grain to rodents has already been estimated (Sultana and Jaeger 1989a,b, and unpubl. data) and data from the radiotelemetry study (see Recommendation 6, above) will provide information on how well jackals in the vicinity of Sripur "attend" the wheat fields. The most difficult aspect will be assessing the impact of jackals on the numbers of rodents. Most previous attempts to assess the impact of predators upon populations of prey have been inconclusive unless the predators have been excluded from portions of the prey population. It may appear practical to fence or "cage" individual bandicoot burrow systems to exclude jackals, but maintaining such jackal exclosures in situations like those encountered in Bangladesh appears formidable. Attempts at answering this question should probably be delayed until after the risks jackals pose to livestock and sugarcane have been clarified (the rodent question may become moot) and until additional thought has been given to the methodologies that would provide reasonable answers. It will be important to select experimental techniques that will affect the results as little as possible.

8. Some agricultural problems appear to be of such a magnitude that some jackal damage management will be needed. Initial development of depredation control procedures should not be delayed. The control procedures could start by incorporating inquiries about chicken and goat husbandry practices into the damage assessment study to determine whether some husbandry practices (e.g., cooping chickens at night, tethering goats, etc.) appear to discourage jackals or reduce losses. Work on several other jackal control procedures could begin as well. Minor modifications of the facilities at Joydebpur would make them suitable for testing attractants and toxicant delivery systems for jackals. In the field, domestic dogs will pose major problems for most jackal removal techniques. Tests with nontoxic baits containing physiologic markers (e.g., Knowlton *et al.* 1988, 1989) could be used to assess the risks various baiting procedures might pose for dogs or other species (e.g., baiting the interior of sugarcane fields, placing baits inside small "culverts," etc.). Detailed records of individual trap sites, types of sets, attractants, length of time specific trap sites are used, etc., during jackal trapping efforts could be an important source of information for developing techniques to increase the efficiency of capturing jackals to reduce depredations.

9. The VPS staff at BARI seems enthusiastic and committed to understanding and resolving the problems vertebrate wildlife cause to agricultural production in Bangladesh. However, they are not currently prepared to pursue those efforts on their own. They will

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need technical, intellectual, and moral support from outside BARI to accomplish their mission.

Necessity dictates the jackal research program (appended) be conducted primarily as a group of field research projects that will require up to 3 weeks of field effort each month. Successful completion will require routine availability of vehicles, drivers, support equipment (microcomputers, etc.), as well as use of competent field assistants. In addition, the jackal research effort will need better access to study sites during wet periods than will be afforded by vehicles normally available. Acquisition of a small, 4-wheel drive all-terrain-vehicle (ATV) is strongly recommended to permit the jackal studies to proceed when normal vehicle access is impractical. Assistance for acquisition and servicing radiotelemetry equipment, instruction in using the computer for handling and analyzing data, etc., will also be needed. The video record/playback capabilities at the VPS facilities at Joydebpur raises the possibility of providing some training in the form of VHS video cassettes, but presumes support to develop appropriate materials for use in the Bangladesh situation.

10. Serious consideration should be given to providing additional academic training for Mr. Pandit at a foreign institution. He is energetic, comprehends and assimilates new information readily, and appears intellectually curious. Current constraints on length of foreign training sponsored by USAID seems unrealistic for typical advanced degree programs in the field of wildlife management. These constraints might be mitigated to some degree through appropriate counsel and negotiation with an appropriate academic institution. Utah State University is currently establishing a comprehensive program for managing problems caused by wild vertebrates, including creation of a Center of Academic Excellence in Animal Damage Management. Mr. Pandit may wish to initiate contact with them. There would be important advantages in having him use a topic directly applicable to Bangladesh agriculture for his dissertation research. Mr. Pandit might be able to use data he is currently collecting as the basis for a Ph.D. dissertation, but such an arrangement would have to be worked out ahead of time and may require negotiations. If commitments could be arranged to use data currently being collected, the foreign training assignment might be kept within the time constraints currently recognized by USAID.

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SUGGESTED JACKAL RESEARCH PROGRAM FOR BANGLADESH

I. Jackal damage assessment near Sripur (farmer interview)

- Study in progress.
- Increase sampling intensity to 5 hectares within each of 4-km^2 blocks each month (random selection of blocks and hectares to be sampled).
- Continue interview process for 12 months at increased sampling intensity.
- Tentative data form left with R. K. Pandit at Joydebpur.

II. Study of daytime resting cover for jackals

- Enhance radiotelemetry study in progress (preferably before 1990 flooding season begins).
- Instrument 15-20 adult jackals.
- Determine daytime resting cover for each jackal 10 times each month for 1 full year.
- Quarterly, estimate jackal home range/territory size by locating a minimum of 5 jackals at hourly intervals for 3 consecutive nights.
- Determine whether jackal abundance can be accurately assessed by trying to flush instrumented jackals from sugarcane fields (before the cane exceeds 3 feet in height).

III. Assess jackal damage to sugarcane

- Conduct damage assessment in the Sripur area during the 1990-1991 harvest season.
- Obtain cooperation of sugarcane farmers to collect and save all damaged stalks of cane from at least 25 fields selected at random.
- Estimate total number of canes in each of the same fields by determining the number of cane stubs on a series of random plots within each field after harvest.

IV. Measure the impact of jackals on rodent populations in grain fields ("Do jackals save grain?")

- Examine data from Study II to determine the degree to which jackals "attend" to grain (wheat or rice) fields.
- Think through the experimental possibilities.

- Conduct initial tests of potential procedures in 1991.
- Pursue study in earnest starting early in 1992.

V. Expand damage assessment database from area around Sripur to other portions of Bangladesh

- Identify procedures by late 1991.
- Initiate in 1992.

VI. Complete publication on elicited howling responses of jackals

- Complete initial draft by May 1990 and submit to F. F. Knowlton for review.
- Revise and submit for publication by October 1990.

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ENVIRONMENTAL DATA - JACKAL STUDY

Hectare No.: _____

Date: _____

Observer: _____

No. of trees:

Banana	_____	Litchi	_____
Bamboo	_____	Other	_____
Jack fruit	_____		
		TOTAL	_____

Cropping pattern:

Field	Length(m)	Width(m)	Crop type	Mean height	No. rat burrows
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Comments: _____

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ENVIRONMENTAL DATA - JACKAL STUDY

Hectare No.: _____

Date: _____

Observer: _____

Human aspect:

No. of houses _____ No. of families _____

No. of people _____ No. of dogs _____

Livestock data (Nos.):

	Current number (alive)	Livestock lost (killed) in previous month to: Jackal	Jungle cat	Civet	Mongoose	Raptor	Other	Unknown
Buffalo								
Cows								
Sheep: (adults)								
(lambs)								
Goats: (adults)								
(kids)								
Chickens (ad)								
Chickens (1/2)								
Chicklets								
No. Predators killed								

Comments: _____

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ANIMAL HANDLING FORM

Ident. Nos.:

Tags: (L)_____ (R)_____

Transmit. No. _____

Transmit. freq._____

Capture information:

Capture date: _____

Release date: _____

Trap type: _____

Bait: _____

Location:

Block No.: _____

Cover type: _____

Animal data:

Species: _____

Sex: _____

Age: _____

Weight (kg):_____

Measurements (mm):

Total lgth. _____

Head lgth. _____

Tail lgth. _____

Hd. ft.lgth._____

Ear lgth. _____

Samples:

Blood _____

Tooth _____

Repro._____

Fecal _____

Other _____

Injuries: _____

_____

_____

Special comments/conditions:

Teeth:_____

Body:_____

Pelage:_____

Reproductive:_____

Other:_____

_____

_____

_____

TELEMETRY TRACKING FORM

Transmitter					Location			
Species	Frequency	Pulse	Date	Time	Block	Cover type	Act.	Comments (no signal, etc.)
Jungle cat	1-06-5.4	50						
Jackal	1-09-4.0	90						
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Suggested Outline for Elicited Jackal Howling Response Paper

SOME FACTORS AFFECTING RESPONSES ELICITED FROM GOLDEN JACKALS

Pandit, Rajat K., Vertebrate Pest Section, Bangladesh Agricultural Research Institute, Joydebpur.

Jaeger, Michael M., Denver Wildlife Research Center, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Denver, Colorado, U.S.A.

RH:

Abstract:

I. Introduction.

- A. Background.
- B. Purpose.
  1. Examine elicited jackal howls as potential census method.
  2. Define limits under which it is useful.
     - a. Examine seasonal effects.
     - b. Examine influence of time of night.

II. Study area.

- A. Location and size.
- B. Topography.
- C. Habitat/land use (influence of cover).
- D. Human density.
- E. Relative jackal abundance.

III. Methods.

- A. Time frame.
- B. Procedure.
  1. Delineation and randomization of blocks.
  2. Play recorded jackal howls (difference between procedures in summer and winter).
  3. Listen - record number of groups and jackals responding.
  4. Use light to determine if any jackals are visible.
  5. Record other parameters.
     - a. Time.
     - b. Wind speed.
     - c. Light conditions.
     - d. Habitat conditions.
     - e. Jackal approaches.
- C. Analyses.
  1. Used Lotus 1-2-3 spreadsheet.
  2. Segregated by category and calculated means, s.d.
  3. Statistics used.
  4. Graphic displays.

Outline for Elicited Jackal Howling Response Paper (Con't)

IV. Results.

A. Data acquisition (amount of data).
   1. Number of nights (summer and winter).
   2. Number of attempts at eliciting responses.
B. Comparison of responses to 1st, 2nd, and 3rd playings.
C. Overall effect of light (levels 1, 2, 3, and 4).
D. Comparisons of temporal responses on moonlit and dark nights.
   1. Percent of stations with responses.
   2. Mean number of groups x hour.
   3. Mean number of jackals x hour.
E. Jackal approaches.

V. Discussion.

A. Effect of light conditions on responses.
   1. Bright - spike in responses 2-3 hours after sunset.
   2. Dark - relatively even response rate throughout dark period.
B. Difference associated with season.
   1. 1-2 hour shift in peak response (moonlit nights).
   2. Delay in willingness to respond in summer.
   3. Possible reasons.
      a. Absence of cover?
      b. Avoiding people?
      c. Is this typical of *C. aureus* elsewhere?
         (1) Other studies.
         (2) Ishurdi.
      d. Breeding season - territoriality.
C. Implications.
   1. Elicited responses as index to abundance.
      a. Not all jackals always respond.
      b. Fraction of population responding changes with light conditions.
      c. Need to standardize conditions for collecting data.
         (1) Dark nights provide more uniform data over a longer time period.
         (2) Peak numbers of responding groups and numbers of jackals 2-3 hours after sunset on moonlit nights.

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TRIP REPORT*

BIRD PESTS in ARGENTINA and URUGUAY--PROJECT PLANNING

February 4-24 and March 14-16, 1990

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ITINERARY

Date	Location	Activity
February 4-5	Denver, Colorado, to Montevideo, Uruguay, via Miami, Rio de Janeiro, and Buenos Aires	Travel
February 6-15	Montevideo	Project development with the Food and Agriculture Organization (FAO) office and Uruguayan lead agency and counterparts
February 16	Montevideo to Salto, Uruguay, and Concordia, Argentina, and return	Travel; joint session with lead agencies of Uruguay and Argentina
February 17-18	Montevideo	Report writing
February 19-20	Montevideo to Delores, Uruguay, and return	Visit bird problem areas
February 21	Montevideo	Report writing; preparation for joint session with Argentine and Uruguayan counterparts
February 22-23	Montevideo to Concordia, Argentina, and return	Travel; session with Argentine counterparts; FAO debriefing
February 23-24	Montevideo to Denver via Rio de Janeiro and Miami	Travel
March 14-15	Denver, Colorado, to Rome, Italy	Travel
March 15-16	Rome	FAO headquarters debriefing
March 16	Rome, Italy, to Kuala Lumpur, Malaysia	Travel

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SUMMARY

The purpose of this trip was to prepare a 1-year plan of activities for implementing the FAO Project TCP/RLA/8965(A) "Integrated Control of Bird Pests." The consultant met with the FAO Regional Representative in Montevideo to discuss the bird project and the purpose of the current mission. He later met with the Coordinating Group (CG), the membership consisting of officials of both Argentina and Uruguay that is charged with coordinating bird management activities common to both countries. Together with their designates, the consultant gathered information on the primary bird problems common to the region, made visits to the field, and participated in joint sessions and individual meetings to determine the best way to begin the FAO bird project. Eleven consultants, including project management, were scheduled at appropriate times of the year for consultants to accomplish their Terms of Reference. Tentative plans were drafted for a proposed training course; these plans include time, target audience, and suggested topics.

BACKGROUND

Previous FAO consultancies (Bucher, 1985; De Grazio, 1985; Meitzinger, 1985) conducted under FAO TCP/URU/4401 and other reports from Argentina, Uruguay, FAO, and USAID (Bucher and Bedano, 1976; Calvi et al., 1976; De Grazio, 1985; FAO, 1980; Martinez, 1976; Mott, 1973; Rodriguez, 1983; Zaccagnini and Bucher, 1983) have shown that pest birds in the region are causing significant damage to agricultural crops. This documentation and an increased concern by crop protection authorities in Argentina and Uruguay led to a joint meeting in 1987 in Cordoba, Argentina, to (1) discuss the bird problems, (2) present results of research and control operations, and (3) formulate a proposal for technical assistance (IICA, 1987). This proposal called for international assistance to develop a comprehensive integrated bird pest management strategy for the most important bird pest problems common to the region. This proposal was later improved, finalized, and submitted to FAO for approval.

The resulting 1-year, binational FAO Project Document TCP/RLA/8965(A) "Integrated Control of Bird Pests" was approved in August 1989.[1] The project will focus on the major bird pest problems common to both Argentina and Uruguay in developing a control strategy which, at reasonable cost and with minimum environmental and human hazard, will protect primary crops from serious bird damage. Eventually such a strategy should benefit other regions of South America that share these same primary bird pest problems. The ultimate objective of the 1-year FAO bird project is to prepare a 5-year plan for implementing an integrated bird pest management project in the binational area.

The purpose of this consultancy was to develop a specific plan for implementing the intent of the 1-year FAO bird project. The Terms of Reference include the following:

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[1] Ms. Ethel Rodriguez and this consultant translated this document from Spanish to English. Our draft translation is attached to this report as Appendix IV.

1. In collaboration with the Coordinating Group (CG), obtain existing information on the problem of bird pests in Argentina and Uruguay based on reconnaissance visits, field visits, and meetings in both the public and private sector.

2. From information gathered in No. 1 (above), define and organize a plan of activities in detail for the first year of the project which will describe how the problems caused by bird pests will be managed in Argentina and Uruguay. The plan of activities should include required personnel, budget (expenses), and a calendar of activities.

3. Participate in the organization of a training program which the bird control units from each country will initiate and expand, with assistance from the project, to a national level. The plan will include topics, target audience, schedule, and budget.

4. Prepare a report of mission that includes all the information necessary by which technical officials at FAO headquarters will be able to follow up on activities.

ACTIVITIES

To determine the primary bird pests and the most important crops affected, the consultant gathered published information, talked to local bird experts, discussed bird damage problems with crop protection authorities, and made field visits to areas with bird problems. The following information was obtained:

Bird Problems in the Region

The Rio de la Plata Region, which includes portions of Argentina and Uruguay, is a major agricultural area for raising crops and livestock. Several bird pest problems that occur in the region are shared by neighboring countries. Control efforts in one country can easily be negated by a lack of effort from across the border. Argentina and Uruguay have been independently supporting bird research and operational control programs. Although some success was achieved, both countries now realize that some major bird pest problems will require a binational or regional approach. For example, some bird control efforts carried out on only one side of the Rio Uruguay have been unsuccessful due to immigration of the problem species from across this river border. A cooperative program that considers bird biology, behavior, and crop damage in the region--not just in each country--is essential to reducing losses that now limit agricultural production in both countries.

Damage estimates caused by birds are valued at U.S. $6 million per year in Uruguay and U.S. $36 million in Argentina (FAO, 1980). Doves (*Zenaida* sp.), pigeons (*Columba* spp.), and parakeets (*Myiopsitta* sp.) are major bird pests, common to the region. In Uruguay, blackbirds (*Molothrus* sp., *Agelaius* sp., and *Pseudoleistes* sp.), finches (*Sicalis* sp.), and ducks

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(*Dendrocygna* sp. and *Netta* sp.) are also involved in damaging crops (Table 1). Bird damage occurs both during the germination and maturation of grain crops. Soybean and sunflower are particularly susceptible to damage during germination; but wheat, sorghum, corn, and rice are also affected. Sorghum and sunflower receive significant damage when maturing; but corn, wheat, barley, rice, and fruit crops (apples, pears, and peaches) are also affected. In Argentina, sunflower, sorghum, corn, and wheat are the primary crops damaged by doves, parakeets, and pigeons (Table 2). Geese (*Chloephaga* spp.) and finches (*Sicalis* sp.) also are responsible for damage to wheat.

Primary Bird Problems in Argentina and Uruguay

Four principal bird pest species cause significant crop damage in Uruguay (Table 3) and in Argentina (Table 4). The bird pest problems in each country are very similar, with the exception of the geese damage to wheat and pasture in Argentina. Thus, the primary bird pest problems common to both countries are the Eared Dove, Monk Parakeet, Picazuro Pigeon and Spot-winged Pigeon. A brief summary of the biology, behavior, and damage for each bird is given in Appendix II. These bird species and their most significant damage problems should receive primary attention during this FAO project.

Project Implementation Site

The Salto Grande Binational Area (SGBA), which borders both countries, is an appropriate area to base the project and conduct field work. It will offer facilities, personnel, and accommodations to support the project headquarters site and is near the bird problems common to both countries. Counterparts from each country would be able to meet and perhaps even work together on certain tasks associated with this project. The SGBA was the site where a binational program on fruit flies was recently implemented. FAO and agencies from Argentina and Uruguay are, therefore, familiar with the procedures associated with a binational program.

Consultancy Schedule

This 1-year project will use the experience of several experts who will work with scientists from Argentina and Uruguay to develop a strategy for managing bird pest problems in the region. From the information on bird problems obtained during this consultancy, the counterparts and consultant determined appropriate times for each consultancy. Bird damage problems peak twice a year--from October to December and again from March to May. The project manager should arrive at the duty station in September 1990, followed later by other consultants. The following timetable, established during the consultancy, is a proposed schedule for project personnel. Not shown in this timetable is this consultant's recommendation (added after this consultancy) for two, 2-week technical assistance consultancies, described below. Consultancy Nos. 4, 10a, and 10b are new. The proposed Terms of Reference recommended by this consultant for each new consultancy are included in Appendix I.

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Timetable showing the optimal time period for completing each of the 11 consultancies

No.	Consultancy	Duration (months)	Month 1990 F...	S	O	N	D	1991 J	F	M	A	M	J
1.	Project manager	9		x	X	X	x	X	X	X	X	X	X
2.	Project development	3	X									X	X
3.	Lethal chemical control	3				X			x	X	x		
4.	Biological control--habitat management	1							X				
5.	Agricultural systems	2			X	X							
6.	Extension/training	2									X	X	
7.	Ecotoxicology	3				x	x				X	X	
8.	Population biology	2			X	X							
9.	Damage assessment (statistics)	1								X			
10.	Nonlethal chemical control												
	a. repellents	1									X		
	b. chemosterilants	1								X			
	TOTAL	28											
	FAO technical visit	0.5						x					

No. = Number from Project Document Annex, with Nos. 10a and 10b added per amendment (see Appendix IV-6 and IV-7).
X = Full month
x = 0.5 month

Explanations for Time Table

Project Development - The current consultancy is considered part of this category of the Project Document. The Terms of Reference require that the second consultant will initiate the development of a 5-year integrated bird pest management, binational project proposal and will jointly, with the project manager and consultants, develop a funding proposal that will be submitted to potential donors. It is now suggested that an additional month be added to the original Terms of Reference so that a consultant can visit the project for 2 weeks in November 1990 to provide a current project assessment to FAO headquarters for their project visit scheduled for January 1991. The remaining 2 weeks of this proposed 1-month consultancy is scheduled for May to provide input to the project development consultant scheduled for May-June 1991 and to assist the project manager in completing the final report, the 5-year binational project proposal, and the funding proposal.

Biological Control - This term was used in the Project Document (Annex 1.4, Terms of Reference), but not in the personal services amendment which was later approved. One consultancy listed in the

above table (habitat management) fits into this category as a cultural control method (one kind of biological control). Repellents and chemosterilants are nonlethal chemical methods of control and should not be included under biological control.

Extension - The training and extension specialist will assist the project manager in the planning and conducting of the general training course. The timing of this consultancy has been scheduled so this can be accomplished.

Responsibility for Project Output

The FAO Project Document, its attached Terms of Reference, and the personal services amendment to the consultant list in the Project Document, do not always use the same language in describing duties of each consultant. Therefore, to clarify this situation, each section was compared and summarized by the consultant in the following table, which indicates who should be responsible for each of six major output areas addressed in the FAO Project Document:

Consultants and their responsibilities according to signed Project Document.

		Project Output					
No.	Consultancy	Binational 5-year project proposal	General technical document	Draft final report	Funding proposal	General training course	Roost toxicant soc./env. impact
1.	Project manager	X	X	X	X	o	o
2.	Project development	o			o	o	
3.	Lethal chemical control	o					o
4.	Biological control--habitat management	o					
5.	Agricultural systems	o					
6.	Extension/training	?			o	X	
7.	Ecotoxicology	?			o	o	X
8.	Population biology	o			o	o	o
9.	Damage assessment (statistics)	?			o	o	o
10.	Nonlethal chemical control						
	a. repellents	o					
	b. chemosterilants	o					

X = primary responsibility; o = input required by Project Document; ? = input implied by language in Project Document.

Training

As a part of this consultancy, suggestions from counterparts were gathered in formulating some initial plans for conducting training during the 1-year FAO bird project. The following information will provide the project manager and the extension/training consultant with a framework from which to finalize training activities:

Seminars for Counterparts

Each of the project consultants will present a technical seminar summarizing the major components of his/her specialty and discussing the results of his/her consultancy. This seminar will be presented to selected country counterparts near the end of the consultant's mission. If necessary, non-Spanish speaking consultants can use national counterparts as translators. This particular training component is included in the Terms of Reference for many of the consultancies. Prior to arrival and during the consultancy, each consultant should prepare for the seminar presentation. Slide, movie, and overhead projectors as well as a conference room will be available for this seminar at the SGBA headquarters.

General Training Course

The second training component of this project is a general or basic training course on "Integrated Bird Pest Management in the Rio de la Plata Region of South America." This training course will be conducted for the benefit of technicians involved in bird control operations and/or research from public and private sectors of Argentina and Uruguay. Counterparts assigned to this project by the host countries (see "Contacts and Acknowledgments" section for names) will take a lead role in this training. Uruguay expects as many as 30 people, including technicians from Sanidad Vegetal (public sector), the farmer associations or cooperatives (private sector), and perhaps some university people involved in bird research. Argentina would have at least as many potential participants. However, the budget does not contain enough money to reimburse transportation and per diem expenses for more than 60 people. If the training will require more than 5 days, the number of participants will have to be reduced, accordingly, from 60. Each country should select trainees who will be able to take a lead role in national training programs to reach others needing this training in their respective countries. Materials for national training will be developed within the project.

The extension specialist will plan and conduct this general training course and draft a training manual during the extension and training consultancy visit. Consultants who will be in the SGBA at the time of this training should also plan to present a few lectures. Any one completing his/her consultancy prior to the general training course should provide an outline and guidance to the national counterpart who, in turn, will present information on the consultant's topic. National counterparts with specific expertise should be available to assist in translating for training consultants who do not speak Spanish. Counterparts will also present lectures and coordinate field trips and/or demonstrations.

The course should begin in April 1991, be at least 5 days, and include lectures, demonstrations, field work, an evaluation, and a pretest/posttest to determine effectiveness.

Suggested topics to be included are as follows:

Topics

PRETEST
PROBLEM DEFINITION
- Major bird problems common to the Rio de la Plata Region
- Bird damage, assessment, losses (value)

BIRD BIOLOGY
- Basic biology and behavior of the primary bird pest species
- Population dynamics

BIRD PEST MANAGEMENT
- Integrated pest management
- Habitat management
- Lethal control
- Nonlethal control

ENVIRONMENTAL AND HUMAN HAZARDS
- Environmental hazards
- Human hazards

EXTENSION
- Extension and training

LAB AND FIELD DEMONSTRATIONS
- Lab exercises
- Field exercises

POSTTEST
COURSE EVALUATION

The seminars and general training course are expected to provide adequate materials that should be appropriate to assemble in a training manual that is specific for the primary bird pest problems in the region. Such a manual, with appropriate visual aids, could eventually be used by counterparts for national bird control training programs. Organization of this manual could take the following form:

Manual

Pretest (to determine extent of knowledge before training)

Topics (to follow those presented at the general training course at Salto Grande)--For each topic, give the following:

- Rationale (describe how the topic relates to bird pest management)
- Purpose (describe why it is included)
- Objectives (list what the student is expected to learn)
- Outline (include the major points of the presentation)

Posttest (determine effectiveness of the course)

Evaluation (include comments from participants to improve course)

Budget Estimates for the Consultancies and the General Training Course

This project is budgeted for $380,000. Funds are retained by the FAO Regional Representative in Montevideo, Uruguay, but available to Argentina and Uruguay. Equipment and supplies will be ordered by FAO in Montevideo. Total cost for consultancies and training is now estimated to be $259,500, leaving $20,500 for funding additional consultancies recommended in this report.

Consultancy Budget Estimate

	Consultancies	Duration (months)	Estimated Costs
1.	Project manager	9	$64,500
2.	Project development*	3	27,000
3.	Lethal chemical control	3	27,000
4.	Biological control-- habitat management	1	10,000
5.	Agricultural systems	2	18,000
6.	Extension/training	2	18,000
7.	Ecotoxicology	3	27,000
8.	Population biology	2	18,000
9.	Damage assessment (statistics)	1	10,000
10.	Nonlethal chemical control		
	a. repellents	1	10,000
	b. chemosterilants	1	10,000
	Total	28	$239,500

* Does not include additional 1 month recommended in this report.

Training Budget Estimate

General training course at Salto Grande Binational Area (SGBA) for 60 people

Travel - $ 30.00/trainee round trip	$ 1,800
Per diem - $ 50.00/trainee/day (5 days)	15,000
Materials, supplies, miscellaneous	3,200
Total	$20,000

RECOMMENDATIONS

1. Reports

Because several consultancies will be conducted in a relatively short time, FAO should require that each consultant draft a report in English or Spanish prior to departing Argentina/Uruguay and prepare a final report within 2 weeks of returning home. There is no provision in the Project Document for translating; therefore, this consultant recommends that each consultant be responsible for submitting a final report in English or Spanish and that FAO be responsible for any required translations.

2. Duties of Host Governments

Host government contributions to the project are specified on pages 9 and 10 of the Project Document (see Appendix IV, pages 9 and 10, in this report). These contributions are sufficient if provided in a timely manner. Between now and the beginning of the project in September 1990, host governments should assure themselves that facilities and logistical support will be available in and around the SGBA. National counterparts in Argentina and Uruguay have already been designated. They should be kept informed by their respective government heads of any project development activity which will affect counterpart involvement.

3. FAO Duties to be Undertaken

FAO must, as soon as possible, select and recruit a project manager. The designated project manager can then provide input which will later facilitate his/her Terms of Reference, which will officially begin in September.

Secondly, FAO must select and recruit personnel for each of the other consultancies. This consultant, with input from Argentine and Uruguayan counterparts, has recommended a person for each of the 11 consultancies (see Appendix III). All have indicated interest and availability; however, FAO needs to contact and recruit them. Consultants from the Denver Wildlife Research Center can be recruited through Dr. Richard Bruggers, Chief, International Programs Research Section to facilitate the recruitment process.

4. Equipment Needs

There will not be a large demand for equipment and supplies required for implementing this project. One vehicle, preferably with 4-wheel drive, will be the only major expense. However, the project manager and the consultants should each be requested to provide a list of materials they will require and submit it to the FAO office in Montevideo for action. This needs to be done as soon as possible so that these materials will be available by September 1990.

5. DWRC Coordination

The International Programs Research Section (IPRS) of the Denver Wildlife Research Center (DWRC) has agreed to coordinate the consultancies of the following DWRC scientists for the approximate time periods indicated in this trip report: Dr. Michael M. Jaeger, Mr. Roger W. Bullard, Dr. James O. Keith, and Dr. Richard L. Bruggers.

6. Conduct of Project Activities

Each of the consultants will perform work which will benefit both Argentina and Uruguay. Field visits, field work, demonstrations, and counterpart involvement should ideally occur in each country. However, time constraints and practical considerations may dictate this to be highly impractical for some consultancy work. The project manager should be in the best position to determine the appropriate locations for any specific studies and whether or not duplication of any work would be practical.

7. Project Manager

This expert should be recruited as soon as possible. Since several other consultancies will involve Denver Wildlife Research Center personnel, the project manager should schedule a visit to the DWRC prior to arrival at the duty station.

8. Project Assessment

An additional month should be added to project development Terms of Reference so that a consultant can visit the project for 2 weeks in November 1990 to provide a current project assessment to FAO headquarters for their project visit scheduled for January 1991. The remaining 2 weeks of this proposed 1-month consultancy is scheduled for May to provide input to the project development consultant scheduled for May-June 1991 and to assist the project manager in completing the final report, the 5-year binational project proposal, and the funding proposal.

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CONTACTS AND ACKNOWLEDGMENTS

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Ms. Ethel Rodriguez, Head, Department of Bird Pests
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Argentina

Direccion de Agricultura

Ing. Agr. Diana Guillen, Directora de la Secretaria Agricultura, Argentina, Buenos Aires
Ing. Agr. Octavio A. Tachella, Director de Agricultura, Provincia de Entre Rios
Ing. Agr. Julio C. Medvescigh, Jefe Dpto. Sanidad Vegetal y Semillas, Parana, Provincia Entre Rios
Ing. Agr. Miguel Angel Villada, Jefe Delegacion Regional, Fitosanitaria Zona 1, Ministerio de Asuntos Agrarios y Pesca, Provincia Buenos Aires, La Plata

INTA (Instituto Nacional de Tecnologia Agropecuaria)

Estacion Experimental Agropecuaria Parana
Casilla de Correos 128
Parana, 3100 Entre Rios Argentina
Phone: 54-43-2-24940/41; Fax # 54-1-111917; Telex # 17518; INTA, Buenos Aires - include the message "por favor enviar a INTA - EEA Parana' Maria Elena Zaccagnini"
Biol. Maria Elena Zaccagnini (M.S.), Vertebrate Pest Researcher
Home: Manuel Galvez 216
Parana, 3100 Entre Rios Argentina. Phone: 54-43-2-14634

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Table 1. Summary of Bird Pest Problems in Uruguay (from De Grazio, 1985).

Order of importance	Crop	Acreage (ha) 1983	Crop stage	Species causing damage	Time period	Major damage areas
1a	Sorghum	58,998	Mature	Blackbirds Doves** Parakeets	Mar-May	Rio Uruguay*
			Emergent	Blackbirds Doves	Oct-Nov	
1b	Sunflower	40,661	Mature	Parakeets Doves	Mar-May	Rio Uruguay
			Emergent	Doves	Oct-Nov	
1c	Barley	61,458	Mature	Blackbirds Doves	Nov-Dec	Rio Uruguay
2a	Corn	37,855	Mature	Parakeets Doves	Mar-Apr	Rio Uruguay
			Emergent	Doves	Oct-Nov	
2b	Wheat	270,216	Mature	Doves	Nov-Jan	Rio Uruguay
			Emergent	Doves	Jun-Aug	
2c	Rice	67,024	Mature	Blackbirds	Feb-Mar	Departmento Treinta y Tres
			Emergent	Ducks	Oct-Nov	
3	Fruits	-	Mature Bud stage	Parakeets	Dec-Apr	Departamentos Canelones and San Jose
4a	Soybeans	11,919	Emergent	Doves	Oct-Dec	Dispersed
4b	Peanuts	-	Mature	Blackbirds Parakeets Doves	Mar-May	Rio Uruguay and Tacuarembo
			Emergent	Blackbirds Doves	Oct-Dec	

* Rio Uruguay includes: Departmentos Salto, Paysandu, Rio Negro, Soriano, and Colonia.
** Doves include: doves (*Zenaida auriculata*) and/or pigeons (*Columba* spp.)

Table 2. Summary of Bird Pest Problems in Argentina.

Order of importance	Crop	Crop stage	Species causing damage	Time period*	Major damage areas*
1	Sunflower	Mature	Doves Parakeets Pigeons	Aug-Sep	Buenos Aires, Cordoba, Entre Rios, Sante Fe
		Emergent	Pigeons	Sep-Nov	Santa Fe, Entre Rios, Cordoba, Buenos Aires
2	Sorghum	Maturing	Doves Parakeets	Feb-Mar	Cordoba, Entree Rios, Santa Fe
		Emergent	Doves Pigeons	Oct-Nov	Cordoba, Entre Rios, Sante Fe
3	Corn	Mature	Parakeets	Jan-Mar	Buenos Aires, Cordoba, Santa Fe, Entre Rios
4	Wheat	Emergent	*Chloephaga* spp. Parakeets	Aug-Sep	Buenos Aires
		Milk stage	Finches	Oct	Entre Rios
		Mature	Doves Parakeets	Nov	Buenos Aires Cordoba, Entre Rios, Santa Fe
5	Fruit trees (peaches)	Mature	Parakeets	Nov-Dec	Buenos Aires,
6	Soybean	Emergent	Pigeons and Doves	Nov-Dec	Cordoba, Entre Rios and Santa Fe
7	Pasture	Emergent	*Chloephaga* spp. and Pigeons	Mar-Apr	Buenos Aires Entre Rios
8	Forest (*Eucalyptus* and *Pinus*)	Seedling	Parakeets	--	Sante Fe, Entre Rios
9	Structures	Electric poles	Parakeets		Cordoba, Entre Rios, and Santa Fe, Buenos Aires
		Airports	Doves	Jan-Dec	Buenos Aires Cordoba, Entre Rios, Santa Fe
			Nighthawks	Jan-Feb	Entre Rios

* Damage in the Buenos Aires Province is generally at the later part of the given range compared to the other more northern provinces.

Table 3. Primary Bird Pest Problems in Uruguay.

Common name	Scientific name	Local name	Affected crop(s)
Eared Dove	*Zenaida auriculata*	paloma torcaza	sunflower, sorghum and barley
Monk Parakeet	*Myiopsitta monachus*	cotorra	corn, sunflower and fruit
Picazuro Pigeon	*Columba picazuro*	paloma de monte paloma grande	sunflower and barley
Spot-winged Pigeon	*Columba maculosa*	paloma manchada	sunflower and barley

Table 4. Primary Bird Pest Problems in Argentina.

Common name	Scientific name	Local name	Affected crop(s)
Eared Dove	*Zenaida auriculata*	paloma torcaza	sorghum, sunflower and corn
Monk Parakeet	*Myiopsitta monachus*	cotorra, lora, or cata	sorghum, sunflower corn and fruit
Picazuro Pigeon	*Columba picazuro*	paloma turca	sunflower
Spot-winged Pigeon	*Columba maculosa*	paloma manchada	sunflower, pasture
Geese	*Chloephaga* spp.	avutarda	wheat and pasture

TERMS OF REFERENCE

International Consultant Specializing in Biological Control--Habitat Management

Duration: 1 month

Location: Salto Grande Binational Area (SGBA), Salto, Uruguay

Activities:

Participate in obtaining information and documentation, both national and international, that will be used in developing the biological control--habitat management component for the binational integrated bird pest management project.

Analyze all existing information and documentation in the binational area where the bird problems are occurring to make recommendations for habitat management as a control method while considering the possible social and ecological impacts.

Take field trips to examine and fully understand the problems that exist in Argentina and Uruguay.

Identify the habitat management control component needed to be incorporated into the binational integrated bird pest management program prior to its initiation.

Work with those responsible for the project, including the specialists and consultants, in developing the integrated bird pest management program.

Participate in your capacity in developing the integrated bird pest management project by giving advice about habitat management.

Present a technical seminar and prepare a technical report with observations, conclusions, and recommendations for biological control--habitat management used as a control component in the project. Specify any negative social, ecological, or economic impact that may result from these recommendations.

TERMS OF REFERENCE

International Consultant Specializing in Nonlethal Chemical Control--Repellents

Duration: 1 month

Location: SGBA, Salto, Uruguay

Activities:

Analyze all existing information and documentation in the binational area of Argentina and Uruguay where bird problems in agricultural crops are occurring. Take field trips to examine and fully understand the problems. Examine the impact and possible risks of nonlethal chemical repellents (including plant chemical constituents; i.e., tannins in sorghum) currently being used in this area.

With this information and insight, propose uses of nonlethal chemical repellent control method(s) and their potential effectiveness for controlling bird damage in the binational area. Evaluate the current research being conducted.

Participate in obtaining necessary additional information and documentation, both national and international, for developing a formal proposal for the nonlethal chemical repellent control component of the binational integrated bird pest management program.

Work with those responsible for the project, including the specialists and consultants, in blending this information and associated documentation with other components (i.e., habitat management and agricultural systems) during the development of the proposed binational integrated bird pest management program for Argentina and Uruguay.

Participate in your capacity in developing the integrated bird pest management project by giving advice about nonlethal chemical repellent control. Assist counterparts in technical matters such as locating sources of chemical products or hybrid seed, formulation procedures, experimental design, and crop application. Assist counterparts in developing material for the General Training Course.

Present a technical seminar and prepare a technical report with observations, conclusions, and recommendations for nonlethal chemical repellents used as a control component in the project. Specify any negative social, ecological, or economic impact that may result from these recommendations.

TERMS OF REFERENCE

International Consultant Specializing in Nonlethal Chemical Control--Chemosterilants

Duration: 1 month

Location: SGBA, Salto, Uruguay

Activities:

Analyze all existing information and documentation concerning bird problems in the binational area or in similar situations elsewhere in the world, and evaluate the potential impact and possible risks from using chemosterilants. Evaluate the potential effectiveness of chemosterilants and any current research being conducted.

Determine the current status of chemosterilants being used in Argentina and Uruguay or elsewhere in the world and make recommendations for further consideration.

Take field trips to examine and fully understand the problems that exist in Argentina and Uruguay.

After reviewing the current situation in the binational area, make a recommendation as to whether or not chemosterilants should be used.

If chemosterilants should be used, develop a proposal for chemosterilant use in a binational approach to integrated bird pest management.

Participate in your capacity in developing the integrated bird pest management project by giving advice about chemosterilants.

Present a technical seminar and prepare a technical report with observations, conclusions, and recommendations for nonlethal chemical chemosterilants used as a control component in the project. Specify any negative social, ecological, or economic impact that may result from these recommendations.

SUMMARY OF THE BIOLOGY, BEHAVIOR AND DAMAGE OF THE MAJOR BIRD PEST SPECIES

Monk Parakeet (*Myiopsitta monachus*):

"Distribution from central Bolivia and southern Brazil south to central Argentina... It is primarily a lowland bird, rarely occurring above 1,000 meters, and is found in low rainf[illegible], areas in open forest, trees along watercourses, savannah woodland, dry *Acacia* scrubland, palm groves, farmlands, and orchards. It is particularly common in the vicinity of human habitations...it is common and widespread in Argentina, especially in the north where very large numbers are often encountered...it is very abundant and generally distributed throughout Uruguay... In many areas, the extensive planting of introduced trees, mainly *Eucalyptus*, has undoubtedly benefited these parrots by changing treeless plains into suitable habitat...found...in open country wherever trees offered shelter, especially in eucalypts around 'estancias' or ranches, in lowland palm groves, in open pastures studded with trees, and dense forest bordering the Cebollati River...in fairly open *Acacia*-dotted plains east of the river... Monk Parakeets are highly gregarious and associate in flocks of from ten to a hundred or more. Their presence in an area is known with certainty because of the enormous nests constructed from twigs and placed in the topmost branches of trees... Small groups go out from the nesting trees and band together in large flocks to feed in open grassland or cultivated fields. While feeding away from shelter they are wary and difficult to approach; sentinels are usually perched atop nearby trees and at the appearance of danger they screech loudly causing the entire flock to fly off... They feed on seeds, fruits, berries, nuts, leaf buds, blossoms, and insects and their larvae... Flocks descend on ripening cereal crops, particularly maize and sorghum, frequently causing widespread damage; they also raid citrus orchards... Breeding commences in October... Birds use the nests throughout the year as roosting quarters..." FROM: Forshaw, J. M. 1981. Parrots of the World. Second edition, second printing with corrections. David & Charles Ltd., London. 616 pp.

Eared Dove (*Zenaida auriculata*):

"South America, Trinidad, Tobago and other islands in the southern Caribbean Sea and the southern Lesser Antilles in the West Indies. Inhabits arid or semi-arid open country usually with some trees, bushes, or patches of woodland and cultivated areas... Feeds principally on seeds picked up off the ground. In Cordoba, Argentina, in an area of arable cultivation interspersed with secondary thorn scrub,...cultivated grains, especially sorghum, wheat and millet comprised 85 per cent of the species' food... Usually in pairs or small groups, although large numbers may gather at a good feeding ground... Often roosts communally...nest in a tree or shrub or on the ground...nesting colonies are in woods in semi-arid regions... In parts of Argentina it also

breeds in very large colonies... In uncultivated parts of Argentina the breeding season is appreciably shorter than in areas where grain is cultivated." FROM: Goodwin, D. 1983. Pigeons and Doves of the World. Third Edition. Cornell University Press, Ithaca, New York.

Picazuro Pigeon (Columba picazuro):

"South America from northeastern Brazil south through the Matto Grosso to Tucuman and Buenos Aires districts of Argentina. Inhabits both woodland and open country with trees or (when feeding on ground) within easy reach of trees. Often near human habitations... Feeds on seeds, buds, young leaves, berries, probably also some invertebrates. Feeds much on the ground but also in trees... Commonly seen in pairs or small parties, in winter often in flocks of up to two hundred or more... Usual pigeon nest in tree or shrub... Nesting recorded in November and December..." FROM: Goodwin, D. 1983.

Spot-winged Pigeon (Columba maculosa):

"Southern South America in northern Argentina, Uruguay, Paraguay, Bolivia and southern Peru in the temperate zone. Inhabits arid or semi-arid and cultivated regions where some trees are available for nesting and roosting... Feeds on the ground, largely on seeds, but has been said by at least one observer to eat 'fruit and green stuff' also...often or usually feeding in flocks and running about with great agility when seeking food... Said to nest in trees..." FROM: Goodwin, D. 1983.

PERSONNEL RECOMMENDATIONS FOR CONSULTANCIES

Mo.	Yr.	No.	Consultancy	Duration (months)	Consultant
Feb	90	2	Project development	1.0	L. Fiedler
Sep	90	1	Project manager	3.0	E. Bucher
Oct	90	8	Population biology	2.0	P. Driscol
Oct	90	5	Agricultural systems specialist	2.0	P. Marko
Nov	90	3	Lethal chemical control	1.0	M. Jaeger
Nov	90	7	Ecotoxicologist	1.0	J. Keith
Nov	90	2	Project development*	.5	R. Bruggers
Jan	91		FAO technical project visit	.5	C. Elliott
Jan	91	1	Project manager	6.0	E. Bucher
Feb	91	4	Biological control--habitat management	1.0	J. Wiens
Feb	91	3	Lethal chemical control	2.0	M. Jaeger
Mar	91	10b	Nonlethal chemical control--chemosterilants	1.0	J. Kennelly
Mar	91	9	Damage assessment (statistics)	1.0	D. Otis
Apr	91	10a	Nonlethal chemical control--repellents	1.0	R. Bullard
Apr	91	7	Ecotoxicologist	2.0	J. Keith
Apr	91	6	Extension and training specialist (Spanish required)	2.0	O. Arregoces
May	91	2	Project development*	2.0 .5	J. Foronda R. Bruggers

* See recommendation No. 8 on p. 11 of this report.

Consultant name	Title	Expertise
Dr. Enrique Bucher	Ornithologist	Centro Zoologica Applicada, University of Cordoba, Argentina; bird biology, ecology, FAO consultant
Dr. Peter Driscol	Bird Biologist	Centre for Biological Population Management of Australia; bird biology and behavior
Dr. Paul Marko	Senior Agronomist	Associate in Rural Development, Burlington, Vermont
Dr. Michael Jaeger	Wildlife Biologist	Denver Wildlife Research Center; FAO African Quelea Control Project, bird biology and control
Dr. James Keith	Ecotoxicologist	Denver Wildlife Research Center; environmental effects of large-scale pesticide applications
Dr. James Kennelly	Assistant Director	U.S. Fish and Wildlife Service, Wildlife Disease Laboratory, Madison, Wisconsin; physiologist
Dr. John Wiens	Professor	Colorado State University; habitat influence on bird populations
Dr. David Otis	Supervisory Wildlife Biologist	Denver Wildlife Research Center; applied statistics, bird biology, techniques for damage estimation
Mr. Roger Bullard	Research Chemist	Denver Wildlife Research Center; repellent development work
Mr. O. Arregoces	Agronomist	CIAT, Columbia; extension training and research, FAO consultant
Mr. J. Foronda	Agricultural economist	Project development, funding proposals. FAO consultant
Dr. Richard Bruggers	Supervisory Wildlife Biologist	Denver Wildlife Research Center; FAO African Quelea Control Project, bird biology, project development

ENGLISH TRANSLATION OF FAO PROJECT DOCUMENT[1]

Region:	LATIN AMERICA AND THE CARIBBEAN
Countries:	ARGENTINA AND URUGUAY
Country site:	URUGUAY - Salto Grande Binational Area
Project title:	Integrated Management of Bird Pests
Project number:	TCP/RLA/8965(A)
Starting date:	October 1, 1989
Ending date:	September 30, 1990
Government organization in charge of implementing the project:	Secretary of Agriculture, Livestock and Fisheries (Argentina); Minister of Livestock, Agriculture and Fisheries (Uruguay); Uruguayan/Argentine Coordinating Group for the joint and simultaneous management of agricultural pests
FAO contribution:	U.S. $380,000

FAO and Government signatures:

[1] This is a draft translation by Ethel Rodriguez and Lynwood Fiedler from Spanish to English of the original document plus the personal services amendment (page IV-6).

I. BACKGROUND AND JUSTIFICATION

Argentine and Uruguayan governments, aware of serious bird pests in their countries, especially in the Salto Grande Binational Area (SGBA), have signed a special agreement for joint and simultaneous management of agricultural pests (September 15, 1987). In the context of this agreement, the preparation of a joint and simultaneous management plan on the topics of bird pests, fruit flies, citrus canker, and biotechnology applied to plant propagation materials, disease diagnosis, and sanitation has been considered. In this regard, the Uruguayan/Argentine Coordinating Group (CG) for the joint and simultaneous management of agricultural pests, while preparing for a binational program on integrated bird pest management, considered it necessary to solicit external technical assistance--mostly international consultants and some specialized equipment.

The SGBA has a sustained economy involving agricultural and livestock exploitation of its soil. Technological development has allowed agriculture to increase and diversify toward a more intensive use of the land, or a more efficient use of resources, resulting in higher productivity per surface unit, higher hand labor occupation, and an increase in required services.

Agriculture acts as a dynamic factor in the economy of the SGBA, contributing to the improvement of its people's standard of living while reducing the tendency for people to migrate toward national capitols.

Similarly, agriculture is an important element of the economy in both countries, not only for self-sufficiency in food and primary industrial materials but also for export earnings derived from various products.

Among existing limitations which reduce productivity potential for sustained agricultural development are plant pests, mainly pigeons and doves (*Columbidae*) and parakeets (*Psittacidae*), which cause losses estimated at U.S. $6 million in Uruguay and U.S. $36 million in Argentina. However, information and methods for a correct evaluation of the problem is not available.

These bird pests, which are part of the plant protection problem, exist over broad territories and have several characteristics for which control can only be possible at a binational level, since unilateral actions only result in partial control with a high cost:benefit ratio.

Between 1973 and 1977, through an agreement between the Uruguay Ministry of Livestock, Agriculture, and Fisheries and the Denver Wildlife Research Center, Uruguayan technicians were trained, several basic studies were conducted, and alternative lethal control methods were analyzed, resulting in the first initiative toward cooperatively studying these pests at a binational level.

In 1984 and 1985, Uruguay received technical assistance and some equipment from FAO. Several specialists recommended the need for an integrated control approach to the problem and for the organization of a binational program along both sides of the Rio Uruguay. Thus, a coordinated, joint effort between Argentina and Uruguay should be encouraged.

In May 1987 a meeting between Argentina and Uruguay recommended the formation of a working group (see CG above) on agricultural bird pests and asked for international organizations to assist in improving human resources and to provide technical experts in bird control.

After several meetings they agreed to write a project proposal on bird pest control to be focused on coordinated and joint actions at a binational level. In this regard, Argentina and Uruguay have asked FAO for technical assistance to help the CG on bird pests.

II. OBJECTIVES OF THE ASSISTANCE

- Contribute to reducing losses caused by bird pests in the SGBA by considering the environmental and social impacts of different control methods.

Specifically,

- Reinforce the CG activities concerning bird pests.
- Prepare a binational proposal for integrated bird pest management and, eventually, a funding proposal.
- Evaluate different control methods at reproductive sites and determine their social and environmental impact.

III. WORK PLAN

The previously defined objectives will be accomplished by consultancies, field trials, technical meetings, and extension activities.

Diagnosis

- Gather information on technical capability, organization, administration, and current infrastructure (on agencies and institutes responsible for bird pest research and control?).
- Analyze this information and write a report.

Binational Program Proposal

- Evaluate available technical information from previous international consultancies and from Uruguayan and Argentine technical work and (summarize the?) results.

- From this evaluation and from other international information sources, formulate a proposal for an integrated bird pest management binational program, which must consider technical training, basic studies, control methods, extension, and external technical assistance.

- (Additionally?) Prepare a proposal for funding.

Development of control methods and (evaluation of?) their ecological impact

- Conduct studies to evaluate the risks and benefits of different control methods at bird pest reproductive sites (nesting colonies?).

Training

- Conduct technical training activities and define the training component of the integrated bird pest management binational program.

IV. FAO CONTRIBUTIONS

Personal Services

- An international expert, specialized in integrated bird pest management, for 12 months (U.S. $86,000)

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- An international consultant, specialized in program and project development, for 2 months (U.S. $18,000)

- An international consultant, specialized in chemical control, for 3 months (U.S. $27,000)

- An international consultant, specialized in biological control, for 1 month (U.S. $10,000)

- An international consultant, specialized in agricultural systems, for 2 months (U.S. $18,000)

- An international consultant, specialized in training and extension, for 1 month (U.S. $10,000)

- An international consultant, specialized in ecotoxicology, for 3 months (U.S. $27,000)

- An international consultant, specialized in population biology, for 3 months (U.S. $27,000)

- An international consultant, specialized in damage evaluation, for 1 month (U.S. $10,000)

- Up to 3 man-months, an international consultant, to evaluate three projects--TCP/RLA/8856(A) Integrated Control of Fruit Flies, TCP/RLA/8961(A) Citrus Canker, and TCP/RLA/8965(A) Integrated Control of Bird Pests--and to analyze the technical/financial feasibility for the development and implementation of a subregional center on plant protection (U.S. $27,000)

- A technical (expert?) from FAO headquarters, for 2 weeks (U.S. $8,000)

October 30, 1989

Personal Services Amendment

1. An international consultant, specialized in integrated control of bird pests, for 9 months, partitioned in two periods. Richard Dolbeer or Richard Bruggers from the Denver Wildlife Research Center (DWRC), Denver, Colorado, has been suggested.

2. An international consultant, specialized in project and program development, for 2 months. Philippe Ruelle or A. Manikowski from FAO has been suggested

3. An international consultant, specialized in chemical control, for 3 months. Clive Elliott (FAO) or Edward Schafer (DWRC) has been suggested.

4. An international consultant, specialized in chemosterilant use against birds, for 1 month.

5. An international consultant, specialized in habitat management as a bird control method, for 1 month. John Wiens from Colorado State University has been suggested.

6. An international consultant, specialized in chemical repellents for birds, for 1 month. Roger Bullard or Russell Mason (DWRC) has been suggested.

7. An international consultant, specialized in training and extension, for 2 months. James Miller (USDA) or Robert Timm (University of California at Davis) has been suggested.

8. An international consultant, specialized in ecotoxicology, for 3 months. James Keith (DWRC) has been suggested.

9. An international consultant, specialized in population biology, for 3 months. Richard Dolbeer (DWRC) or John Wilson from the Centre for Biological Population Management of Queensland University of Technology, Australia, has been suggested.

10. An international consultant, specialized in damage evaluation, for 1 month. David Otis or Michael Jaeger (DWRC) has been suggested.

Terms of Reference modifications are as follows: In No. 1, the consultancy period is shortened from 12 to 9 months. It has been partitioned into two periods. In No. 4, biological control is partitioned into three, 1-month consultancies. In No. 7, the consultancy period has been increased from 1 to 2 months.

(End of the personal services modifications)

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Official Trips

- Official trips for the project will be conducted by international experts and FAO.

Subcontractor

- The preparation of the final report will be done at FAO headquarters.

General operating expenses

- Some general operating expenses in the SGBA include preparation of technical documents and reports.

Direct operating expenses

- This includes the direct operating expenses from the project at FAO headquarters.

Materials and supplies

- Acquire some materials and supplies for environmental impact of control at reproductive sites, up to U.S. $15,000.

Equipment

- Acquire of a vehicle, new sprayers, and some other necessary equipment for the implementation of the project, up to U.S. $40,000.

The national counterparts and the FAO specialist will help develop detailed material and equipment lists at the beginning of the project, without exceeding the authorized amount for these expenses on the project budget. With exception of the vehicle, the materials and supplies acquired for the Technical Cooperation Program (TCP) project will be transferred to the national counterpart organizations.

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Training

- Conduct technical training activities on integrated bird pests management at the SGBA.

V. REPORTS

During the first month of his consultancy, the international expert will prepare a detailed work plan for the implementation of the project with a time schedule for activities. During the project implementation, the expert will present at least one report concerning how activities have progressed.

At the end of his mission, each one of the consultants will present a brief technical document with the principal results, conclusions, and recommendations from his assistance.

At the end of the project, the international expert will present a general technical document to include the most important results, conclusions, and recommendations of the project as well as a proposal for a binational integrated bird pest management program and, eventually, a funding proposal.

Based on these documents and according to the regulations of the Technical Cooperation Program, he will draft a final project report to be completed at FAO headquarters and submitted to both governments.

VI. GOVERNMENTAL CONTRIBUTIONS

The Secretary of Agriculture, Livestock and Fisheries of Argentina (SAGYP) and the Minister of Livestock, Agriculture, and Fisheries of Uruguay (MGAP) through the CG (which will be the executive counterpart of the project) will provide for the participation of plant protection (departments?) in both countries and the collaboration of provincial governments, agricultural (farmer) associations, and other state and private institutions, which will make possible the support for the project. Regarding Argentine and Uruguayan contributions, the governments will:

a. Provide the facilities and logistical support to facilitate the activities of the international expert and cooperate with materials and human resources necessary to implement and develop the study of environmental risks associated with bird control in their reproductive sites.

b. Accommodate the specialist with local transportation.

c. Designate national counterparts necessary to facilitate the (work?) of the several international specialists missions.

d. Furnish international experts all the information (they need?).

BUDGET FOR THE FAO CONTRIBUTION TO THE PROJECT
(in US $)

Region: LATIN AMERICA AND THE CARIBBEAN

Countries: ARGENTINA AND URUGUAY

Country site: URUGUAY - Salto Grande Binational Area

Project title: Integrated control of bird pests

Project No.: TCP/RLA/8965(A)

10.	Personal services		$268,000
	- Experts and consultants	$260,000	
	- FAO technical support	8,000	
20.	Official travel		7,000
30.	Subcontractor (report)	1,000	
40.	General operating expenses		14,000
46.	Direct operating expenses		15,000
50.	Materials and supplies		15,000
50.	Equipment		40,000
80.	Training		20,000
	TOTAL		$380,000

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TERMS OF REFERENCE

International Expert Specializing in Integrated Bird Pest Management

Duration: 12 months

Location: Salto Grande Binational Area (SGBA), Salto, Uruguay

Activities:

Responsible for executing the program.

In cooperation with the Coordinating Group (CG), summarize all existing information and documentation about bird problems in Argentina and Uruguay.

Participate in obtaining all existing information regarding the bird pest problems in Argentina and Uruguay through visits and meetings with institutions, the public sector, and the private sector.

Take field trips to examine and fully understand the problems and make more accurate recommendations.

Develop a working analytical systematic model which will define and elaborate the systems for solving the bird pest problems in Argentina and Uruguay.

Identify technical, organizational, administrative, and coordinative restraints that might interfere with normal progress in solving the problem.

Coordinate and participate in developing a proposal for a binational integrated bird pest management program.

Coordinate the programming and supervise the development of studies aimed at looking at risks and benefits from controlling birds in their breeding areas.

Participate in organizing and developing the capability of an integrated pest management program for pest birds and also the capability to examine and elaborate on these bird pest problems.

Prepare the final report.

TERMS OF REFERENCE

International Consultant Specializing in Project and Program Development

Duration: 2 months

Destination: SGBA, Salto, Uruguay

Activities:

Analyze, jointly with the project leader and the CG, the existing information about bird pest problems in the Argentina/Uruguay region.

Propose the gathering and/or generation of additional information considered necessary for the development of an integrated bird pest management binational program proposal.

Jointly with the project leader, propose and analyze a strategy and logistic support toward the formulation or development of a funding proposal for the integrated bird pest management binational program.

In coordination with the project leader and with the support of the project consultants, develop a funding proposal.

Prepare a technical report including observations, conclusions, and recommendations.

TERMS OF REFERENCE

International Consultant Specializing in Chemical Control of Birds

Duration: 3 months

Location: SGBA, Salto, Uruguay

Activities:

Analyze all existing information and documentation in the region where the problems are occurring, and evaluate the impact and possible risks of chemical control methods currently being used in this area. Also, evaluate the effectiveness of these control methods and the current research.

After reviewing the prevalent situation, make a proposal on what chemical control methods should be used in this region of Argentina and Uruguay.

Participate in obtaining information and documentation, both national and international, that is necessary in developing a proposal for chemical control for a binational approach to integrated bird pest management.

Take field trips to examine and fully understand the problems that exist in Argentina and Uruguay.

Analyze, then propose, alternative chemical control methods for evaluation; then incorporate these methods into the integrated bird pest management program.

Identify the chemical control component needed to be incorporated in the integrated bird pest management program in agriculture.

Prior to its initiation, work with the specialists, consultants, and those responsible for the project in developing the integrated bird pest management program.

Work with the project leader and other specialists in conducting and executing the pertinent work toward the evaluation of alternate control methods on birds at their reproductive sites.

Participate in your capacity in developing the integrated bird pest management project by giving advice for chemical control.

Prepare a technical report with observations, conclusions, and recommendations that the chemical control component developed and used in the project will not have a negative social, ecological, or economic impact.

TERMS OF REFERENCE

International Consultant Specializing in Biological Control

Duration: 1 month

Location: SGBA, Salto, Uruguay

Activities:

Determine the current status of biological control being used in Argentina and Uruguay, and make recommendations of further considerations.

Participate in obtaining information and documentation, both national and international, that will be used in developing the biological and biotechnical component for the binational integrated bird pest management project.

Analyze all existing information and documentation in the region where the problems are occurring to make recommendations for biological control while considering the possible social and ecological impacts.

Take field trips to examine and fully understand the problems that exist in Argentina and Uruguay.

Analyze and propose alternative biological control methods to be evaluated and then incorporated into the integrated bird pest management program.

Identify the biological control component needed to be incorporated in the binational integrated bird pest management program.

Work with specialists, consultants, and those responsible for the project in developing the integrated bird pest management program.

Participate in developing the integrated bird pest management project by giving advice for biological control.

Prepare a technical report with observations, conclusions, and recommendations that the biological control component be used in the binational integrated bird pest management program and that new alternative methods be evaluated.

TERMS OF REFERENCE

International Consultant Specializing in Agricultural Systems

Duration: 2 months

Location: SGBA, Salto, Uruguay

Activities:

Analyze existing information in regards to agricultural systems and practices currently being used in the region.

Search for additional information, both national and international, to be used in developing integrated agricultural systems.

Take field trips in the area where the problems exist.

Analyze the prevalent situation in the problem areas in relation to current agricultural practices and bird pest problems.

Analyze and make recommendations for alternative agricultural practices (crop composition, which area to plant, planting times, varieties, crop rotation, etc.) in the region that are compatible with crop production and the integrated bird pest management project.

Be responsible for developing the crop systems component to be incorporated in the integrated bird pest management program in agriculture.

Work with those responsible for the project, including the specialists and consultants, in developing the integrated bird pest management project prior to its initiation.

Participate in your capacity in developing the integrated bird pest management project.

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TERMS OF REFERENCE

International Consultant Specializing in Training and Extension

Duration: 1 month

Destination: SGBA, Salto, Uruguay

Activities:

Analyze extension systems on plant pest problems of the region, particularly on bird pests.

Propose research and participate in the gathering of additional information necessary to both national and international levels about extension programs on integrated bird pest management.

Take perform field trips to the areas where problems occur.

Diagnose the situation in the problem area, relating it with the extension systems currently used regarding bird pest problems.

Be responsible for the development of an extension program on integrated bird pest management.

Collaborate with the project leader, specialists, and project and program development expert (Annex 1.2) on the development of the funding proposal.

Participate in training about integrated pest management and extension on bird pest problems and programs.

Prepare a technical report in Spanish about the observations, conclusions, and recommendations on activities performed and project proposals made toward the adequate performance of program activities in the extension component; and orient appropriate authorities about the necessity of reinforcing analysis and development as a basic strategy to solve problems related to integrated pest management in (agricultural?) production, protection, and commercialization programs.

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TERMS OF REFERENCE

International Consultant Specializing in Ecotoxicology

Duration: 3 months

Destination: SGBA, Salto, Uruguay

Activities:

Analyze the existing information and documentation about the regional problems, environmental impact and risks caused by the use of several bird control methods currently used, (evaluate or investigate?).

Propose information needs concerning the actual situation on toxic residues in the area.

Participate in the national and international (gathering?) necessary in order to establish the environmental component of the eventual funding proposal.

Visit areas in order to recognize and diagnose these problems.

Analyze and propose alternatives to be evaluated for incorporating them into the integrated bird pest management program.

Develop the environmental impact component for the integrated bird pest management program.

Collaborate with the project leader, the specialist in program and project development, and the project consultants in developing the funding proposal.

Participate in training activities about environmental (impact?) in integrated bird pest (management?) problems.

Prepare a technical report in Spanish with observations, conclusions, and recommendations to permit the development of an environmental impact component for the project.

Participate with the project leader and the rest of the consultants in the planning, execution, and evaluation of different studies to establish the environmental impact of different control methods in different sites.

TERMS OF REFERENCE

International Consultant Specializing in Population Biology

Duration: 2 months

Location: SGBA, Salto Grande, Uruguay

Activities:

Analyze existing information concerning the biology and population dynamics of the local bird pests.

Propose and participate in the gathering of national and international information to support the formulation of a binational program on bird pest management.

Conduct field visits for diagnosis of common problem areas in Argentina and Uruguay.

Analyze and propose research topics about biology and population dynamics on bird pests to be incorporated in an integrated bird pest management program.

Work with the project development, project manager, and other consultants on developing a funding proposal for bird pest management in the area.

Participate in training sessions on biology and population dynamics.

Prepare a technical report in Spanish containing the observations, conclusions, and recommendations about future strategies to be considered by the CG for assuring continuous studies on population biology to be used as a decision tool for future alternate control strategies.

Collaborate with the project leader in the planning and execution of studies evaluating the ecological impact of different control methods against bird pests in their reproductive sites.

TERMS OF REFERENCE

International Consultant Specializing in Agricultural Bird Pest Damage Evaluation

Duration: 1 month

Destination: SGBA, Salto Grande, Uruguay

Activities:

Analyze existing information about problems in the region and the economical and social impact (from damage losses) due to bird pests (doves, pigeons, parakeets) in agriculture.

Propose information currently necessary for (evaluating?; quantifying?) the negative impact due to bird pest problems in the binational agricultural area.

Propose and participate in the gathering of information necessary to diagnose the possible negative impact of bird pests.

Visit areas in order to recognize and diagnose the problem.

Develop the evaluation of the 'economic and social impact of bird pests' component in the program for integrated bird pest (management?).

Collaborate with the project leader, the consultant in program and project development, and other project consultants in the development of the funding proposal.

Participate in training activities concerning evaluation of the impacts (damage, losses etc.) caused by agricultural bird pests.

Prepare a technical report in Spanish with observations, conclusions, and recommendations, to assure that the evaluation of the impacts (economic and social) can be adequately developed for the (integrated?) bird pest management program.

TRIP REPORT*

HAWAII, BANGLADESH, and PAKISTAN

Computer Assistance and Training

February 6-March 10, 1990

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Unpublished Report

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ITINERARY

Date	Location	Activity
February 6	Denver, Colorado, to Hilo, Hawaii	Travel
February 7-9	Hilo	Help personnel at the DWRC Hilo, Hawaii, field station with various aspects of computers; problem-solving, setup, and training.
February 10-13	Hilo, Hawaii, to Dhaka, Bangladesh	Travel
February 14-March 5	Dhaka	Provide assistance to the Vertebrate Pest Section (VPS) in the use of the VPS Project's computer. Train Project personnel in the use of SAS and SAS/GRAPH. Assist Project personnel in establishing data sets for research results and in programming the most commonly needed statistical analyses and graphic presentations of data.
March 5-6	Dhaka, Bangladesh, to Islamabad, Pakistan	Travel
March 6-9	Islamabad	Provide assistance to the Vertebrate Pest Control Project (VPCP) in the use of SAS for storing, analyzing, and graphing research results.
March 9-10	Islamabad, Pakistan, to Denver, Colorado	Travel

OBJECTIVES

Hawaii

To provide assistance to Denver Wildlife Research Center (DWRC)/Mammal Control Research Section field station personnel in the use of computers, and provide training to scientists from the U.S. Department of Agriculture (USDA) and other governmental agencies in the use of SAS, a statistical package used for analyzing research data.

Bangladesh

To assist the U.S. Agency for International Development (USAID)/DWRC/ Vertebrate Pest Section (VPS) Project personnel in establishing data sets for research results and in programming the most commonly needed statistical analyses and graphic presentations of data and to train Project personnel in the use of SAS and SAS/GRAPH.

Pakistan

To provide assistance to the USAID/DWRC/Vertebrate Pest Control Project (VPCP) personnel in the use of a Project computer and training in the use of a variety of SAS statistical and data analysis packages.

HAWAII

Station personnel in Hawaii are familiar with computers. In particular, Mr. Robert Sugihara, biological technician (wildlife) with the Mammal Control Research Section, is very knowledgeable with computers and had set up equipment at the Hilo field station and had completed most of the basic work, which included setting up menus and batch files. However, there were some areas in which they either had no expertise or needed to expand their capability. Help and/or training was provided in the following areas:

Hard Disk Management

1. Tape system backup (6386)
2. File backup (6300)
3. System security
4. Organizing hard disk, directories, subdirectories

DWRC Utilities

The DWRC Denver-based Computer Services Project has developed many utility menus and packages to enhance the use of computers. Several of these were installed:

1. ANSWER--an XTALK (crosstalk) script program to automatically put a modem in ANSWER mode ready to accept incoming calls.

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2. REST--a small program to prevent print from being burned into the monitor when the microcomputer is left on, but unused, for long periods of time.

3. DOS Utilities--a menu-driven system to assist in the use of various DOS functions; i.e., copying disks, formatting disks, backing up specific directories, restoring deleted files, and changing directories.

4. FONTS--a menu-driven system for downloading soft fonts to the laser printer.

WordPerfect

Although the field station personnel had been using WordPerfect to do their word processing, there were some advanced features and applications with which they needed assistance:

1. Working with tables
2. Macros
3. Loading soft fonts in WordPerfect
4. Styles
5. Using mail merge
6. Graphics and text

LOTUS 1-2-3

The Hilo field station had not used Lotus 1-2-3 (a spreadsheet package) before and needed a training session to get them started in its use.

Telemail/XTALK

1. Transferring files between Hilo, DWRC, and field stations
2. Sending binary files via Telemail
3. Using Telemail commands

SAS

Work was done in the following areas:

1. A 1/2-day seminar was given to Hilo field station personnel as well as to personnel from the U.S. Fish and Wildlife Service in Hilo.
2. SAS/GRAPH: example graphs; labeling; and specifying fonts
3. Use of FSP (full-screen product) for data entry
4. Data manipulations
5. Creating reports from SAS datasets
6. SAS routines written by other users

BANGLADESH

The VPS Project in Bangladesh had purchased and set up an IBM PS/2 computer, but had never really used it. Project personnel had very limited knowledge and experience with computers. The software that had been installed included WordPerfect and Lotus 1-2-3. Dr. Frederick Knowlton, wildlife biologist from the DWRC Logan, Utah, field station, Predator Control Research Section, who was at Dhaka between January 15 and February 17 consulting on predator-prey relationships previous to my arrival, had worked a little with the Project personnel in the use of these computer software packages.

Hard Disk

The computer has a 60-mg hard disk. DOS will only work with hard disks of up to 32 mg. Computers with hard disks larger than that have to be partitioned into logical disk drives. This had not been done prior to my arrival, so the first thing I did was to save all the data files and then repartition the hard disk. Next, I reinstalled the programs and user files, putting all the program files on one partition and all the user files on the other partition. This is a more efficient way to set up a computer, as it keeps the program files from being inadvertently deleted and leaves a lot more room for user-created files.

I then set up a system of menus to make the computer as "user friendly" as possible. The menus allow the user to choose which program to use (see Attachment 1) and in some cases bring up a submenu to make further choices. I installed all the programs listed on the menu and provided instruction and/or training for each of the programs.

WordPerfect

WordPerfect is a word processing package used for writing reports and correspondence. Dr. Knowlton had worked a little with Project personnel on the use of this package. When I reinstalled WordPerfect, I also installed an on-line tutorial. The Project personnel felt that they would be able to learn WordPerfect by using the tutorial and by going through the lessons in the workbook provided by WordPerfect. However, as a means of giving them a little more experience, I had them use WordPerfect to write SAS code until the SAS package was installed and to edit format lines in the HOME RANGE package.

Lotus 1-2-3

Lotus 1-2-3 is a spreadsheet package. It is set up in a column and row format, which is a logical format for entering data; it is the primary program used at Denver for inputting data. Dr. Knowlton had been working with Project personnel prior to my arrival regarding inputting their data using Lotus 1-2-3. I worked with them a little to expand their knowledge of this package. They felt they could learn the use of this package by

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using the tutorial provided in the manual. This package does not have an on-line tutorial. Just before my departure from Denver, we received a new version of Lotus (Lotus 2.2), which I took to Bangladesh to install. I was unable to provide a manual for the new version at that time, but the one they already had contained all the necessary basic information. I ordered a new manual for them upon my return to Denver.

HOME RANGE Program[1]

I installed a HOME RANGE program that was recommended and used by Dr. Knowlton. This program uses radio-tracking data to determine the home range of an animal. I set up a menu-driven system to make it easy to use (Attachment 2) and wrote a user's manual to assist in its use (Attachment 3). I also created a Lotus spreadsheet template for the input of data. The template is a read-only file that can be retrieved and used to input the data into specific columns that can be read by the HOME RANGE program.

SAS

I installed SAS (Statistical Analysis System) and provided training to Project personnel (Parvin Sultana and Rajat Pandit) in the basics of SAS. Because of a problem encountered with the disks containing the SAS program, a good copy of the program was not received until 2 days before my departure from Bangladesh; thus only 2 days of on-line training could be provided. However, before SAS arrived, the Project personnel learned to write the code to do much of the basis SAS manipulations, using their own data to set up the code. When SAS finally arrived, they used these programs.

SAS is the most versatile, widely-used package for agricultural research type data. It is the package used by the statisticians at Denver and at many other research centers. It is being used in most of the major universities for data analysis, and thus is the statistical software being learned and used by many researchers currently coming out of universities. SAS is a little more difficult to learn initially; but once it is learned, SAS is better able to handle a more diverse type of data and thus handle types of analyses that other systems cannot. Now that SAS has been installed, DWRC and VPS personnel can jointly work on programs/projects using SAS and mail disks or other related materials to and from Dhaka.

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[1] Samuel, M. D., D. J. Pierce, L. J. Nelson, and K. R. Dixon. 1985. User's Manual for Program HOME RANGE. University of Idaho, Forest, Wildlife, Range Experiment Station. Technical Report 15. 69 pp.

Samuel, M. D., and E. O. Garton. 1985. Home Range: A weighted normal estimate and tests of underlying assumptions. Journal of Wildlife Management 49:513-519.

SAS is a large system--to install the whole system requires 20 mg of disk space. It includes many modules: the ones I installed included the BASE system, which is what is used to put raw data into SAS data sets and manipulate the data; SAS/STAT for doing the statistical analyses; SAS/GRAPH for creating graphs; SAS/FSP, a full-screen product used for entering data into SAS data sets and editing the data; and SAS/AF, for creating menu-driven systems within SAS. The last two products are a little more sophisticated to set up and are usually only used by application programmers; but by installing them on the system, it allows us to develop applications at Denver and mail them to Dhaka.

SAS is a licensed product, which means it has to be renewed each year, or else it will expire after a certain date. Currently, DWRC is maintaining a SAS license. Each year, after the license is renewed, DWRC receives instructions and a code from the SAS Institute, Inc., enabling us to extend the expiration date. As long as DWRC has its license and is providing support to the VPS Project, DWRC can continue to send the updated information to Dhaka.

Even though Project personnel received only 2 days' training in SAS, I felt the work we had done should have been enough to allow them to get started with SAS by using an on-line tutorial system. However, more training is needed. A summary of SAS training opportunities is given later in this report. On returning to DWRC, I ordered and mailed all the necessary manuals.

Data Forms: One of the things we worked on while I was in Dhaka was setting up a way of entering data collected from the "Rodent Control Questionnaire." The nature of the questionnaire was such that the data collected from it could not be entered using Lotus. I felt the best way to handle entering the data was to set up a data entry screen using SAS/FSP. However, the form that had been set up had problems for entry into any type of a data set. It was agreed that the form would be redesigned and the new form sent to me in Denver, so I could set up the data input screen and send the program and user instructions back to Dhaka.

ProCite

ProCite is a bibliographic data search and retrieval system used by DWRC personnel both in Denver and its field stations. I installed the ProCite system and worked with Project personnel on its use. No manual had been provided with the software, so all training was based on my limited knowledge of the package. On my return to Denver, I requested that the DWRC Librarian (Diana Dwyer) send a copy of the manual to Bangladesh.

WordPerfect Tutorial

As noted under WordPerfect, I installed the WordPerfect tutorial/workbook package and set it up as a menu item, to allow Project personnel further training.

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DOS Utilities

DOS is the operating system for the microcomputer. To make it easy for microcomputer users not familiar with DOS to be able to use some of the DOS features most needed, we had created a menu-driven system at Denver which I set up on the Project computer. This system features the following:

Copying from one floppy disk to another (including from one size disk to another).

Formatting all sizes of floppy disks

Backing up to a floppy disk (in case there is a problem with backing up to a tape)

A hard-disk manager utility that allows the user to change directories, sort directories, restore deleted files, and copy information from floppy disks to the hard disk.

A floppy-disk manager utility that allows the user to change directories, sort directories, and copy information from floppy disks to the hard disk.

Tape Backup

The IBM has a 40-mg tape backup unit attached to it. It had never been used, and there were no instructions provided with it. I had used tape backup software on other systems and, by trial and error, was able to work my way through a series of menus that finally allowed me to attempt to back up the hard drive. However, I got an error message that seemed to indicate a bad tape. Only one tape had been provided, so there was no way to verify that it was bad and, without a manual, no way to check on the error message. We requested another tape and a user's manual from the dealer who had furnished the computer; he was willing to supply a manual, but indicated a new tape would cost around $100. The manual he provided, however, was for the setup of the unit and did not include instructions on running it. A new tape and user's manual were requested from Denver. They finally arrived 2 days before I left Bangladesh. In that time I was able to back up the hard disk onto the new tape and set up a menu-driven system for using the tape backup system.

It is important that a computer be backed up regularly in a country where the power system is unstable. The Project should get more tapes and use a system of rotating each set of backup tapes. That way, if one tape goes bad, there are others available.

TRAINING

The best way to learn a package is to take some initial training, work on the system for awhile, and then take more training. Initial training was

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provided for everything installed on the computer. Additional training is needed for some of the packages.

WordPerfect and Lotus

As I indicated previously, on-line tutorials and/or manuals for WordPerfect and Lotus 1-2-3 were provided so that the Project personnel could work on their own to learn these systems. Computers located at both the Bangladesh Agricultural Research Institute (BARI) and the Bangladesh Rice Research Institute (BRRI) contain these software packages, and personnel at both BARI and BRRI are familiar with their use. Either of these places would be a good resource should our Project personnel desire further assistance with WordPerfect or Lotus.

SAS

I provided initial training although, because of not enough time and the problem of getting SAS installed, not as much as I would have liked. After VPS personnel have had a chance to work with the system for awhile, they will need more training.

I have looked into several options for their SAS training.

(1) Travel to a SAS subsidiary.

SAS has subsidiaries all over the world. The closest subsidiaries to Bangladesh seem to be Hong Kong and Singapore. There are also subsidiaries located in Japan, Malaysia, Australia, and New Zealand (see Attachment 4). Some of these may provide SAS training.

(2) Have SAS send a trainer to Bangladesh.

While in Bangladesh, I talked to people from several organizations (e.g., BRRI, CHECCHI) who showed interest in SAS; in some cases, they were actively engaged in trying to get SAS and install it on their computers. If there are enough people interested in SAS training, it might possibly be cost-effective to have SAS send someone to provide training. It would probably take 20-25 people, however, because it would cost many thousands of dollars to provide this type of training. When SAS provides training, they usually provide the computers for the training. That might prove a problem in Bangladesh. It would have to be coordinated through the closest SAS subsidiary to Bangladesh, so right now a lot of questions are unanswered.

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(3) Computer-based training.

Computer-based training allows the user to sit at the computer and follow instructions on the screen. A course guide is provided to assist with the training.

There are 7 computer-based courses available through a license agreement that would cost $195/course for the first year and $95/course for each succeeding year. However, if 4-5 courses are licensed, there is a 10% discount; if 6-7 courses are licensed, there is a 15% discount. That is very cheap training.

(4) Video-based training.

Video-based training uses videotapes to provide the training instructions. Workbooks and diskettes with practice data files and programs are also provided.

There are 9 courses available for the video-based training. They are provided on a license basis, ranging from $1,000-$2,000/course for the first year, and $750-$1,500/course for each succeeding year. There are discounts available for licensing multiple courses. Because there are more courses, more subjects are covered.

SAS also has several video tutorials, which are sold, not licensed. They cost $195/course; additional copies are $95 each. There are discounts available for multiple purchases. However, these tutorials are for more experienced SAS users and do <u>not</u> cover the SAS basics.

I have discussed all of these options with the SAS Institute, Inc., in Cary, North Carolina; they suggest that the most cost-effective training would be the computer-based training. SAS is sending a course outline and demo diskettes with samples of the computer-based training. We can look at the training program here in Denver and also send it to Bangladesh personnel for their opinions.

The training I provided was strictly in writing SAS code to set up SAS data sets and use the elementary type of statistical procedures: e.g., PROC MEANS, PROC FREQ. Even the types of training recommended above only provide training in these same areas. To really be able to get the full benefits of SAS, a statistician should work with Project personnel on the ways to set up studies and use SAS to do more complicated analyses. I, therefore, recommend that a TDY be set up for a statistician to visit the Project. Also, I recommend that I make a followup TDY after about a year. From prior experience, I know that, even with training provided by one of the above methods, there will be problems and questions after that period of time that will need to be answered. Furthermore, I recommend that a room more compatible than the current one be established for computer use and learning.

PAKISTAN

The Pakistan VPCP has computer people (including Ejaz Ahmad) knowledgeable in its use. No help was needed in setting up equipment or in training personnel in its basics. Training in some of the more popular packages (e.g., WordPerfect and Lotus) is available in Pakistan. I installed two software packages (Lotus 2.2 and SAS) and trained Project personnel in the use of SAS.

Lotus 1-2-3

Just before my departure from Denver, I received copies of the new version of Lotus 1-2-3 (Lotus 2.2), which the Project had not received; so I installed it on their computer while I was there and gave a short presentation on the new features.

SAS

Although the Project has had access to other statistical packages, these packages were unable to provide the types of analyses required. One of the scientists associated with the Project had used SAS while obtaining his Ph.D. in the United States and felt SAS was the package they needed in Pakistan. However, all his experience with SAS had been on a mainframe, and he needed training in the use of SAS on a microcomputer. As in Bangladesh, no local training was available. I installed SAS and provided training to Project personnel in its use.

FOLLOWUP

I ordered and mailed SAS manuals to all field stations and sent computer materials, including diskette holders and printer stand, to Bangladesh. The SAS manuals included the following:

SAS Language Guide for Personal Computers
SAS Procedures Guide
SAS Applications Guide
SAS Guide to Macro Processing
SAS/FSP User's Guide
SAS/GRAPH User's Guide
SAS Technical Report P-190, Update to SAS/GRAPH Software
SAS/IML (Interactive Matrix Language) Guide for Personal Computers
SAS Technical Report P-172, Changes and Enhancements to SAS/IML
SAS/STAT User's Guide
SAS Technical Report P-179, Additional SAS/STAT Procedures

Attachment 1

DENVER WILDLIFE RESEARCH CENTER
VERTEBRATE PEST SECTION
BANGLADESH AGRICULTURAL RESEARCH INSTITUTE
JOYDEBPUR, BANGLADESH

****

1. WordPerfect
2. Lotus 1-2-3
3. Home Range
4. SAS
5. ProCite
6. WordPerfect Tutorial
7. DOS Utilities
8. Tape Backup

****

A:\>

```
*****************************************************************
*                                                               *
*                      HOME RANGE PROGRAM                       *
*                                                               *
*****************************************************************
*                                                               *
*              1.  Create data file                             *
*              2.  Add headers to file                          *
*              3.  Edit home range file                         *
*              4.  Run home range program                       *
*              5.  Run plot program                             *
*              6.  Print home range output                      *
*                                                               *
*              R.  Return to main menu                          *
*                                                               *
*****************************************************************

A:\HRDATA>
```

GENERAL INSTRUCTIONS

The following are conventions used throughout the HOME RANGE program instructions:

(1) Brackets < > around a word of letter indicate a key to be held down; do not type the word.

(2) Italicized words (*filename*) indicate that the user should supply his own word in that place.

(3) Lines that are centered and bolded indicate messages that should appear on the screen.

(4) Everything in boxes are keystrokes to be entered at that point.

HOME RANGE PROGRAM

1. <u>Create data file</u>

The data portion of the home range file is created in LOTUS, where there is a form file created to allow you to fill in your data and save it for use in the home range program.

- Choose Option 1 from the menu.

- Change to HRDATA directory

```
/ F D hrdata <ENTER>
```

- Retrieve form file, HRFORM

```
/ F R
```

- Highlight HRFORM.WK1 and press <ENTER>.

- Fill in the data in the proper columns. The column widths as set up in the form file should <u>not</u> be changed, as they are set to correspond to the way the program will read the data.

- Be sure to save the filled-in spreadsheet under a <u>different</u> <u>name</u>, not as HRFORM.

```
/ F S filename <ENTER>
```

- If you try to save the file as HRFORM, you will get an error. If this happens, clear the error message

```
<ESC>
```

and save the file again, using a different name.

- Then save the data as a DOS file, using the same *filename* as the spreadsheet file:

```
/ P F filename <ENTER> R
```

- Highlight the range of data to be saved; do <u>not</u> include the column titles at the top.

<ENTER> G Q

- Exit LOTUS

2. <u>Add headers to file</u>

Choose Option 2.

This option adds the header information to the data file created in LOTUS.

As per the instructions on the screen:

> Type DT followed by the name of the print file created in the HRDATA directory of LOTUS (eg, dt jackal).

Use the *filename* the print file was saved under in LOTUS.

```
dt filename <ENTER>
```

A few messages will flash by, then the menu will return to the screen.

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3. Edit home range file

Choose Option 3.

The following message will appear on the screen:

> Remember, to retrieve your file, use <ALT><H>.
> To save your file, use <ALT><S>.
>
> Press any key to continue . . .

You will be in WordPerfect. Do not try to retrieve a file using 'Retrieve' or 'List Files.' Instead, hold down the <ALT> key, and keeping it depressed, press H.

<ALT><H>

You are editing the file for 2 reasons:

(1) To enter the proper information in the header cards. The instructions on the information in these cards can be found in the "User's Manual for Program Home Range."

When changing the information on the header cards, be sure to keep it in the same columns as the original. If you should make a mistake, and are not sure what the proper columns are, exit the editing program and recreate the file using Option 2.

The information on the FORMAT line should not be changed.

(2) To remove any blank lines. This is important. The program won't run if there are any blank lines.

Place the cursor on the first blank line (under the FORMAT line), then press <DELETE> until all the blank lines are removed.

Move through the document using <HOME><DOWN> until you have found and removed all the blank lines.

To save the file, do not use the 'Exit' key. Instead, hold down the <ALT> key, and keeping it depressed, press S.

<ALT><S>

This will save the file as a DOS file and return you to the Home Range Menu.

4. Run Home Range Program

Use this option only after creating the home range file (#2) and editing the file (#3).

Choose option 4; the following prompt will appear,

WHAT IS THE NAME OF INPUT FILE? E.G. B:ANIMAL.DAT ==>

Type

hrdata.dat <ENTER>

The next prompt asks,

Do you want to output harmonic values
from grid to file for later plotting? [y|n]

Type

y <ENTER>

The program next prompts,

Do you want to output animal locations
for plotting in consecutive order? [y|n]

Type

y <ENTER>

After generating some lines of output, the screen will emit a beep and the next prompt will appear,

ENTER AN 8-DIGIT SEED FOR RANDOM NUMBER ==>

Type in any 8-digit number, ie

12345678 <ENTER>

When the program ends, you will receive the prompt,

DO YOU WANT TO RUN THIS PROGRAM AGAIN? [Y|N]

Type

n <ENTER>

Do <u>not</u> try to rerun the program from here. If you do want to run it again, run it from the menu.

5. Run Plot Program

This option can only be used after running the plot program (#4).

Choose Option 5.

The HPLOT screen will appear with the following prompt at the bottom

press any key to continue

Press any key

The DISCLAIMER OR WARRANTY screen will appear with the following flashing message at the bottom

Press SPACE BAR to continue or ESC key to quit

Press

<SPACE BAR>

The INTRO menu will appear at the top of the screen with the following options:

Setup Menu Info Quit

Type

M

A new menu will appear with the following options:

Graph Plot Files ChDir Shell Quit

Type

E

When the next menu appears,

Low High ColorEGA MonoEGA EmulHGC Quit

Type

C

The program will next prompt for the name of the data file:

Name of input data file :

Type

hrdata.plt <ENTER>

And the plot should appear on the screen.

NOTE!! If you should get the following error message:

Data File Format Error

reset the computer by holding down the following keys at the same time:

<CNTL><ALT><DELETE>

and run the Home Range program again (Option 4).

To print a copy of the plot, press

<Print Screen>

When finished viewing the plot, press

<SPACE BAR>

When the following menu appears,

Graph Plot Files ChDir Shell Quit

Type

q

Following a beep, a new menu will appear with the options

No Yes

Type

y

And you will be returned to the menu.

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6. <u>Print home range output</u>

Before using this option, you should have run the home range program (#4).

Choose Option 6.

If, after choosing this option, you see the message

Name of list device [PRN]:

Press the <ENTER> key.

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Program Activities, Progress, and Future Action Plans for Cooperative Denver Wildlife Research Center Projects in Bangladesh and Pakistan

BANGLADESH and PAKISTAN*

Richard L. Bruggers
Chief, International Programs Research Section
February 28-March 24, 1990

Michael W. Fall
Chief, Predator Control Research Section
March 10-24, 1990

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ITINERARY

Date	Location	Activity
Richard L. Bruggers		
February 28-March 2	Denver, Colorado, to Dhaka, Bangladesh	Travel
March 2-9	Dhaka, Bangladesh	Project administration
March 10	Dhaka to Islamabad, Pakistan	Travel
March 10-22	Pakistan	Project administration and review
March 23-24	Islamabad to Denver, Colorado	Travel
Michael W. Fall		
March 10-12	Denver, Colorado, to Islamabad, Pakistan	Travel
March 12-22	Pakistan	Project review
March 23-24	Islamabad to Denver, Colorado	Travel

OBJECTIVES AND ABSTRACT

In Bangladesh, the main objectives were to (1) determine if U.S. Agency for International Development (USAID) funding support for the DWRC Vertebrate Pest Project would continue beyond October 1990 until June 1993 (the current termination date) and, if so, (2) identify appropriate short-term technical assistance to support the work plan. In Pakistan, the main objectives were to (1) develop with DWRC Project Leader and Project scientists a work plan for the period of July 1990 to June 1991, and (2) identify the critical issues that will be unresolved when the Project ends in July 1991.

BANGLADESH

Vertebrate Pest Project Overview

DWRC technical assistance to the Vertebrate Pest Section (VPS) in the Bangladesh Agricultural Research Institute (BARI) through funding support by AID/Dhaka began in December 1978. The specific objectives of this Project have been to identify vertebrate pest problems, evaluate control techniques, develop strategies to manage vertebrate pests, and train staff and develop an institutional identity for VPS. The ultimate project goal is to institutionalize a vertebrate pest management (VPM) research capacity in Bangladesh.

Three DWRC project leaders have held resident positions since 1978: Mr. Richard M. Poché (December 1978-1980), Mr. Joe E. Brooks (1981-1985), and Dr. Michael M. Jaeger (1986-1990). Dr. Jaeger will return to DWRC in October 1990 and will not be replaced with another resident DWRC project leader. The main purpose of my TDY was to determine if AID/Dhaka intended to continue to support DWRC technical assistance to the VPS and, if so, to work with the Project Leader and counterpart scientists to formulate a technical assistance technology transfer plan for the period October 1990 to June 1993 in support of the project Work Plan.

The main issue of continued AID/Dhaka support was resolved in a Project Review Committee (PRC) meeting held on March 9, 1990. The bases for this PRC meeting were the recommendations for an External Project Review, sponsored by AID/Dhaka in June and July 1989 at both DWRC headquarters in Denver, Colorado, and at the Project site in Dhaka. The USAID/PRC meeting included the following participants: Director and Deputy Director of Food and Agriculture, the Environmental Officer, the Program Officer, the Project Review Specialist and the two Agriculture Development Officers who have been responsible for this Project. The meeting was chaired by Dr. Phil Warren, the current AID/Dhaka Project Manager. Dr. Jaeger presented a summary of Project activities and current status (Attachment No. 1) and recent developments in the Government of Bangladesh (GOB) formulation of a draft National Action Plan for Rodent Control in Bangladesh and the rationale for continuing to support the Project. This Action Plan, if approved, would implement annual control campaigns from July through

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October. During July to August, control efforts would be oriented to reduce postharvest losses in rice stored in farmers' houses. During September to October, control efforts would be oriented to reduce preharvest damage in aman rice, wheat, and boro crops, and postharvest losses in stored aman paddies. Field control will target burrowing rats in fields, embankments, roads and railways (Attachment No. 2).

The recommendations from the USAID/PRC were the following:

- continue Project activities through June 1993;
- support establishment of the VPS as a separate division;
- develop and implement the national rat control plan;
- improve VPS office and research facilities; and
- provide formal and informal training to VPS staff and other BARI staff, as appropriate, to strengthen the GOB vertebrate research effort.

As a result of these recommendations, the remainder of the TDY was spent working with Dr. Jaeger, VPS counterpart scientists, and Head of the Section, Dr. Abdul Karim, in various aspects of developing a short-term TDY technical assistance schedule and identifying and programming the necessary resources to carry it out. In general, DWRC assistance will focus on (1) developing and implementing programs to monitor crop losses, (2) evaluating the effectiveness of the Department of Agriculture Extension (DAE) training of block supervisors, and (3) following the use, quality, and potential environmental impact of rodenticides. If this activity is successful, the GOB/USAID/DWRC Project will have

- provided techniques to improve control of rodent damage;
- incorporated these techniques into an effective, environmentally sound control strategy;
- assured farmer use and acceptance of the strategy; and
- worked with GOB officials to assure that the strategy is recommended and implemented nationally.

Other Activities

The termination of the resident DWRC Project Leader position is going to result in numerous logistical concerns that will need to be addressed if the VPS field activities are to be maintained and implemented effectively through short-term DWRC TDY's until 1993. Among others, consideration should be given to hiring a Foreign Service National (FSN) as a logistics coordinator and maintaining at least one of the current AID-supported drivers to provide reliable transportation to both VPS staff and TDY scientists.

A variety of other issues will also need to be resolved in this final 2½ years if a VPM capability is to be institutionalized at BARI. Many of them are identified in Attachment No. 1 and include:

- establishing the VPS as a division;

- clarifying the use of PL-480 funds for VPS operating expenses;

- improving facilities and equipment (such as constructing a bioassay room, purchasing additional computers and setting up a computer room, furnishing the library and conference room, accessing the use of the generator in the adjacent building);

- providing additional training in computers, scientific design, and research management (such as in-country SAS and OICD management courses to Project scientists, and word processing training to the Project secretary);

- developing professional linkages between VPS scientists and other national research institutes (such as timely exchange research tours);

- maintaining of longer-term, problem-oriented research (for example, the work Mr. Rajat K. Pandit recently initiated with the assistance of Dr. Frederick F. Knowlton, DWRC Predator Control Research Section); and

- analyzing data and publishing of quality research findings (between 7-10 scientific documents need to be published in a timely manner to disseminate the most recent findings of the Project).

Finally, many Project activities have taken place since Dr. Bruggers' April 1989 TDY, the most important of which was the successful completion of a large-scale rodent control demonstration in rice between September and November 1989. Preliminary results of this demonstration reconfirmed the efficacy of zinc phosphide bait cakes and Phostoxin®[1] fumigants as control methods, reconfirmed the efficacy of the control strategy and clearly showed that farmers can implement it effectively when provided with good quality rodenticides. This large-scale demonstration has led to the establishment of the National Rat Control Action Plan.

A second important development has been the initiation of a mechanism to make PL-480 funds available to the VPS to meet recurring expenses and hopefully permit its scientists to continue intensive field research and implementation activities. Other activities during this time period included the External Review, technical assistance TDY's in the area of rodent control (Mr. Lynwood A. Fiedler), extension evaluation (Dr. Robert M. Timm), predator research (Dr. Knowlton), and computer data base training (Ms. N. Paige Groninger). In addition, Mr. Pandit, [VPS/ Scientific Officer (SO)] received training in many aspects of predator research at DWRC and its field station in Logan, Utah.

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[1] Reference to trade names does not imply endorsement by U.S. Government.

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PAKISTAN

Vertebrate Pest Control Project Overview

The USAID/Government of Pakistan (GOP) Vertebrate Pest Control Project (VPCP) with DWRC was initiated in March 1985. DWRC Project Leader, Mr. Joe E. Brooks, arrived in November 1985 under GOP/USAID Post-Harvest Management Component of the Food Security Management (FSM) Project. During Dr. Bruggers' April 1989 TDY to Pakistan, USAID expressed a desire to continue to extend support to the VPCP from June 1990 until October 1993 under the framework of the Management of Agricultural Research and Technology (MART) Project. The original objectives of this current TDY to Pakistan had been to (1) evaluate the past Project activities and accomplishments (1986-1990) and (2) develop detailed strategies, work plans, and benchmarks for this follow-on Project. However, in late February 1990, it was learned that funding would not be available for continuing this vertebrate pest management activity under MART, but that resources were available to continue it through June 1991 under FSM. As a consequence, the TDY objectives were revised to (1) identify and prioritize Project activities for the period of July 1, 1990, to June 30, 1991, and develop a Scope of Work to implement them and (2) identify critical needs that will be left unresolved when the Project terminates in June 1991. Dr. Fall, who worked for the DWRC International Programs Research Section (IPRS) from 1970-1981 and who helped design several DWRC overseas projects, joined Dr. Bruggers in Pakistan to assist in this review of Project activities.

The Scope of Work for the remaining time period (Attachment No. 3) emphasizes identifying needs and developing mechanisms to institutionalize VPM at the National Agricultural Research Centre (NARC), and completing ongoing research and technology transfer. DWRC activities during this time period will continue under the supervision of Mr. Brooks. Mr. Brooks will be based in Denver beginning in June 1990, but he will make three lengthy TDY visits to Pakistan during this period and will be supported by technical assistance and administration TDY's to the Project by four other DWRC scientists.

The staff discussion of unresolved critical issues (Attachment No. 4) outlined the sustainability issues of institutionalization, technology development, and information transfer that are important if USAID and the GOP are to fully realize a return on their substantial investments in improving the management of vertebrate pest to agriculture. During the final year of activities under the Project, DWRC staff will continue discussions with GOP and USAID personnel to assure that these longer-range issues can be resolved by continuing efforts by Pakistani scientists.

Other Activities

During this TDY, the VPCP, under the auspices of NARC, was holding its sixth 2-week training course on Vertebrate Pest Management; the VPCP has provided VPM training to over 100 individuals. This course has been held annually during the life of this Project. Topics covered included the

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biology, pest status, and management of rodents, porcupines, parakeets, and wild boar; public health concerns of vertebrate pests; and audiovisual techniques and other aspects of information disseminations and extension. Nineteen individuals representing agriculture research institutes, universities, Ministry of Agriculture, the military, and airports participated in the course. The course instructors were the scientific staff of the VPCP and scientists of the Pest Management Research Institute (PMRI) and Faisalabad University.

The VPCP is also involved in improving the skills of rural women in vertebrate pest control through the USAID-sponsored Farming Systems Research (FSR) Project. We were briefed on the objectives of this activity by NARC personnel, Mrs. Bushra Tariq and Mrs. Naheed Mahmood, who are studying the present pest control and grain handling methods and evaluating the current skill of women in poultry husbandry and pest control techniques. Farm women are being trained in the identification of pest species, the proper storage of grain, the safe use, handling and storage of pesticides and fumigants, and the correct methods of controlling insect and vertebrate pests. Since October 1989, 165 women from two villages have received this training.

Discussion were held with Dr. Abdul Latif Rao, Pakistan Conservator of Wildlife, at his request, to discuss concerns about the burgeoning population of urban house crows (*Corvus splendens*). It seems likely that between 1-10 million crows are roosting and foraging in and around Islamabad and Rawalpindi and causing both public and possibly wildlife impacts. It was agreed that a short-term consultancy is needed to assess this concern (Attachment No. 5).

Visits were made to Fateh Jhang to look at wild boar habitat and discuss damage to wheat and boar control demonstration activities with local farmers, and to Faisalabad to meet Dr. M. A. Beg, Dr. M. H. Khan, Dr. A. A. Khan, and many of their 20 graduate students, to discuss their VPM research activities. These activities are partially supported by the USAID/VPCP. This support, which has been provided this university since 1987, has resulted in an aggressive complementary applied research program on many aspects of several vertebrate pest species, including parakeets, sparrows, boar, rodents, and porcupines. To date, about 22 individuals have received M.Sc., M.Phil, or Ph.D degrees, and another 27 are currently enrolled; six scientific publications already have been generated. This activity is filling an increasingly valuable role in providing individuals trained in VPM to the agriculture and wildlife community. So far, six individuals have obtained positions in wildlife pest management or wildlife related areas.

Meetings also were held with Dr. M. Hanif Qazi (Member, Crop Sciences), Pakistan Agricultural Research Council (PARC), and Dr. C.M. Anwar Khan, Chairman, PARC, to brief them on current and planned project activities. During these meetings, discussions focused primarily on the issues of VPM institutionalization, but also covered public sector involvement in manufacturing and distributing rodenticide baits, public sector representation in the current VPM training course, and the potential nontarget hazards of wild boar baiting.

Finally, many other ideas were discussed that would be potentially valuable to initiate, depending on time and personnel availability during the final year. These include:

1. renovating the Project warehouse area for an animal (primarily rodent) holding and testing facility and obtaining additional laboratory and office space;

2. making the necessary arrangements to fill any positions that could become vacant with the departure of USAID counterpart staff as AID/Islamabad support ends in June 1991;

3. arranging a research study tour to the United States for Mr. A. Aziz Khan, Head of the VPCL/PMRI;

4. inquiring into the process for registering an anticoagulant grain bait for wild boar with the Pesticide Agriculture Advisory Committees, Ministry of Agriculture;

5. requesting PARC to change the annual dates of the 2-week Vertebrate Pest Training course from March to April so as to provide the time needed to attract more international participants as well as reduce the probability of rains which make field work impossible to conduct;

6. installing an international telephone line and modem at the VPCP office to permit direct computer contact between VPCP and DWRC;

7. developing a video tape presentation that highlight the VPCP activities and accomplishments; and

8. providing additional DWRC technical assistance in several areas including:

   (a) preparing pelletized anticoagulant grain-based baits for wild boar;

   (b) reviewing of Ph.D. research proposals of Mr. Shahid Munir on the mode of action and environmental fate of rodenticides and of Mr. Ejaz Ahmad on the ecology and management of wild boar. Both individuals will begin Ph.D. programs at Punjab University at Lahore in 1990;

   (c) analyzing the purity of locally available zinc phosphide technical material;

   (d) training VPCP staff in study skin preparation;

   (e) transferring equipment and materials to the VPCP;

   (f) providing new or replacement equipment and reprints, publications, and other technical information;

   (g) consulting on statistical aspects of planned research and scientific publications; and

   (h) sectioning teeth to determine the age of wild boar.

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VERTEBRATE PEST COMPONENT

ARP SUPPLEMENT

Project Status: A Summary

by

Michael M. Jaeger

March 6, 1990

This briefing document summarizes the status of the project in terms of achieving its main objectives:

- developing and implementing technology to substantially reduce losses to vertebrate pests, and
- assuring the maintenance and sustainability of a functional and self-sufficient vertebrate pest management capability at BARI.

I. Developing andImplementing Vertebrate Pest Technology

The researchprocess necessary to resolving the principal vertebrate pest problem in Bangladesh, rat damage in Aman rice, is now in its final stages. A National Plan ofAction to implement the technology has recently been drafted with the DAE/MOA. The major accomplishments in achieving this Action Plan will be briefly described.

Principal Pest Problem

Preharvest damage to rice and wheat by burrowing rats is the principal problem, and has been the focus of research efforts during the ARP II Supplement. Projected annual losses to these two crops range from 200,000 to 450,000 metric tonnes annually. Additional sources of rodent damage include postharvest losses in farmers homes, preharvest losses to potatoes,pulses, sugarcane, coconut and a variety of other fruits and vegetables, as well as structural damage to embankments and foundations. These losses have not been adequatly quantified. Other vertebrate pest problems of importance include depredation of livestock and poultry by predators such as jackals, and bird damage to sprouting wheat and a variety of ripening fruits. Research on the postharvest rodent and predator problems also has been undertaken during this period.

Control Methods

Through extensive field tests, rodenticides have been identified that are effective and practical under Bangladesh conditions. These include both poison baits and a toxicant fumigant which when used in burrow systems at the recommended dosage and during the proper time of the year can be extremely cost effective and environmentally safe.

Good quality rodenticides of the recommended concentration and dosage of the active ingredient have not previously been available in Bangladesh. The problems of quality control and adulteration of zinc phosphide were found through chemical analysis at DWRC. This serious concern was brought to the attention of the MOA/DAE which has recently taken steps to correct the problem, including the registration of three pre-formulated rodenticides which had been tested by the project, and are referred to above.

Control Strategy

An annual strategy has been developed for when and where postharvest rat control can be the most cost-effective in the agroecosystem of Bangladesh. This was necessary because the long-term reduction of rat numbers has been found to be impractical due to very high population growth rates, and therefore recovery rates, characteristic of rodents. This strategy recommends that control be conducted only once annually and that it be focused during September-October, prior to flowering of the aman rice crop, and that it be done cooperatively by all the farmers in an area. If the control is done effectively at this time, the density of burrowing rats will remein low during the remainder of the year. This strategy has been proven successful in large-scale field tests in 4800 ha sites the past two consecutive years.

Farmer Acceptability

Large-scale field tests in the 1989 aman rice season demonstrated that farmers can and will use this technology effectively, and that, therefore, no major social or technical constraints exist to impede its implementation. This evaluation was accomplished in cooperation with local government and MOA/DAE Block Supervisors.

Implementation

Prospects for nation-wide implementation of this technology and strategy through the MOA/DAE and local government have been greatly enhanced recently. On January 3, 1990 a meeting was convened by the Minister of Agriculture to review the status of national rat control campaigns organized by DAE and of the research progress at BARI and BRRI. The outcome included the establishment of a committee to design an Action Plan for implementing rodent control at the national level. Included on this committee were M.M. Jaeger, DWRC, and E.D. Magallona, Cheechi, together with representatives of MOA/DAE,BARI and local government,LGRD. The committee has met 8-10 times since then to develop this Action Plan. The plan which has been developed is significant for the following reasons:

- it incorporates the technology developed by theUSAID project,
- it recommends a systematic research-oriented approach in the form of a two-year pilot study covering 7 districts. During the study, rodenticide quality and distribution, cost-benefit of the control and farmer training are to be carefully monitored. The final National Rat Control Strategy will be based on the results of this study, and
- it recognizes the potential importance of biological control agents on rodent numbers, particularly predators, and the need to minimize the threat to them from poisoning by rodenticides.

Following the analysis of this 2 - 2½ year study, a National Rat Control Strategy will be formulated and recommended and implemented in Bangladesh. It is therefore, important that USAID/DWRC continue to have an influence on the study and the development of the long-term National Rat Control Strategy. The main rodent control field activities of this study will occur between April and November in both 1990 and 1991. Any future DWRC activites should focus on implementing, monitoring, and evaluating this pilot study. The inter-agency task force to oversee the entire activity and process includes a DWRC representative for this purpose.

When this activity is completed , the USAID/DWRC project will have

- provided another technique to resolve a major pest problem,
- incorporated the technique into an effective, environmentally-sound control strategy for rodent pest management in rice,
- assured farmer use and acceptance of the strategy, and
- worked with GOB officials to assure that the strategy is recommended and implemented nationally.

II. Vertebrate Pest Management Sustainability

BARI Organization and Staffing Needs

The Vertebrate Pest Component (ARP II Supplement) is implemented through the Vertebrate Pest Section (VPS) under the Entomology Division at BARI, Joydebpur. The VPS has been staffed by three Senior Scientific Officers (SSO), and one Scientifiic Officer (SO), all trained under this project, and all still with the project. A full staff should include at least a Principal Scientific Officer (PSO) and an additional SO, which have not been provided. Re-organization of the vertebrate pest activity has been recommended and should be supported. Division status will (a) allow for the leadership necessary to effectively direct and administer a research program and maintain control of funds and equipment necessary to implement the program, and (b) permit expansion of staff to begin addressing in greater detail other vertebrate pest problems in the country.

Funding

Transition to the use of PL-480 Title III funds for daily operating expenses began in October 1989. However, problems still exist in the use of this funding source and include (a) a lack of clear and established guidelines as to what they can be used for and(b) uncertainty as to how they must be accounted for. This has resulted in considerable confusion and as a result, a general hesitancy on the part of BARI management to use them. In addition, inadequate per diems for VPS staff and inadequate daily wage allowances for for field labaor are problems that must be resolved for field research to continue effectively and expeditiously.

Facilities and Equipment

The VPS is housed in a separate structure at BARI which includes offices, library-conference room, computer room, laboratory, and an animal testing room. Outdoor facilities include a two-vehicle garage, an aviary, jackal pens, and an enclosure for holding burrowing rodents. Although this is a good facility, several improvements are needed. Plans are now underway to construct an independent structure for laboratory bioassy experiments. In addition, the organization of the library and reprint collection is needed. Likewise, to accomodate the VPS scientist currently at Colorado State University on a statistics and computer modelling PhD, and as current staff become more familiar and dependent upon computers

for data analysis and publication preparation, additional computers will be needed. It would, therefore, be desirable to convert one of the offices into a computer room in which several individuals could work or learn from each other simultaneously. The room currently serving as the computer room is inadequate for this purpose.

Training

Training has recieved major emphasis in this project and has included

- Ph.D (3) and MSc (3) degree programs abroad and 1 Ph.D locally,
- extensive practical, hands-on experience during field research,
- specialized learning from visiting scientists during TDY,
- publication of research findings in technical journals,
- attendance at professional meetings and conferences, and
- study tours abroad.

The VPS staff, although small in number, has certainly been one of the most productive units at BARI and with capable, supportive leadership should be able to continue an extremely viable research program to resolve vertebrate pest problems. Some needs still exist, including additional computer training, particularly in the area of data analysis, and probably some research management training. An additional major gap in training still is unfulfilled. The VPS/BARI professional staff are now competent technicians, but still they are not yet scientists experienced in the process of moving through the logical series of research steps necessary to solving a problem. An important reason to complete the research forthe Action Plan to succesfully implement preharvest rodent control in rice, would be to take the staff through the entire process from start to finish.

Long-term Research Program

Long-term research priorities and strategies need to be updated and agreed upon by BARI. A predator research program is now being designed with the help of DWRC with the initial objective of determining the relative benefits of predators to rat control versus the damage they do to livestock and poultry. In addition, decisions need to be made as to how some of the other vertebrate pest problems that were identified during the review will be addressed. One option is through research grants to support graduate programs in wildlife departments in Bangladesh Universities. This has been successfully implemented inthe USAID/DWRC project in Pakistan.

Professional Linkages

As was recognized by the External Review, an important component to maintaining a research capability will be the continuation of linkages with DWRC as a "sister research institution." Too often in the past, once research capabilities are built up in developing countries, it is expected that they will remain, irrespective of when complete donor support is eliminated. Mechanisms to assure the long term linkage between the VPS and DWRC, or other institutions need to begin to be developed. It is clearly recognized that USAID cannot maintain this relationship indefinitly but it is important to recognize also that funding support should not be abruptly eliminated, if theVPS is to have the time to make the organizational and logistical changes that will be necessary for it to stand on its own eventually.

Analysis and Publication of Research Findings

A considerable amount of valuable research has been accomplished in the last few years of this project. These findings should be properly analyzed and written up and published, as they are applicable elsewhere, especially in the sub-continent. Publication, and the review process associated with it, are an important part of the research process and can lead to further advancement in the area of study. In addition, technical reports and publications of important findings in recognized, appropriate journals with international circulation provides recognition to the program. The current DWRC project leader will need some time after returning to DWRC, assist VPS scientists in the data analysis and publication of research findingsgenerated during this phase of the project.

Attachment No. 2

DRAFT

ACTION PLAN FOR RODENT CONTROL IN BANGLADESH

DRAFT

ACTION PLAN FOR RODENT CONTROL IN BANGLADESH

EXECUTIVE SUMMARY

An action plan for rodent control developed by an Interagency Committee convened by the Director-General, Department of Agricultural Extension is presented. In order to better appreciate the implementation strategies, a background and justification as well as research results are presented first.

The plan calls for the formation of an Inter-agency Task Force supported by a Secretariat at DAE to oversee the implementation of the short-term strategy and develop a long-term strategy.

In the short-term strategy (2 years), seven districts have been identified for implementation of a total, inter-agency approach. Target months will be July to August for post-harvest control of roof rats, house mice and burrowing rats in farmers' houses and September to October for preharvest control of burrowing rats in agricultural areas, and high grounds including roads, highways, railways, and embankments. Zinc phosphide and brodifacoum baits will be used only by the farmers for controlling rodents in their households, crop fields and high grounds. Aluminum phosphide tablets will be used solely for controlling burrowing rodents on the roads, highways, railroads and embankments by the personnel of Roads and Highways Division, Local Government Department, Bangladesh Railway and Bangladesh Water Development Board.

Zinc phosphide shall be distributed to farmers by the Deputy Directors, DAE through Upazila Parishads and the Block Supervisors during the short-term program period of two years free of cost in order to synchronize application and to ensure thorough coverage. Other agencies will get their supply of aluminum phosphide tablets free of cost from the Deputy Director of Agricultural Extension of the Districts.

The Block Supervisors, DAE and the Supervisors (or equivalent) of the other agencies shall be given 2-3 days training. Training shall be conducted jointly by the Vertebrate Pest Section, BARI and PPW, DAE. The DAE shall, in turn, conduct, farmer classes and field days for the purpose.

Monitoring and Evaluation shall be done by the Planning and Evaluation Wing of DAE with assistance from the research agencies. The monitoring and evaluation format shall be jointly developed with Vertebrate Pest Section, BARI. This exercise is vital to identify issues, constraints and other shortcomings which should be considered in developing the nationwide program.

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GENERAL RECOMMENDATIONS FOR NATIONAL RODENT CONTROL CAMPAIGNS

The following recommendations are based on experience with control campaigns and on research findings from Bangladesh as well as elsewhere.

A. Seasonal Strategy

A control campaign should be conducted during the four months period from July through October. This should be divided into two phases with separate objectives and control strategies (Table-1).

1. July-August

   The objectives here are to reduce post-harvest damage to boro and aus paddy stored in farmer's houses. Control should target roof rats, house mice, and burrowing rats in households.

2. September-October

   Objectives here are to reduce:

   - preharvest damage in aman, wheat, and boro crops,
   - post-harvest damage to stored aman paddy, and
   - structural damage to embankments

   Control should target burrowing rats in fields embankments, roads and railways.

If control is thorough at this time, it will effectively reduce pre-and post-harvest damage to grains and structural damage to embankments for the remainder of the year. In addition, control to burrowing rats at this time, when their population density is beginning to increase from its seasonal low, can be extremely cost-effective. This is in contrast to control following the aman harvest after which the population density begins decreasing and control can have a negative cost-benefit because rats would soon die anyway from natural causes.

B. Control Strategy (Integrated Pest Management)

1. An IPM strategy should be employed which takes advantage of <u>biological control agents</u> and <u>non-chemical methods</u>. The most important biological agents are:

   - seasonal decline in density of burrowing rats through the dry season,
   - monsoon floods, and
   - predators

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Focusing control in September-October and directing it towards burrow systems takes advantage of this seasonal timing, minimizes the dosage of chemicals required, and reduces the chances for primary or secondary poisoning of predators by placing the rodenticide inside the burrow tunnel.

Trapping, flooding of burrow systems, and other non-chemical means of control should be encouraged. Trapping has proven to be most effective against house mice in farmer's houses.

2. Chemical methods are an important part of the control strategy. In order to achieve the most cost-effective and safe use of rodenticides, the following recommendations are made"

   - Zinc phosphide baits should be limited in use to treating burrow systems during the most critical period for control in September and October so as to reduce the problem of bait shyness.

   - Aluminum phosphide fumigation should be used in burrow systems outside of the house and at anytime during the campaign period.

   - Brodifacoum baiting should be used inside of burrow systems or within houses where its placement is away from domestic animals or children.

C. Extension

For the control campaign recommended here to be successful, BAE must ensure the following:

1. The availability of good quality rodenticides;

2. That control is done cooperatively by the farmers in an area, and at the prescribed time before damage begins to occur;

3. That farmers recognize active rat burrow systems and know how to treat them; and

4. That farmers understand the importance of using rodenticides safely. Brodifacoum baits, for example, should be used with care to assure that they, or the rats poisoned by them, are not eaten by non-target animals.

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ACTION PLAN

This plan consists of two phases - a short-term plan of action and a long-term strategy. For the short-term, massive government intervention is envisaged. It will mobilize the extension service personnel supported by research, and such other sectors as may be available. This intervention is considered essential considering that the mobilization of farmers for such a massive activity takes time and effort whereas the problem should be addressed NOW. Farmers shall also be tapped but as part of the program.

The Government of Bangladesh has adequate extension personnel that could be mobilized for the purpose especially if properly motivated and if the area of coverage is limited. On the other hand, research institutions have already developed applicable technologies to deal with the problem. It is now a question of "marrying" the two capabilities for the job at hand. Other sectors could also be motivated to lend a helping hand.

It should be stressed however that while the campaign may be successful, any reduction in rat population will only be temporary. Annual control is needed and this necessitates a long-term strategy which should be evolved as soon as possible. In this long-term strategy, farmer organizations, both formal and informal, are expected to carry the brunt of the activity. The extension service, mainly DAE, should adjust its activities accordingly as the government moves from one phase to another as DAE is expected to be mainly responsible for the program. In a like manner, research institutions are expected to conduct "strategic research" -- this will be dealt with in the next section.

Environmental ramifications of rodent control should be considered. In some situations control will be inadvisable for example where rats pose no threat to agriculture and where their destruction threatens predators. Predators can be an important means of biological control and their destruction can worsen the rat problem.

A. Formation of an Inter-agency Task Force

1. National Level

A Task Force, known tentatively as the "Inter-agency Task Force on Vertebrate Pest Control" shall be constituted to oversee the activity. It shall report directly to the Secretary Ministry of Agriculture through the Director-General of the Department Agricultural Extension. The composition of the Task Force will be as follows:

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1.	Mr. Md. Mazharul Haq, Director, Plant Protection Wing, DAE	Convenor
2.	Mr. A. F. M. Mustafizur Rahman Director (Engineering) Ministry of Communication Railway Division.	Member
3.	Dr. M. A. Sattar Director Land & Water Use Bangladesh Water Dev. Board.	Member
4.	Dr. F. M. Maniruzzaman Executive Arboriculturist Roads and Highways Department	Member
5.	Dr. M. A. Karim C.S.O. and Head Entomology Division BARI	Member
6.	Mr. Maksumul H. Chowdhury Asstt. Secretary Local Govt. Division Ministry of Local Govt. and Rural Development	Member
7.	Mr. Abdul Wahab Akonda Senior Research Officer Wildlife Forest Department	Member
8.	Dr. F. D. Magallona IPM Specialist ARP-II (Supplement)	Member
9.	Dr. M. M. Jaeger Specialist BARI-USAID.	Member

Terms and Reference

- To execute the action plan by individual agency
- To review the program activities from time to time and resolve the problems
- The draft training modules for concerned agencies
- Local Govt. Division will issue necessary instruction from time to time to the Upazila Parishads.
- To evaluate the action program

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- At the end of the year the Task Force shall prepare a report for the Secretary, Ministry of Agriculture.

Support of the Task Force

In support of this Task Force, the DAE shall constitute a Secretariat to collate, disseminate, synthesize and coordinate all reports to and from the field. This Secretariat may actually be considered the "Command Center" for all activities; digesting the information from the field and disseminating the orders from the Task Force. As a most critical component of the Programme, it should be adequately staffed and supported. Due consideration should be given for the creation of an operationally functional Vertebrate Pest Section at DAE which can serve as Secretariat. The optional staff complement is (1) a Deputy Director, (2) an Assistant Director, (3) Four Rodent Control Officers.

2. District Level

A Task Force shall be constituted at the district level with the following:

1.	Deputy Director, Department of Ag. Extension	Convenor
2.	Representative Bangladesh Railway	Member
3.	Representative Roads and Highways Department	Member
4.	Representative Water Development Board	Member
5.	Representative Local Govt. and Rural Development	Member
6.	Representative Forest Department	Member
7.	Representatives BARI/BERI.	Member

Terms of Refereuce

- To implement the Action Program approved by the National Task Force in their respective jurisdiction.

- To coordinate and cooperate program activities among the concerned agencies.

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- To convene meetings once a month to review their program activities.

- To keep the National Task Force abreast of the program's monthly progress.

3. Upazila Level

The upazila parishad will implement the action program. The Chairman of the Upazila Parishad will be the Convenor and other concerned agencies will be the member of the program implementation committee. Due importance should be given by the Upazila Parishad to execute the action program.

B. Training

A massive but concerted training program has to be mounted in support of these activities. The Task Force shall draft a training plan. Priority shall be given for the training of supervisors of the extension service and the other government agencies. A modular approach, i.e, a different module for different clientele (e.g. agricultural extension service, forestry, roads and highways, railroads) shall be developed. The formulators will be given training by the subject matter specialists.

Before the training, DAE shall conduct a survey to determine farmers training needs. This is preferably done in the months March-April.

The VPS, BARI and the PPW, DAE shall jointly develop the training modules for approval by the Task Force. The training itself shall be implemented by DAE at the regional, district or upazila level where appropriate. Technical support shall be provided by VPS/BARI, BRRI and other experts to be identified by the Task Force.

The topics in the training program shall include: a) rodent biology and behavior, b) rodenticide use, c) bait preparation and application, d) safety in handling, e) monitoring of efficacy and f) reporting and evaluation.

C. Short-term Programme

1. During the short-term program period seven districts will be targeted for extensive activities in the first two years. These are Chittagong, Comilla, Jamalpur, Jessore, Pabna, Patuakhali and Rangpur. These sites were chosen as they are close to regional/subregional research stations which can serve as "command centers". The experience encountered in these sites could then

serve as lesson for the nationwide program envisioned to be mounted in the future. The arrangements are shown in Tables 2 (a,b, and c) and 3.

All upazilas in the above mentioned districts will be involved in the program. In other districts, normal rat control programs will be undertaken.

2. To synchonize application times and ensure complete coverage of the areas involved, rodenticides of tested quality should be supplied free of cost to farmers and other agencies at the right time and place during the short-term program period.

3. Director (PPW) will purchase the total quantities of 3% zinc phosphide bait, 0.005% brodifacoum formulation and aluminum phosphide tablets (each 3 gram of 57% a.i) considering the total requirements of the rodenticide for all upazilas of the seven selected districts. The above purchase will be made in two lots in a year for July-August and September-October control periods.

4. Quality control monitoring should be strict. The formulation, packing and labelling process should be closely monitored by PPW, DAE. Samples of each batch of imported and formulated materials should be analyzed and a report made within one week of sampling. The Pesticide Analysis Laboratory, DAE should be properly supported for this activity.

5. The Deputy-Director, Agricultural Extension of the district will be responsible for receiving and distributing the bait materials to the upazila parishads as well as to other agencies. The upazila parishad will, in turn, distribute the bait materials to the farmers.

6. Farmers will obtain bait materials (zinc phosphide and brodifacoum) from Upazila Parishad through the block supervisors.

7. The areas under the Bangladesh Railway, L.G.R.D, BWDB, and Roads and Highways Department, in the seven selected districts will be treated by the necessary personnel who will be given training. They will get the necessary quantities of aluminum phosphide tablets from district office of the DAE free of cost.

8. The Deputy-Director, Agricultural Extension of the District shall calculate the bait requirements for his district, taking the following into consideration:

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i. No. of active burrows/ha (4 average)
ii. Quantity of bait/burrow (1 tablet or bait per burrow)
iii. Roads and embankments (available from R&H)
iv. Railroads and embankments (available from BR)
v. Local roads and embankments (available from LGRD)
vi. Water-related embankments (available from BWDB)

9. In the seven selected districts, all extension personnel will be mobilized for the activity during the months of September and October.

10. Transport of rodenticides to regional headquarters for distribution to district or upazila headquarters shall be coordinated with the Secretariat.

11. The bait cakes should arrive at district/upazila headquarters 7 days before implementation of the program.

12. The Block Supervisor in-charge shall make a pre-treatment survey of his area of responsibility by May and June. A report shall be made to the Task Force by July. The Block Supervisor shall be supported by at least two Subject Matter Officers (SMO) or equivalent.

13. Block Supervisors shall oversee the distribution of bait cakes and their application.

14. Within one week, a report shall be made on the implementation of the program by the extension and deputized personnel concerned. Thereafter, a weekly report shall be prepared. The VPS, BARI shall prepare a reporting format in consultation with Planning and Evaluation Division, DAE.

15. For the other agencies, a similar system shall be implemented but modified according to their unique needs.

16. The Task Force shall select appropriate sites in each region where the program can be monitored or evaluated after each campaign. This evaluation shall serve to identify constraints, problems and other activity areas so that future campaigns can be better implemented.

This post-treatment monitoring will be done by a group composed of BARI, BRRI, and DAE personnel. For DAE, the Planning and Evaluation Division shall be involved. The monitoring format, taking into consideration local peculiarities, shall be developed by VPS, BARI in

consultation with Planning and Evaluation Division, DAE and the field extension staff.

17. A similar exercise will be done for July-August except that aluminum phosphide tablets/pellets, brodifacoum wax blocks, coumatetralyl and bromodiolone are used. Emphasis, however, shall be on local control on an as-needed basis.

D. Long-term Programme

Ultimately, farmers or farmer groups have to assume responsibility for rodent pest control or any pest control activity for that matter. Thus, while the current activity is with government intervention, a scheme should also be developed whereby government slowly distances itself from implementation of the program - it shall still assume overall responsibility.

The Task Force shall develop such a program. This program shall be submitted to the Secretary, Ministry of Agriculture, within two months after completion of the short-term program.

RESEARCH RECOMMENDATIONS

Continuous research is needed in order to assure the effectiveness of control campaigns. The following are recommend.

A. Monitoring Campaigns

A statistically meaningful sampling scheme needs to be developed and implemented in order to estimate the impact of campaigns on reducing damage. If no significant reduction is achieved, then changes can be made in either strategy, rodenticide use, or extension practices. Monitoring is essential to effective extension.

B. Monitoring Pesticide Quality

In order to assure good quality rodenticide, it is necessary to develop a program for regular testing. This is most practically done by bioassay with laboratory animals.

C. Farmer Training Needs

No basic study has yet been done to determine what Bangladeshi farmers understand about rodent problems and their solutions. This information is needed in order to determine specific training needs. A study to obtain this information is soon to be undertaken by the DAE.

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D. Selective Control

More information is needed about the cropping patterns, flood patterns, soil characteristics, etc., which are associated with the highest levels of rat damage. From this information, predictions can be made as to which areas are likely to have the greatest losses. Extension efforts can then be more selectively focused to where they can have the greatest impact.

E. Biological Control

Recent research suggests that predation is an important biological control of rodent in Bangladesh (Sultana and Jaeger, 1989b). Additional information is needed about the relative benefits of predators such as jackals and jungle cats in order to manage them more efficiently, and to assure that beneficial species are not needlessly poisoned by the improper use of rodenticide.

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Scope of Work Draft: 3/18/90

Vertebrate Pest Control Project
July 1, 1990 - June 30, 1991

During this final year of the Vertebrate Pest Control Project (VPCP) under the Food Security Management (FSM) Project, the main emphasis of the program will be to identify the needs and a plan to institutionalize the vertebrate pest control activities begun at NARC and to complete ongoing research and technology transfer.

When the VPCP was established at NARC, no formal counterpart organization was established by the Government of Pakistan. To correct this situation, a substation at PMRI/VPCL was initiated at NARC in June, 1989. This activity needs to continue within the NARC structure after termination of the VPCP. The deliverables will be to assure that VPCL staff are prepared to integrate VPCP functions within their scope of activities and to assist in identifying resources and organizational mechanisms for this to occur smoothly and efficiently.

The transfer to farmers of a method to reduce rodent damage to wheat and rice will be carried out. This large-scale control demonstration is now in its third crop cycle and should be carried forward into a fourth (rice) and fifth (wheat) cycle. The deliverables will be a method and strategy to transfer developed rodent control technology to farmers.

The first phase of studies on the biology and behavior of wild boar will be completed. Trapping and radio-tracking of wild boar in the croplands in Faisalabad District will be done in September/October. Deliverables will be information on the nightly foraging range and daytime resting areas, analysis of food habits and breeding periods, and preparation of a preliminary control strategy.

Development of methods for control of wild boar are under evaluation. Baiting in soil furrows or in wooden bait boxes has shown promise but needs further field evaluation. Paraffin baits worked well but pelletized baits (about the size of rabbit lab chow) may work better. Pelletized baits will be prepared at DWRC and evaluated in Pakistan. Deliverables will be preliminary recommendations on effective, environmentally safe methods of controlling boar damage.

The ecotoxicology of several rodenticides will be assessed in target and non-target species, in commercial technical material, baits and in the environment through pesticide residue analysis. This is an important environmental issue that has not previously been addressed in Pakistan. A GOP/NARC counterpart scientist will be trained to carry out this research in the field and laboratory The deliverables will be the sustained capability of analytical chemistry for conducting rodenticide residue.

An enormous amount of scientific data has been accumulated during the life of this project. An important aspect of the research program is to publish these findings. During this final year deliverables will include a number of scientific and technical publications coauthored by counterparts to document project accomplishments & help establish the international identity of the VPCL.

Work will continue on training of operational grain storage personnel in cooperation with the Storage Technology Development and Transfer (STDT) Project. Training materials presently in develpoment will be completed, printed, and made available to the STDT training centre. Audio/visual materials will be duplicated and distributed. The VPC Project will participate in training in vertebrate pest management methods at the grain storage demonstration centres at Manga Mandi, Dipalpur and Islamabad.

The training of rural women in pest management methods at Farming Systems Research (FSR) sites will be completed in cooperation with the FSR programme and the Entomology Research Laboratory (ERL) at NARC. Plans for producing a training video cassette and photo illustrated womens handbook in pest management are in hand and these materials will be delivered during the project year. This work is being carried out at the FSR sites near Fateh Jang where wild boar pilot control trials are also done.

Cooperative research studies and implementation of vertebrate pest management curricula at the University of Agriculture at Faisalabad will continue. This continuing effort is helping to institutionalize VPM at the University and has assisted almost two dozen graduate students in obtaining capabilities in VPM research and management. Deliverables will be 6 research reports and theses.

March 13, 1990

Tentative Plan of Work for DWRC TDY Assistance to Pakistan Vertebrate Pest Control Project
July 1, 1990 - June 30, 1991

	1990							1991					
Individual	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Brooks, J.	Ann. Leave	DWRC	3 1/2 months				DWRC	3 months			DWRC	2 months	
			1. Control demonstration in rice at Gujrat.					1. Field trial of furrow baiting efficacy on wild boar at Thal desert area.				1. Wrap up project activities at Islamabad.	
			2. Wild boar food habit and reproductive data analysis at Islamabad.					2. Rodent control demonstration in wheat at Gujrat.					
			3. Field evaluation of pellets or paraffin baits for wild boar at Faisalabad or Fateh Jhang.										
			4. Supervise ecotoxicology research of Shahid Munir at Islamabad.										
DWRC Electronics				1 month									
				1. Radiotracking wild boar									
USDA Extension									1 month				
									1. Extension materials & evaluation				
DWRC Mammalogist										½ m			
										1. training in taxidermy			
Bruggers, Section Chief												½ m	
												1. Project administration	

Attachment No. 4

(3/22/90)

Expected Unresolved Vertebrate Pest Management Issues in Pakistan at the Time of VPCP Termination in June 1991

CRITICAL ISSUES TO BE ADDRESSED

The proposed curtailment of USAID support for vertebrate pest management (VPM) in Pakistan in June 1991 would result in a number of important activities that remain uncompleted. From October 1985 to June 1990, USAID has supported development of the Vertebrate Pest Control Project (VPCP) at the National Agricultural Research Centre (NARC) to carry out research, development, and training on priority vertebrate pest problems, including protecting crops before harvest and conserving production during postharvest storage. The return on the substantial investment by USAID and the Government of Pakistan will not be fully realized unless mechanisms can be developed to address the sustainability issues of institutionalization, technology development and implementation, and information transfer during a follow-on transition period after departure of the USAID/Denver Wildlife Research Center (DWRC) resident adviser in June 1990. Continued USAID/DWRC funding support is fortunately available from July 1990 to June 1991 to complete and implement methods for control of rodent damage in rice and wheat; additional important issues will need to be resolved, including:

- Institutionalization of VPM at NARC
- Space requirements for VPM research and development
- Continuing the relationship between the NARC Vertebrate Pest Control research staff
- Registration of pesticides for control of economic damage by wildlife species
- Development and evaluation of a Master Trainers curricula and training materials for agricultural extension workers
- Institutionalization of VPM curricula and support of graduate student research in VPM at several agricultural universities in Pakistan
- Private sector marketing mechanisms for distribution of quality formulated rodenticide baits
- Development and evaluation of a VPM program for rural women at Farming Systems Research (FSR) sites
- Development of inexpensive, effective, and environmentally acceptable methods for farmer control of wild boar
- Strategy and timing for protection of wheat, rice, and sugarcane from rat damage
- Development of inexpensive, effective, and environmentally acceptable methods for control of porcupine in reforestation and hillside agriculture in NWFP and Azad Jammu and Kashmir
- Protection of stored grains and food from rodent damage in farms and villages

Attachment No. 5

VERTEBRATE PEST CONTROL PROJECT

Food Security Management
Post Harvest Management Component
GOP/USAID Project

F - 213,
National Agricultural Research Centre
Islamabad, Pakistan
Tel : 82005209
813712

Dr. Abdul Latif Rao
Conservator of Wildlife
Ministry of Food & Agriculture
Street 84, House No. 485
Islamabad

March 18, 1990

Dear Dr. Rao:

I thank you for taking the time to discuss with us your concerns about the crow situation in and around Islamabad and Rawalpindi. Since our discussion, we have visited the roosting area you described between Zero point and Faizabad. We were all certainly impressed by the magnitude of the roosting crow population. However, we also saw a large number of kites and some eagles in the area. This observation further supports the need to investigate the overall crow pest problem and the potential adverse impact of any management efforts on other animal species before beginning any lethal crow control program.

As we discussed, it is our recommendation that a short consultancy (perhaps 1-month) is needed to look into the situation in greater detail and develop specific recommendations for follow-up action investigations. The USDA/APHIS Denver Wildlife Research Center (DWRC) has several scientists that have been involved in crow pest problems, both domestically and internationally. Upon my return to DWRC, I will inquire as to the interest of these individuals and the availability of funding support from the Fish and Wildlife Service.

Although Mr. Joe Brooks our Project Leader for the USAID-funded DWRC-Vertebrate Pest Control Project (VPCP) at NARC, does not have the time nor mandate to investigate this situation, he and the VPCP can provide logistical support for such a DWRC consultancy.

In the meantime, I have enclosed some background literature on crow pest situations elsewhere in the world. Finally, as you requested, the VPCP will bring this situation to the attention of the Pakistan Agricultural Research Council. Please let Mr. Brooks or Mr. A.A. Khan know if they can be of further assistance.

Sincerely,

Richard Bruggers

Richard Bruggers
Chief, International Programs Research Section
DWRC

cc: Mr. Joe Brooks, Team Leader
Mr. A Aziz Khan, Principal Scientific Officer
Mr. David A. Ferguson, USFWS

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TRIP REPORT*

ITALY, MALAYSIA, INDONESIA, and the PHILIPPINES

March 14-April 3, 1990

Lynwood A. Fiedler

Wildlife Biologist (Research)

International Programs Research Section

Denver Wildlife Research Center

USDA/APHIS/S&T

P.O. Box 25266

Denver, Colorado 80225-0266 U.S.A.

Unpublished Report

June 28, 1990

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* This work was conducted with funds contributed to the Animal and Plant Health Inspection Service/Science and Technology/Denver Wildlife Research Center by the United Nations Food and Agriculture Organization for implementing the FAO Project TCP/RLA/8965(A) "Integrated Control of Bird Pests," the International Rice Research Institute in Los Baños, and the U.S. Agency for International Development under the Project "Vertebrate Pest Management Systems R&D" PASA DAN-4173-X-AG-6001-00.

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ITINERARY

Date	Location	Activity
Mar 14-15	Denver, Colorado, to Rome, Italy	Travel
Mar 15-16	Rome	Debriefed the Food and Agriculture Organization (FAO) on Argentine and Uruguayan binational bird project consultancy completed in February 1990
Mar 16-17	Rome to Genting Highlands, Malaysia	Travel
Mar 18-23	Genting Highlands	Attended and participated in the 3rd International Conference on Plant Protection in the Tropics
Mar 23	Genting Highlands to Jakarta, Indonesia	Travel
Mar 24-27	Jarkata	Met with U.S. Agency for International Development (USAID) and the Director of the Indonesian Department of Food Crop Protection
Mar 28-29	Jarkata to Los Baños, Philippines	Travel
Mar 29-31	Los Baños	Met with International Rice Research Institute (IRRI) and National Crop Protection Center (NCPC) officials concerning rodent control
Apr 1-3	Los Baños to Denver, Colorado	Travel

OBJECTIVES AND SUMMARY

The purpose of this trip was to: (1) debrief United Nations Food and Agriculture Organization (FAO) officials in Rome on a consultancy I conducted for the FAO bird project in Argentina and Uruguay during February 1990, (2) present two papers and attend the 3rd International Conference on Plant Protection in the Tropics in Malaysia, (3) determine the current status of rodent problems in Indonesia, and (4) discuss with International Rice Research Institute (IRRI) officials the details of a proposed expert panel session on rodents in rice to be held later this year at the IRRI in the Philippines.

ACTIVITIES

FAO

In February 1990, I completed a consultancy to Argentina and Uruguay to develop a plan for implementing the FAO project "Integrated Control of Bird Pests." A draft report "Bird pests in Argentina and Uruguay--project planning" was prepared and submitted to FAO headquarters in Rome. At FAO headquarters, I discussed with Dr. Ernesto delas Casas, Crop Protection Specialist in the Plant Production and Protection Division, the details of this draft report. A final draft was submitted to FAO headquarters on May 25, 1990, and approved. I also met with Ms. Ilona Borhegei, Acting Editor for the Plant Production and Protection Division, to discuss the FAO technical paper that I am writing entitled "Rodent pest management in eastern Africa."

Malaysia

The 3rd International Conference on Plant Protection in the Tropics was held this year in Genting Highlands, Malaysia. This conference, held every 4 years, has established itself as an important international plant protection meeting and had a special rodent session in this year's program.

I presented two papers, "Efficacy of burrow fumigation in reducing rodent activity in Philippine rice fields" (Fiedler, L. A., M. S. Ahmed, and Z. Ya) and "A study of the toxicity of the anticoagulant brodifacoum to American kestrels (*Falco sparverius*)" (LaVoie, G. K.). About 600 people from about 35 countries attended this conference. I had an opportunity to meet vertebrate pest professionals from throughout the world, particularly from Southeast Asia, as well as to interact with colleagues from the German Gesellschaft für Technische Zusammenarbeit (GTZ) and private industry.

Indonesia

Indonesia has had serious rodent problems for many years. The rodent control technology developed and successfully used in the Philippines to reduce rat damage in rice and other crops appears directly transferable to

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similar situations in Indonesia. However, funding to transfer this technology is needed if advancements in rodent control in this major rice-producing country are to be made.

I met with Dr. George Like from the Office of Agriculture and Rural Development of the AID/Jakarta Mission and his associate Mr. Johannes, who arranged a visit with the Indonesian Food Crop Protection Director, Dr. Wiganasantana. Dr. Wiganasantana considers rodents to be the second most important crop pest problem in Indonesia; a new kind of stem borer currently ranks first. He does not consider brown planthopper or tungro (leafhoppers) to be as much of a problem as rodents. About 200,000 hectares are now estimated to be seriously affected by rodents. Dr. Wiganasantana has gained some experience with rodent problems since he participated in an AID-sponsored rodent control training course held in Southeast Asia in 1972. It was the DWRC, through Michael Fall, Nelson Swink, Glenn Hood, and John De Grazio, that conducted the 1972 training course. Dr. Wiganasantana is anxious to initiate a major rodent control program and pleased to see that the DWRC is interested in providing technical assistance.

DWRC and the Ministry of Agriculture (MOA) prepared proposals for initiating rodent control projects about 1972 and again in 1978. These proposals could be modified or updated and easily implemented with funding. We agreed that on my next opportunity to visit Indonesia, we would reconsider looking into possible funding support and beginning these proposals.

Philippines

Dr. Graeme Quick, Head, Agricultural Engineering Division at the IRRI, and I have been developing plans to implement a rodent research effort through the IRRI. This has led to a possible meeting at the IRRI in Los Baños of international rodent experts to gather information, express ideas, and recommend future action for reducing rat damage in rice and other crops in farmers' fields as well as research farms. I met with Dr. Quick at the IRRI, and we discussed the proposed IRRI-sponsored expert panel session on rodent control in rice and other crops in the Tropics. A tentative date, September 9-14, 1990, was set; potential participants, listed; and program content, reviewed (see Appendix 1).

Current rodent research being done by the IRRI staff, primarily within the Department of Engineering, was presented to me for comments and advice. An outline of research activities was drafted for Dra. M. Hoque, an IRRI associate from the Philippine National Crop Protection Center (NCPC) in Los Baños. Later, I met with the Director of IRRI, Dr. Klaus Lampe, who is supportive of initiating rodent control research efforts through the IRRI and who will be an active participant in the upcoming IRRI rodent session in September.

Finally, I visited with Dr. Romulo Davide, Director of the NCPC, who is interested in reviving the activities of the Rodent Research Center that were once prominent within the NCPC. Dr. Davide wants to assemble, with DWRC's help, a project proposal on rodent control that could be submitted to the Ministry of Agriculture for approval and then to USAID for possible support.

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CONTACTS AND ACKNOWLEDGMENTS

FAO, Rome

Dr. Ernesto delas Casas, Plant Production and Protection Division
Ms. Ilona Borhegei, Acting Editor, Plant Production and Protection Division

Indonesia

Dr. George E. Like, AID/Jakarta, Agriculture and Planning Division, Office of Agriculture and Rural Development (ARD)

Mr. Johannes, AID/Jakarta, ARD

Dr. Satta Wiganasantana, Director, Food Crop Protection

Philippines

Dr. Graeme Quick, Head, Agricultural Engineering Division, International Rice Research Center (IRRI), Los Baños

Dr. Klaus Lampe, Director, IRRI

Dr. Romulo Davide, Director, National Crop Protection Center (NCPC), Los Baños

Dra. Melanda Hoque, Vertebrate Pest Researcher, NCPC/IRRI

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Revised version
May 15, 1990

EXPERT PANEL MEETING ON RICE RAT CONTROL
INTERNATIONAL RICE RESEARCH INSTITUTE
SEPTEMBER 9-14, 1990

1. Introduction

Rodents are an omnipresent threat to food supplies and human health. In Asia, rats consume at least 5% of the annual rice crop. Rat predation levels vary widely from extremely severe to moderate, according to seasonal factors and locality.

At IRRI, rat control is a drain on resources, and a constant source of concern due to the loss of valuable rice genetic material. Rats have caused an estimated $1 million worth of damage to research trials over the Institute's history. IRRI has been involved with nonconventional methods of control, and now seeks to galvanize work on long-term methods of controlling rats in rice-dependent agriculture worldwide, as well as resolving the rat problem on the research farm.

As a first step, IRRI proposes to host an expert panel meeting in September 1990. A small team of the world's leading experts on rat control, rodent population dynamics and vertebrate pest biology will be assembled in Los Baños to assess, interact and generate new approaches to rat control in rice agriculture.

Their task will be to generate a four-pronged action program and to recommend ways for financing a long term worldwide effort to control rats in rice agriculture.

2. Purpose of Meeting:

The purpose of bringing this working group to Los Baños is to assemble the best expertise from around the world to pool their knowledge, interact, and propose fresh solutions to the problem of losses due to rodents, especially in rice agriculture. The expert panel should develop nonconventional approaches, improved models, and new methodologies, both short and long term, for application in the wider world of production agriculture -- wherever rodent pests pose a significant problem but especially in rice agriculture.

3. Working Group Participants: See list attached.

4. Expert Panel Meeting Itinerary:

Day 1

1. Introductions -- Welcome by Director General

2. Background: Outline of the rodent problem. Objectives set for the Panel Meeting. Four pronged attack on rat control:

   (i) Rat control worldwide and regionally;

   (ii) Rural village rodent problems and control;

(iii) Rat control on IRRI farm and on other research facilities and locations;

(iv) Development of control models

3. Quantification of extent of losses to rodents both in rice based and in non-rice crops in rice agriculture.

4. Tour of IRRI Farm and NCPC. Demonstration of certain technologies for rodent control.

5. Presentations of invited speakers, to provide state of the art papers on their areas of speciality.

Day 2

1. Presentations continued

2. Epidemiology: keynote address

3. Brainstorming Session 1: What are the possible solutions?

4. An analysis of the proposed solutions with a consideration of costs/benefits

5. Sociological aspects of rodent control: Community characteristics and roles.

Day 3

1. Environmental impact considerations of rodent control approaches

2. Application and implementation of the techniques -- first, on IRRI farm and other research facilities; second, on a broader front in production agriculture

   a. farm level

   b. village level

   c. community level

   d. national and international or regional level

3. Brainstorming Session 2: Who can do what, and where?

Day 4

1. Wrap-up Sessions outlining strategies, preparations needed for support from community/government or other agencies

2. Funding needs (FAO/WHO inputs). Current donor activity. First draft proposal for potential donors.

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3. Future programs and follow through from this expert panel's efforts.

4. Closing session

Follow through: involves the preparation of a booklet on the outcome of the panel meeting, including the abridged specialist papers, and implementation of relevant recommendations.

PRIMARY LIST OF PARTICIPANTS
EXPERT PANEL MEETING ON RICE RAT CONTROL
September 9-14, 1990

Dr. Ishwar Prakash
Center for Rodent Research & Training
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TRIP REPORT*

CHAD

April 1-25, 1990

G. Keith LaVoie
Wildlife Biologist (Research)

International Programs Research Section
Denver Wildlife Research Center
Science and Technology
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
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Denver, CO 80225-0266 U.S.A.

Unpublished Report

June 4, 1990

* This project was conducted with funds contributed to the U.S. Department of Agriculture/Animal and Plant Health Inspection Service/Science and Technology/Denver Wildlife Research Center by the U.S. Agency for International Development/Africa Bureau under the Project "Vertebrate Pest Management (DWRC) African Rodent Control Research," PASA DAN-4173-X-AG-6001.

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ITINERARY

Date	Location	Activity
April 1-3	Denver, Colorado, to N'Djamena, Chad, Africa	Travel
April 3-21	Chad	Field work to continue the rodent density monitoring program. Briefings with USAID and Crop Protection.
April 21-25	N'Djamena, Chad, to Denver, Colorado	Travel

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OBJECTIVES

The objectives of this consultancy were to make timely suggestions for improving the N'Gouri rodent population monitoring study after 6 months of data collection, to consider sample sites for a second rodent population monitoring area near Abeche, and to facilitate the establishment of the Denver Wildlife Research Center (DWRC)/Agency for International Development (AID) Rodent Research Project in Chad.

ABSTRACT

Rodent population sampling began in November of 1989 in the N'Gouri area. Populations have been monitored monthly in quadis and dunes near N'Gouri. The sixth sampling period in the rodent population monitoring study at N'Gouri was completed during this consultancy. Rodent index values for these 6 months show a nearly consistent decline in rodents in quadi and dune sampling sites. The very low trap success in the N'Gouri area during the sixth sampling period suggests that rodent densities may be at the nadir of their annual cycle. During this consultancy it was decided to look for a second population monitoring area more accessible than Abeche. The N'Djamena-Bilaka area was visited, but rejected. Suggestions are made to improve the rodent monitoring studies in N'Gouri and to improve communications among the many people and agencies involved in the project. Arrangements to initiate laboratory and office construction and to secure housing and furniture to facilitate the Spilletts' arrival were not accomplished because the nonfunded extension of the overall USAID\Africa Bureau Project under which this rodent activity is supported has not yet been signed.

BACKGROUND

Severe chronic rodent problems and spectacular periodic rodent irruptions have probably occurred in the Sahelian Africa for centuries. Following a 1984 drought, Chad had ample rain in 1985 and 1986. Rodent damage to agriculture in 1986 and very high rodent densities in 1986 and 1987 prompted the Ministry of Agriculture (MOA)/Chad to request assistance from the DWRC through AID/Chad to assess the rodent problem and make recommendations to develop a rodent control program for the Sahelian region. Prior to this current consultancy, seven others were made by DWRC biologists. The first consultancy (LaVoie, Unpublished Trip Report, DWRC, June 19, 1987) confirmed the high rodent densities, tentatively identified some of the rodent species involved, assessed the possibilities of even higher rodent densities during the 1987 growing season, and suggested possible control methods. Although rodent densities did not increase during the 1987 growing season, they did remain chronically high. The second consultancy (Mitchell, Unpublished Trip Report, DWRC, December 31, 1987) conducted experimental field evaluations of warfarin grain baits, trained agricultural extension personnel in rodent control methodology, and made recommendations based on the results of these experiments. The third consultancy (LaVoie, Unpublished Trip Report, DWRC, May 20, 1988) identified rodent pest species in irrigated and dryland agricultural areas, conducted cage and small plot rodenticide evaluations in irrigated quadis, trained agricultural extension personnel in rodent control methodology, and made recommendations based on these assessments. The

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fourth consultancy (Fiedler, Unpublished Trip Report, DWRC, September 27, 1989) planned for the establishment of a proposed rodent control project in Chad. The fifth and sixth consultancies (LaVoie, Unpublished Trip Report, January 10, 1990; and Wilson, Unpublished Trip Report, DWRC, February 5, 1990) selected sites and initiated a long-term monitoring study of rodent populations in quadis and dunes and trained counterpart scientists in identification, trapping, autopsy, and data collection methods. The seventh consultancy (Bruggers, Unpublished Trip Report, DWRC, January 10, 1990) was to discuss implementation activities and budget considerations for the rodent research project PASA with AID/Chad. During the 4-month interval between the initiation of the monitoring study by Dr. John Wilson and counterpart, Mr. Abdelwahib Yacoub, and this eighth consultancy, the monthly data collections were carried out by Mr. Yacoub and two MOA/Crop Protection Service (CPS) technicians, Messrs. Djimtoide Baoral and Maila Dourbaga.

CURRENT SITUATION

The DWRC/USAID rodent research project in Chad, funded by the USAID/Washington/Africa Bureau, was initiated in early 1990 with the selection of Dr. Juan Spillett to be stationed in Chad. The original objectives of this consultancy were to familiarize the new Project Leader, Dr. Spillett, with the study areas and sampling methods and to assist in selecting a new study site in Abeche and begin laboratory and office construction. However, delays in signing the nonfunded extension of the overall USAID/Africa Bureau Project under which this rodent activity is supported prevented the transfer of Dr. Spillett to DWRC. Because of these delays, the objectives were modified to assist Mr. Yacoub, the project counterpart scientist, during the April data collections at the N'Gouri study sites, to suggest timely improvements in the population monitoring studies, select monitoring sites in Abeche, and initiate laboratory and office construction prior to the arrival of the project leader. It is now anticipated that Dr. Spillett will be at post in early June; but due to the lack of project approval, laboratory and office renovation have not begun.

N'Gouri

Rodent population samples have now been collected monthly from eight quadis and three dune sites in the N'Gouri area (Fig. 1.) since November and December 1989, respectively. Some serious problems occurred during the second sampling period and immediately before the third sampling period. During the second trapping period (December 1989), about 9% (167/1850) of the traps were stolen or removed by predators or other animals. In late December 1989 and early January 1990, six of the eight quadi sites were treated with the rodenticide chlorophacinone. Mr. Yacoub resolved these problems in a timely, commendable manner by (1) having wire stakes made to prevent trap removal by predators and other animals, (2) enlisting the assistance of the farmers during each trapping period, and (3) requesting the Sous Prefet to meet and discuss the importance of the study with all farmers in the sampling areas. Mr. Yacoub's actions resulted in negligible trap losses since the December incident. Discussions with the people who initiated the rodent control operations in the six quadis indicated that communications had failed at the inception of the monitoring program when

— RÉPUBLIQUE DU TCHAD —

1976

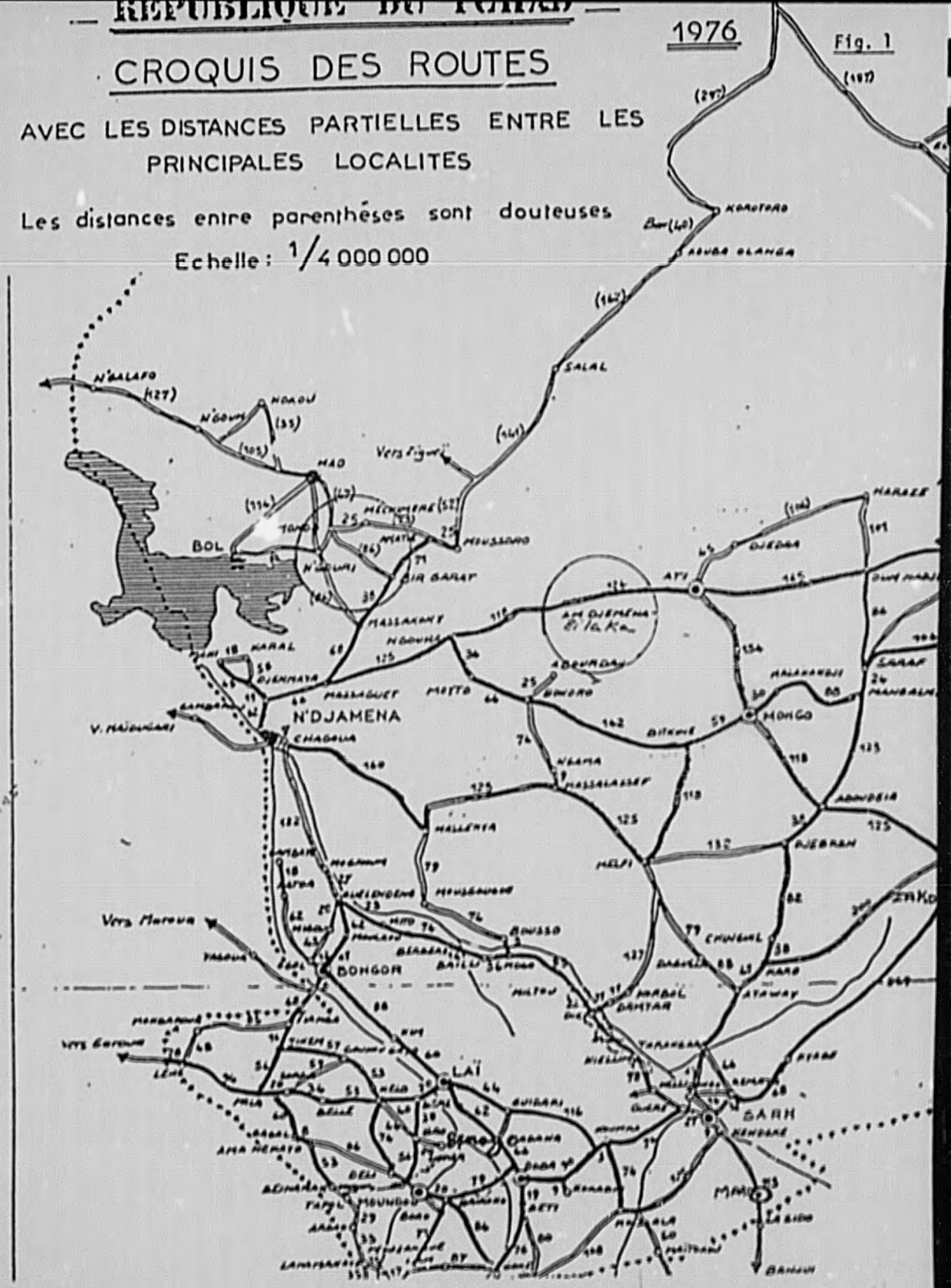
Fig. 1

CROQUIS DES ROUTES

AVEC LES DISTANCES PARTIELLES ENTRE LES PRINCIPALES LOCALITES

Les distances entre parenthèses sont douteuses

Echelle : 1/4 000 000



a request was made not to use rodenticides at the sample sites. I believe a full understanding of the importance of having rodenticide-free quadis for sampling has now been achieved.

During this consultancy I accompanied Mr. Yacoub and CPS technicians to the N'Gouri for the sixth population monitoring. An excellent description of the study protocol and sites is given by Wilson (Unpublished Trip Report, DWRC, February 5, 1990). Only 11 rodents (7 from quadi and 4 from dune sites) were trapped during this period. This is the lowest trap success of any sampling period since the study began, which suggests that rodent populations may be at the nadir of their annual cycles (Figs. 2 and 3). The data from the six sampling periods are presented in Appendix 1. The rodent species listed in the data as No. 1 were identified as *Tatera robusta*; unfortunately, we were unable to retrieve a specimen of No. 2 in good enough condition to make an identification.

From reviewing these data, it is apparent that we need to know the impact of our monthly trapping on the populations that we are monitoring. Verification is needed that the monthly removal of rodents has no significant impact on the trap success in future months. I suggest that every third month we should select at least two new quadis and one dune in the N'Gouri area and apply trapping techniques identical to those now being used in the eight quadis and three dunes sampled monthly. The new quadis and the dune(s) selected every third month should have the same size and production characteristics as the quadis currently being sampled. It would also be very desirable to know the methods and intensity of any rodent control conducted during the past 2 years. Quadis treated with any rodenticides after early January 1990 should not be chosen.

The time spent in the monthly monitoring activities in the N'Gouri area might be substantially reduced after Dr. Spillett arrives if the work can be divided between two teams: (1) Dr. Spillett, a CPS technician, and driver; (2) Mr. Yacoub, a CPS technician, and driver. Each team should have a vehicle. A suggested schedule for each team follows:

Monday	0800-1500	Drive to N'Gouri and unload.
	1700	Set trap lines in three dune sites.
Tuesday	a.m.	Pick up traps and record data from dune sites. Set interior trap lines in two quadis.
	p.m.	Set exterior trap lines in two quadis.
Wednesday	a.m.	Pick up traps and record data from two quadis. Set interior trap lines in two quadis.
	p.m.	Set exterior trap lines in two quadis
Thursday	a.m.	Pick up traps and record data from two quadis. Make site descriptions.
	p.m.	Make site descriptions as needed.
Friday	a.m.	Return to N'Djamena.

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RODENT POPULATION FLUCTUATION

NGOURI AREA

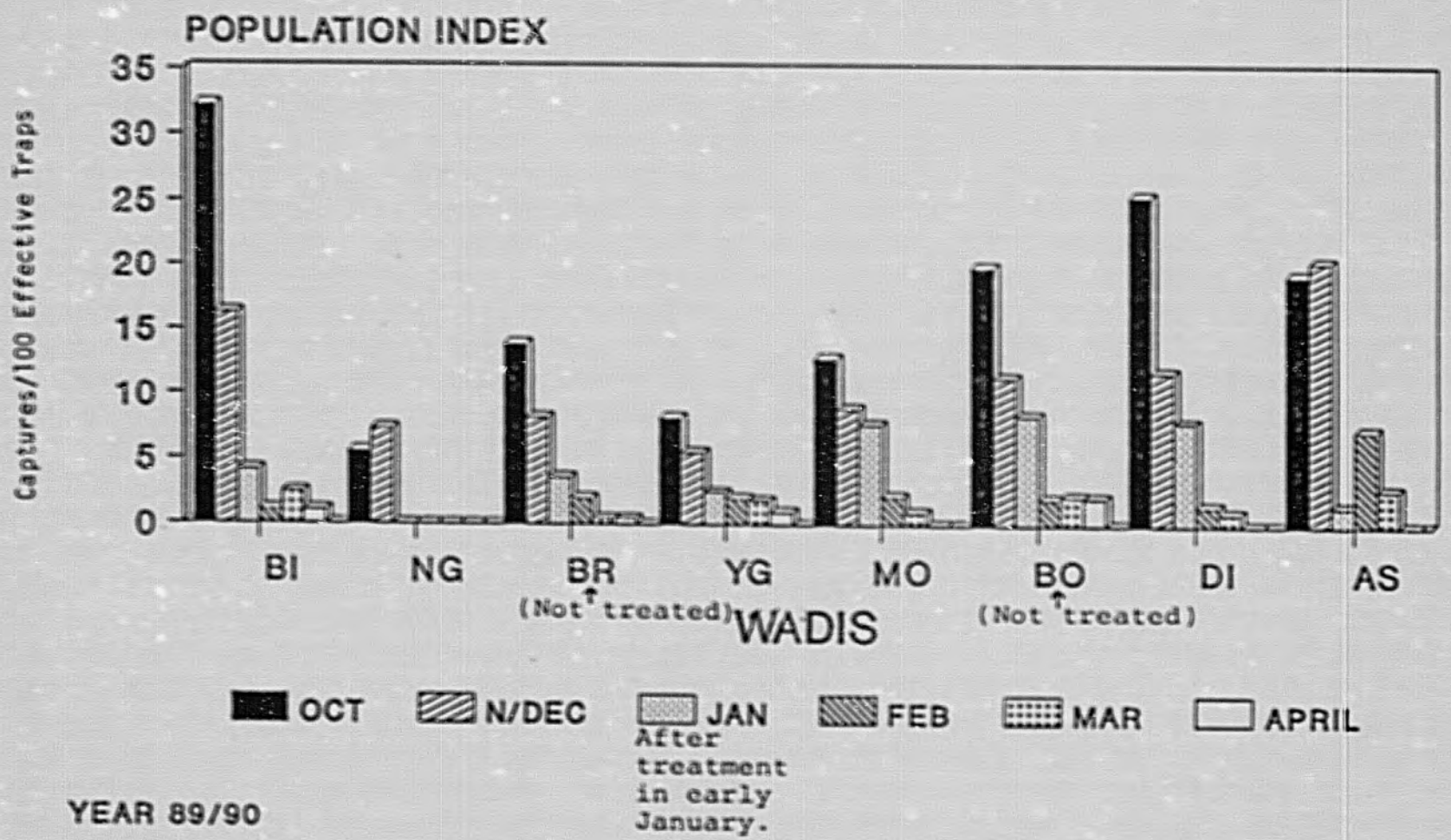

Fig. 2

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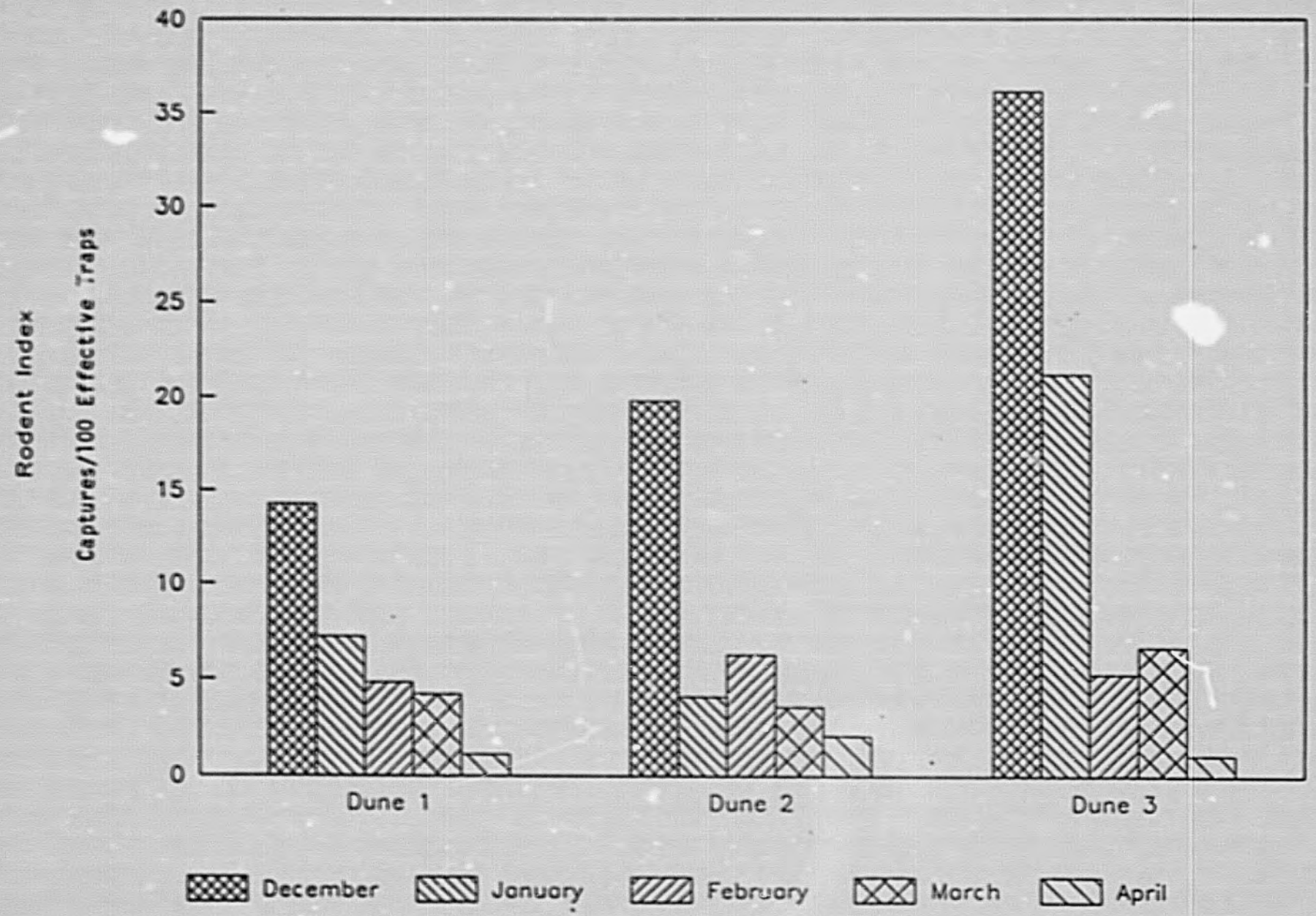
Rodent Index
Captures/100 Effective Traps
40
35
30
25
20
15
10
5
0
Dune 1
Dune 2
Dune 3
December
January
February
March
April

Fig. 3

With this schedule, the N'Gouri work should be completed in about 5 days; however, an additional day or two may be needed every third month to sample the additional "control" quadis and dunes or during the rains when transport to some sites may be delayed.

The need for a second vehicle for use in the field was discussed with Messrs. Fuller and Yacoub who, in turn, made arrangements with Dr. N'Garomillet, Director of Crop Protection Service, for CPS to use locust project funds to purchase a new Toyota pickup for the rodent project's field activities. The rodent project will need to cover costs of the vehicle including fuel, driver's wages and per diem, and maintenance. It is my understanding that routine maintenance consisting of an oil change and lubrication will be performed on the CPS vehicle each time it returns from the field, regardless of the kilometers driven. I hope this maintenance schedule can be negotiated on a kilometer-driven basis that would encompass at least two trips to N'Gouri, since each oil change and lubrication costs about $250.

Abeche

I had planned the go to Abeche and select sites for a second populations monitoring area. When Abeche was originally selected as the second monitoring area in November 1989, it was anticipated that (1) the project leader and Mr. Yacoub would fly to Abeche, (2) a CPS vehicle and assistance from CPS technicians would be available, (3) trapping activities would be completed in about 1 week, and (4) the project leader and Mr. Yacoub would fly back to N'Djamena. The Abeche area was to have been sampled every third month; however, this plan no longer appears feasible for a variety of logistical reasons including distance, road conditions, and vehicle availability. Messrs. Yacoub and Fuller indicated that there might be more accessible areas near Mango and N'Djamena-Bilala, both within a 1-day's drive from N'Djamena; therefore, Mr. Yacoub and I decided to examine the N'Djamena-Bilala area (Fig. 1) for a possible monitoring site, rather than going to Abeche.

N'Djamena-Bilala

The N'Djamena-Bilala area, near Lac-Fitry, is about a 7- to 8-hour drive (355 km) from N'Djamena. The area is a primary livestock production area with secondary agricultural and fishing activities. Quadis around the lake are strikingly different from those in Abeche and N'Gouri. Quadis are irrigated by digging channels from the lake to a series of very small agricultural plots. Vegetables including okra, tomatoes, onions, sweet potatoes, lettuce, cucumbers, beans, and corn are grown in these small quadis surrounding the lake. We met with personnel of Secour Catholique pour le Developement (SECADEV) to select prospective rodent monitoring sites: three quadis (Quadis Yao, N'golo, and Sceta, all within 100 km from N'Djamena-Bilala) and four dunes (one in each cardinal direction and within 5 km from N'Djamena-Bilala). From our brief visit to Quadi Yao and the four dunes and discussions with farmers, it appears that this area is unsuitable as a second rodent population monitoring site because (1) the vegetable production areas are very small, (2) quadis are underwater

4-6 months each year, (3) rodents have not been a major problem to farmers since 1984-85, (4) dune populations of *Gerbillus andersoni* appear to be moderate, and (5) the area may be inaccessible during the rainy period. I suggest that Dr. Spillett examine other areas such as Mango to avoid the accessibility problems associated with Abeche.

Mr. Abdelwahib Yacoub's Departure

Unfortunately for the DWRC/AID Chad Rodent Research Project, Mr. Yacoub anticipates leaving Chad in early June to attend Michigan State University, Lansing, Michigan, to pursue a 2-year course of study leading to a M.S. degree in agricultural economics. Mr. Yacoub's absence will be felt by all concerned with this project, but we wish him great success and hope he may rejoin us at some time in the future. Although we had hoped that the project leader would arrive in time to work with Mr. Yacoub and his replacement, this now appears doubtful. Therefore, I suggest that Dr. Spillett request Mr. Nasson (USAID/DMS) as the driver for the N'Gouri sampling trips because he knows the locations of all quadi and dune sampling sites.

Conclusions

I found transportation, sample validation, and communications to be major concerns with respect to the technical aspects of this project. The acquisition and availability of a second vehicle for field use should resolve the transportation problems. By sampling at least two new quadis and one dune every third month, the issue of trapping impact on rodent populations can be addressed. However, it is doubtful that the communications problem can be fully resolved. Implementing activities in Chad involves several agencies, numerous people, and the use of at least two (sometimes three or more) languages--i.e., French, English, and one or more local languages. Since most of the past DWRC consultants did not speak French, information was not always received by the individuals or agencies involved in a clear and timely manner. I suggest that the project leader and counterpart jointly develop a monthly proposed itinerary and activities statement, including objectives of each trip or activity, and circulate it in the appropriate language (French or English) to all involved parties, welcoming their comments. The statement should then be amended to reflect changes and be recirculated.

ACKNOWLEDGMENTS AND CONTACTS

I am particularly grateful for the assistance by Mr. Yacoub, who organized and coordinated all field activities and whose patience and understanding made this a consultancy a success. I would also like to thank Mr. Kurt Fuller who has spent many hours working on this project during the past months and continues to give support and guidance to the project.

MOA/Chad

Dr. N'Garomillet, Director, Crop Protection Service

USAID/Chad

Dr. Bernie Wilder, USAID Representative
Mr. Kurt Fuller, Agricultural Development Officer
Mr. Abdelwahib Yacoub, Counterpart Scientist
Mr. Bill Stringfellow, O.R.T. Project Leader
Mr. Nasson, Development Management Systems (DMS) Driver

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Coding Protocol and Monthly Data

(November 1989 through April 1990)

TRIP:

1 = November 1989	4 = February 1990
2 = December 1989	5 = March 1990
3 = January 1990	6 = April 1990

Note: Population sampling trips are made approximately every fourth week.

AREA: N'Gouri

SITE:

Quadis -

AS = Asankadori	BR = Broudou	NG = Ngarfari
BI = Binam	DI = Dibinintchi	YG = Ygra
BO = Boui	MO = Molori	

Dunes - D1, D2, and D3 = Dunes 1, 2, and 3

Note: Detailed site descriptions are given by Wilson, Unpublished Trip Report, DWRC, February 5, 1990.

LOC: Location of trap lines in and near the quadis and in dunes:

CC = Cultivated margin	NI = Noncultivated interior
NC = Noncultivated margin	CE = Cultivated exterior
CI = Cultivated interior	NE = Noncultivated exterior

SP: Species:

U = Unknown	M = *Mastomys* sp.
A = *Arvicanthus niloticus*	#1, 2 = Unknown
G = *Gerbillus andersoni*	

Note: U indicates that only part of the animal was present. #1, 2 indicates that the genus or species were not known--skin, skull, and measurements were forwarded to DWRC for identification.

H-B: Head and body length (mm) U = unknown

TAIL: Tail length (mm) U = unknown

SEX:

U = Unknown
11 = Male immature
12 = Male mature
21 = Female immature
22 = Female mature
23 = Pregnant
1U = Male unknown condition
2 = Female unknown condition

WEIGHT: Weight to the nearest 5 g for animals over 100 g; to the nearest 2.5 g for animals under 100 g: U indicates a significant portion of the animal has been eaten.

NO-EMB: Number of embryos

SIZE: Size of embryos

1 = early-term
2 = mid-term
3 = late-term

EFF-TRAPS: The number of traps not sprung without animals or missing per line.

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TRIP REPORT*

MOROCCO

Environmental Pesticide Project

May 7-26, 1990

James O. Keith
Wildlife Research Biologist

International Programs Research Section
Denver Wildlife Research Center
Science and Technology
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
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Unpublished Report

June 7, 1990

* This work was conducted with funds contributed to the Animal and Plant Health Inspection Service/Science and Technology/Denver Wildlife Research Center by the U.S. Agency for International Development under the "Morocco Locust Control Project," PASA 608-0196-P-00-0005.

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ITINERARY

Date	Location
May 7-9	Travel from Denver, Colorado, to Rabat, Morocco
May 10	In Rabat
May 11	Travel from Rabat to Agadir
May 12	Travel from Agadir to Tiznit
May 13	Travel from Tiznit to Sidi Ifni
May 14	Travel from Sidi Ifni to Agadir
May 15	Aerial observation of possible study sites
May 16	Selection of training area near Aït Baha
May 17-19	In Agadir
May 20	Travel from Agadir to Rabat
May 21-23	In Rabat--training session
May 24	Travel from Rabat to Casablanca
May 25-26	Travel from Casablanca to Denver, Colorado

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BACKGROUND

The Denver Wildlife Research Center is currently conducting an environmental project in Morocco with the support of AID/Rabat. The project consists of training and research in ecotoxicology to evaluate the effects of two insecticides widely used for locust control in Morocco. The training will prepare Moroccan scientists to independently conduct environmental pesticide studies in the future. Evaluation of the effects of the locust insecticides, malathion and dichlorvos, is needed as their impact was not assessed before they were introduced for widespread use in Africa for locust control.

A schedule of training and research activities for this project is given in Attachment 1.

OBJECTIVES OF TRAVEL

This trip to Morocco had two primary objectives. One was to select a field study area for training and research; the other was to initiate the project with an introductory training session in Rabat. Mr. John McConnell, who had just arrived in Morocco to serve as local project coordinator, and I visited with Mr. Joe Kitts, USAID, and Government of Morocco (GOM) personnel in Rabat, Casablanca, and Agadir to become familiar with the latest project plans and developments.

ACCOMPLISHMENTS

In Rabat on May 9 and 10, Messrs. Kitts, McConnell, and I discussed the arrangements necessary for local purchases, hiring, travel, and security in establishing the project, a study area, and a field camp. Mr. McConnell has decided to locate in Agadir to be nearer to study sites and the National Center for Locust control at Ait Melloul. Communication with Mr. Kitts will be maintained by fax, telephone, and occasional trips to Rabat. Mr. Kitts will rent a small truck for Mr. McConnell's use, in addition to the new project vehicle, which is scheduled for delivery in June. None of the necessary equipment or supplies has arrived, but ordering is now underway in the United States and all materials (except gas chromatographs) are scheduled to be shipped via air freight in early June.

On May 10, Messrs. Kitts, McConnell, and I met with Commandant Moha Layid, Deputy Director of Locust Control, Mr. Abdelaziz Arifi, Director of the Direction de la Protection des Vegetaux (DPV), and their staffs in Rabat. Plans for use of a military helicopter for survey to select study areas were discussed as well as arrangements for the first training session.

Mr. McConnell and I left Rabat on May 11 and spent 3 days traveling through the country south of Agadir evaluating areas for possible location of study sites. On Tuesday morning, May 15, we met at the National Center for

Locust Control with the Director, Thymi Ben Halima, and other DPV staff. Mr. Ben Halima expressed his preference for studying effects of locust insecticides in the habitats most frequently treated, rather than in atypical habitats that might be selected because they contained a greater abundance of animals for study. After this brief meeting, Messrs. McConnell, Kitts, and I joined Messieurs Charhbili, El Addami, El Hani, Ghaout, and Mouhim at the Agadir Airport for a helicopter survey of potential study areas.

Following our flight, we met again with Mr. Ben Halima. I suggested that if he preferred, we could conduct our experiments with malathion and dichlorvos in the desert steppe south of Guelmim, but for training I felt we should locate in a richer habitat that presented greater opportunities for observing, capturing, and studying animals. I recommended an area near Aït Baha, about 60 km southeast of Agadir. This location would simplify travel for participants and the maintenance of a camp during numerous sessions this summer.

This proposal seemed agreeable to everyone and on Wednesday, May 16, the prospection team drove to Aït Baha to select a specific area for study. This was accomplished, and a site for a camp was located. DPV staff in Guelmim will notify local authorities, obtain authorizations, and look into arrangements for camp help, water, and other requirements. Mr. McConnell will begin procurement for the establishment of a camp in early June.

The experimental area that will be treated with malathion and dichlorvos must be large. Experimental plots will each be 4-6 km^2. Five plots will be needed to replicate each of the two treatments and provide for a control plot. An area of such size (10 x 10 km) was not found during the survey except in the desert steppe south of Guelmim. A specific area for the experimental phase of this project will be selected later this year.

On May 17, I prepared materials for the first training session, while Messrs. McConnell and Kitts met with DPV staff to arrange for establishment of a camp. The camp, which will have an ability to accommodate up to 40 persons, will require purchase and transport of considerable equipment and supplies, the hiring of several cooks and helpers, and periodic provisioning with food, water, and other perishables.

The first training session was held in Rabat on Monday and Tuesday, May 21 and 22. It had been scheduled for 3 days, but as Wednesday, May 23, was a Moroccan holiday, the session was concentrated into just 2 days. The content of the session is outlined in Attachment 2, and Moroccan participants are listed in Attachment 3.

Project teams were organized (Attachment 4) with the understanding that training and research activities would be open to all participants, regardless of their primary team assignments. The training session beginning in late July will especially provide latitude for participation in a variety of training activities. During experimentation participants, of necessity, will work on specific tasks that are planned on the basis of available manpower.

Eight of the Moroccan scientists indicated their intention to participate in the next training session on radiotelemetry (see Attachment 4), but actual numbers could be somewhat higher or lower. This session is scheduled between June 18 and July 7, with Moroccan participants present from June 25 to July 5. As Aid Al Adha, a movable feast day, has now been scheduled for July 3, the training period in camp must be terminated July 1.

Six Moroccan scientists indicated they would not be able to attend the training session that begins in late July, but it is not certain how many of the others actually will attend.

It was evident in this first session with the Moroccan scientists that they are quite familiar with the general concepts of insecticide toxicity and the potential environmental hazards of field applications. Likewise, they have been well trained and have considerable experience in pest control and in field studies of insects, birds, rodents, insecticide efficacy, and crop protection. In subsequent training sessions, methods and concepts for investigating pesticide effects on organisms and ecological relationships should receive priority. They are familiar with the animals and plants of southwestern Morocco and their biology and ecology in the natural as well as managed environment.

The Moroccan scientists lack and are anxious to obtain all types of reference literature. All trainers should provide copies of selected journal articles, brief guides, and descriptions of methods pertinent to their subjects. In addition, handouts should be prepared of course outlines, texts of oral presentations, supplemental bibliographies of subjects covered, and other material of interest. Slide presentations would be appropriate as a generator will be available in camp. Especially relevant books should be supplied to locations where specialized work is undertaken. The need to leave abundant resource materials with the Moroccans cannot be overemphasized. All trainers should prepare adequate copies (30) of the various materials for distribution to ensure that all project participants, their supervisors, USAID, DWRC, and the Consortium for International Crop Protection (CICP) receive a complete set of project documents.

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CONTACTS AND ACKNOWLEDGMENTS

Rabat

Institute National de la Rechercher Agronomique (Insects)
Salé (Ornithology and Rodents)
Pesticide Office (Registration and Regulation)

Aït Melloul

Center National de la lutte Antiacridienne (All Biological Subjects)

Murrakech

Laboratoire National des Rongeurs (Rodents)

Casablanca

Official Laboratoire Chemique Analyses (Residue Analyses)

Moroccan Environmental Pesticide Project

Schedule of Activities

Dates (1989-1991)	Personnel	Activities	Location
Nov 27-Dec 16	Keith	Project planning	Rabat
May 5	McConnell	Project coordination	Rabat
May 7-26	Keith	Training--ChE Selection of study area	Rabat Agadir
May 21-Jun 2	Gillis	Training--chemistry	Casablanca
Jun 18-Jul 7	Kolz Phillips	Training--radiotelemetry	Camp
Jul 23-Aug 11	Heisterberg Keith LaVoie Matteson	Training--birds Training--ChE and residues Training--mammals Training--arthropods	Camp
Aug 20-Sep 8	Moroccan Scientists	Skill development I	Camp
Sep 10-29	Engeman Keith	Experimental design/statistics Review of skill development	Camp
Oct 1-19	Moroccan Scientists	Skill development II	Camp
Oct 21-27	Keith	Review of skill development	Rabat
Feb 3-23	Research--pretreatment data		Camp
	Bourassa	Radiotelemetry--aerial	
	Bruggers	Birds	
	Curnow	Mammals	
	Hegdal	Radiotelemetry--ground	
	Keith	ChE and residues	
	Matteson	Arthropods	
Feb 24-Mar 2	Keith Matteson	Treatment of plots	Camp
Mar 3-23	Research--posttreatment data		Camp
	Avery	Birds	
	Fiedler	Mammals	
	Johnson	Radiotelemetry--aerial	
	Keith	ChE and residues	
	Matteson	Arthropods	
	Phillips	Radiotelemetry--ground	
July (3 weeks)	Keith	Report and manuscript coordination	Rabat

Training Session 1: May 21-22, 1990

1. Introduction to Project

   a. Coordinator in Morocco--John McConnell

   b. Organization of Denver Wildlife Research Center. CICP Participation.

   c. Study Areas

      (1) Training: Aït Baha near Agadir

      (2) Experimental: To be selected near Guelmim

   d. Study Teams

   e. Resumés--Moroccan Scientists

2. Science of Pesticide-Wildlife Ecology

3. History of Pesticide-Wildlife Investigations

4. Review of Organophosphate Effects

5. Residues--Collection of Samples, Analysis, and Interpretation

6. Measurement of Cholinesterase--Concepts, Methods, and Interpretation

7. Laboratory Dissection--Removal of Brain and Gizzard. Maintenance of Journal and Catalog

Ministry of Agriculture
Direction de la Protection des Vegetaux et de la Repression des Fraudes
Service de la Protection des Vegetaux

Project Participants

ABASSI	My Tahar	Entomologist	Rabat
ABIDI	Abdellah	Chemist	Rabat
AKCHATI	Mohamed	Phytopharmacien	Rabat
ALAOUI	Abderrahim	Ornithologist	Rabat
ARROUB	El Hassan	Mammalogist	Rabat
BAOU	Ahmed	Entomologist	Rabat
BENCHRA	Mohamed	Phytopharmacien	Rabat
BOUGHDAD	Ahmed	Entomologist	Rabat
CHARHBILI	Mustapha	Entomologist	Guelmim
DAIA	Mohamed	Chemist	Rabat
DLIOU	Ahmed	Phytopathologist	Agadir
EL ADDAMI	Lhassane	Mammalogist	Guelmim
EL FAYQ		Phytopathologist	Layoune
EL HANI	Abderrahim	Ornithologist	Rabat
EL HARMOUCHI	Ahmed	Phytopharmacien	Rabat
EL ISMAILI	Ahmed	Entomologist	Oujda
GHAOUT	Said	Entomologist	Rabat
ID MESSAOUD	Brahim	Mammalogist	Marrakech
MOUHIM	Ahmed	Entomologist	Agadir
OUZAOUIT	Ahmed	Mammalogist	Marrakech
SAHIL	Sallek	Entomologist	Agadir
SALAH BENNANI	Ahmed	Entomologist	Rabat
TARHY	Mustapha	Chemist	Casablanca

Project Teams

Administration:	Government of Morocco (GOM)--Arifi (Rabat), Ben Halima (Aït Melloul) USAID--Kitts (Rabat)
Coordination:	GOM-Mouhim (Aït Melloul), DWRC--McConnell (Aït Melloul)

	DWRC	GOM
Insect Studies:	Matteson	Abassi Baou Boughdad El Falq* El Ismaili* Ghaout* Mouhim Sahil* Salah
Bird Studies:	Avery Bruggers Heisterberg	Alaoui Dliou* El Addami El Hani
Mammal Studies:	Curnow Fiedler LaVoie	Arroub Charhbili Id Mesaaoud Ouzaouit
Chemistry:	Gillis	Abidi Akchati Benchra* Daia Tarhy
Radiotelemetry:	Bourassa Hegdal Johnson Kolz Phillips	Akchali Arroub Charhbili Daia El Addami El Falq El Hani Ghaout
Cholinesterase and Residues:	Keith	Abidi Akchati Benchra El Harmouchi Sahil

* Will not be able to attend Training Session 4.

TRIP REPORT*

MOROCCO

Chemical Analyses of Pesticides

May 21-June 2, 1990

John N. Gillis
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National Enforcement Investigations Center
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Denver Federal Center
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Unpublished Report

June 29, 1990

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ITINERARY

Date	Location	Activity
May 21-23	Denver, Colorado, to Casablanca, Morocco	Travel
May 24-27	Agadir/Study Site	Travel to study site for sample collections
May 28-30	Casablanca	Training of Moroccan chemists, discussion of proposed methods, and tour of the laboratory facilities
May 30-June 1	Rabat	Discuss aspects of proposed chemical research
June 1-2	Rabat, Morocco, to Denver, Colorado	Travel

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OBJECTIVES

This TDY was primarily to train Moroccan chemists in the methods of chemical analyses needed to monitor the impact on the environment and nontarget wildlife of locust control pesticides. Objectives of this TDY included the following: to train Moroccan scientists in the chemical aspects and methods needed during research to evaluate the impact on the environment and nontarget wildlife of locust control sprays; to evaluate the equipment and facilities at the Laboratoire Official D'Analyses et de Recherches Chimiques in Casablanca, Morocco, for participation in the research; to visit the field trial study site to collect representative soil and vegetation samples to train chemists in the proposed analytical methodology; and to discuss chemistry aspects of this research and other pesticide-related topics with Mr. Joe Kitts (USAID/Rabat Locust Coordinator). All objectives were accomplished.

ACTIVITIES

Study Site Visit/Sample Collection

Mr. John McConnell, DWRC Project Logistics Coordinator, and I traveled to the study site near Aït Baha to collect representative samples of soil and vegetation. Mr. McConnell obtained information about the plants that would be eaten by native wildlife in the area. Vegetation that might be eaten by nontarget birds and mammals, other vegetation representative of the study area, and soil from the site were collected to train chemists in methods that would be used to analyze samples during the experimental portion of the laboratory training. Custody seals were used on all sample containers to demonstrate acceptable custody procedures.

Training

Training was conducted at the Laboratoire Official D'Analyses et de Recherches Chimiques in Casablanca, Morocco. Nine individuals from laboratories in Rabat and Casablanca attended the session (Attachment 1). During the first day, proposed methods for analyzing malathion and dichlorvos in samples were handed out, and the feasibility of these methods was discussed. Methods were provided to analyze formulations, water, soil, vegetation, and animal tissues. Other topics discussed included equipment and methodology required for the collection and analyses of air samples at pesticide storage sites and research study sites, discussion of studies that have been conducted by the laboratory on the degradation of pesticides used on tomatoes and oranges, objectives of the planned locust control research, possible screening methods for produce prior to export, and the number and types of samples currently analyzed by the laboratory.

The laboratory staff provided me with a tour of their laboratory facilities. This included the laboratory for the analysis of fatty acid content in oils; the laboratory for the analyses of sugar products; the

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laboratory used for the analyses of polymers, plastics and chemical products that have been imported, and the pesticide laboratory.

I met briefly with Dr. Ahmed Laaberki, the laboratory director. During our meeting we discussed the agenda for the training and how this training would benefit laboratory personnel involved with the research to be conducted.

During the second and third days of the laboratory session, two of the proposed methods were performed on the soil and vegetation samples collected at the study site. Soil samples were fortified with about 2 ppm of malathion and dichlorvos and were then extracted according to the proposed method. The recovery was approximately 78% for both pesticides from the soil. Fruit collected from the plant *Argonia* was fortified with about 2 ppm of malathion and dichlorvos and used to demonstrate the method for the analyses of vegetation samples. The fruit extracts contained many interferences, and further cleanup was required. The effect of the additional cleanup on the recovery of the two pesticides from the fruit was not evaluated because of a lack of time. The soil method appears to be acceptable in its present form, and the vegetation method may have to be modified, depending on the types of vegetation present at the sites to be treated during the study. The fruit used for the demonstration of the vegetation method probably represents a difficult vegetation sample because of the oils and other interferences present.

I was given a tour of the laboratory section that performs analyses of alcohols by Mr. Ahmed Dghoughi, supervisor. This section performs analyses to determine the alcohol (ethanol) content of beer, wine, and other alcoholic beverages sold or imported in the country. Mr. Dghoughi expressed an interest in any methods for the determination of procymidone in wine. I sent a residue method for this pesticide to Mr. Dghoughi through Mr. Tarhy at the Casablanca laboratory. Mr. Dghoughi also participated in several discussions during the laboratory session.

At the close of the laboratory training session several general topics such as detection limits, standard operating procedures (SOP's), study plan for the research, and commonly encountered problems with pesticide formulation and residue analyses were discussed. Copies of a variety of EPA SOP's that relate to these subjects will be provided to Mr. Tarhy.

Meetings with Mr. Joe Kitts

I had the opportunity to meet with Mr. Joe Kitts of the Rabat Locust Control Project on May 30 and 31. Mr. Kitts was very concerned over the environmental impacts of the use of pesticides to control locusts and the potential hazards to people, domestic animals, and wildlife in the study sites. He outlined some of the precautions to be taken to minimize the exposure to people and domestic animals during the study.

Another concern expressed by Mr. Kitts was the storage of large quantities of pesticides in Morocco. Currently several options to eliminate the storage of large amounts of pesticides are being considered. Among the

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options discussed were the reformulation and use of some of the stored pesticides, continued storage until the chemicals can be used or disposed of, and permanent disposal, such as incineration.

Mr. Kitts was very knowledgeable on these topics and had done a considerable amount of background research. There are no simple answers to the problem of how to dispose of unusable or unwanted pesticides. I suggested that whenever possible the pesticide could be used as it was originally intended, with reformulation to remove contaminants if necessary. In cases where this would not be possible, such as with environmentally unacceptable pesticides, incineration is probably the best method for disposal. Mr. Kitts stated that he is currently evaluating options for incineration, such as portable incinerators. I will provide Mr. Kitts with any information that I receive on incineration or alternative disposal methods.

FINDINGS AND CONCLUSIONS

- A structured approach, starting with basic concepts or theory, should be encouraged during training and discussions. Persons involved with future training sessions should provide each participant with a copy or outline of the material to be covered prior to the start of each session.

- The assistance of Mr. John McConnell proved to be invaluable. Mr. McConnell is fluent in the local languages, familiar with the culture of the Moroccan people, and able to communicate effectively. Communication with Moroccan scientists involved in the project was challenging at times, but it was not an insuperable obstacle. The English classes attended by the laboratory staff prior to my arrival appear to have been a worthwhile investment. Several of the laboratory staff were progressing well with their English skills. During the training and discussions I was able to communicate verbally with most of the staff, and the information was relayed to those not proficient in English. Despite some recent training in French, my lack of fluency in French did prove to be a problem when dealing with persons outside of the laboratory environment.

- At the time of the training session, much of the equipment required to support the research was not available in the laboratory. This placed some limitations on the experimental training. However, methodology was practiced and numerous discussions related to the research and laboratory capabilities were held with the Moroccan scientists. This equipment is expected to arrive in the very near future.

- The equipment for the laboratory must be available, and the new gas chromatographs must be installed and be operating prior to the time that samples will be received by the laboratory. This must be done so that samples collected during the research can be analyzed in a timely manner. Prolonged storage of samples could affect results and conclusions of the chemical analyses.

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- Training of Moroccan scientists in the proper operation of the new gas chromatographs would be most beneficial. But as far as I know, this type of training is not available in Morocco. The training provided by the vendor who installs the equipment will probably be minimal, but I would recommend that Mr. Tarhy and others on his staff be present during the installation of the instrument. I will try to contact someone in the Denver area who has this type of instrument and visit his/her laboratory. I have also obtained an operator's manual for the Varian 3400 gas chromatograph, so that I can be somewhat familiar with its operation before returning later in the year for the next training session. I had felt that a service kit that has replacement circuit boards should be purchased with the new gas chromatographs; but when I contacted the Varian Instrument Company, I was told that they no longer sell service kits for the Model 3400 gas chromatograph. For this reason, major replacement parts will have to be ordered as they are required.

- The number and type of samples to be collected for analyses during the research should be carefully considered to ensure that adequate personnel and equipment will be available at the laboratory. Based on the results of the experiments performed during the training, soil samples should not be a problem. Certain types of vegetation and tissue samples could prove to be time-consuming and difficult to analyze. If at all possible, the contents of the crops (in the case of birds) and stomachs (for mammals) should be collected for analyses. Animal muscle and organ tissue should not be collected for this study unless absolutely necessary, as their analyses might not be possible.

- Equipment and training for sampling air was discussed. Messrs. Tarhy and Kitts indicated a concern for monitoring air in the vicinity of pesticide storage sites. Such equipment could be used to collect air samples during the research if this information is desirable. I sent Mr. Tarhy some background information on low-volume air sampling.

- Laboratory personnel requested that I send references for screening of samples for several different pesticides. I have sent Mr. Tarhy the method used by the California Department of Food and Agriculture and the method from the Pesticide Analytical Manual, which is used by many laboratories in the United States.

- The Moroccan scientists that participated in the laboratory session were knowledgeable on the analyses of various pesticide samples and were very willing to receive new information. They lack the resources to obtain current information on new developments in methodology for the determination of pesticides and information on new pesticide products. It would be desirable for the laboratory to obtain some additional reference material on the subjects of pesticides and pesticide analyses.

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Attachment 1

Chemistry Training Session I

May 28-30, 1990

Laboratoire Official D'Analyses et de Recherches Chimiques
Casablanca, Morocco

Project Participants

Mr. Mostafa Tarhy	Casablanca
Mr. Behazzouz	Casablanca
Mrs. Dinari	Casablanca
Ms. Mana	Casablanca
Mr. Daia	Rabat
Mr. Ben Chraa	Rabat
Mr. Bennis	Rabat
Mrs. Semmah	Rabat
Mr. Abidi	Rabat

TRIP REPORT*

An Assessment of the Rodent Problems in the Republic of Yemen

May 28-June 22, 1990

G. Keith LaVoie
Wildlife Biologist (Research)

International Programs Research Section
Denver Wildlife Research Center
Science and Technology
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
P.O. Box 25266
Denver, CO 80225-0266 U.S.A.

Unpublished Report

July 20, 1990

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SCOPE OF WORK

A. Study and identify rodents found in the fields.

B. Establish procedures for measuring the economic impact of postharvest losses due to rodent damage on the annual production of the most important Yemeni crops, particularly cereals and vegetables.

C. Study the best methods to control these rodents and check damage caused by them under diversified environmental conditions.

D. Establish a training program for local employees to study rodents and effective methods of control.

E. Develop a list of equipment necessary for furnishing a laboratory for rodent control under the main laboratory of the Plant Protection Authorities (ARA).

F. Submit a final report at the end of the TDY.

ABSTRACT

The objectives of this consultancy were to survey rodents, provide methods to estimate their impact on agriculture, study methods of control, establish a training program for Yemenis in rodent biology and control methods, and provide a list of equipment needed to furnish a rodent research laboratory. The areas surveyed were the central highlands near Sana'a and Dhamar at about 2,300 m above sea level, the southern highlands near Ibb and Taiz at 2,800 m and 1,500 m above sea level, respectively, and the Red Sea Tihamah coastal region, in and near Hodeidah. Heavy infestations of black rats (*Rattus rattus*) were found in all storage structures, markets, and other buildings in all areas surveyed. Other rodents found in buildings were house mice (*Mus musculus*) in the highlands and Norway rats (*Rattus norvegicus*) in storage areas in Hodeidah. Although most cereal grain crops had already been harvested, farmers and Agricultural Research Authority (ARA) personnel related severe rat damage to cereal grains. Heavy infestations of the sand rat (*Meriones rex*) were found adjacent to agricultural fields in the central and southern highlands. This species also reportedly occurs in the Tihamah. These large jirds are seedeaters that can consume and store large quantities of cultivated and noncultivated seeds. Black-tufted gerbils (*Gerbillus famulus*) were also trapped in the central highlands, and although they appear to have a wide distribution, their pest status could not be determined. Based on trap success and signs of rodents in storage structures, postharvest losses to rodents are very high and the potential for transmission of rodent-borne diseases transmitted to man, such as salmonellosis, leptospirosis, and plague, is probably equally high. Since virtually all cereal crops had been harvested, statistically reliable estimates of crop damage by jirds were not possible. However, based on

jird distribution and the number of burrow openings observed, crop losses of cereal grains at planting and wheat at the reproductive stage are probably very high. A 2-day class in general rodent biology, identification, and damage assessment methods was given to ARA personnel. Recommendations include: (1) a followup consultancy in 1991 to present an intensive training course for ARA Crop Protection Division and Extension personnel who may be actively involved with rodent problems, (2) training of one Yemeni in the United States in a course of study leading to a graduate degree in vertebrate pest management, and (3) the establishment within the Crop Protection Division of a laboratory to assess rodent damage and develop methods to reduce storage and field losses from rodents.

BACKGROUND

In June of 1989, the United States Department of Agriculture (USDA), under the Trade and Development Missions Program mandated by the Agricultural Aid and Trade Missions Act, recruited and sent a seven-person team to the Yemen Arab Republic. Among other objectives, this team was asked to consider and propose cooperative trade and development initiatives or opportunities, as appropriate. The team found that the Government of Yemen gives development of agriculture a high priority and reiterated the support of the U.S. Government for this goal and its commitment to help develop the private sector of Yemen.

Under the Yemen Agricultural Development Support Program (ADSP), funded by the U.S. Agency for International Development (USAID), the Consortium for International Development (CID) is providing training and technical assistance to the Yemen Ministry of Agriculture and Fisheries (MOAF) to assist in developing the Yemeni agricultural sector. Colorado State University (CSU) has been the lead institution assisting CID; Mr. Keith LaVoie, Wildlife Biologist, of the International Programs Research Section/Denver Wildlife Research Center (DWRC/IPRS) under Science and Technology/Animal and Plant Health Inspection Service/U.S. Department of Agriculture (APHIS/S&T/USDA) was assigned as a consultant for this project.

INTRODUCTION

The Republic of Yemen, formerly the Yemen Arab Republic and the Peoples Democratic of Yemen, is on the southeastern portion of the Arabian Peninsula. All travel and activities described in this report were carried out in the former Yemen Arab Republic; consequently, findings and recommendations apply only to that area.

Yemen's topography changes radically from east to west, with widely varying altitudes, climates, and vegetational zones. The coastal area, or Tihamah along the Red Sea, is 30 km to 60 km wide; with irrigation it provides a rich agricultural plain. To the east of the Tihamah, basaltic mountains rise abruptly to over 2,000 m. The mountains are cut by wadis, which are usually terraced for agricultural production. There are several large basins in the highlands, such as Sada in the north, Sana'a and Dhamar in

the central area, and Ibb and Taiz in the south. The eastern mountains gradually slope to the Ruba' Al Khali Desert (see Fig. 1). Monsoon winds bring seasonal changes to the mountains. The western slopes receive up to 1,800 mm of rain from May to September from the southwestern monsoon; from October through February, cold, dry winter months are the result of the dry air masses from central Asia. The principal crops of Yemen are sorghum, millet, wheat, maize, legumes, and vegetables.

It is believed that a significant proportion of Yemeni agricultural production is lost to vertebrate pests, particularly rodents. Yemen has virtually no history of rodent control; consequently, research and instruction are prerequisites to any control operations.

RESULTS

Objective (A): *Study and identify rodents found in the fields.*

A study and trapping survey of the central highlands, southern highlands, and Tihamah (or Red Sea coastal region) was completed. The rodent species captured and those reported in the literature are shown in Table 1. Our trap success of 10.5 percent is an indication of high rodent densities but does not indicate the extremely high populations of *Rattus rattus* and *Meriones rex* because our trapping methods included trials of various baits, some of which were completely ineffective in heavily infested buildings and fields. None of the trap baits were effective for *M. rex*, and those specimens that were trapped were caught by placing traps in their burrow entrances to catch this species as it emerged. Another trapping problem encountered in the Ibb area, which reduced trap success, was the removal of specimens and traps by feral dogs.

Extremely high densities of *R. rattus* at all storage and dwelling sites I surveyed suggested that up to 5 percent of cereal grains and vegetables in storage may be consumed by commensal species. Time available in the areas surveyed was not sufficient (8-12 days) to obtain reliable estimates of cereal grains or vegetables consumed by rodents. In markets and farm storage facilities, the consumption and caching of cereals and vegetables by rodents is probably extremely high because of the high concentration of rodents and foods in small areas. There is virtually no rodent control on farms, in markets, or in storage facilities other than the occasional locally made traps. Large government or commercial storage facilities have high commensal rodent populations, but the volume of cereals and other commodities is sufficiently large to reduce the overall percentage of food consumed by rodents. In addition to direct losses of commodities consumed by rodents in large storage facilities, other causes of loss include damaged bags, spillage, and labor--these costs may even exceed rodent consumption losses.

Fig. 1. Yemen Arab Republic (from Piepenburg, 1987).

Table 1. Rodents of the Republic of Yemen.

Region	Area	Site	Species
Central highlands	Sana'a/ Dhamar	Commensal	*Rattus rattus**
		Commensal and field	*Mus musculus**
		Field	*Meriones rex**
		Field	*Gerbillus famulus**
Southern highlands	Ibb/Taiz	Commensal	*Rattus rattus**
		Commensal and field	*Mus musculus*
		Field	*Meriones rex**
		Field	*Arvicanthis niloticus*
		Field	*Acomys dimidiatus*
Northern highlands	Sada	Field	*Meriones rex*
		Field	*Gerbillus famulus*
		Commensal and field	*Mus musculus*
		Commensal	*Rattus rattus*
Tihamah	Zabid/ Hodeidah	Commensal	*Rattus rattus**
		Commensal	*Rattus norvegicus**
		Commensal and field	*Mus musculus*
		Field	*Meriones rex*
		Field	*Gerbillus cheesmani*

* Indicates this species trapped on this survey; other species and locations were listed by Harrison (1972).

Objective (B): *Establish procedures for measuring the economic impact of postharvest losses due to rodent damage on the annual production of the most important Yemeni crops, particularly cereals and vegetables.*

Reliable loss estimates of cereals and vegetables in storage can be made by methods such as rodent population estimates in both large and small storage structures. However, reasonable sample sizes are required. One such method of estimating rodent populations is the Change-in-Ratio Method. This method is best used in small storage areas, i.e., on-farm storage structures.

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The Change-in-Ratio Method involves: (1) measuring rodent activity for 1 night using tracking tiles, (2) removal trapping of rodents for 3 to 5 days, depending on densities and trap success, and (3) measuring rodent activity again for 1 night, using the same number and placement of tracking tiles. This calculation is expressed as:

$$P_1 = \frac{T_1 \times n}{T_1 - T_2} = \frac{T_1}{P_1} = \frac{T_2}{P_2}$$

Where,

T_1 = proportion of tracking tiles active (e.g., 80/100) before removal trapping
T_2 = proportion of tracking tiles active (e.g., 20/100) after removal trapping
n = the number of rodents removed (e.g., 120)
P_1 = estimate of original population
P_2 = estimate of remaining population after removal trapping

For example,

$$P_1 = \frac{T_1 \times n}{T_1 - T_2} = \frac{0.8 \times 120}{0.8 - 0.2} = \frac{96}{0.6} = 160$$

Assuming that an average weight of the rodents trapped was 150 g and knowing that a rat will consume about 12.5 percent of its body weight each day, the daily consumption estimate in this structure is as follows:

160 rats x 150 g (weight) x daily consumption
160 x 150 g = 24,000 g (biomass)
24,000 g x 0.125 = 3.000 kg/day consumed

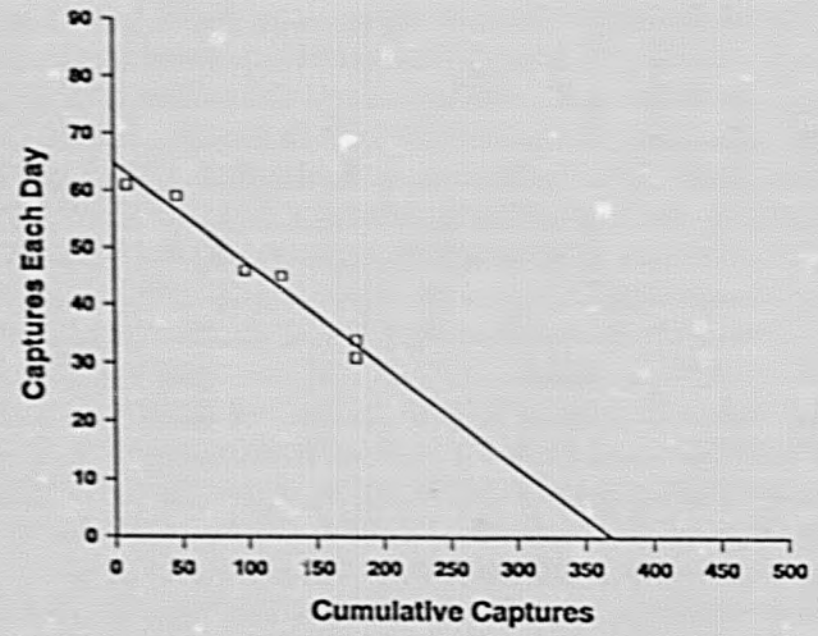
Note: Confidence limits cannot be calculated for this method.

Another method of rodent population estimation in structures is calculated by the regression of daily captures. This method requires 4 to 10 consecutive nights of removal trapping. This method is best used in larger structures. An example of this method is shown in Figure 2.

Bag or container damage can easily be calculated by randomly sampling lots of 100 bags in several areas of each storage facility and calculating the percentage of bags penetrated by rodents.

Wheat crops had been harvested prior to this consultancy; thus crop damage by *M. rex* could not be estimated. One method to estimate rodent field damage to wheat (the rodent problem most commonly reported) is to establish a simple transect sampling of damage/undamaged tillers. The only equipment

Figure 2. An example of estimating a rodent population and losses by removal trapping for six nights in a storage structure.



If: 249 Rattus rattus are trapped in six nights, then the

Estimated population is 355 Rattus rattus.

If: Average weight of the 249 rats was 162 g, and the

Average food consumption of these rats is 12.5% of their body weight each day,

Then: 355 rats x 162 g = 57,510 g

57,510 g x 12.5% = 7,189 g lost each day.

required is a 1-m x 1-m frame, a table of random numbers, and some hard work. To use this method:

1. Select an area of wheat fields (usually with reported rodent problems).

2. Assign a number for all wheat fields in the area of approximately 5 km^2 that are in a reproductive state. If there are about 100-200 fields, a sample of 3-5 percent should provide a reliable estimate of all fields within the areas.

3. Select fields to be sampled from a table of random numbers.

4. Establish within each field to be sampled one or more transects with 10 sample points each that are again selected from a table of random numbers (points are paces along the transect). Fields not exceeding 1/4 ha need only one transect, while larger fields will require proportionally more transects. For example: one sample field selected is about 1/4 ha and thus requires one transect across the field with 10 sample points along the transect. Sample points are paced from the start of the transect. In this instance, let us assume that the transect is 60 paces long; using the table of random numbers, we selected our ten sample points at 8, 12, 14, 19, 26, 29, 41, 44, 56, and 58 paces. At these ten distances, the sample frame is dropped, and the total number of undamaged tillers, as well as the number of tillers cut by rodents within the sample frame, is counted.

5. From these data an estimate of the percent of damage for each field sampled can be calculated and extrapolated to other fields in the area for an area estimate.

Damage estimates are the most basic requirement of a rodent damage control program. I strongly encouraged my counterpart, Mr. Abdul Elah Ahmed Musheed, to use the pre- and postharvest methods of damage assessment described above. The method described for wheat may be applied to other cereal crops. I also want to suggest that these estimates and analysis of the data be completed prior to the upcoming training TDY.

Objective (C): *Study the best methods to control these rodents and check damage caused by them under diversified environmental conditions.*

I found evidence of severe pre- and postharvest cereal grain and vegetable losses due to rodents. However, I hesitate to recommend any control methods before reliable damage assessments have been initiated, minimal applied research has been completed, and counterparts have been trained in safe and appropriate methods of rodent control. Although I will suggest some rodenticide trials for pre- and postharvest reduction in rodent damage, only through training and in-country research can rodent control methods be developed to meet this objective.

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I suggest limited trials of warfarin, a first generation anticoagulant, as the primary control tool to reduce rodent damage in storage facilities. This rodenticide should be available to rodents on a continuing basis in all trial storage areas. The material is mixed at a 1:19 ratio of rodenticide to a cereal base. Before adding the warfarin concentrate, the cereal base should be lightly coated with vegetable oil. On cracked or broken maize, this is about 2 to 4 percent vegetable oil. The rodenticide is then added and should form a uniform coat on the grain. An identifying coloring agent (usually green) should also be incorporated for safety. If the rodenticide is from a U.S. source, the coloring agent is on the rodenticide concentrate. If this is not the case, food coloring materials may be used. Bait can be mixed in small batches (1-2 kg) in plastic bags or in large batches in a commercial mixer; e.g., cement mixer, but not a food mixer. In preparing any bait, persons mixing it should wear a dust mask and rubber gloves--they should not eat or drink anything during the mixing. They should thoroughly wash their bodies and all equipment after mixing the bait. All bags of rodenticide baits should be clearly labeled. Vitamin K therapy is used in cases of accidental warfarin poisoning of humans or domestic animals.

During these trials, warfarin bait should be continuously available in storage facilities in a container, usually called a bait station, that permits rodents to enter but restricts other animals. Each bait station should contain about 200 g of bait, and the bait should be replenished as required. Any dead rodents found in the building should be removed and buried.

Field baiting trials for control the of *M. rex* and other species may be initiated with zinc phosphide on a grain base such as wheat at a 2 percent concentration. There are numerous registered zinc phosphide rodent bait formulations used in the United States. Figure 3 is a specimen label approved by the U.S. Environmental Protection Agency. Individuals working with zinc phosphide baits should be aware of the restrictions and hazards shown on this specimen label for a 2 percent rodent bait. Bait may be mixed as suggested above for warfarin (e.g., using a plastic bag and vegetable oil), observing all safety measures suggested. Field application of about 5 g should be placed in each active burrow opening. If bait efficiency is not 85-95 percent, then prebaiting with clean wheat may be required before applying a rodenticide. Field rodent control trials should take place immediately before damage is expected, e.g., at the reproductive stage of wheat in the central highlands. Active burrow openings may be determined by closing all burrow openings with soil in the area to be treated 2-3 days before baiting. Those burrows open on the day of baiting are "active" and should be baited.

The selection of rodenticides, bait base materials, formulation, and baiting techniques should evolve from a research program designed to determine the safest and most efficacious methods. I urge that toxicants not be used until ARA personnel have completed a training course in which they receive specific instructions and demonstrations on proper use and safety techniques.

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Figure 3. An Environmental Protection Agency approved container label for a 2% A.I. rat and mouse bait.

APPLICATION DIRECTIONS FOR NORWAY RAT AND ROOF RAT: Apply 1 to 2 teaspoon amounts of ZP Rodent Bait per placement. For outdoor use, place bait in active rat burrows or tamperproof bait boxes. Maintain an uninterrupted supply of fresh bait until all signs of feeding have stopped. Do not treat the same area with ZP Rodent Bait at less than 30 day intervals.

APPLICATION DIRECTIONS FOR HOUSE MOUSE: Apply 1 teaspoon amount of ZP Rodent Bait per placement at 8 to 12 foot intervals. For outdoor use, protect bait from rain or snow. Maintain an uninterrupted supply of fresh bait until all signs of feeding have stopped. Do not treat the same area with ZP Rodent Bait at less than 30 day intervals.

Collect and dispose of all dead animals and excess bait properly.

STORAGE AND DISPOSAL

PROHIBITIONS: Do not contaminate water, food, or feed by storage or disposal.

PESTICIDE DISPOSAL: Pesticide, spray mixture, or rinsate that cannot be used should be disposed of according to procedures approved by federal, state or local [illegible] authorities.

CONTAINER DISPOSAL: Triple rinse (or equivalent) and dispose of in an approved landdfill or bury in a safe place.

GENERAL: Consult federal, state or local authorities for approved alternative procedures.

WARRANTY: Seller makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. Buyer assumes all risk of use and/or handling of this material when such use and/or handling is contrary to label instructions.

ZP® Rodent Bait

CONTROLS RATS AND MICE

ACTIVE INGREDIENT	Zinc Phosphide	2%
INERT INGREDIENTS		98%
	TOTAL	100%

KEEP OUT OF REACH OF CHILDREN

CAUTION

STATEMENT OF PRACTICAL TREATMENT

If swallowed — drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger or blunt object.

Avoid use of all oils. Have patient lie down and keep warm. Do not induce vomiting or give anything by mouth to an unconscious person. Get medical attention.

If on skin or in eyes — flush with plenty of water.

See right side panel for additional precautionary statements.

Manufactured by
BELL LABORATORIES, INC.
Madison, WI 53705 U.S.A.

EPA EST. NO. 12455 WI-1 EPA REG. NO. 12455-18AA

NET CONTENTS 1 lb. (454 grams)

SPECIMEN LABEL

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION

Keep away from humans, domestic animals, and pets. May be fatal or harmful if swallowed or inhaled. Avoid skin contact. Do not breathe dust. Avoid contamination of feed or foodstuffs. Avoid contact with acids.

ENVIRONMENTAL HAZARDS

This product is toxic to wildlife. Keep out of lakes, streams or ponds.

DIRECTIONS FOR USE

GENERAL CLASSIFICATION

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

USE RESTRICTIONS: Use against the Norway rat, roof rat and the house mouse, in and around homes, industrial, agricultural and commercial buildings, and similar manmade structures. ZP Rodent Bait must be placed in locations not accessible to children, pets, domestic animals and wildlife, or in tamperproof bait boxes. Do not place ZP Rodent Bait in areas where there is a possibility of contaminating food or surfaces that come in direct contact with food.

SELECTION OF TREATMENT AREAS: After removing as much food, water, and harborage as possible, determine dry acid-free areas where rats and mice will most likely find and consume the bait. Generally, these areas are along walls, by gnawed openings, in or beside burrows, in corners and concealed places, between floors and walls, or in locations where rats and mice or their signs have been observed.

Objective (D): *Establish a training program for local employees to study rodents and effective methods of control.*

A 2-day class in rodent control training for 30 students was completed in Dhamar on June 17, 1990. An outline of the material covered is given in Appendix I. The interest level was good. Emphasis was on species identification and damage appraisal methods in storage facilities and the field. Counterparts received equipment for damage appraisal and will conduct appraisals in storage and field situations.

Training of ARA and Extension personnel is the most pressing and basic need, since Yemen has virtually no history of rodent control. A 3-week training course should be presented as soon as possible in Yemen to individuals who will be involved in vertebrate pest problems. The training course should emphasize applied research, organization of control programs, and extension of rodent damage reduction methods. The CID ADSP/CORE Team Leader has agreed to fund this followup consultancy. (A suggested daily schedule is shown in Appendix II).

One individual should be in charge of vertebrate pest control research and operations in pre- and postharvest situations. This individual should receive extended training leading to a graduate degree in vertebrate pest management. Details of institutions offering graduate degrees with emphasis in vertebrate pest management and other training opportunities, conferences, and literature relevant to vertebrate pest management are presented in Appendix III.

There is little doubt that a laboratory specializing in vertebrate pest management research is needed. After completion of training, the individual discussed above should be in charge of this laboratory. The laboratory personnel should be responsible for all research and training of extension personnel in vertebrate pest management. This laboratory should initially be staffed with at least one technician and secretary. As its usefulness is realized, additional staff should be added.

Objective (E): *Develop a list of equipment necessary for furnishing a laboratory for rodent control under the main laboratory of the Plant Protection Authorities (ARA).*

The space requirements and equipment needed for a vertebrate pest management research laboratory are listed in Appendix IV.

After the followup training course, funding for USDA/DWRC participation in the research and extension phases, renovation or construction of a vertebrate pest laboratory, and equipment for the proposed activities may be available by an additional component to the Farming Practice for Productivity (FPP), a USAID-sponsored project to be initiated in Yemen.

HEALTH HAZARDS

Although not in the Scope of Work, it seems appropriate to discuss the health hazards associated with rodents, particularly as they relate to storage of grains and vegetables. Rodents are primary reservoirs for numerous diseases which are transmissible to man (Gratz, 1988). These pathogens include bacterial, rickettsial, viral, protozoa, and arthropod organisms. Although a description of each disease transmissible to man and domestic animals from rodents is beyond the scope of this report, a brief description of the more common ones follows:

1. Leptospirosis, also called infectious jaundice, is transmitted in rodent urine. Fatalities are high in young and old patients. This disease is often difficult to diagnose, even with good diagnostic facilities.

2. Salmonellosis, commonly known as infectious food poisoning, is a disease that can be transmitted by rodent-contaminated food or liquids. The house mouse and the black rat are common carriers of this group of disease organisms. This disease can be fatal, particularly in children.

3. The plague, the Black Death epidemic of the 14th Century, originated in Asia and swept across the Middle East and Europe killing thousands of people daily. World Health Organization (WHO) data for 19 countries ranged from 1,000 to 3,000 cases of the plague diagnosed annually over the past decade. There are many undiagnosed cases of plague. The rat flea transmits the bacillus *Yersinia pseudotuberculosis* to man.

4. Other important rodent-borne diseases include: rickettsialpox, hemorrhagic fevers, rat-bite fevers, trichinosis, lymphocytic choriomeningitis, murine typhus, and intestinal parasites, such as tapeworms.

Hazards resulting from rodent infestations of Yemeni storage facilities could easily present excessive health risks. In general, there is no doubt that many illnesses and deaths are the result of rodents and their contamination of commodities. In Yemen, the lack of diagnostic facilities probably obscures the rodent-related diseases and mortalities. A reduction of rodent numbers in storage structures and the resulting decrease in contamination will reduce the health risks from rodent-borne diseases.

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CONTACTS AND ACKNOWLEDGMENTS

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Dr. Mohamed Al-Nassiri - ARA Research Entomologist
Mr. Mohamed Meskakea - ARA, Taiz
Mr. Saleh Al-Mokalah - ARA, Taiz
Mr. Gafer - TDA, Hodeidah
Dr. Abdul Rahman Salam - ARA Director General, Dhamar

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YEMEN RODENT CONTROL CLASS OUTLINE
Dhamar, 16-17 June 1990

Conducted by
G. Keith Lavoie
USDA/APHIS/DWRC
International Programs Research Section

I. Rodent Control General

A. Identification

1. Vertebrate--animals with back bone, e.g., snakes, birds and mammals (contrast with invertebrates)

2. Mammals--vertebrates with warm blood (contrast with reptiles), e.g., rodents, dogs, whales, camels, and man

3. Rodents = Order Rodentia--1,700 species (largest order of mammals)

4. Most characteristic is teeth--diastema

5. Families of Rodents (Primary Pest Families)

a. Muridae: True rats and mice (tails, usually without hair)
b. Cricetidae: Jirds and Gerbils (usually hairy tails)
c. Sciuridae: Squirrels (Tree and ground, usually diurnal)
d. Genius and species identification
(1) Importance of species identification to determine when and how to control
(2) Methods of identification:
(a) Trapping and study skins
Study skin and skull preparation
Data: HB (mm), T (mm), E (mm), HF (mm)
Location, collector, date
Notes
(3) General characteristics: teeth, skull, skin, color, tail, size, feet, ears, etc.

B. Biology and Behavior

1. Rodent signs
a. Holes or burrows usually on edges of fields
Size is often characteristic of species
(ground cover may hide); some species make no burrows.

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b. Runways may be sign of infestation. Pathways that rodents habitually use. Paths in the grass or rub marks from oils in fur.
c. Droppings
d. Feeding activities--or damage
e. Blocked burrow during day (gerbils)
f. Activity may be day, but usually night, for predator protection
g. Activity areas are usually small

2. Diet--This is the problem
   a. Rodents may be omnivorous or vegetarian

3. Breeding
   a. Sexually mature at 2-3 months
   b. Gestation is usually about 3 weeks and can become pregnant within 24 hours of giving birth--increase numbers rapidly by this and other mechanisms
   c. Irruptions from good conditions--fall just as rapidly from poor conditions

II. Rodent Pests of Yemen

A. Central Highlands

1. Dhamar area
   Mus musculus--stores
   Rattus rattus--stores
   Meriones rex--fields
   Gerbillus famulus--fields

B. Southern Highlands

1. Ibb--Taiz area
   R. rattus--stores
   M. rex--fields
   M. musculus--stores and fields
   Arvicanthis niloticus--fields
   Acomys dimidiatus--fields

C. Tihamah

1. Zabid--Hodeidah area
   R. rattus--stores
   Rattus norvegicus--stores
   Gerbillus cheesmani--fields
   M. musculus

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D. Northern Highlands

1. Sada area
   M. rex--fields
   G. famulus--fields
   M. musculus--stores
   R. rattus--stores

III. Identification Techniques for Commensal Rodents of Yemen

A. A commensal rodent is -

B. Commensal rodents of Yemen

1. *Rattus rattus* (black rat or roof rat)

   a. Large rat 125-175 g adult; head and body (HB), 150-240 mm
   *b. Tail (no hair) is longer than HB
   c. Dark gray to black dorsal
   d. Nose pointed
   e. Ears medium to large and rounded
   f. Eyes large
   *g. Likes to climb
   h. Not a strong digger
   i. Omnivorous, meat, grains, etc.--chews wires, etc.
   *j. Leaves rub marks on high walls
   k. Found in villages, stores, and urban areas
   l. May become a field pest

2. *Rattus norvegicus* (brown rat or Norway rat)
   a. A large rat, 200-400 g; 210-280 mm HB
   *b. Tail hairless and shorter than HB
   c. Blunt nose
   *d. Small ears with short fine hair
   e. Pelage is brown to grayish
   f. A good digger
   *g. Requires water
   h. Omnivorous
   i. Found in villages and stores

3. *Mus musculus* (house mouse)

   a. Small weight; 15-20 g; 60-100-mm HB
   b. Naked tail equal to HB
   c. Nose pointed
   d. Ears medium to large
   e. Pelage variable, usually gray dorsal and tends white ventral
   *f. Teeth have notch in posterior of incisors
   g. May dig small, complex burrows
   h. Mainly a seedeater, but is omnivorous
   i. May be commensal or agricultural field pest

IV. Identification Techniques for Field Rodents of Yemen

1. *Acomys dimidiatus* (spiny mouse)
   a. Small weight, 15-25 g; 60-80 mm, HB
   b. Tail longer than HB, but usually broken
   c. Ears medium to large
   d. Pelage variable, but spine-like hairs on back
   e. Lives in rocky areas
   f. Makes small burrows euphorbia
   g. May not be a pest of agriculture
   h. Found only near Taiz

2. *Mus musculus* (house mouse)
   See above. Field pest status unknown

3. *Gerbillus famulus*
   a. A medium-sized gerbil; 15-30 g; 30-110 mm HB
   b. Sand-colored dorsal white ventral
   *c. Soles of hind feet have no hair
   d. Tail is always longer than HB
   *e. Tail has highly developed black tuft
   f. Ears large
   g. May have its own burrow or live in association with other rodents
   h. Found in central and southern highlands
   i. A seedeater--may not be a significant pest to agriculture

4. *Gerbillus cheesmani maritimus*
   a. Small to medium gerbil 15-20 g; 91 mm HB
   *b. Soles of hind feet are hairy
   c. Pelage darker sandy
   d. Tail longer than HB (up to 140 mm)
   *e. Tail tuft is grayish brown
   f. Ears are large
   *g. Occurs only in Tihamah coastal zone
   h. From about Hodeidah south
   i. Probably a pest in millet and sorghum plan

5. *Meriones rex* (Jirds or sand rats)
   *a. Large rat-like, but with hairy tails; 100-150 g; 140-180 mm HP
   b. Pelage variable, brown to buffy gray dorsal
   c. Tail fully haired, usually with a black terminal tuft
   d. Ears medium
   *e. Soles of hind feet are not haired
   f. Tail is longer than HB on littoral sp., but shorter than HB on mountain form
   g. Upper incisors with one anterior groove
   h. Ears large
   i. Two subspecies--one littoral, the other mountainous
   j. Usually numerous in fields in Yemen--probably a serious pest to cereal grain crops, particularly wheat in the highlands

V. Damage and Damage Appraisals to Stored Foods and Grains in Yemen

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A. Large commercial and Government stores

1. Heavy infestations of *Rattus* and *Mus* were seen.
2. Damage consisted of bag damage up to about 10 percent (simple percentage count).
3. Consumption of grains probably at greater than 1 percent
4. To estimate percent of damage:
   a. Estimate rodent population (discussed below)
   b. Assume rats eat 10-15 percent of weight in grain each day

B. Small on-farm and market storage

1. Extremely high infestations of *R. rattus* were observed.
2. Damage to containers and structures was extremely high.
3. Damage of food appeared to reach up to 10 percent.
4. Damage estimate method is described below.

C. Estimating populations (two methods)

1. Regression of daily captures
   a. Removal trapping for 6-10 nights
   b. Illustrate a regression graph, and calculate

2. Change-in-Ratio Method (good for small shops, etc). (Measures activity before and after trap removal) (A change in percent activity = change in population
   a. Tracking tiles 1 night
   b. Trap 4-10 nights
   c. Tracking tiles 1 night

$$\frac{T_1 - T_2}{n} = \frac{T_1}{P_1} = \frac{T_2}{P_2}$$

T_1 = Tile positive (1st time) = 0.80 (80/100)
T_2 = Tiles positive (2nd time) 0.20 (20/100)
N = rat trapped

$$P_1 = \frac{T_1 \times n}{T_1 - T_2} = \frac{0.8 \times 120}{0.8 - 0.2} = \frac{96}{0.6} = 165$$

165 rats x 150 g (weight) = 24,750 x 1.25 = 3,094 g x day
365 x 3,094 = 1,129,310 g or 1,129 kg/yr

Estimating Field Damage (Wheat)

A. Random selection of fields
B. Sample fields using a sample quadrant (50 x 50 cm or 1 m x 1 m). The frame is positioned 10 times while walking predetermined transects across a field (10 for small, and 20 for large).
C. Count total tillers, and cut tillers in frame each time.
D. Damaged tillers divided by total tillers x 100 = percent damaged

VI. Chemicals Control--Rodenticides

A. Anticoagulants--Define--For Commensals

1. Excellent for *R. rattus* and *M. musculus*
2. Rodents must consume for 3-5 days
3. Put in bait holders--describe
4. Bait holders around the walls 10-15 m apart in densely populated structures
5. Mix concentrate with a cereal base; if maize, use coarsely ground or broken at 1:19; 5 percent vegetable oil
6. Can be mixed in mixer or in plastic bags for small batches (color green)
7. Safety--wear dust mask and rubber gloves to mix and use
8. Clearly mark bags, and color bait green with food coloring
9. Primary hazards--use bait box
10. Secondary hazards--possible, but not common; pick up and bury dead animals
11. H_2O base baits

B. Acute--Define--For Field Use

1. Zinc phosphide Zn_3P_2
   a. Effective for *M. rex*
   b. Mix bait at 2 percent Zn_3P_2 with wheat and oil
   c. Place a tablespoon of prebait in the active burrow entrances--Cover burrows to determine active burrows--Mark sample holes, 25 in two or three areas
   d. Place about 5 g of bait at each burrow entrance
   e. Animals should be dead in 2 days
   f. Safety, as above

VII. Evaluate Control Operations

A. Commensal

Use tracking tiles--1 day before and after; e.g., 50 percent active before, 10 percent active after control = 4/5 = 80 percent

B. Field

1. Close holes/open holes method
   a. After 3 days, close holes; as previously mentioned, come back in 2-3 days and count open holes; mark and count number of closed burrows in each sample area

      Sample: e.g., 20 marked are closed, and 1 reopened; e.g.,
      1/20 = 95 percent (repeat several times and take average)
      2/25 = 92 percent
      0/15 = 100 percent
      average = 96 percent

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VIII. Control Programs

A. Farmers (and scientists) must be involved.
B. Rodenticides and labor must be continually available.
C. Commensal control is a continuous program; someone must check and refill bait boxes every day at first; then, about 1-2 times per week.
D. Field control should be carried out on a large area.
   1. Time to control is just before damage is expected; e.g., reproductive stage of wheat--N.B. rodents can repopulate rapidly.

SPECIES	LOCAL	AREA	SITE	DEGREE OF INFESTATION
RATTUS RATTUS	CENTRAL HIGHLANDS	SANA'A	STORES	SEVERE
		DHAMAR	STORES	SEVERE
MUS MUSCULUS		SANA'A	STORES	UNDETERMINED
		DHAMAR	STORES	UNDETERMINED
MERIONES REX		SANA'A	FIELD	LOCALLY SEVERE
		DHAMAR	FIELD	LOCALLY SEVERE
GERBILLUS FAMULUS		SANA'A	FIELD	UNDETERMINED
RATTUS RATTUS	SOUTHERN HIGHLANDS	IBB	STORES	SEVERE
		TAIZ	STORES	SEVERE
M. MUSCULUS		IBB	FIELD/STORES	UNDETERMINED
		TAIZ	FIELD/STORES	UNDETERMINED
M. REX		IBB	FIELD	LOCALLY SEVERE
		TAIZ	FIELD	LOCALLY SEVERE
ARVICANTHIS NILOTICUS		TAIZ/IBB	FIELD	UNDETERMINED
ACOMYS DIMIDIATUS		TAIZ/IBB	FIELD	UNDETERMINED
G. FAMULUS		TAIZ/IBB	FIELD	UNDETERMINED
M. REX	TIHAMAH	ZABID	FIELD	UNDETERMINED
GERBILLUS CHEESMANI		ZABID	FIELD	
R. RATTUS		HODEIDAH	STORES	SEVERE
RATTUS NORVEGICUS		HODEIDAH	STORES	SEVERE
M. MUSCULUS		HODEIDAH	STORES	UNDETERMINED

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Proposed Draft

YEMEN RODENT CONTROL WORKSHOP
Daily Schedule

Rodent Control, General

Day*		
1	AM	Discussion--introduction--overview of course objectives--pretest.
	PM	Demonstration and field exercise--basic tools--traps, tracking tile preparation, and bait holders. Module I-A. Students prepare baits; set traps and tracking tiles.
2	AM	Field exercise--trapping--students prepare baits; set traps, tiles, and record data in field.
	PM	Discussion--identification of major pest species--distinguishing physical characteristics. Biology of major pest species--similarities and differences in habitats and behavior. Module I-B.
3	AM	Field exercise--trapping--students pick up traps, tiles, animals, and record data. Field exercise--study skin preparation--students prepare lifelike and flat specimens of major pest species. Module I-C.
	PM	Field exercise--continue study skin preparation.
4	AM	Discussion--chemical repellents and toxicants--covering types of acute and chronic toxicants and repellents. Module I-D.
	PM	Discussion--safety with chemicals--emphasizing precautions to protect adults, children, domestic animals, and nontarget wildlife. Module I-E. Discussion--rodent-borne diseases. Module I-F.
5	AM	Discussion--elements of an effective rodent control program--emphasizing remedial and preventive strategies, chemical and physical methods, an integrated approach. Human and physical resources required. Module I-G.
	PM	Discussion--students review the week's activities.

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* Course is designed for two instructors and division of students into agricultural and commensal study groups after the fifth day.

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Agricultural Rodent Control

Day		
6	AM	Discussion--field rodents as pests--economic losses of pre- and postharvest crops. Module II-A.
	PM	Field exercise--rodent presence--students will inspect agricultural areas for signs and damage by rodents. Students will select several areas for continued work.
7	AM	Discussion--continuation of field rodents as pests.
	PM	Field exercise--rodent indices--students return to preselected agricultural areas and lay out bait holders for census baits, tracking tiles, and bait unset traps.
8	AM	Field exercise--rodent indices--students will inspect census baits, tracking tiles, and bait unset traps as needed and record data.
	PM	Discussion--rodent population assessments--indices, their uses, and methods of determining them. Module II-B.
9	AM	Field exercise--rodent indices--students will inspect census baits and bait unset traps as needed and record data.
	PM	Discussion--chemical methods for rodent control--emphasizing bait selection, toxicant selection, bait placement, and recordkeeping. Module II-C.
		Discussion--other nonchemical control methods--including predation, habitat manipulation, disease, resistant crops, etc. Module II-D.
10	AM	Field exercise--rodent indices--students will inspect tracking tiles, inspect census baits, bait traps as needed, and record data.
	PM	Discussion--agricultural rodent damage assessments. Describe general and specific methods of rodent crop damage estimates that may be used to determine when control methods should begin and to assess a control program. Module II-E.
11	AM	Field exercise--population indices--students will bait and set traps and tracking tiles at positions selected last week.
	PM	Field exercise--damage assessment--students will design and conduct one or more damage assessment on select crops.
12	AM	Field exercise--population indices--students will identify rodents and record data from traps and tracking tiles; reset traps and tiles.
	PM	Field exercise--habitat manipulation--students will inspect agricultural areas and discuss methods to reduce crop damage by habitat manipulation.

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13 AM Field exercise--population indices--students will identify rodents and record data from traps and tracking tiles; reset traps and tiles.

PM Field exercise--grain bait preparation--demonstration of safe, effective, anticoagulant bait preparation.

14 AM Field exercise--rodent indices--students will identify rodents and record data from traps and tiles. They will also collect, clean, and store traps and tiles.

PM Field exercise--select one or more sites and initiate an integrated control program.

15 AM Discussion--calculation and analysis of trapping and census bait data to estimate population size and the efficacy of a "control" method.

PM Discussion--review and posttest.

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Postharvest Rodent Control

Day		
6	AM	Discussion--commensal rodents as pests--define commensal rodents, how to determine their presence, and the economic and health aspects. Module III-A.
	PM	Field exercise--rodent presence--students will inspect buildings for signs of rodents, talk to owners about rodent problems, and select several buildings for continued work.
7	AM	Discussion--rodent population assessment--indices their uses and methods of determining them. Module III-B.
	PM	Field exercise--rodent indices--students return to preselected buildings and lay out activity tiles and baited, but unset, snap traps.
8	AM	Field exercise--rodent indices--students will inspect and re-ink tiles, bait traps as needed, and record data.
	PM	Discussion--commensal rodent trapping--emphasizing bait selection, size, and trap placement when using traps as a control method or efficacy measurement tool. Module III-C.
9	AM	Field exercise--rodent indices--students will inspect and re-ink tiles, bait traps as needed, and record data.
	PM	Discussion--rodent pest management procedures--identifies the greater hazards associated with chemical control of commensal rodents, emphasizing the selection of toxicants, bait placement, bait storage, and recordkeeping. Module III-D.
10	AM	Field exercise--rodent indices--students will inspect tiles, bait traps as needed, and record data.
	PM	Discussion--indirect control methods--including population control, sanitation, storage, and integrated pest control. Module III-E.
11	AM	Field exercise--grain bait preparation--demonstration of safe, effective, anticoagulant bait preparation. Comparison of costs of local formulation *vs* commercially prepared baits.
	PM	Field exercise--trapping as a control method and population indices--students will bait and set traps at the positions designated last week. They will also ink tiles.
12	AM	Field exercise--trapping as a control method and for population indices--students will identify rodents and record data from tiles and traps. They will ink tiles; bait and set traps.

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	PM	Field exercise--habitat manipulation--students will inspect buildings and surroundings and discuss methods to reduce rodent populations by decreasing habitat and rodentproofing.
13	AM	Field exercise--trapping as a control method and for population indices--students will identify rodents and record data from tiles. Students will re-ink tiles, and bait and set traps.
	PM	Field exercise--burrow counts--students will locate rodent burrows, map, if required, and close burrows.
14	AM	Field exercise--trapping as a control method and population indices--students will identify rodents and record data from tiles and traps. They will also collect, clean, and store tiles and traps.
	PM	Field exercise--burrow counts--students will examine burrows closed the previous day and record data.
15	AM	Discussion--calculation and analysis of trapping and tile data--students will estimate population size and efficacy of trapping as a control method.
	PM	Discussion--review and posttest.

Proposed Draft

YEMEN RODENT CONTROL WORKSHOP

OUTLINE

I. Rodent Control General

A. Basic Tools

1. Snap Traps

2. Tracking Tiles (activity boards)

3. Bait Holders

B. Identification, Biology, and Behavior of Pest Species

1. Vertebrate, Rodent, Pest--Define

2. Characteristics of Pest Species

3. Biology of Pest Species

C. Study Skin Preparation

1. Skinning

2. Lifelike Specimen

3. Flat Specimen

D. Chemical Repellents and Toxicants

1. Repellents

2. Chronic toxicants

3. Acute toxicants

E. Safety

1. Purchase and Storage

2. Toxicant Preparation

3. Toxicant Application

4. Secondary Hazards

F. Rodent-borne diseases

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G. Effective Rodent Control Strategies

1. Remedial and Preventive Strategies

2. Goals

3. Baiting

4. Habitat Manipulation

5. Human Variables

6. Resources

7. Information and Monitoring

II. Agricultural and Rural Rodent Control

A. Field Rodents as Pests

1. Preharvest Damage

2. Postharvest Damage

B. Rodent Population Assessments

1. Removal Method

2. Activity Board

3. Trapping

4. Burrow Counts

5. Census Baits

C. Chemical Methods for Rodent Control

1. Preventive Control Strategies

2. Remedial Control Strategies

3. Bait Preparation

4. Prebaiting

5. Baiting

6. Fumigation

D. Other Nonchemical Control Methods

1. Predation

2. Habitat Modification

3. Introduction of Disease

4. Antifertility Agents

5. Sound

6. Trapping

7. Exclusion

8. Rodent-resistant Crops

E. Agricultural Rodent Damage Assessments

1. Essential Elements

2. Uses of

3. Sampling

4. Calculation of

5. Examples of

III. Postharvest Rodent Control

A. Commensal Rodents as Pests

1. Commensal Rodents--What, Where, Why, and How

2. Signs of Commensal Rodents

3. Damage and Property Losses

4. Nuisance Factors

B. Population Assessments

1. Population Indices, Definition, and Uses

2. Tracking Tiles

3. Snap Traps

4. Census Baits

5. Other Methods

C. Direct Control Methods--Trapping

1. Right Trap and Bait
2. Pretrapping Period
3. Location and Position
4. Trap Shyness
5. Right Number of Traps
6. Glue Boards

D. Rodent Pest Management Procedures

1. Survey Infestation
2. Choosing an Appropriate Control Method(s)
3. Timing
4. Bait Formulations
5. Prebaiting
6. Bait Distribution
7. Assessing Efficacy
8. Maintenance

E. Indirect Rodent Control Methods

1. Population Control
2. Sanitation
3. Proper Storage
4. Rodentproofing

Materials Needed for Workshop

Overhead projector
Movie projector, 16 mm
Slide projector
Transparencies
Film "Ratopolis"
Slide series-6
Tracking tiles
Rat traps
Mouse traps
Tracking tile data sheets
Trapping data sheets
Printers ink
Small paint roller
Acetone
Rags
Small plastic bags
Pesola scales
Damage estimate data sheets
Live traps (two types)
Welders gloves
Work gloves
Forceps
Glue boards
Flags
Survey tape
Lacquer
Container for tiles
Flea powder
Flashlights
Dissecting kits
Identification tags
Borax
Cotton
Needles and thread
Wire
Scales
Metric ruler
Scoops
Rubber gloves
Bag or bait container
Grain
Bait mixer ? (plastic bags will do)
Corn oil ?
Respirators ?
Poison labels
Bait carriers
Bait holders
Bait for census
Rodenticides
Dissecting kit
Warfarin

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VERTEBRATE PEST MANAGEMENT TRAINING OPPORTUNITIES

EDUCATIONAL OPPORTUNITIES

Utah State University, Logan, Utah, U.S.A. Dr. Joe Chapman, Dean of the College of Natural Resources, Dept. of Fisheries and Wildlife. B.A., M.S., and Ph.D. in wildlife management with emphasis in vertebrate pest management.

Colorado State University, Fort Collins, Colorado, U.S.A. Dr. Robert Cook, Dept. of Fisheries and Wildlife. B.S., M.S., and Ph.D. in wildlife management with emphasis in vertebrate pest management.

Colorado State University, Fort Collins, Colorado, U.S.A. Dr. Julius Nagy, Dept. of Fisheries and Wildlife. Vertebrate Pest Management, Short Course. August 1991.

CONFERENCES AND SYMPOSIA

Vertebrate Pest Conference. San Diego, California. March 1991. Contact Mr. Rex Marsh, Wildlife and Fisheries Biology, University of California, Davis, CA 95616.

The Eastern Wildlife Damage Conference. Various locations, fall of 1991. Contact Scott Caraven.

The Great Plains Wildlife Damage Workshop. Lincoln, Nebraska, U.S.A. Scott Hyngstrom, 202 Natural Resources Hall, University of Nebraska, Lincoln, NE 68583. April 15-18, 1991.

Sorghum in the 1990's Symposium. ICRISAT. Bamako, Mali. October 1991.

Training Course on Vertebrate Pest Management. Pakistan Agricultural Research Council, Vertebrate Pest Control Laboratory, Islamabad, Pakistan. April 1991.

Northeastern Fish and Wildlife Conference. Nashua, New Hampshire, U.S.A. Charles Miner, New Hampshire Fish and Game, Concord, New Hampshire U.S.A.

Annual Meeting of the American Society of Mammalogists. Frostburg State University, Frostburg, MD. June 1991.

Symposium: Managing Wildlife in The Southwest. Tucson, Arizona, U.S.A. Paul Krausman or Norm Smith, School of Renewable Natural Resources, 325 Biological Science, E., University of Arizona, Tucson AZ 85721. October 16-18, 1990.

North American Wildlife and Natural Resources Conference. Edmonton Convention Centre, Edmonton, Alberta, Canada. L. L. Williamson, Wildlife Management Institute, 1101 14th St., NW., Suite 725, Washington, DC 20005. (Phone: 202/371-1808) March 22-27, 1991.

International Canada Goose Symposium. Marc Plaza Hotel, Milwaukee, WI. April 21-25, 1991.

Workshop on the Use of Microcomputers in Wildlife Biology. July 30-August 3, 1990. Colorado State University. Fort Collins, CO. Contact Dr. Gary C. White, Dept. of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523.

Kansas State University Conference on Applied Statistics in Agriculture. Spring 1991. Manhattan, Kansas. Contact Dr. George Milliken, Department of Statistics, Dickens Hall, Kansas State University, Manhattan, KS 66506.

XX Congress Internationalis Ornithologicus. December 2-9, 1990, Christchurch, New Zealand. Contact Dr. P. Berhold, Vogelarte Radolfzell, D-7760 Schloss Moggingen, West Germany.

52nd Midwest Fish and Wildlife Conference. December 2-5, 1990, Minneapolis, Minnesota. Contact Minnesota Department of Natural Resource, Section of Wildlife, Box 7,500 Lafayette Road, St. Paul, MN 55155.

LITERATURE OF INTEREST

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FAO/WHO. 1977. Rodent Pest Biology and Control--Bibliography 1970-1974. FAO Plant Productions and Protection Paper No. 7, Rome.

Control of Mammal Pests. Edited by C.G.J. Richards and T. Y. Ku. 1987. Tailor and Francis, 242 Cherry St., Philadelphia, PA 19106-1906.

East African Mammals: An Atlas of Evolution in Africa, Vol. I. Kingdom, Jonathan. Univ. of Chicago Press, 11030 S. Langley Ave., Chicago, IL 60628. 09/1984 (840901) 446 pp. $35.00. ISBN: 0-226-43718-3.

Vol. II, Pt. A: Insectivores and Bats. 404 pp. $32.50. ISBN: 0-226-43719-1.

Vol. II, Pt. B: Hares and Rodents. 428 pp. $32.50. ISBN: 0-226-43720-5.

Vol. III, Pt. A: Carnivores. 491 pp. $37.50. ISBN: 0-226-43721-3.

Vol. III, Pt. B: Large Mammals. 450 pp. $37.50. ISBN: 0-226-43722-1.

Vol. III, Pt. C (Bovids). 394 pp. $32.50. ISBN: 0-226-43724-8.

Vol. 3, Pt. D, Academic Press, 1250 Sixth Ave., San Diego, CA 92101. $136.00. ISBN: 0-12-408345-5.

Libyan Mammals. Hufnagl, Ernst. Oleander Pr, 210 Fifth Ave., New York, NY 10010. $16.00. ISBN: 0-902675-08-7.

The Mammals of Africa: An Identification Manual. Meester, J.-Editor; Setzer, H. W.-Editor. Smithsonian, 955 L'Efant Plaza, Rm 2100, Washington, DC 20560. 1971 - $49.50 x three-ring binder. ISBN: 0-87474-116-5.

Rats and Mice. 1984. A. P. Meehan. Rentokil Lm. Felcourt, East Grinstead, N. Sussex, England.

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Rodent Pests and Their Control in the Near East. J. H. Greaves 1989. FAO Plant Production and Protection Paper. FAO, Rome, Italy.

Rodent Pests--Biology and Control: A Bibliography. Plant Production and Protection Paper 7, 836 pp. 1977. $29.50, Bernan-Unipub, 4611-F Assembly Dr., Lanham, MD 20706-439.

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Atlas of Speciation in African Non-Passerine Birds. Snow, D. W.-Editor. Sabbott-Natural History Books, 5239 Tendilla Ave., Woodland Hills, CA 91364. 1978. $130.00. ISBN: 0-565-00787-4.

Atlas of Speciation in African Passerine Birds. Hall, B. P. and R. E. Moreau. International Specialized Bk. Services, 5602 NE Hassalo St., Portland, OR 97213-3640. 1970. $100.00. ISBN: 0-565-00680-0.

Bird Faunas of Africa and Its Islands. Moreau, R. E. Academic Press, 1250 Sixth Ave., San Diego, CA 92101. 1967. $74.50. ISBN: 0-12-506650-3.

The Birds of Britain and Europe with North Africa and the Middle East. Parslow, Heinzel and Fitter. Greene Pub., 15 Muzzey St., Lexington, MA 02173. 1985. $14.95. ISBN: 0-00-219210-1.

Birds of the Middle East and North Africa. Hollom, P. A., R. Porter, S. Christensen, and I. Willis. Buteo, P.O. Box 481, Vermillion SD 57069. 1988. 280 pp. $32.50. ISBN: 0-931130-15-8.

Collins Field Guide of the Birds of East Africa. Williams, J. G.; Arlott, N. Greene Pub, 15 Muzzey St., Lexington, MA 02173. 1985. 416 pp. $21.95. ISBN: 0-8289-0661-0.

Eagle Days: A Study of African Eagles at the Nest. Steyn, Peter. Longwood Publishing Group, 27 S. Main St., Wolfeboro, NH. Longwood Pub Group 1985. 2nd ed. 163 pp. $24.95. ISBN: 0-88072-065-4.

Field Guide to the Birds of East Africa. Williams and Arlott. Greene Pub, 15 Muzzey St., Lexington, MA 02173. 1985. $24.95. ISBN: 0-00-219179-2.

Handbook of the Birds of Europe, the Middle East, and North America: The Birds of the Western Palearctic. Vol. 1: Ostrich to Ducks. Cramp, Stanley-Editor; Simmons, K. E.-Editor; Ferguson-Lees, I. J.-Editor. Oxford Univ. Press, 16-00 Pollitt Dr., Fair Lawn, NJ 07410. 1977. $135.00. ISBN: 0-19-857358-8.

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Handbook of the Birds of Europe, the Middle East and North Africa: The Birds of the Western Palearctic, Vol. 5: Tyrant Flycatchers to Thrushes. Cramp, Stanley-Editor. 1988. 1080 pp. $175.00. ISBN: 0-19-857508-4.

Quelea Quelea: Africa's Bird Pest. Edited by R. L. Bruggers and C.C.H. Elliott. 1989. 402 pp. Oxford University Press, Walton Street, Oxford, England OX2 6DP. $48.00.

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Handbook of Toxicology of Pesticides to Wildlife. 1970. R. Tucker and D. G. Crabtree. Resource Public. No. 84. Supt. of Documents, GPO, Wash., DC 20402. 131 pp.

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Statistics in the Environmental Sciences. 1984. S. M. Gertz and R. F. Weston, ed. ASTM Spec. Techn Pub. 845. ASTM, 1916 Race St, Philadelphia, PA 19103. 122 pp.

STP 625/Test Methods for Vertebrate Pest Control and Management Materials: First Symposium. Editors: Jackson/Marsh. $26.00. ISBN: 0-8031-0199-6.

STP 680/Vertebrate Pest Control and Management Materials: Second Symposium. Editor: J. Beck. $31.50. ISBN: 0-8031-0761-7.

STP 693/Avian and Mammalian Wildlife Toxicology. Editor: E. Kenaga. $16.25. ISBN: 0-8031-0287-9.

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SUGGESTED BASIC LABORATORY EQUIPMENT

Item	Stock No.	Unit Price	Quantity	Source*
Balance Pt 1200	B1417-66	795.00	1	1
Balance analyt. B120s	B1417-9	1495.00	1	1
Calculator programmable	G1120-6	50.00	1	1
Microscope dissecting	522MI	1597.00	1	1
Illuminator	369VBF	128.00	1	1
Illuminator bulb	M5000-14	20.29	1	1
Intubation needles	A4330-15	80.44	1	1
Disposable gloves	G7236-20	12.19	12	1
Gloves rubber	G7214-2	17.09	2	1
Hot plate\stirrer	H2402-1A	290.00	1	1
Funnel	F7452-16	8.96	1	1
Graduated cylinder	C9074-25	5.65	2	1
Graduated cylinder	C9074-100	7.43	2	1
Graduated cylinder	C9074-500	12.72	2	1
Forceps, curved	D2565-1A	3.16	3	1
Forceps, straight	D2566-1A	6.32	3	1
Forceps, rat tooth	D2567-3A	12.07	2	1
Weighing dishes	D2165-1	11.38	2	1
Scissors	D2655-A	9.90	3	1
Halsted forceps	D2680-1A	9.68	2	1
Scalpel	D2865-3	36.25	2	1
Blades	D2865-23	67.09	1	1
Syringes, 3 cc	S9565-3L	12.05	1	1
Syringes, 5 cc	S9521-5L	22.70	1	1
Syringes, 10 cc	S9521-10L	24.50	1	1
Bottles, 125 ml	B7533-4	76.32	2	1
Jar pint	B7544-1	61.18	2	1
Bottle brush	B8675-250	19.78	1	1
Bench drying rack	S9253-3	58.50	1	1
Wash bottles	B7890-250	10.91	6	1
Vial	B7791-24	45.94	1	1
Vial	B7817-20	19.00	1	1
Vial	B7817-70	20.76	1	1
Balance wt. set	B2175-1	7.40	1	1
Balance wt. set	B2175-5	19.15	1	1
Spatula	S1565	1.86	10	1
Blue M gravity oven	M8625-4A	540.00	1	1
Calipers	M1109-1	18.90	2	1
Laboratory tray	B2916-1	20.60	2	1
Laboratory coats, Sizes 3, 4, and 5	A5059	19.00	6	1
Respirator	23368	15.85	4	2
Respirator filters	23369	4.75	4	2
Flagging	57925	11.40	12	2
	57930	11.40	12	2
	57927	11.40	12	2
Pesola scale, 50 g	93536	38.95	4	2
100 g	93537	38.95	4	2
300 g	93538	38.95	4	2

Item	Stock No.	Unit Price	Quantity	Source*
Tally meters	53030	11.50	4	2
Dissecting kits	53771	13.25	4	2
Scalpel blades	53775	5.75	5	2
Plastic bag large	79149	11.95	5	2
Plastic bag small	79212	34.95	2	2
Bag ties	71124	2.50	1	2
Spring scale	93613	17.00	1	2
Spring scale	93496	47.65	1	2
Range finder	38985	112.50	1	2
Range finder case	38988	15.25	1	2
Rolatape	38999	86.50	1	2
Dissecting pan	53854	4.95	2	2
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Binoculars	91102	142.00	1	2
Industrial apron	33338	12.95	2	2
Tomahawk live trap	35761	43.50	24	2
Cage rodent size w/feeders	RD071007UB60	4000.00	1	3
Macrolon bottle 16OZ	M-16	3.05	80	4
5/16" ball water tube	TD200	1.95	80	4
Double seal stopper	S100	1.00	100	4
Sure lock bottle hold.	H100	11.30	80	4
Ear tag rat size, Monel Nos. 1-5000	1005-1	67.88	5	5
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Transformer 1 kW	01F 009	187.78	1	6
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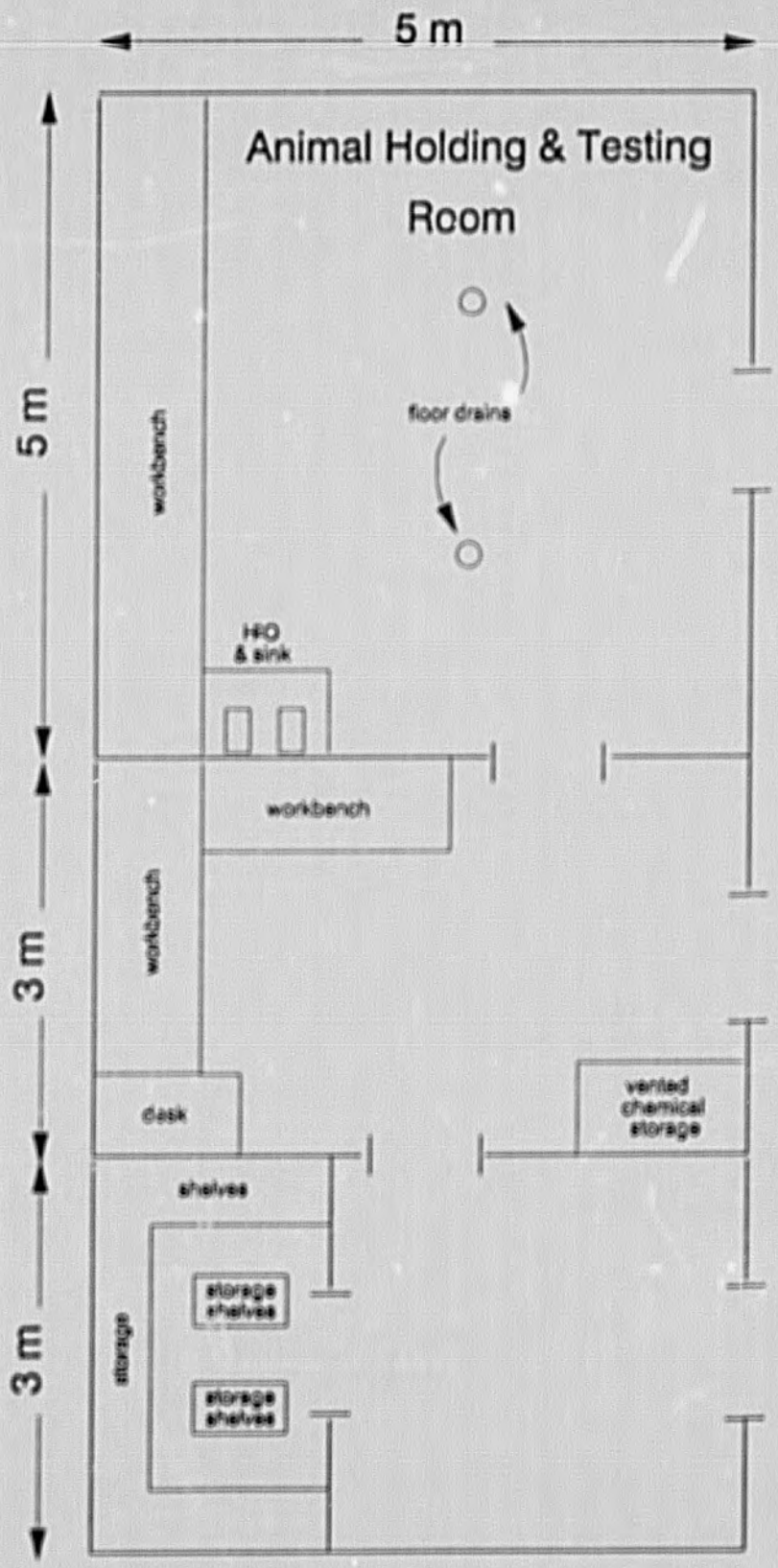
Suggested Yemen Vertebrate Pest Laboratory Floor Plan



TRIP REPORT*

MOROCCO

ENVIRONMENTAL PESTICIDE PROJECT

Wildlife Telemetry Training

June 17 to July 2, 1990

A. Lawrence Kolz
Electronic Engineer

Robert L. Phillips
Wildlife Research Biologist

Denver Wildlife Research Center
Science and Technology
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
P. O. Box 25266
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Unpublished Report

July 20, 1990

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ITINERARY

Date	Location
June 17-18	Travel from Denver, Colorado to Casablanca, Morocco
June 19	Travel from Casablanca to Agadir, Morocco
June 20-21	In Agadir
June 22	Travel to Aït Baha and return
June 23-24	In Agadir
June 25-26	Classroom lectures at Aït Melloul
June 27	Field training at Aït Baha
June 28	Lectures and field training near Aït Melloul
June 29	Inventory of equipment at Aït Melloul
June 30	Travel from Agadir, Morocco to Paris, France
July 1-2	Travel from Paris, France to Denver, Colorado

BACKGROUND

Personnel from the Denver Wildlife Research Center (DWRC) are training Moroccan scientists to perform environmental studies for evaluating the ecological effects of insecticides commonly used for locust control in Africa. There is concern that the repeated application of malathion and dichlorvos may seriously impact the indigenous wildlife populations in certain areas of Morocco. To study some aspects of the effects of these insecticides, the Moroccan biologists are being trained to use wildlife telemetry equipment. This technology transfer to the Moroccan scientists will significantly enhance their ability to monitor the response of various species of wildlife to measured concentrations of the insecticides.

OBJECTIVES OF TRAVEL

This travel to Morocco gave research personnel from the DWRC the opportunity to conduct a comprehensive workshop on wildlife telemetry techniques for Moroccan scientists. Training in radio tracking was to be conducted in three phases. A series of lectures were presented in Phase I to introduce the basic radio tracking techniques and concepts as established by current state-of-the-art equipment designs. Phase II was to allow the participants to operate and train with equipment in a controlled environment using "fixed location" transmitters. Phase III was to complete the workshop by involving the participants in the capture, instrumentation, and radio tracking of birds and mammals in the field.

A secondary objective was to train the electronics staff at the Locust Control Center in Ait Melloul in operation of the radio location equipment recently acquired from Southern Avionics, Inc., of Beaumont, Texas.

ACCOMPLISHMENTS

We arrived in Agadir on June 19 and met Mr. John McConnell, DWRC Logistics Coordinator, at the Amadil-Atlas Hotel for preliminary planning of the scheduled training. Mr. McConnell advised us that the camping equipment and some of the telemetry equipment had not yet arrived and that we needed to take an inventory as soon as possible to determine what equipment was available for training.

On June 20 and 21, Mr. McConnell confirmed that the camping supplies would not arrive in time for us to set up a camp at the training site near Ait Baha. Without camping supplies, it was necessary to house all workshop participants at the Kamal Hotel in Agadir and commute to the field on a daily basis for Phase II of the training. A tracer was initiated to locate the training equipment sent by air freight. The missing freight packages contained both the directional antennas and animal trapping equipment necessary for Phase II and Phase III of the training, respectively.

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On June 22, Mr. McConnell transported us to the Locust Control Center in Aït Melloul to see the lecture room and to meet their personnel. We were graciously received by Mr. Ahmed Benider and his staff of three electronics technicians. Mr. Kolz was informed that the radio equipment manufactured by Southern Avionics had been removed from the Locust Center and sent to a warehouse in Rabat. Mr. McConnell started an inquiry into the possibility of having some of this equipment returned to Aït Melloul so that the electronics staff could receive training from Mr. Kolz. From Aït Melloul, we proceeded to the training site at Aït Baha. Mr. Phillips explored the area for species of wildlife that might be trapped and used in Phase III of the training; only a few shrikes and magpies were observed. The area was extremely dry and heavily grazed by domestic livestock, and these conditions limited the number of birds and small mammals available for trapping.

On June 23 and 24, we selected 35 mm slides for the introductory lectures and finalized the outline for the workshop (Attachment 1). We also ensured that the radio transmitters and receivers were fully operational for demonstrations in the classroom.

The workshop was convened on June 25 at the Locust Control Center with 14 participants present. We had prepared handout materials for 12, so several of the participants worked together and shared the materials. The participants received a folding clip board, 3-ring notebook compiled with pertinent technical data, a written summary of radio tracking technology (by L. Kolz), and a topical outline. All the participants were enthusiastic about the opportunity to attend the radio tracking workshop, and as a group, there was immediate participation with dialogue and questions. The language barrier was effectively bridged by partitioning the lecture into segmented topics followed by short discussions among the students. In this manner, specific questions could be addressed in a timely manner.

The radio tracking lectures were continued in the classroom through June 26. Mr. McConnell advised us that he has been unable to locate the air freight containing the directional antennas. This loss was very unfortunate, for it was absolutely necessary to have antennas for the field work scheduled to begin the following day near Aït Baha. The decision was made to try and adapt TV antennas that were available in Agadir to the frequency of the wildlife tracking equipment. For this purpose, Mr. Kolz purchased two 5-element TV antennas and physically modified them to a 3-element Yagi antenna design. Mr. McConnell received a call from the bus station that a package had been received. Fortunately, this package contained additional radio transmitters that could be used for the field training.

Mr. Phillips described various data recording methods and the proper use of maps with the students on the morning of June 27. During this classroom time, Mr. Kolz worked with the electronics personnel at the Locust Center and completed the construction of the Yagi antennas. The antennas were then tested and proved to be adequate for the field training. The decision was made to proceed with the class to Aït Baha for the field training.

Two Land Rovers were used to transport the participants from Aït Melloul to Aït Baha. At Aït Baha, the class was divided between Mr. Kolz and Mr. Phillips for specific instructions with the receivers, headsets, and antennas. Radio transmitters were distributed throughout the area so that each student could develop the skills necessary to radio locate these fixed targets. Both high power and low power transmitters were used for this training to provide the students with the experience to detect audio signals in a static background. All the participants demonstrated a working knowledge of the tracking equipment and methods before completion of this training period.

The morning of June 28 was partially used for additional lecturing before proceeding to a field site east of Aït Melloul. This new site was selected as a training area in order to reduce the amount of travel time. Also, the vegetative cover was more dense and diverse than the Aït Baha site. Field observations suggested that this area was also much richer in bird life. Subsequently, small bird and rodent transmitters were hidden in the vegetation, and each student was required to radio locate and recover a transmitter. In general, the students had little difficulty in locating transmission in the general area, but they expressed surprise at how difficult it was to actually sight the transmitters. This hide-and-seek training proceeded until all participants were satisfied with their skills development. We decided to cancel Phase III of the training because the trapping supplies necessary to capture animals had not arrived.

On June 29th, we completed an equipment inventory at Aït Melloul with Mr. McConnell and determined what equipment should be left in Morocco or returned to Denver. All of the telemetry equipment designed to operate at 164 MHz was packaged for shipment to Denver. The test equipment, tools, and electrical cables were stored at the Locust Control Center. Mr. McConnell was also advised to store the directional antennas at the Locust Center whenever the missing air freight packages arrive. We checked one last time to determine if the radio equipment from Southern Avionics was being sent to Agadir, but there were no communications from Rabat to indicate any interest in this training.

June 30 - Spent time with several of the workshop participants at the Kamal Hotel before departing Agadir for our return to Denver.

Participants at the Telemetry Training

Name	Specialty	Base Location
My Tahar Abassi	Entomologist	Rabat
Abderrahim Alaoui	Ornithologist	Rabat
El Hassan Arroub	Mammalogist	Rabat
Ahmed Benider	Chief Electronics	Aït Melloul
Mustapha Charhbili	Entomologist	Guelmim
Ahmed Dliou	Phytopathologist	Agadir
Lhassane El Addami	Mammalogist	Guelmim
Abdelanalek El Fayq	Phytopathologist	Layoune
Abderrahim El Hani	Ornithologist	Rabat
Omar Al Hillali	Electronic Tech	Aït Melloul
Ahmed El Ismaili	Entomologist	Oujda
Brahim Id Messaoud	Mammalogist	Marrakech
Ahmed Mouhim	Entomologist	Agadir
Sallek Sahel	Entomologist	Agadir

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Wildlife Telemetry Training Outline

I. Introduction to wildlife tracking methodologies
   A. 35mm slide talk
   B. Conventional tracking techniques
   C. Satellite technology
   D. Automation of tracking equipment

II. Demonstration of equipment
   A. Transmitters
   B. Receivers
   C. Antennas
   D. Animal attachments

III. Initial training with equipment
   A. Receiver controls
      1. Channel selection and tuning
      2. Gain settings
      3. Automatic sweep
   B. Transmitter signals
      1. Listening for the desired signal
      2. Pulse rate
      3. Multiple transmitters
   C. Directional antennas
      1. Proper handling of cabling
      2. Pointing and body positioning
      3. Effects of buildings and metal fences

IV. Technical aspects of wildlife telemetry
   A. Introduction of terminology
      1. Definition of terms
      2. Ohm's Law
      3. Power equations
      4. The dBm
      5. Introduction to circuit theory
   B. Wildlife transmitter design
      1. Radiated power
      2. Antennas
      3. Pulse width
      4. Pulse repetition frequency
      5. Weight considerations
      6. Battery life
   C. Telemetry receivers
      1. Radio interference
      2. Design limitations
      3. Minimum discernible signal

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D. Estimation of radio reception distance
   1. Free space radio propagation
   2. Radio propagation with ground scatter
   3. Radio line-of-sight
E. Receiving antennas
   1. Isotropic
   2. Directional

V. General discussions regarding animal tracking systems.
   A. Manual versus automated tracking systems
   B. Satellite tracking of animals
   C. Future developments

VI. Attaching radio transmitters to animals
   A. Different methods for attaching transmitters
      1. Neck collars for mammals
      2. Tail mounts for birds
      3. Body loops for birds
   B. Demonstration of proper procedures
      1. The attachment
      2. Animal handling techniques
      3. Release techniques

VII. Field radio tracking procedures
   A. Demonstration of using a receiver
   B. Demonstration of using an antenna
   C. Locating an instrumented animal

VIII. Data recording and analysis
   A. Forms for recording telemetry data
   B. Examples of how wildlife telemetry data is used
      1. Mortality studies
      2. Home range and movement studies
      3. Migration studies

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Report

to the

DEPARTMENT OF LANDS AND SURVEYS

COMMONWEALTH of THE BAHAMAS

on

Predator Control to Protect Nesting Bahama Parrots

by

James O. Keith
Wildlife Research Biologist

International Programs Research Section
Denver Wildlife Research Center
Science and Technology
Animal and Plant Health Inspection Service
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Denver, CO 80225-0266 U.S.A.

September 26, 1990

Funds for this research were provided by the Commonwealth of The Bahamas and the U.S. Department of Agriculture/Animal and Plant Health Inspection Service.

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ABSTRACT

Recent studies on Abaco Island in the Commonwealth of The Bahamas have indicated a serious loss of productivity in Bahama parrots due to predation by feral cats. The Department of Lands and Surveys, Commonwealth of The Bahamas, asked the Denver Wildlife Research Center (DWRC), U.S. Department of Agriculture, to assess the problem and recommend steps to reduce feral cat populations. This report describes impressions obtained by a DWRC biologist during a brief visit (June 25-July 3, 1990) to Abaco Island. It presents a brief literature review, and contains recommendations for future action.

CAT PREDATION ON PARROTS

The Bahama parrot (*Amazona leucocephala bahamensis*) is the northernmost member of the genus *Amazona*, which is represented by species and subspecies throughout the West Indies. The Bahama parrot once was present on all large islands in The Bahamas (Fig. 1), but now is found only on Abaco Island and Great Inagua. Populations on these two islands have been considered endangered by the International Union for Conservation of Nature since 1966. The parrots on Abaco Island are unique among the *Amazona* as they do not nest in trees, but nest in underground cavities formed by water in the limestone substrate. This habit has greatly increased their susceptibility to introduced mammalian predators such as cats (*Felis catus*) and rats (*Rattus rattus*).

In 1985, U.S. and Bahamian biologists began the first intensive studies of the parrot's reproductive biology in the pine forest (*Pinus caribaea*) and hardwood coppice of southern Abaco Island (Fig. 2). In 1985, 1986, and 1987, cat predation was low and parrots successfully produced young in between 44 and 60 percent of nests with eggs (Gnam 1990). However, 45 percent of parrot nests were lost to cat predation in 1988, and only 29 percent of nests fledged young. Female parrots either were injured or killed at 9 of the 14 nests that failed.

Cats undoubtedly have been present to influence parrot nesting success on Abaco Island for many years (Snyder et al. 1982). Cats probably have increasingly dispersed from refuse dumps near two settlements, 6 and 10 miles away from nesting areas, as human populations have increased. Since the 1960's when roads were established to facilitate logging, cat populations may have been augmented by humans discarding unwanted cats along roads through parrot nesting areas. It is clear from recent studies that the intensity of cat predation varies between years. Years with increased cat predation on nesting parrots may reflect random occurrences of higher immigration rates or increased releases of unwanted cats by humans.

On Abaco Island the habitats where parrots nest probably have a low carrying capacity for cats. Populations are sparse, and longevity and fecundity probably are low. Most kittens probably die before reaching maturity, and adults in the population probably are replaced as often by immigrants as by young they produce. Cat abundance on southern Abaco Island may average less than one cat per km^2, but it is apparent that in

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certain years cats eliminate a large proportion of parrot productivity. Although cats and parrots have been associated for many decades on Abaco Island, cats still may be detrimental to long-term population stability. They appear responsible for a loss in productivity that becomes additive to other decimating factors such as logging, hunting, and the sale of parrots to the pet trade. As the negative influence of cats can be eliminated relatively easily, their control should be initiated.

BIOLOGY OF FERAL CATS

On islands with rats and nesting seabirds for food, cat numbers commonly range from 4 to 14 per km^2 (Macdonald and Apps 1978), but can reach as high as 220 per km^2 (Apps 1986). The home range of cats is related to the abundance and distribution of food. Individual cats have been found to use areas from 0.03 ha to 990 ha (Apps 1986). Smallest home ranges occur where cats use human refuse. More usually home ranges are between 11 and 63 ha (Apps 1986), and they are larger for adult males than for adult females and juvenile animals (Macdonald and Apps 1978). Home ranges overlap, and Apps (1986) found that, on the average, about 12 other cats were sometimes present in the home range of each individual cat.

Cats use established dens and prefer higher, well-drained sites for their lairs. They are opportunistic predators and scavengers and will eat most animals and many parts of plants. Cats select prey based largely on its availability, but prefer to eat mammals rather than birds when both are abundant. Most birds taken by cats either feed or nest on the ground. Cats primarily are active at twilight and at night, but may move and hunt at any time of day. They can live 7 to 8 years, and females may have 2 litters a year with about 4 young per litter (Veitch 1985).

In New Zealand, cats have been involved in the extinction of 6 endemic species and over 70 localized subspecies of birds from islands (Karl and Best 1982). Rats, too, have been implicated in the reduction and even the elimination of birds from islands (Moors 1985). The relationship between cats, rats, and birds can be a complex one. On Stewart Island in New Zealand, rats were the principal food (>90 percent) of cats (Karl and Best 1982). Removing cats may allow rats to increase, and high rat populations often can cause more losses to birds than low cat populations. It has been inferred that rats have reinvaded areas after cats were removed (Elton 1953), so that in solving one problem, a more serious one was created.

CAT CONTROL ON ISLANDS

Cats have been eradicated from several uninhabited islands in New Zealand. These seabird nesting sanctuaries ranged in size from 28 to 2,817 ha (Veitch 1985), and costs of eradication were considerable. On Little Barrier Island (2,817 ha), it took 4 years' effort by 128 people working a total of 3,800 man-days to eliminate 151 cats. It required a team of workers 1 year to clear Jarvis Island, a U.S. possession of 414 ha, of 120 cats to protect nesting seabirds. Cats earlier had eliminated rats (*Rattus exulans*) from the island (Rauzon 1985).

Control of cat populations has been achieved with a variety of methods, including the use of disease, poisoning, trapping, and hunting. It usually is necessary to use combinations of methods to achieve population reduction (Beck 1975). Any one method can eliminate most cats, but the others are essential in helping to eliminate the last animals.

The use of disease to decimate cat populations is practical only if all cats on an island can be killed. It is used as the first method of control, as it can quickly eliminate 50 percent or more of the population. Other reduction methods can then be applied. Feline panleucopenia virus (feline enteritis) was introduced on Marion Island (Eramus 1979) and on Jarvis Island (Rauzon 1985) to initiate eradication of feral cats.

Hunting has been an important tool in the elimination of cats from islands in New Zealand (Veitch 1985) and South Africa (Bloomer and Bester 1990). Hunting success is highly correlated with the experience of the hunters, but also with the stage of eradication efforts. It took 250 hours of hunting to eliminate the last two cats from Jarvis Island (Rauzon 1985). Night hunting using spotlights (100,000-200,000 candle power) and 12-gauge shotguns is productive (van Rensburg and Bester 1988, Rauzon 1985). Hunting by day with a .22-calibre rifle and scope has been successful (Rauzon 1985). The bag during the first week of hunting on Jarvis Island averaged almost 2 cats per man-hour of hunting, but this dropped to 0.19 cats per man-hour during the second week. With a cat density of 44 cats per km^2, the kill averaged about one cat per hour of hunting (Rauzon 1985).

In a few cases, poisons have been used in conjunction with other methods to reduce cat populations. In New Zealand, Compound 1080 was shown to be effective against cats; its LD_{50} value of 0.3 to 0.5 mg/kg indicates its high toxicity to cats (Veitch 1985). Pieces of fish inoculated with a 20 percent aqueous solution of Compound 1080 were used on Little Barrier Island. Laboratory work in the United States showed Compound 1080 to be superior to other toxicants tested for cat control (Fellows 1982). There are no toxicants registered with the U.S. Environmental Protection Agency for cat control. Without registration, toxicants can neither be used in the United States nor recommended for use elsewhere. Any use of a toxicant for cat control must be proceeded by a thorough evaluation of its efficacy and environmental impact. The nontarget effects of a toxicant must be evaluated in the habitat where the toxicant will be used. Effects can vary considerably between different ecological settings. (On Abaco Island, for instance, bait and dead cats could poison endemic land crabs (*Cardisoma guanhumi*), lizards (Gekkonidae and Iguanidae), and even the Bahama hutia (*Geocapromys ingrahami*), which are reported to be on Abaco Island by local residents.)

Trapping, as with hunting, has been a primary method in many cat control programs. Both cage traps and gin (leg hold) traps have been used, but the gin trap has proven to be the most successful (Veitch 1985). Fresh fish has been the most acceptable bait. Trapping is labor intensive, as indicated by the following records from Little Barrier Island, New Zealand (Veitch 1985):

Year	Trap-Nights (TN)	Cats Caught (C)	TN/C
1977	2,637	26	101
1978	37,332	37	1,009
1980	32,615	5	6,523

As cat populations were reduced, the trapping success decreased rapidly.

Eramus (1979) concluded that with high cat densities and a positive growth rate, none of the current control methods would limit feral cat numbers. In contrast, with low cat numbers and a zero or negative growth rate, he felt control was possible and that night hunting might be the best method.

CAT CONTROL ON ABACO ISLAND

It would be unrealistic to attempt feral cat eradication from Abaco Island. Costs would be excessive due to the Island's size and the constant development of feral individuals from the domestic cat population. The feral cat population on southern Abaco Island is low and probably has either a negative or a low growth rate. The population there may be sustained largely by infrequent and erratic immigration. The elimination of cats in parrot nesting areas is possible, but reinvasion of animals will certainly occur over time. The only realistic approach to protecting parrots is to remove cats annually prior to the parrot nesting season. It would be advisable to check for cats again later each year during the period when female and nestling parrots are especially vulnerable. Thereby, any cats reinvading immediately after initial control efforts could be removed before they caused losses to parrots.

Most female parrots lay their eggs between mid-May and early June; incubation continues into early July, and young are in nests until early in September. Females begin to spend less time in nests in late July, and most young probably can escape predation after September 1 (Rosemarie Gnam, pers. comm.). With this nesting chronology, it would be desirable to remove cats from nesting areas in April and eliminate any remaining cats in mid-June.

Most parrot nests on southern Abaco Island are located in an area of about 800 ha (S. G. Chambers, pers. comm.). Cats should be removed from an area of about 4,000 ha (15.4 mi^2) to create a cat-free area around nests and help protect parrots from predation. This is an area larger than any of the islands, worldwide, from which cats have been successfully removed. Elimination of cats from 4,000 ha would be a difficult task and would require the services of professional hunters/trappers. Prebaiting at permanent stations at the edge of the control area would be desirable to concentrate cats prior to hunting and trapping activities. This work would involve a total of several days' time over several weeks and might most efficiently be accomplished by Department of Lands and Surveys personnel.

I have contacted several trappers who would be willing to annually control cats during 3 weeks in April and 1 week in June on the 4,000-ha area on southern Abaco Island. These professionals would supply all equipment and

supplies necessary to accomplish their work, and each would use a somewhat different approach to achieve cat control.

1. Rancher's Supply, Inc.
   P.O. Box 725
   Alpine, TX 79831

   Attn: Mr. Roy McBride
   Phone: (915) 837-3630
   Fax: (915) 837-3680

   Mr. McBride would use dogs to hunt and remove cats.

2. Mr. Jon Heisterberg
   State Director, North Carolina
   Animal Damage Control
   U.S. Department of Agriculture
   P.O. Box 25878
   Raleigh, NC 27611
   Phone: (919) 856-4124
   Fax: (919) 856-4776

   and

   Mr. Douglas Hall
   State Director, Georgia
   Animal Damage Control
   U.S. Department of Agriculture
   School of Forest Resources
   University of Georgia
   Athens, GA 30602
   Phone: (404) 546-2020

   Messrs. Heisterberg and Hall propose a combination of hunting and trapping for cat control and feel that the job will require at least two people during the first 3 weeks.

3. Mr. Andy McKinney
   P.O. Box 961
   Gillette, WY 82716

   No Telephone

   Mr. McKinney is a hunter/trapper who devotes most of his time to the capture of wild animals. He specializes in the use of snares.

Messrs. McBride and McKinney indicated similar costs for their services.

Charges	Total costs (28 days)	
Fee - $125/day	$ 3,500	
Expenses - $125/day	3,500	
Vehicle and gas - $75/day	2,100	
Airfare	900	(2 trips)
	$ 10,000	

Messrs. Heisterberg and Hall proposed to work together during the first 3 weeks, with one of them returning for the final week in June.

Charges	Total costs	
Salary (supplemented by USDA)	$ 1,000	
Per diem - $125/day	6,125	(49 man-days)
Vehicle and gas - $75/day	2,100	(28 days)
Airfare	900	(3 trips)
	$ 10,125	

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It should be stressed that the cost estimates are preliminary and subject to change. If funds can be found to support this proposed work, the Commonwealth of The Bahamas, through their Department of Lands and Surveys, should request a current budget from these indivduals and contract directly for the work. All of the above hunters/trappers, as well as other individuals and groups in the United States, should be able to successfully remove feral cats from parrot nesting areas. Only experience will indicate the exact amount of time and effort, using various control methods, to accomplish the task. It should be stressed that traps and snares used to capture cats must be of a size that will not present hazards to hunters' dogs. Also, padded traps can be used to prevent damage to the legs of captured cats. When cats are removed, they should be killed, and this can be done most humanely by professional hunters/trappers.

A system for monitoring cat and rat abundance should be initiated in the parrot nesting area. Populations should be assessed several times each year; typical methods used to assess populations are described by Davis (1982). Information on numbers of animals would allow assessing the effectiveness of cat control and the resulting influence on rat abundance. If rat populations increase following cat control, programs to reduce rat numbers may become necessary to protect parrots.

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Fig. 1. Islands of the Bahamas (from Gnam 1990).

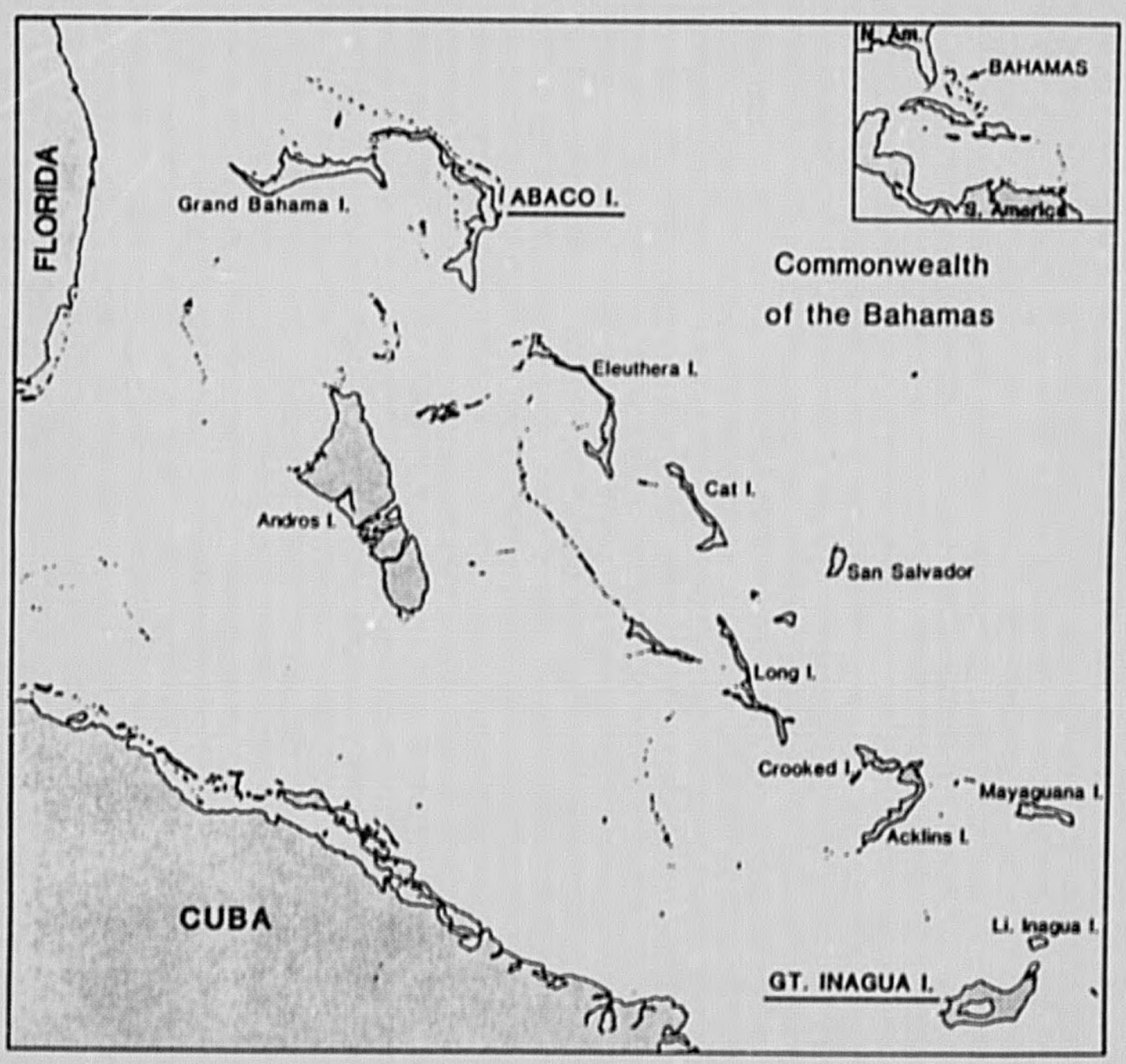
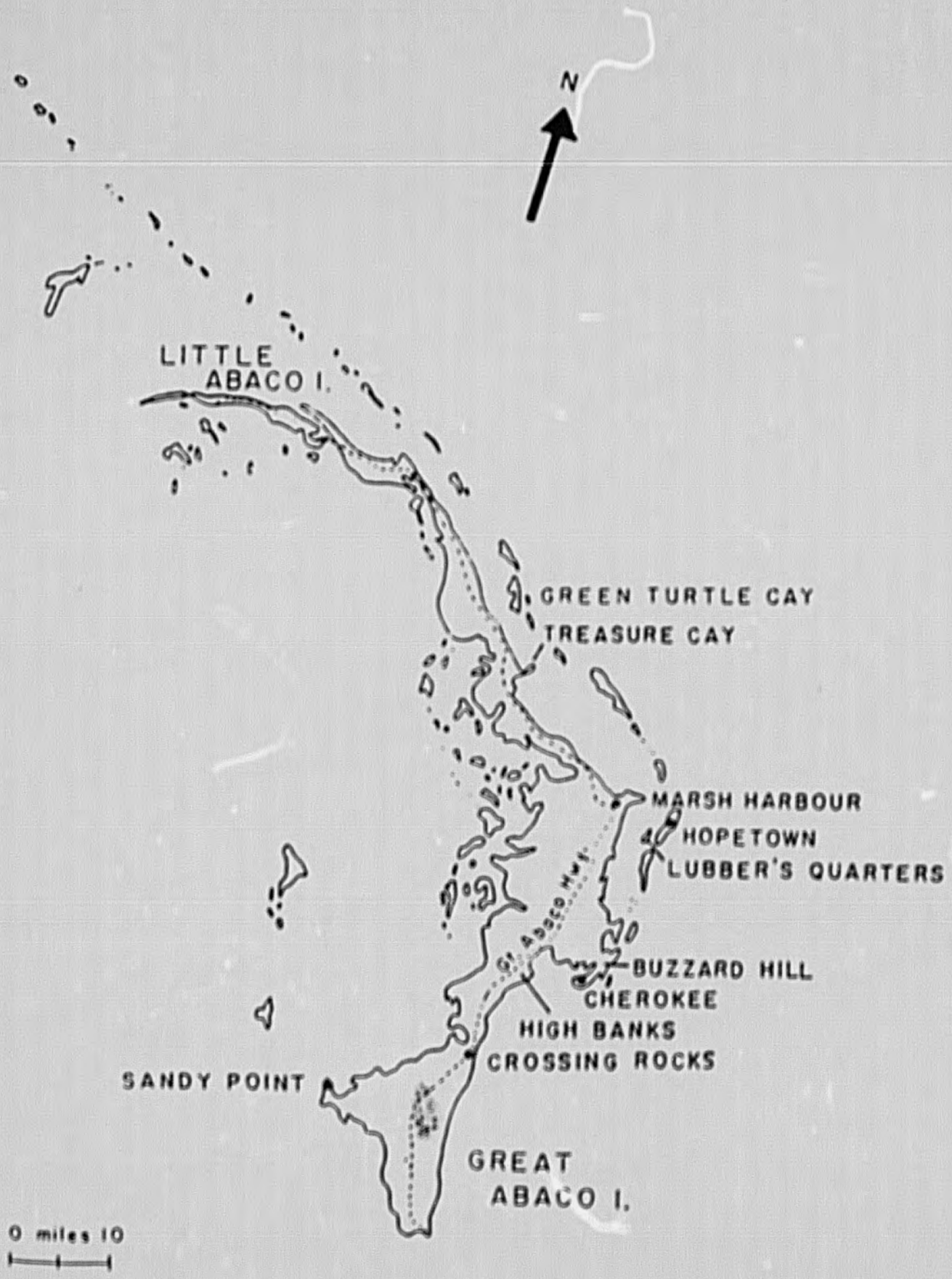


Fig. 2. Abaco Island, showing parrot nesting area (in gray) at southern end of island (after Snyder et al. 1982).



TRIP REPORT*

RODENT PESTS IN GUINEA-BISSAU

July 22-August 18, 1990

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ITINERARY

Date	Location	Activity
Jul 22-23	Denver, Colorado, to Amsterdam, Netherlands	Travel
Jul 24	The Netherlands	Personal
Jul 25-26*	Amsterdam to Antwerp, Belgium	Travel; also met with rodent experts at the University of Antwerp to discuss current rodent research in Africa
Jul 27-28	Antwerp to Bissau, Guinea-Bissau, via Amsterdam and Lisbon, Portugal	Travel
Jul 29-Aug 17	Guinea-Bissau	Worked with the Agency for International Development (AID)/Bissau and counterparts within the Crop Protection Service (CPS) Department of the Ministry of Agriculture to assess rodent damage to crops
Aug 18	Bissau to Denver, Colorado, via Lisbon and New York	Travel

* Costs were incurred by PASA DAN 4173-X-AG-6001.

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SUMMARY

The purpose of this trip was to (1) visit several rodent experts at the University of Antwerp in Belgium to discuss current rodent research in Africa and (2) participate in rodent field work in Guinea-Bissau. I spent 2 days in Antwerp with Drs. Walter Verheyen, Ron Verhagan and Herwig Leirs and toured their facilities. We also discussed results from their recently completed, Danish-supported rodent project in Tanzania and possible future cooperative work on African rodents to benefit both of our organizations' interests. While in Guinea-Bissau, I worked with the U.S. Agency for International Development (AID)/Bissau and counterparts within the Crop Protection Services (CPS) Department of the Ministry of Agriculture on the more serious rodent damage problems in priority crops. Agricultural crops growing near the towns of Bula, Bissau, Bafata, and Contuboel were examined for rodent damage potential, and rodents were trapped to determine species present and current infestation levels. A work plan was proposed for the CPS Department to continue to investigate the most important of these rodent problems over the next several months.

BACKGROUND

Previous work on rodents in Guinea-Bissau has been extremely limited. A quick review of the literature revealed only two publications dealing with rodents in the country. Monard (1941) collected and briefly described 11 rodents and 1 rabbit (Lepus senegalensis Rochebrune):

Species, Collection areas (Month)*

1 Heliosciurus gambianus gambianus Og., Mansoa (Dec), Contuboel (Jan), Pitche (Feb)--West African sun squirrel
2 Heliosciurus multicolor** occidentalis n. ssp., Cutia (Dec)
3 Funisciurus pyrrhopus F. Cuv., Pitche (Feb)--African striped squirrel
4 Euxerus (=Xerus) erythropus Geoffr., Contuboel (Jan.), Pitche (Feb.)--African ground squirrel
5 Cricetomys gambianus gambianus Wat., Cacheu (May)--Giant pouched rat
6 Rattus rattus L., Cutia (Dec), Mansoa (Dec)--Roof rat; black rat
7 Rattus alexandrinus** Geoffr., Mansoa (Dec)
8 Mastomys (=Praomys) coucha (=natalensis) A. Sm., Bissau, Mansoa, Enxale, Contuboel, Bagingara, Catio, etc.--Multimammate rat
9 Arvicanthis rufinus** (=niloticus) Tem., Contuboel, Pitche--African grass rat
10 Taterona** (=Tatera?) guineae (=robusta?) Thos., Catio
11 Thryonomys swinderianus Tem., Cacheu (April, May)--Cane rat

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* = Common names have been added at the end of each currently recognized species.
** = No longer a recognized taxonomic name (Honacki et al., 1982).

Five of these 11 rodents were referred to as pests. The African ground squirrel (E. erythropus) was described as "L'animal est un grand depredateur" or a big pest and common in peanut and millet fields; and the giant pouched rat (C. gambianus) was mentioned as "cause de grands ravages" or causing great damage in granaries, homes, and food storage facilities. The black rat (R. rattus) was "comme d'habitude, en commensal de l'hemme et exerce ses depredation," or a common commensal pest. The multimammate rat (M. coucha) was "tres abondant" or very abundant in Guinea-Bissau, particularly in rice fields. Two distinct forms were noted: a lighter colored variety in the fields and a darker variety in homes. The cane rat (T. swinderianus) was called "farfan" in creole, "kansolo" in mandingue, or "kansolaye" in fulah, and was widespread, abundant and "un grand depredateur de champs de riz ou de mil" or a big pest in rice and millet fields. In the dry season, it was present in dry weeds.

The second publication, by Gautun (1988), summarized the rodent species present in nine West African countries. Sixteen species (6 "probably occurring") were listed for Guinea-Bissau. The 10 species known to exist include Cricetomys gambianus, Mus musculus, Nannomys spp., Rattus rattus, Rattus norvegicus, Arvicanthis niloticus, Praomys tullbergi, Mastomys huberti, Graphiurus murinus and Euxerus erythropus. Those listed as probable were Tatera gracilis (kempi), Tatera guineae (=robusta), Lemniscomys striatus, Thanomys buntingi (sp.), Myomys daltoni, and Mastomys erythroleucus.

LaVoie (1989) in a previous consultancy during October-November 1989 snap-trapped rodents for several days near Bula (Agricultural Zone 1, east central) and Catio and Caboxanque (Agricultural Zone 3, coastal) using dried fish for bait. In harvested vegetable fields near Bula, 96 trap-nights resulted in the capture of 8 specimens, 1 Mastomys erythroleucus, 5 Mastomys natalensis* and 2 Mus sp.; this was an 8.3% trap success (unadjusted for sprung or lost traps). In Catio and Caboxanque, the same two Mastomys species were captured in swamp rice, upland rice, and vegetable fields; but no Mus sp. was trapped. Trap success in this second area was 27% (unadjusted). The black rat was captured (4 in 12 trap-nights) in grain storage buildings in Bula and Catio. Also mentioned were two rodents, an African ground squirrel (E. erythropus), seen on many occasions along the road from Catio to Caboxanque in Zone 3 (about 5-11 animals per kilometer), and the giant pouched rat (C. gambianus), reportedly doing significant damage to rice and vegetable crops on the Island of Bubaque.

A significant fact mentioned by LaVoie was that in Guinea-Bissau rodents are popularly used as a human food source. The degree that this occurs needs to be verified since it will influence any rodent control strategy developed in Guinea-Bissau using rodenticides.

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* Mastomys spp. identified by D. Wilson, U.S. Museum of Natural History, Washington, D.C.

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ACTIVITIES

During my consultancy four areas were snap-trapped. Study skins were made from all collection sites and left with CPS Department personnel for their use in a reference collection. Ponate is in Agricultural Zone 1; Granja Pessube in Zone 0 (which includes Bissau and the surrounding area); and Contuboel and Bafata, in Zone 2. Results are summarized:

Da/Mo/Yr	Location	No. traps	Traps			Catches		% Trap Success*		Weather
			Sprng	Unsprng	Missing	Rodent	Other	Adj	Unadj	
02/08/90	Ponate	50	14	35	0	1	0	2.4	2.0	Rain
03/08/90	Ponate	50	7	40	1	2	0	4.7	4.0	No rain
	Total	100	21	75	1	3	0	3.6	3.0	
08/08/90	Granja P	52	0	44	8	0	0	0.0	0.0	Rain
09/08/90	Granja P	51	4	31	16	0	0	0.0	0.0	No rain
	Total	103	4	75	24	0	0	0.0	0.0	
14/08/90	Contuboel	50	1	46	1	1	1	4.3	4.5	Rain
15/08/90	Contuboel	42	1	27	22	0	0	0.0	0.0	Rain
	Total	92	2	73	23	1	1	1.3	1.3	
14/08/90	Bafata	48	2	46	0	0	0	0.0	0.0	Rain
15/08/90	Bafata	49	4	38	3	3	1	7.0	6.4	Rain
	Total	97	6	84	3	3	1	3.3	3.2	

*

$$\text{Adjusted} = \frac{\text{No. catches}}{\text{No. catches + unsprung traps + 0.5 (sprung traps)}} \times 100 = \%$$

$$\text{Unadjusted} = \frac{\text{No. catches}}{\text{No. catches + sprung and unsprung traps}} \times 100 = \%$$

Bula

From August 1-3, 50 rat snap traps baited with dried fish were set for 2 nights in a 0.5-ha plot on the Central Experiment Station at Ponate, near Bula. About half the plot was fallow, with the other half planted with maturing sorghum, peanuts (bush type), and corn. Five grid lines about 10 meters apart, with traps spaced about 10 meters along each grid, were used. In addition, two snap traps baited with peanut butter and three leg hold traps (No. 2) were set in the area for demonstrating other trapping methods.

Results from 100 trap-nights include three multimammate rats (*M. erythroleucus*). All three rats had peanut in their stomachs: one rat was trapped in the peanut patch, while the other two rats were trapped about 35-45 meters away from the peanut patch in fallow ground. About 20% of the traps were missing bait each morning, mostly from unsprung traps. One snap trap was found dragged from its original position about 50 meters

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with the bait missing and sprung. All the peanut butter on the two extra traps was missing both mornings, with both traps sprung during the first night and unsprung during the second night. The leg hold traps produced no catch.

Bisaque

An agricultural field near the CPS Department building in Bissau was selected to monitor rodent populations over several months. Forty-seven snap traps were set on August 7 and 8 in a grid fashion with 6 transects of 6-10 traps spaced about 10 meters apart. In addition, some traps were set in a nearby nursery, home, and warehouse. No rats were trapped in the field; but 3 black rats were caught in the home, and 1 black rat was caught in the warehouse.

Bafata

On August 13 and 14, 49 rat snap traps baited with dried fish were laid out in a grid 10 paces apart from each other in agricultural fields at the Cotton Project facilities. Peanuts, sorghum, and cotton were growing in the 5- to 6-ha research farm. Traps were set in corn, peanut, sorghum, and cotton (all in early vegetative growth stages) in late afternoon the first day and in fallow and peanut (maturing) fields the second day. No catches were recorded the first night; but three Mastomys spp. were caught the second night, even with a very heavy rain that occurred from about 2200 hours until 2400 hours and light intermittent rains that continued throughout the night. Study skins were made from two of these specimens, one M. erythroleucus and one M. natalensis (smaller and darker than M. erythroleucus).

Contuboel

On August 13 and 14, 50 rat snap traps baited with dried fish were laid out in a grid 10 paces apart from each other at about 1700 hours. Peanuts, corn, and sorghum were growing in the area. A large uncultivated area was present adjacent to these crops. Some small rodents were seen in short grasses of the trapped area. Study skins were prepared of the two small mammals that were caught [M. erythroleucus and a shrew (genus and species unidentified)]. We checked the area in the afternoon of August 14, but did not see any diurnal rat activity. Some traps were sprung, possibly by children whom field workers saw playing near our traps. Additional traps were baited with peanuts and set nearby. A Tomahawk live trap baited with dried fish did not catch anything. The second night resulted in no catches; however, 22 of the 50 set traps were missing, probably removed by villagers.

CONCLUSIONS

To assemble a preliminary priority list of important crops and rodent pests damaging those crops at identified growth stages in Guinea-Bissau, the previous work by Monard (1941), Gautun (1988), and LaVoie (1989) and the

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present work were combined. The following table summarizes these priority rodent pest problems (question marks denote information that is yet unknown or unconfirmed):

Table 1. Guinea-Bissau agricultural rodent problems, a preliminary list of the major crops damaged by rodents.

Agricultural zone	Crop	Growth stage	Months*	Rodent pest species
0	Peanut	Seeding	June	?
		Seedling	June-July	?
		Maturing	November	?
1	Rice, rainfed	Maturing	November	Mastomys erythroleucus Mastomys natalensis
	Millet	Seeding	June	?
	Sorghum	Seeding	June	?
	Peanut	Seeding	June	?
		Seedling	June-July	?
		Maturing	November	Xerus erythropus ? Mastomys erythroleucus
2	Millet	Seeding	June	?
	Sorghum	Seeding	June	?
	Peanut	Maturing	November	Xerus erythropus
	Rice, rainfed	Seedling	June	?
3	Rice, swamp	Seedling	June	Mastomys erythroleucus Mastomys natalensis
4	Rice, rainfed	Seedling?	June	Cricetomys gambianus
		Vegetative?	August	
		Maturing?	October	
	Vegetables	Maturing?	November-April	Cricetomys gambianus

* Assumes the average rainy season starts in June, although this may occur from May to July.

The CPS Department personnel, particularly Alfesene Balde and Claudino Pereira, have received adequate training and experience to obtain the kind of information that is outlined in specific recommendations in Table 2. That work is vital. Without the data that these recommendations will provide, cost-effective control methods that are also cost-beneficial will remain unknown.

Much information is still needed in order to begin field trials of possible rodent control methods appropriate in Guinea-Bissau. Before determining an effective control strategy for Guinea-Bissau, the following information is

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needed: (1) the species involved, (2) when it causes damage, (3) the crops that are damaged, (4) the extent of damage, and (5) the significance of damage within each agricultural zone.

RECOMMENDATIONS

Table 2. The following activities are recommended for implementation by the CPS Department personnel during the next year (August 1990-September 1991).

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1. Determine the rodent species that are encountered in the primary agricultural crops in different areas of Guinea-Bissau.

   a. Continue to trap, identify species, and make study skins.
   b. Denote the areas in Guinea-Bissau where these species are common.

2. Verify which species are causing damage in what particular crops.

   a. Trap in priority crops at times of expected damage, and examine stomach contents of trapped rodents.

3. Assess the degree of damage to various crops.

   a. Perform simple damage estimates by randomly sampling 1% of plants in a field, and record damaged and undamaged plants.

4. Establish reference specimens of primary rodent pests for future use within Guinea-Bissau.

   a. Continue to build a collection of study skins of primary rodent pests of Guinea-Bissau.

5. Monitor rodent populations in two selected areas (Bula and Granja Pessubé) on a sustained bimonthly schedule of trapping, and relate to known rainfall.

   a. Use the same areas (Ponate and Bisaque) that have already been trapped for continued comparisons.

6. Initiate bait comparison trials in selected areas to determine an appropriate bait to mix with rodenticides.

   a. Use rice and a number of other available bait materials, and place two or more different baits at the same locations to offer the rat a choice. Record amounts taken of each kind of bait material tested, and determine which may be appropriate to use with rodenticides.

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CONTACTS AND ACKNOWLEDGMENTS

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- Mr. Gilbert, Program Assistant

University of Antwerp (RUCA)

- Dr. Walter Verheyen, Director, Laboratory of General Zoology
- Dr. Ron Verhagan
- Mr. Herwig Leirs, Research Associate

RAT COLLECTION DATA FROM GUINEA-BISSAU

Prepared by Alfesene Balde, Claudino Pereira, and Lynwood Fiedler
August 1990

Codes used for recording data in table below:

RAT NO. = Number given to each rodent trapped in the field
AREA = Nearest village, town or city where animals were trapped
DATE = Date when the trapped rodent is removed from the trap
TRAP = Type of trap: R = Rat snap trap (such as the Victor large)
M = Mouse snap trap (such as the Victor small)
S = Sherman (metal folding) box (live) trap
L = Leghold trap No. 2
X = Wire mesh live trap (such as Tomahawk)
Y = Road kill
BAIT = Type of bait used in trap:
F = Dried fish
P = Peanut butter
S = Sweet potato
N = None used or not applicable
SPP = Species; M1 = Mastomys erythroleucus
M2 = Mastomys natalensis
Cg = Cricetomys gambianus
Mm = Mus musculus
An = Arvicanthis niloticus
S = Sex: M = Male
F = Female
WT = Weight (in grams)
TOT = Total length (in mm)
H/B = Head and body length (in mm)
TAL = Tail length (in mm)
HF = Hind foot length (in mm)
EL = Ear length (in mm)
T = Testes position: S = Scrotal
A = Abdominal
Le = Length of testes (in mm)
V = Vagina; P = Perforate
I = Imperforate
M = Mammae; L = Large, greater than 1mm
S = Small, less than 1mm
I = Invisible
U = Uterus; L = Large
S = Small
EM = Embryos; Number of embryos
CR = Length of embryos from the crown to the rump (in mm)
Sto = Contents of stomach (with room for three items);
P = Peanut (white, coarse)
C = Corn
I = Insect
S = Seeds
U = Unknown
SKIN = Study skin; Y = Study skin prepared and labeled
N = Study skin not prepared
SKUL = Study skull; Y = Skull prepared and labeled
N = Skull not prepared

RAT DATA FROM GUINEA-BISSAU

Rat No.	Area	DATE Da Mo Y	TRAP	BAIT	SP	S	MEASUREMENTS(g,mm) WT	TOT	H/B	TAL	HF	EL	REPRODUCTION MALE T	LE	FEMALE V	M	U	EM	CR	STO	SKIN	SKUL
001	PONATE	02 08 0	R	F	M1	M	95	288	150	138	25	20	S	22						P--	N	Y
002	PONATE	03 08 0	R	F	M1	F	70	250	135	115	25	19			P	L	L	12	20	P--	N	N
003	PONATE	03 08 0	R	F	M1	F	46	245	130	115	25	20			I	S	S			P--	N	N
004	BISAQUE	08 08 0	R	F	Rr	F	166	397	181	216	36	25			P	L	S	0		---	Y	Y
005	BISAQUE	08 08 0	R	F	Rr	F	115	380	170	210	35	25			P	L	S	0		---	N	N
006	BISAQUE	08 08 0	R	F	Rr	F	76	340	155	185	33	23			I	S	S	0		---	Y	Y
007	GRANJA P	08 08 0	R	F	Rr	M	51	290	135	155	31	20	S	--						---	Y	Y
008	CONTUBOE	14 08 0	R	F	M1	M	75	240	120	120	25	19	A	19						U--	Y	Y
009	BAFATA	15 08 0	R	F	M1	F	55	235	130	105	23	*			P	S	L	10	6	U--	N	N
010	BAFATA	15 08 0	R	F	M1	F	67	265	138	127	25	22			P	L	L	0		IU-	Y	Y
011	BAFATA	15 08 0	R	F	M2	F	40	222	118	104	27	20			I	S	S	0		P--	Y	Y
012	N'SALMA	15 08 0	Y	N	An	M	149	303	141	162	35	20	S	20						U--	Y	Y
013	BANCULEM	13 08 0	X	F	Rr	M	111	369	190	198	34	22	S	18						---	N	N
014	GRANJA P	13 08 0	R	F	Rr	M	70	300	123	177	32	20	S	17						---	N	N
015																						
016																						
017																						

* = Part missing due to predation

Rat No.	Zone No.	Habitat	Crops present	Growth stage	Crop damage	Weather
001	1	Agricultural	Peanut	maturing	Yes	Heavy rain, 1 hr.
002	1	Agricultural	Peanut	maturing	Yes	No rain
003	1	Agricultural	Peanut	maturing	Yes	No rain
004	0	House	-	-		
005	0	House	-	-		
006	0	House	-	-		
007	0	Warehouse	-	-		
008	2	Agricultural	Fallow, next to corn	vegetative	No	Heavy rain,wind
090	2	Agricultural	Corn	vegetative	No	Heavy rain
010	2	Agricultural	Fallow, next to peanut	vegetative	No	Heavy rain
011	2	Agricultural	Fallow, next to peanut	vegetative	No	Heavy rain
012	1	Agricultural	Fallow, road kill			Rain
013	0	House	-	-		
014	0	House	-	-		
015						
016						
017						

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TRIP REPORT*

IRRI EXPERT PANEL MEETING ON RODENT PESTS IN RICE

LOS BAÑOS, PHILIPPINES, and

DWRC HILO FIELD STATION CONSULTATION

Lynwood A. Fiedler
Wildlife Biologist (Research)
International Programs Research Section
September 7-20, 1990

Michael W. Fall
Chief, Predator Control Research Section
September 7-18, 1990

Denver Wildlife Research Center
USDA/APHIS/S&T
P.O. Box 25266
Denver, Colorado 80225-0266 U.S.A.

Unpublished Report

November 20, 1990

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ITINERARY

Date	Location	Activity
September 7-8	Denver, Colorado, to Los Baños, Philippines	Travel
September 9-16	International Rice Research Institute	Attended expert panel session on rodents in rice
September 16-17	Los Baños to Manila	Travel and met with U.S. Agency for International Development/Office of Rural and Agricultural Development
September 17	Manila, Philippines, to Honolulu, Hawaii	Travel
September 17	Honolulu to Hilo, Hawaii	Travel (Fiedler)
September 17-18	Honolulu to Denver, Colorado	Travel (Fall)
September 18-19	DWRC Hilo field station	Participated in rodent field work in sugarcane and macadamia nut
September 19-20	Hilo to Denver, Colorado via Honolulu, Hawaii	Travel

IRRI RODENT MEETING

SUMMARY

From September 10 to 14, 1990, we participated in the "Expert Panel Meeting on Rice Rodent Control" hosted by the International Rice Research Institute (IRRI) in Los Baños, Philippines. This expert panel of 14 specialists, each with a background related to rodent problems in rice-based agriculture, presented papers on current knowledge, and participated in discussions which defined particular problem areas and summarized research and rodent pest management accomplishments and needs. The panel also drafted a number of recommendations that addressed short- and long-term solutions to primary rodent damage problems. A proceedings, which includes papers presented at the meeting, was drafted by the panel and will be finalized by the IRRI.

ACTIVITIES

The principal recommendation was for IRRI to assume a coordination role and to maintain databases on (1) publications related to, and (2) people working on, rodents in tropical rice. IRRI agreed to act as a catalyst to promote research and the adoption of effective control methods for reducing rodent damage in rice, a problem which continues to limit rice production throughout the Tropics. A monograph on rodents in rice was suggested as a means to fill information gaps that now exist.

Rodent damage to tropical rice has long been a recognized problem, but funding for efforts to find and promote worldwide solutions has declined substantially in the past decade. IRRI is 1 of 13 international agricultural research centers; its primary objective is to develop techniques for increasing production of rice and associated crops. Since IRRI's early successful efforts to develop high-yielding rice varieties, it broadened its program to examine other factors that may limit rice production. Rat damage to rice on IRRI's own research farms has drawn attention to the fact that greater efforts are needed to deal with rice yield losses due to rodents. As a result, Dr. Klaus Lampe, IRRI Director General, and Dr. Graeme Quick, Head, Agricultural Engineering Division, organized a meeting of rodent experts to present papers and participate in discussions for the purpose of defining specific problem areas, identifying needed areas of research, and developing recommendations for reducing rodent losses in farmers' fields as well as on research farms.

Experts from seven countries and other invited observers with experience in or related to rodent control in rice assembled on September 10 at IRRI. During the first two days, various papers were presented, including those by M. W. Fall on "Controlling rice losses to rodents in rural communities"

and L. A. Fiedler on "Rodent pest problems on experimental rice farms." Also, two panel discussions were held--one on "Chemical control status and strategies" and the other on "Rodent damage: how to systematically monitor the extent and cost of rodent losses." A tour of the IRRI research farm was conducted by the IRRI Farm Operations. The complete program is attached as Appendix 1.

The participants divided into two working groups and assumed the task of defining the major rodent damage problems and specifying appropriate long- and short-term actions or recommendations that might lead to solutions. The group drafted summaries that identify research gaps in rodent control in rice, outline strategies, and propose recommendations. (A draft Executive Summary and Recommendations is attached as Appendix 2.) On the fifth and last day, all summaries and a draft proceedings were completed; peer review and editing of papers and the proceedings were begun.

Papers presented by individual participants will be published in a session proceedings. These papers ranged from rodenticide trials performed more than 20 years ago, which still remain significant, to new approaches to biological rodent control.

After the formal program, we discussed areas of common interest between DWRC and IRRI with Drs. Lampe and Quick and agreed to consider development of a Memorandum of Understanding (MOU) between DWRC and IRRI to facilitate future cooperative rodent research. At present, IRRI research interest is encompassed by its project on engineering approaches to pest control; DWRC has broader interests and expertise in control methods development ranging from animal behavior to environmental assessment. Opportunities also exist for productive cooperation in technical information transfer.

IRRI has offered to play a coordinating role to bridge the gap between rodent researchers and donor organizations interested in developing effective rodent pest management programs in rice-based agriculture. This catalyst role is one that IRRI does well and could provide new impetus to developing and improving rodent pest management programs in rice-growing areas. Specific items recommended by the Expert Panel were for IRRI to coordinate establishing databases on (1) rodent research workers and (2) publications on rodent problems in rice.

One unanimous conclusion that arose from the presentations and discussions was that the best existing rodent control technologies are not being fully used by small farmers in many rice-growing regions. The reasons for this range from the simple lack of locally available rodent control materials for farmers to more complex reasons related to national agricultural policies. Greater emphasis on operational program management and extension of known rodent control technology as well as continued research efforts are needed to assist farmers so that they might increase rice production.

On September 17 we visited the AID/Manila Mission to summarize the IRRI meetings and discuss the current AID programs in the Philippines relative to DWRC interests.

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DWRC HILO FIELD STATION

Lynwood Fiedler also visited the Denver Wildlife Research Center (DWRC)/ Mammal Control Research Section field station at Hilo, Hawaii, to become familiar with on-going rodent damage control studies in sugarcane fields and macadamia nut orchards and to more closely coordinate DWRC's international rodent research efforts with those of this field station.

DWRC had a field station in Hawaii between 1967 and 1983. The primary objective of this cooperative project between DWRC and the Hawaiian Sugar Producers Association (HSPA) was to conduct research and develop methods for controlling rodent damage to sugarcane. The field station was closed in 1984, but it reopened in 1988 to resume rodent control research primarily in sugarcane but also in macadamia nut orchards. The former laboratory has been upgraded to meet current good laboratory practices and animal care and use guidelines. Several laboratory and field studies have already been completed or are in progress.

Rat damage in sugarcane fields was assessed with Dr. Mark E. Tobin, project leader, Mr. Robert T. Sugihara, biological technician (wildlife), and Miss Ann E. Koehler, biological technician (wildlife), using the "Point Distance Nearest Neighbor (PDNN)" method. The results of this study will be compared with yield data being collected from the same plots by HSPA personnel. Discussions also were held on current and future research work. Testing perimeter control methods such as fencing, baiting, and limited weed control or combinations of these to limit immigration of rats from adjacent gullies and uncultivated land would appear to be desirable. We also discussed the possibility of modifying the PDNN damage appraisal method so that only a 100-cm (or about one step) radius is used from a selected central point of a circle rather than the 150-cm radius currently used. The 150-cm distance requires taking a second step in at least four directions from the selected point to clear vegetation and to look for damaged stalks. The reduced radius would increase the number of points examined during the same time period and perhaps even improve the efficiency in locating damaged stalks that are difficult to find in the entangled, leaf covered, weedy mat of lodged cane which may be five stalks deep or more.

We visited a trapping study site at the Mauna Loa macadamia nut plantation and discussed rodent control options in the orchards. Variation of the crown-baiting technique used successfully to control rat damage to coconut in the Philippines may have applications to the macadamia nut problem. The damage patterns to coconut and macadamia nut by black rats (*Rattus rattus*) are similar in that rats move through the canopy of both coconut palms and macadamia nut trees. Baiting crowns of a percentage of the trees with rodenticides might target those rats damaging nuts and reduce costs in time and labor. The current trapping study will provide data on relative abundance, food habits, reinvasion potential, and nut damage trends which, in turn, might provide additional insight on the potential value of the crown-baiting method.

A summary of current research on rodent damage in Hawaiian sugarcane was recently published by Dr. Tobin in the California Vertebrate Pest Control Conference Proceedings [Tobin, M. E., et al. 1990. Rodent damage to Hawaiian sugarcane. Pages 120-123 in Proc. 14th Vertebr. Pest Conf. (L. R. David and R. E. Marsh, eds.), Univ. of California, Davis. 372 pp.] This laboratory and field project has made excellent progress in the first 18 months since the field station reopened.

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CONTACTS AND ACKNOWLEDGMENTS

International Rice Research Institute, Los Baños

Dr. Klaus Lampe, Director General

Dr. Graeme Quick, Head, Agricultural Engineering Division

Mr. Orlando Santos, Head, Farm Operations

National Crop Protection Center, Los Baños

Dr. Romulo Davide, Director

Dra. Melanda Hoque, Training and Extension Programs

U.S. Agency for International Development/Manila

Dr. Kevin A. Rushing, Mission Environmental Officer, Office of Rural and Agricultural Development (ORAD)

Mr. Barry Primm, Economist, ORAD

DWRC Hilo Field Station, Hawaii

Dr. Mark E. Tobin, Project Leader

Mr. Robert T. Sugihara, Biological Technician (Wildlife)

Miss Ann E. Koehler, Biological Technician (Wildlife)

Mr. Rodney G. Medeiros, Biological Aide (Wildlife)

PROGRAM

Rodents and Rice

Expert Panel Meeting on Rice Rodent Control

Seminar Room, Chandler Hall
10 – 14 September 1990

International Rice Research Institute
P.O. Box 933, 1099 Manila, Philippines
Los Baños, Laguna, Philippines

Program

8 and 9 September

Arrival of participants
Check-in at IRRI Guesthouse

10 September, Monday

0800H Seminar Room, Chandler Hall.
Opening Program. Introductions,
Outline of Local Arrangements,
Meeting Objectives ..... *Dr. Graeme R. Quick*
Convenor

0815H Formal Opening. Welcoming Remarks ..... *Dr. Klaus J. Lampe*

0830H MORNING SESSION (SESSION ONE)
Introduction and welcome
on behalf of host nation ..... *Jesus P. Sumangil*
Morning Session chairman

0835H **Keynote Address— Rodent Control:**
The Need for Research ..... *Dr. Ishwar Prakash*

0920H **Controlling Rice Losses to Rodents:**
Field, Storage, Research Areas and
Rural Communities ..... *Dr. Mike Fall*

1000H Picture taking; morning break

1030H **Societal Impact of Rodents**
in Rice Agriculture ..... *Dr. Norman Gratz*

1035H **Rodent Control Management Lessons**
from Program Successes and Failures ..... *David C. Drummond*

1145H Group discussion on morning session

1200H Lunch: Executive Dining Room

1315H Briefing for field trip: **Rodent Problems**
in Rice Field Research ..... *Graeme Quick*
Convenor

Appendix 1

1330H Field Trip.
Tour of IRRI Research Farm ..... *O. G. Santos*
Commentator.

Stops for discussions of exhibits with Farm Manager, Rodent Control Supervisor; NCPC Scientist *Dr. M. Hoque*, and Agricultural Engineers. Then visit Cargill Research Farm and one area farmer who uses a lethal rat barrier, Bay, Laguna.

1630H **Experience on Rodent Control in the Philippines** ..... *J. P. Sumangil*

11 September, Tuesday

0800H PLENARY SESSION TWO ..... *Dr. K. L. Heong*
Chairman

0805H **Ricefield Rodent Population Dynamics** ..... *Okimasa Murakami*

0835H **Ricefield Rodent Control in SE Asia and Associated Aspects of Population Dynamics and Ecology** ..... *Brian Wood*

0900H **Rodent Habitat Manipulation** ..... *Dr. Bruce Colvin*

0930H Morning break

1000H **Cultural Control of Rice Field Rats** ..... *Y. M. Lam*

1035H **Rice Rodent Epidemiology, Speciation and Behavioral Aspects** ..... *Dr. Lim Boo Liat*

1110H **Biological Rodent Control, Past and Future** ..... *Dr. Grant Singleton*

1145H Group discussion on morning session

1200H Lunch (Executive Dining Room)

PLENARY SESSION THREE ..... *Dr. Paul Teng*
Chairman
IRRI IPM Coordinator

1330H **Community/Government Motivation and Extension Methods for Successful Rodent Control** ..... *Dr. William B. Jackson*

1400H **Recent Developments in Rice Rat Control** ..... *Dr. Alan P. Buckle*

1430H Panel Discussion on Chemical Control Status and Strategies ..... *Dr. Jim Litsinger*

1500H Afternoon break

1515H **Economic and Community Aspects of Rodent Damage and Control** ..... *Heimo Posamentier*

1545H **Rodent Problems and Control on Tropical Experimental Rice Farms** ..... *Lynwood Fiedler*

1615H Group discussion on **Rodent Control Programs; Agency-operated or agency supported programs** ..... Chaired by *Heimo Posamentier*

1900H Official Dinner at IRRI Guesthouse

12 September, Wednesday

0800H Working Groups:
Specifying appropriate and effective research and rodent control programs.
Convenor outlines assignments for Two Working Groups. Two working group leaders, *H. Posamentier* and *L. Fiedler*, (Rapporteurs *Dr. Terry Woodhead, Dr. Mike Fall*) nominate group members, and direct respective groups. Groups are to develop strategies to address such issues as: What are the gaps in research? Who Can Do What, When and Where? Both groups work contemporaneously on the same issues, then pool their findings later.

0845H Divide into two Working Groups.

1200H Lunch (Executive Dining Room)

1330H Panel session.
Rodent Damage: How to systematically monitor the extent and cost of rodent losses.
Participants include *Wood, Benigno, Fall, Singleton, Lim, Buckle, Posamentier* ..... *Dr. Terry Woodhead*

1415H Resume Two Working Group Activities

13 September, Thursday

0800H Donor perceptions of Priorities on Rodent Control. A Panel Group.

0845H Working Groups Resume:
Followup: Analyses of Donor Perceptions.

1100H Working Groups prepare/consolidate their respective findings ready for presentation by their respective spokesman.

1200H Lunch (Executive Dining Room)

1330H Working groups reconvene and group leaders present summaries of outcome of working group sessions..... *Dr. Terry Woodhead*
Chairman of afternoon session
IRRI Agricultural Engineering

1430H Wrap-up Session.
Convenor: **Specifying appropriate and effective research and control programs.**
Outlining strategies, future programs.
Preparations needed for support from appropriate agencies. Funding requirements in relation to current donor activities.
Draft proposals.

1500H Working Break
Close of formal part of Expert Panel Meeting.
Convenor presents Technical Summary Statement.
Presenters briefed for IRRI Thursday Seminar, in which selected panelists provide a seminar to the general audience which attends IRRI Rice Research seminars

1600H IRRI Rice Research Seminar **Rodents and Rice** (The Regular Thursday Seminar), Chandler Hall Auditorium. *Dr. Lampe* introduces panelists and outlines what the "Rodents and Rice" meeting has been about.
Panelists' presentation for 30 minutes.

1640H Discussion from the floor

1650H **Closing remarks and farewell** ..... *Dr. K.J. Lampe*
Director General

1700H Program Concluded

14 September, Friday

Informal discussions. Preparations of **Rodents and Rice Monograph** arising from this meeting. Editing contributions and refining the recommendations with convenor.
Staff visits.

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F. Lanting
H. T. Manaligod
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G. R. Quick
(meeting convenor)

DRAFT

EXECUTIVE SUMMARY

In many parts of the rice world, rodents are the worst pests faced by farmers. Crop losses to rodents often exceed the combined losses of all other pests of rice. Rodents also consume and contaminate stored food in homes and storage areas and are reservoirs of diseases transmitted to humans and domestic animals. Efforts to control rodents by farmers have included such drastic measures as poisoning irrigation water, clearing or burning unfarmed areas that serve as refugia for rodents and other wildlife species, or using devices such as direct line electric fences that have killed humans and livestock. Otherwise productive areas are sometimes abandoned. Although accurate economic estimates are not available, there is high potential for increasing food availability and improving the quality of rural life by developing effective rodent control programs.

Research in a number of countries during the past 20 years has substantially improved our knowledge of the ecology and control of a number of rodent species that damage rice. Such work has highlighted the importance of an understanding of the ecology of each rodent species in relation to farming practices and the need to examine the economic and social constraints that face farmers and rural communities. Despite technical successes in some regions, sustainable rodent control programs for farms and villages and a wider knowledge of important research findings have yet to be developed. Clearly, the time has come for greater efforts to make rodent control an essential part of the package of rice technology delivered to farmers and to apply the principles of integrated pest management (IPM) to designing sustainable programs. Agricultural production packages that exclude rodent control are incomplete and may lack credibility at the farm level.

From September 10-14, 1990, IRRI assembled an international panel of experts, with broad experience in rodent control, to squarely face all aspects of the problems that rodents cause throughout the rice world. Since its founding, IRRI has had a continuing problem with rodents and has expended considerable effort and funds to protect valuable experimental plots and unique rice varieties from constant rodent depredations. These problems served to catalyze IRRI's interest in the broader world problem of rodent damage. The expert panel was asked to examine prospects for short-term and long-term solutions to rodent damage and to suggest approaches to reduce losses on agricultural experiment stations, in farmers' fields, and within rural communities.

The meeting was stimulating and productive. Papers presented by the panel members served as a focal point for interesting and enthusiastic discussions. These papers summarized research efforts, described programs, identified problems with the extension of rodent control technology, and outlined some new work such as biological and mechanical control that may lead to more effective ways to reduce rice losses. Follow-up discussions and brainstorming sessions focused on specific issues.

Effective control measures are available for some of the major pest species, but progress in implementing control programs has been slow and poorly supported. In many cases, the need to increase the emphasis on effective organization and management of operational control programs and to develop means to market rodenticides in rural areas is of critical importance. Innovative extension efforts are needed to help farmers realize the benefits of improved rodent control. Continuing research efforts are required to adapt control programs to other problem species; to assure that rodent control programs can be conducted without harmful environmental impacts; and, ultimately, to develop technology based on IPM principles that relies less on the use of rodenticides alone for effective damage control.

The most important outcome of the meeting was a series of recommendations. These were drafted as guidelines for action by policy makers in national governments and donor organizations. They range from improving coordination and communication among scientists addressing these problems, to developing better worldwide loss data, to increasing public awareness of rodent damage and associated health problems. Given the threats to the rice world from rodents and the clear opportunities to increase rice yield and improve rural health by effective rodent control, this meeting was timely and important. If the recommendations are acted upon, the monetary and health benefits that may be credited to this week of exciting and stimulating discussion at IRRI will be incalculable.

RECOMMENDATIONS

DRAFT

The impact of rodents on rural societies through crop and storage losses, structural damage, and the transmission of disease requires the concerted action of scientists, national governments, and international organizations. Opportunities exist in many countries to increase rice yields through improved rodent control and to lessen the deleterious environmental impacts sometimes associated with emergency control efforts by farmers. By applying the principles of Integrated Pest Management (IPM) to designing rodent control strategies, by fostering better use of existing technology for rodent control, and by supporting efforts to develop alternatives that require less reliance on rodenticides, the rice world can make positive gains in developing sustainable plant protection programs that minimize adverse impacts on rice agroecosystems. These recommendations by the IRRI Expert Panel on Rice Rodent Control provide guidance for coordinated action programs by national governments, donor organizations, and others concerned with realizing the full potential of crop production to feed the world's growing population.

1. COORDINATION

There is a pressing worldwide need for international coordination on all aspects of rodent control in rice-based agriculture. The present situation is one of fragmented and even declining activity. The International Rice Research Institute (IRRI) should expand its existing databases to include key elements related to vertebrate pests of rice. In addition IRRI should take a lead role in coordinating and catalyzing activity in the following areas:

- providing policy advice to national governments
- assisting in donor intervention on priority crop damage problems in rice-based agriculture
- assisting national programs to maintain momentum and improve effectiveness

2. NATIONAL POLICY ADVICE

In many parts of the rice world, coordinated rodent control strategies are unknown or dimly perceived, standard rodenticide evaluation procedures are lacking, and means for farmers to access materials and information on safe and effective use are inadequate.

This situation needs to be corrected by improving the information base on rodent damage available to policy-makers, developing packages of targeted national recommendations to make crop protection a routine part of agricultural production, providing policy advice and guidelines for rodenticide registration, and facilitating private sector networks to make essential materials available to rural communities. Policy-makers within national agencies and regional and international donor organizations should recognize the continuing critical need for resources to prevent losses to rodents. The international donor community should take a proactive role so that rodent outbreaks and chronic losses are forestalled by careful management rather than addressed in periodic emergency programs.

3. DONOR INTERVENTION

There are many potential sources of assistance, financial and material, which might be available to address problems if agencies were approached systematically with sound proposals. Interested organizations or government bodies should be supported in their efforts to access such international assistance by establishing mechanisms for coordinating the efforts of donors. IRRI and other international research centers that already provide forums for donor coordination should assume a greater role in providing information, technical advice, and direction for international assistance to improve rodent control efforts in rural areas.

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4. MAINTAINING PROGRAM MOMENTUM

There are continuing problems with the lack of continuity of international initiatives for rodent control research and operations, and with the slow processes by which the findings from such efforts become widely known to key users. To resolve such problems related to rice-based agriculture, IRRI should establish a small technical steering committee to assist coordination among such efforts, determine when meetings or workshops are needed, provide or arrange provision of technical advice when requested, and develop a monograph of current knowledge to serve as a benchmark document for future action.

5. PROJECT EVALUATION

More thorough evaluation of the impact of completed rodent control assistance projects needs to be made. It is critically important that appropriate methods are used to identify key elements related to success and that such information is widely disseminated for use in planning future assistance programs. Organizations conducting operational programs or providing assistance should consider incorporating elements for post-implementation evaluation studies. IRRI and other technical coordination organizations should develop guidelines for protocols that might be used for such assessments.

6. SUPPORT FOR RESEARCH

At least 20 species of rodents are important pests in rice-based agriculture worldwide. Even the same species may have widely differing behavior under differing ecological conditions. Basic information is still needed for many of these problems. Continued, intensified biological research is needed worldwide, but the necessary priority studies vary by species, region, and cropping system. More research emphasis needs to be placed on evaluating pilot schemes for integrated control and sustainable systems to transfer information, technology, and materials to farmers.

The dynamic nature of pest problems requires support and training for scientists in national programs who can adapt new developments in rodent control to changing local problems. IRRI and other coordinating organizations should work to obtain increased, stabilized support for such efforts and should assist funding agencies in identifying research priorities.

7. LOSS ASSESSMENT

Although loss assessment methods are available for some rodent damage problems, no coordinated effort has been made to compare methodologies, adjust them for differences among species or crops, or develop estimates of impact on storage losses and rural health. Many published estimates of losses are statistically unsound. Coordinated efforts are needed to obtain better loss assessment data worldwide – not only on the impact of rodent damage on standing crops, but also on post-harvest goods, on structures such as irrigation systems and buildings, and on public health. IRRI and other technical coordination organizations should help guide and support such efforts to facilitate policy-making and implementation of economically realistic and environmentally safe control programs.

8. TECHNICAL BACKSTOPPING AND FOLLOW-UP ASSISTANCE

Access to specialized facilities and know-how in developed countries should be made easier for existing national organizations worldwide. Current emphasis by donor organizations on large assistance projects makes some of the critical sources of information and technical assistance inaccessible when no project exists. A range of organizations (universities, research institutes, museums, and the private sector) should be identified and supported to provide long-term technical backstopping.

Rodent control is not only a technical but even more of an organizational challenge, which takes time to implement, follow through, and monitor. It is particularly important that donor-assisted projects plan for

modest follow-on support after termination of major programs to supply national organizations with the latest technical information, enable participation in seminars and workshops, and supply low-cost critical materials for program maintenance. International centers, such as IRRI, should assess the feasibility of assuming a greater international role related to such needs in rodent control and should help identify means to assure that effective national programs can sustain their effectiveness.

9. EXTENSION

Extension efforts or other forms of information transfer designed to make rural families aware of the serious losses and health impacts caused by rodents have been inadequate. Existing technology for protecting susceptible crops from rodents has not been easily accessible to farmers in many parts of the world. Better ways are needed for bringing rodent control information and materials to farmers, making full use of all available media resources for motivation and information transfer. In addition, extension services need adequate support (facilities, equipment, and transport) to assure that research results and new technical developments are incorporated in programs for farmers. In many areas the role of women in rice farming could be pivotal to achieving success with rodent control efforts; extension services should give increased attention to the potential roles of women and even of children in devising means to increase community involvement in rodent control. Investigation and validation of new approaches, augmentation of successful rural extension programs to include information on rodent problems, international coordination, and more rapid dissemination of technical information are all needed. IRRI and other coordinating organizations should examine the feasibility of taking a larger role on bringing more effective information transfer techniques to bear on the problem of reducing rodent damage.

10. RESEARCH FARMS

Like other activities on research farms, the purpose of rodent control programs should be to facilitate essential research. Operational activities should address the needs of researchers and should, ideally, never dictate research schedules. Well managed and centrally coordinated rodent control programs on research farms are best implemented by designating trained rodent control managers to coordinate operations; establishing predetermined tolerance levels for rat infestation in consultation with researchers; and developing IPM strategies that encompass the entire farm environment, taking appropriate account of the behavioral and ecological characteristics of local pest species. Detailed, site-specific rodent control specifications and operating plans should be developed and used to guide essential activities. Monitoring of farm infestations should be incorporated to provide ongoing assessment of program effectiveness. Appropriate emphasis should be placed on staff training and worker safety. Cooperative efforts to reduce rodent infestations on adjacent properties may make the job of protecting research plots less costly and more effective.