PD-ABL-081

CHAD RODENT CONTROL RESEARCH PROJECT*

Government of Chad Ministry of Agriculture,
U.S. Agency for International Development,
and
USDA/APHIS/S&T Denver Wildlife Research Center

Progress Report

1989-1991

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Unpublished Report

October 1991

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* This work was conducted with funds contributed to the U.S. Department of Agriculture (USDA)/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 "Africa Emergency Locust/Grasshopper Project," PASA AFR-0517-P-AG-2042-00.

PROGRESS REPORT
1989-1991
CHAD RODENT CONTROL RESEARCH PROJECT
A MINISTRY OF AGRICULTURE/U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
AND USDA/APHIS/S&T/DENVER WILDLIFE RESEARCH CENTER PROJECT

EXECUTIVE SUMMARY

Rodent population sampling was initiated by the Chad Rodent Control Research Project (CRCRP) in October 1989 in dune and wadi agricultural sites near N'Gouri. In August 1990, sampling was begun in recessional agriculture at Karal, near Lake Chad. Population sampling was done approximately monthly at these sites since then.

The dominant rodent species on wadi agricultural sites is the unstriped grass rat or Nile rat (*Arvicanthis niloticus*), although Anderson's gerbil (*Gerbillus andersoni*) and the fringe-tailed gerbil (*Tatera robusta*) may be present in small numbers. *G. andersoni* predominates on dune sites, where millet is extensively grown. At Karal, the predominant rodent species are *G. andersoni*, the multimammate rat [*Praomys* (=*Mastomys*) *natalensis*], and mice (*Mus* species).

Population densities of all species declined sharply from October 1989 until March 1990. Rodent densities have remained low since that time, probably because the rainfall in August 1990 was not sufficient to stimulate population recoveries. These extremely low densities appear to be the low point in the rodent population cycles. Due to such low densities, rodent captures have been too few from which to draw conclusions on reproductive activity and recruitment of young into populations. It appears the animals may be maintaining themselves through "trickle" breeding.

Bait preference trials, using *A. niloticus* and *R. rattus* (a house or village rat in Chad), revealed that millet was preferred over maize, sorghum, rice, and wheat.

The limited testing of the toxicity of zinc phosphide for *A. niloticus* and *P. natalensis*, carried out in October 1990, agrees with the findings of others in published literature (Suliman et al. 1984; Gill and Redfern 1979) that these species are quite susceptible to a 2% concentration or less of the poison in baits.

Training of Chad Ministry of Agriculture (MOA) personnel in rodent research and control methods was done by several Denver Wildlife Research Center (DWRC) scientists on TDY visits in 1987, 1989, and 1990. In-service field and laboratory training of MOA counterpart staff has been done by the Project Leader since his arrival in July 1990. Project personnel presented a 2-day workshop to 18 MOA Crop Protection technicians on November 26-27, 1990. Included in this workshop were presentations on rodent identification, biology, ecology, data collection and population monitoring. Ten issues of "Rat Facts," a one-page informational sheet concerning the CRCRP, have been distributed to Chad/MOA, AID/N'Djamena, and DWRC personnel since September 1990.

INTRODUCTION

The Sahelian region encompasses about 20 percent of Africa and includes portions of nine African nations, with a population of about 30 million people (Indicateurs Demographiques et Socio-Economiques des Pays Membres du CILSS--1989). The Sahel previously was a major food-producing area for northern Africa. But, because of droughts and crop depredations by birds, rodents, and insects, the Sahel now is a food-deficit region (FEWS Bull. No. 13/90, January 30, 1991).

Periodic rodent irruptions, such as those of 1962, 1977, and 1986-87 (Fiedler 1987, Trip Report), probably have occurred in the Sahel for centuries. Although Sahelian rodent outbreaks often have been widespread and have severely reduced food production, these phenomena have been poorly documented and seldom studied. Even the major rodent pest species involved in crop depredations often have not been identified, nor have their reproductive biology or basic population dynamics been determined. Methods to quantitatively assess rodent damage to selected Sahelian agricultural crops, most notably vegetables, have not been developed. Rodent control methods have not been thoroughly evaluated under Sahelian conditions.

Nineteen consultations by APHIS/DWRC personnel to Sahelian countries were conducted from 1987 through 1991 (see Appendix I). These consultations were undertaken primarily because of the 1986-87 rodent irruption and because of a lack of knowledge concerning rodent pests in the Sahel. The trip reports for each of these consultations are cited and briefly summarized (see Appendix II). Nine of these consultations were made to Chad to initiate or implement the CRCRP, which is a cooperative program between the Chad MOA/Crop Protection Service (CPS), U.S. Agency for International Development (USAID)/Agricultural Development Office, and the USDA/APHIS/S&T/DWRC. Funding is provided by the USAID/Africa Bureau under the Africa Emergency Locust and Grasshopper Assistance (AELGA) Project. Systematic field sampling of rodent populations for this Project was initiated by Dr. John Wilson in October 1989. The Project was fully implemented with the arrival of the Project Leader, Dr. J. Juan Spillett, in July 1990.

This report presents the objectives of the CRCRP, outlines study methods, and reviews accomplishments through mid-1991, as related to the stated objectives. Activities, including additional consultations needed to accomplish objectives, and reasons for an extension are discussed.

OBJECTIVES

The general objectives of this technical assistance, according to the Participating Agency Service Agreement (PASA), are to begin to (a) determine the life cycles of the major rodent pests of the Sahel; (b) evaluate the efficacy and appropriateness of alternate control methods; and (c) prepare training materials on rodent biology and control for use by

the National CPS. The specific activities to accomplish these objectives can be categorized as follows:

A. Develop effective, safe, economical, and acceptable rodent control measures to protect crops.

1. Rodent Pest Identification - Identify and prioritize major rodent pests involved in crop depredations in selected dryland and recessional areas in the host country and the Sahel.

2. Rodent Population Dynamics - Begin to develop methods to assess chronic rodent populations for comparison with periodic rodent irruptions.

3. Rodent Crop Damage - Begin to assess the economic importance of damage to principal agricultural crops.

4. Rodent Control Techniques - Conduct basic studies to test efficacy, cost-effectiveness, and cultural acceptability of various known rodent control techniques.

B. Provide training and begin to develop guidelines for a long-term rodent control strategy.

1. Train Ministry Personnel - Provide on-the-job training to Chad MOA/CPS personnel involved in the rodent project.

2. Present Seminars/Workshops - Present seminars, as requested, and conduct one workshop for CPS technical personnel; begin to develop materials for a training manual.

3. Project Reports - Submit project reports and study results to USAID and MOA.

4. Rodent population Monitoring and Control - Begin development of recommendations for a long-term rodent control strategy in priority crops.

C. Organize laboratory and office space and facilities; obtain equipment and supplies.

METHODS AND RESULTS

A. Develop effective, safe, economical, and acceptable rodent control measures to protect crops.

1. Rodent Pest Identification

a. N'Gouri Area - Rodent sampling sites were selected in late 1989 in typical "wadi" and "dune" cultivations in the N'Gouri area,

approximately 230 km northwest of N'Djamena. Wadi cultivation is the labor-intensive irrigation and cultivation of onions, tomatoes, peppers, okra, manioc, sorghum, and millet in scattered, small (< 5 ha) oases. Dune cultivation is the extensive dryland farming of millet on dunes or sandy hills surrounding the wadis. Both cultivations are done entirely by hand.

Rodent sampling was initiated in October 1989 and trapping was done approximately monthly thereafter. One wadi site was added in June 1990 and two others in July 1990. Animals were trapped on linear transects with 25 stations (one rat snap trap at each station) at 10-m intervals. Four transects were set in each wadi (i.e., NC = Noncultivated Margin, NI = Noncultivated Interior, CC = Cultivated Margin, and CI = Cultivated Interior) each month (Fig. 1). Two other transects (25 stations with one rat snap and one mouse snap trap at each station) were set on adjacent dune areas (i.e., CE = Cultivated Exterior and NE = Noncultivated Exterior). The CE and NE data were combined with the dune trapping data. Small (15-20 mm^2) pieces of cardboard impregnated with peanut oil were used for baits, following the suggestions of Dr. Wilson during his 1989 visit.

Three dunes were sampled monthly beginning in November 1989; one more dune site was added in July 1990. Two linear transects of 50 stations, using mouse snap traps set at 10-m intervals, were set on each dune.

Trapped rodents were identified to species, and data were recorded of sex, weight, body measurements, age class (immature or adult), and reproductive condition on each animal.

A. niloticus (73%) was found to be the dominant rodent species on wadi sites, followed by *G. andersoni* (16%) and *T. robusta* (9%). We could not identify 2% of the animals (Fig. 2). *G. andersoni* (91%) predominated on dunes, followed by *A. niloticus* (3%), and 6% other or unidentified animals (Fig. 3).

b. Karal Area - Rodent population sampling was initiated in August 1990 on "recessional" agricultural crops or adjacent vegetative types in the Karal area, south of Lake Chad and approximately 130 km north of N'Djamena. Recessional agriculture is the planting of crops on lands that are flooded each year by the rising waters of Lake Chad as a result of the rainy season. As the waters recede and the lands dry, rice, corn, sorghum, millet, cow peas, peanuts, manioc, okra, sweet potatoes, water melon, cantaloupe, gourds, and tomatoes are planted.

Rodent populations were sampled in different crop types and in adjacent vegetation types with linear transects of 25 stations (one rat snap and one mouse snap trap at each station) spaced

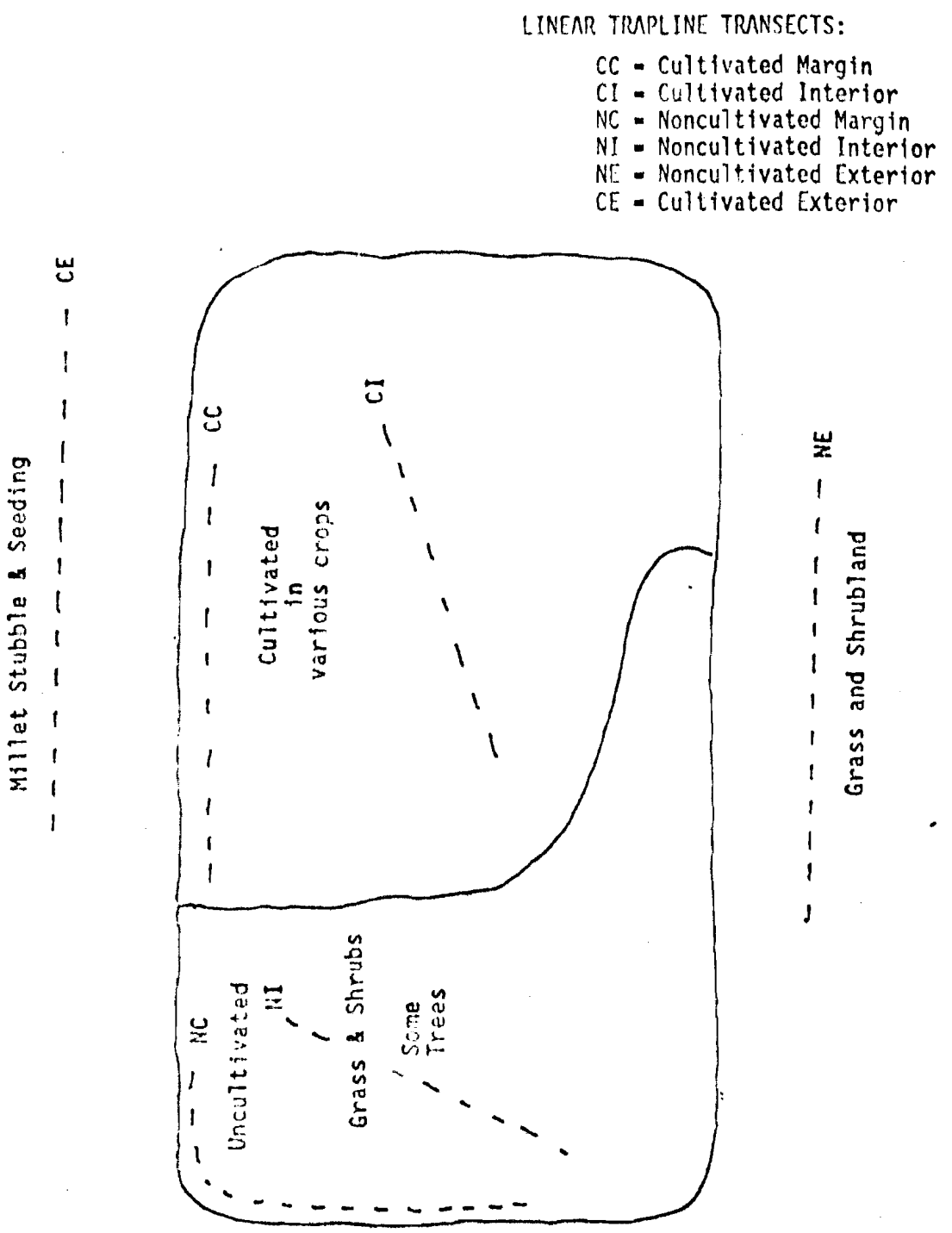

Fig. 1. Typical locations for six linear trapline transects used to sample rodent populations at approximately monthly intervals on each wadi study site in the N'Gouri, Chad, area.

Note: Data for rodents trapped on transects outside (CE and NE) of the wadis are included with that for rodents trapped on dune sites.

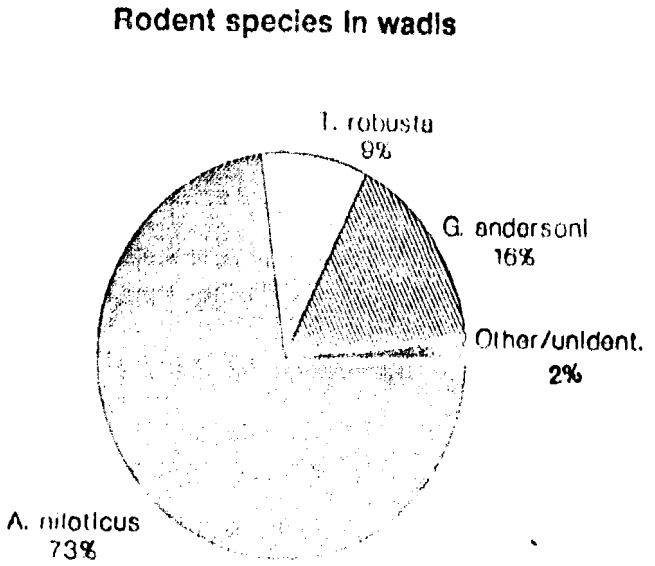

Fig. 2. Rodent species trapped from wadis near N'Gouri, Chad.

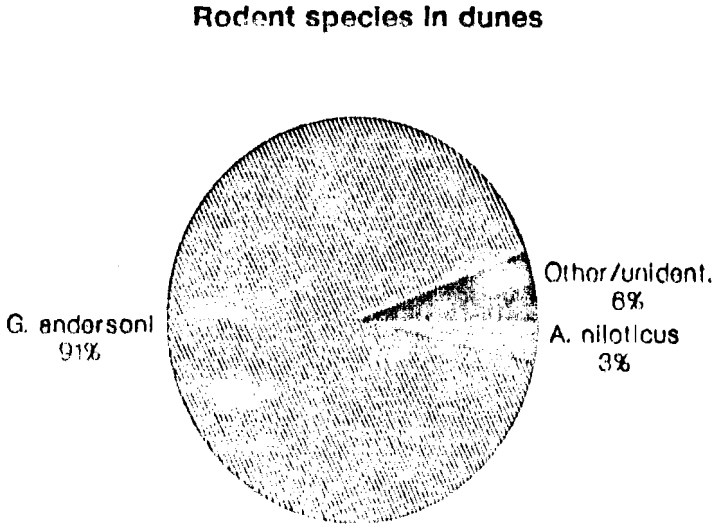

Fig. 3. Rodent species trapped from dunes near N'Gouri, Chad.

10 m apart. Data were recorded for trapped rodents as was done in the N'Gouri area.

G. andersoni was found to be the dominant rodent species (39%), followed by *P. natalensis* (30%), and *Mus* species (30%). One rodent was not identified (Fig. 4). *G. andersoni* was associated primarily with noncultivated sandy areas, *P. natalensis* with sweet potatoes and peanuts, and the *Mus* species with sweet potatoes.

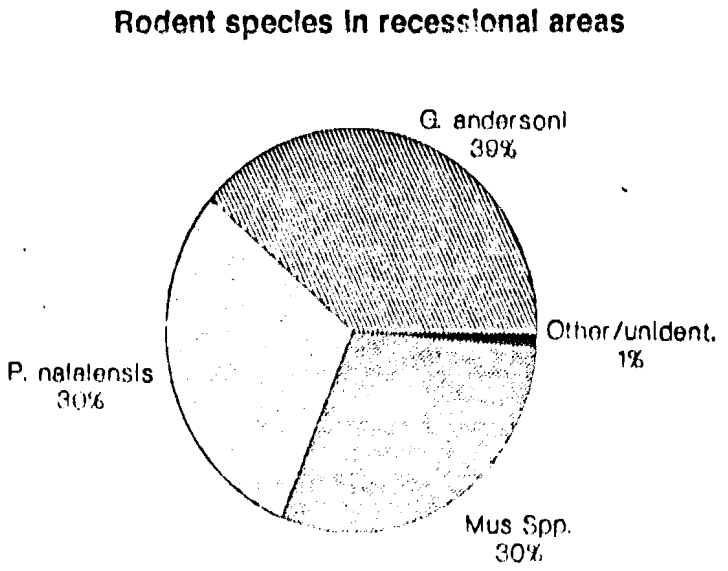

Fig. 4. Rodent species trapped from recessional agricultural areas near Karal, Chad.

c. Other Areas - Limited sampling was done in the MOA's horticultural farm about 20 km southwest of N'Djamena in October 1990. Rodents captured in dense grass around fruit trees and along fence rows were primarily *A. niloticus*, but a few *R. rattus* also were captured.

Traps were set on the MOA's Gassi Seed Farm about 16 km south of N'Djamena in November 1990. *P. natalensis* predominated, although a few *G. andersoni* also were taken. This site is only a few kilometers from the horticultural farm, but is across the Chari River. Of interest is the sharp difference in rodent species composition from the two areas.

2. Rodent Population Dynamics

a. Age Structure - Each trapped rodent was classified either as "adult" or "immature" based upon its size and reproductive condition. Population age structure changes for dominant rodent species that were trapped in wadis and dunes near N'Gouri are presented in Figs. 5 and 6.

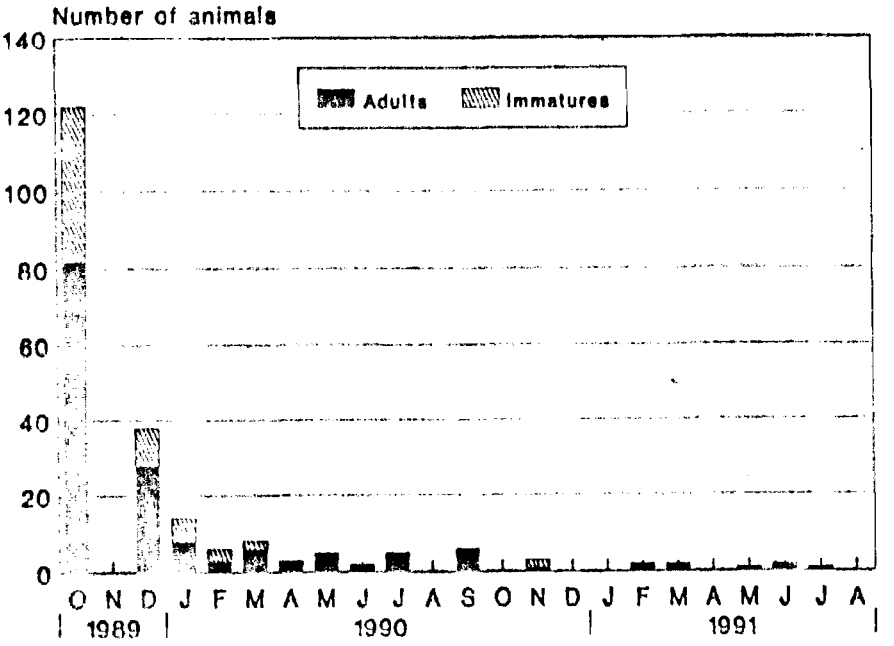

Fig. 5. Age structure of *Arvicanthis niloticus* in the N'Gouri area.

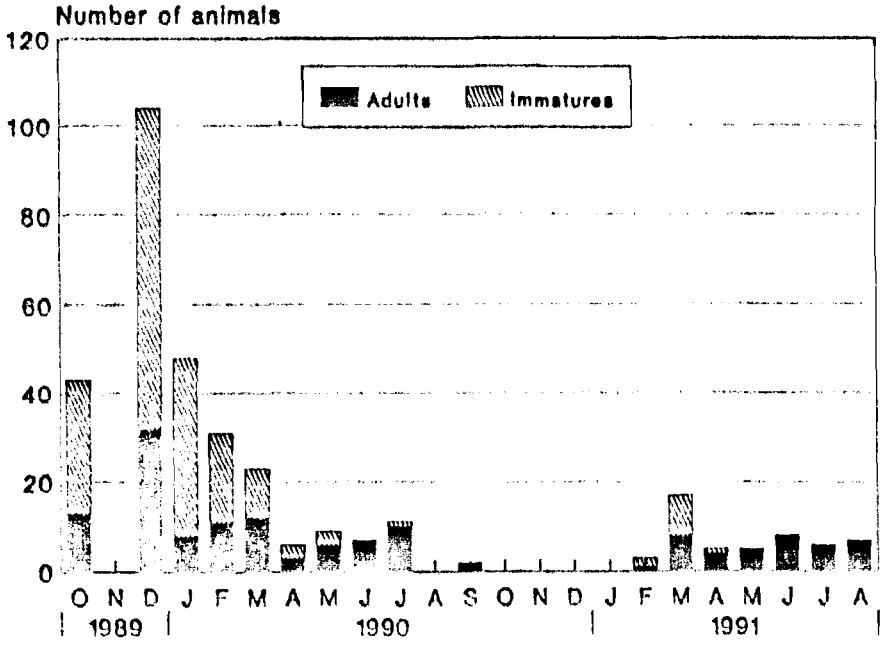

Fig. 6. Age structure of *Gerbillus andersoni* in the N'Gouri area.

These data indicate that breeding in both *A. niloticus* and *G. andersoni* continued for 4-5 months following the end of the rainy season in early October 1989. A few immatures of *G. andersoni* were seen after March 1990, suggesting there may be a low level of breeding during the balance of the year within this species.

Age structure data for rodents trapped in recessional agricultural areas are based only upon small samples. It is interesting to note that none of 23 *P. natalensis* trapped were immature. Four immature *G. andersoni* were seen in the October and November 1990 sampling periods. Immature *Mus* sp. were found in each sampling period (Table 1).

Table 1. Age structure for rodent species trapped in recessional agricultural crops in the Karal area, Chad.

Sampling dates	Species*	Adult	Immature	Unknown
Aug/Sep 1990	Ga	19	0	1
	Pn	14	0	2
	Msp	4	3	0
Oct/Nov 1990	Ga	9	4	0
	Pn	5	0	0
	Msp	5	6	0
Feb/Mar 1991	Ga	1	0	0
	Pn	1	0	0
	Msp	0	1	0
Apr/Jun 1991	Ga	2	0	0
	Pn	2	0	0
	Msp	1	1	0
Jul/Aug 1991	Ga	1	0	0
	Pn	1	0	0
	Msp	2	2	1

* Ga = *G. andersoni*, Pn = *P. natalensis*, Msp = *Mus* species

b. Reproductive Indices - Adult females in trapped samples were necropsied to determine pregnancy. Embryos were counted and classified by relative size (i.e., "Early-term" = small, but producing a discernable distention of the uterine horn; "Mid-term" = an obvious distention of the uterine horn, but no fetal features apparent; "Late-term" = large, fetal form apparent).

Reproductive data for adult female *A. niloticus* and *G. andersoni* trapped in wadi and dune sites in the N'Gouri area between October 1989 and November 1990 are presented in Table 2. These data indicate that both species were in a breeding phase into December 1989, but sample sizes thereafter are so small that definite conclusions can not reliably be made. The presence of some pregnant females essentially throughout the year suggests that reproduction may continue when good quality food is available. Mean numbers of embryos for pregnant *A. niloticus* were 7.1, and 5.1 for *G. andersoni*.

Table 2. Reproductive condition and embryo numbers in female *A. niloticus* and *G. andersoni* trapped from wadi and dune sites near N'Gouri.

Sampling dates	Species	Pregnant	Nonpregnant	Mean No. embryos
Oct/Dec 1989	An	20	26	7.0
	Ga	19	11	5.2
Jan/Mar 1990	An	2	3	7.0
	Ga	3	6	4.3
Apr/Jun 1990	An	2	3	6.5
	Ga	3	1	4.0
Jul/Sep 1990	An	4	1	8.0
	Ga	1	1	7.0
Oct/Dec 1990	An	0	0	-
	Ga	0	0	-
Jan/Mar 1991	An	1	3	17.0
	Ga	2	7	3.5
Apr/Jun 1991	An	0	3	-
	Ga	0	17	-
Jul/Aug 1991	An	0	1	-
	Ga	2	11	6.0

Reproductive data for adult *G. andersoni*, *P. natalensis*, and *Mus* sp. trapped in the Karal area between August 1990 and August 1991 are presented in Table 3. Samples sizes of adult females are small, but breeding was seen in all three species during the last half of 1990. Further, there were immature *Mus* sp. in each monthly sample during that period. There has been no evidence of pregnancy during 1991, but the samples have been too small to draw conclusions.

Table 3. Reproductive condition and number of embryos for female *G. andersoni* (Ga), *P. natalensis* (Pn), and *Mus* sp. (Msp) trapped near Karal, Lake Chad.

Sampling dates	Species	Pregnant	Nonpregnant	Mean No. embryos
Aug/Sep 1990	Ga	7	4	5.4
	Pn	8	1	10.5
	Msp	0	2	-
Oct/Nov 1990	Ga	3	3	5.3
	Pn	1	2	5.0
	Msp	1	0	5.0
Feb/Mar 1991	Ga	-	-	-
	Pn	-	-	-
	Msp	0	1	-
Apr/Jun 1991	Ga	0	1	-
	Pn	0	1	-
	Msp	0	1	-
Jul/Aug 1991	Ga	-	-	-
	Pn	-	-	-
	Msp	0	3	-

c. Relative Density Indices - It was thought once-per-month sampling on wadi and dune sites might be further reducing rodent populations following the dramatic population declines in early 1990. Therefore, additional wadi and dune sites, not trapped before, were trapped from June or July through November 1990. Essentially, the trapped samples from these new sites were no different than the samples from the original sites, indicating that trapping monthly was not depleting the populations. The percentage of trapping success for both wadi and dune sites remained relatively high from October 1989 until March 1990. It then dropped sharply and has remained consistently low throughout the remainder of 1990 (Fig. 7).

Six of the original eight wadi sites were treated with rodenticide (chlorophacinone) by MOA/CPS personnel in late December or early January 1990. However, there were no appreciable differences in the percentage of trapping success between treated and untreated sites thereafter. Rodent populations on all study sites, including treated and untreated wadis as well as dunes, markedly decreased with the onset of the hot, dry season in 1990.

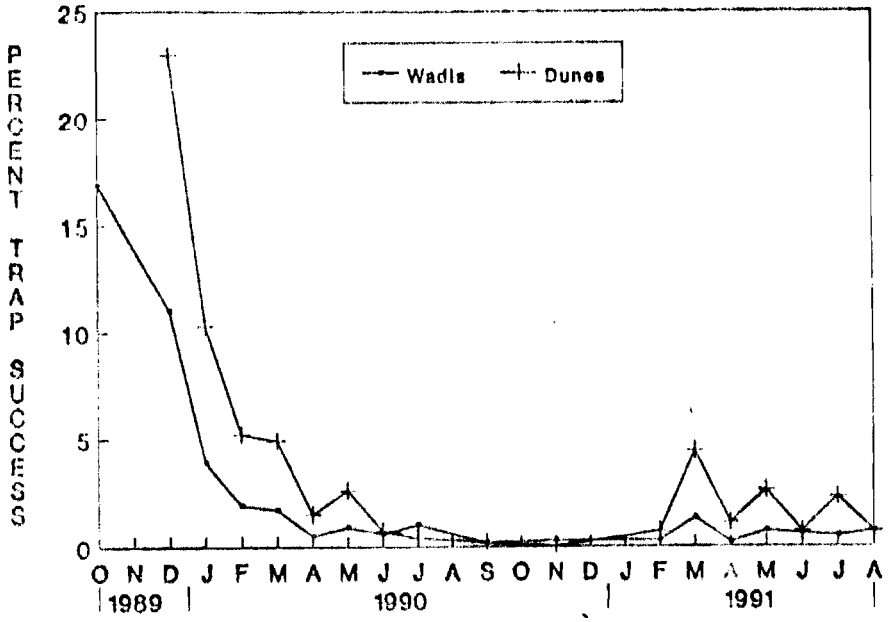

Fig. 7. Percentage of trapping success for rodents in wadi and dune sites near N'Gouri, Chad.

A total of 588 rodents was captured from wadis near N'Gouri during the period October 1989 until August 1991. Most of the captures occurred in the period October 1989 through March 1990 (Fig. 8). A total of 167 rodents was captured from dunes in the period December 1989 until August 1991. Again, most of these were captured by March 1990 (Fig. 9). These data demonstrate that rodent population densities for *A. niloticus* and *G. andersoni* on both wadi and dune sites declined dramatically with the onset of the hot, dry season or after the demise of green or luxuriant vegetation. Population densities then remained relatively constant--even through the short 1990 rainy season in late July and early August. The annual rainy season in the N'Gouri area normally occurs between late July and early October. However, only a few light rains occurred in late July and early August 1990. There were no rains after August 15. There was a short "green-up" of vegetation following these light rains, but there was no appreciable increase of rodent population densities associated with it.

Trap success data for *G. andersoni*, *P. natalensis*, and *Mus* sp. sampled in the Karal area between August and November 1990 remained relatively constant for all three species (Table 4). Trap success, however, has remained quite low since then (see Fig. 10).

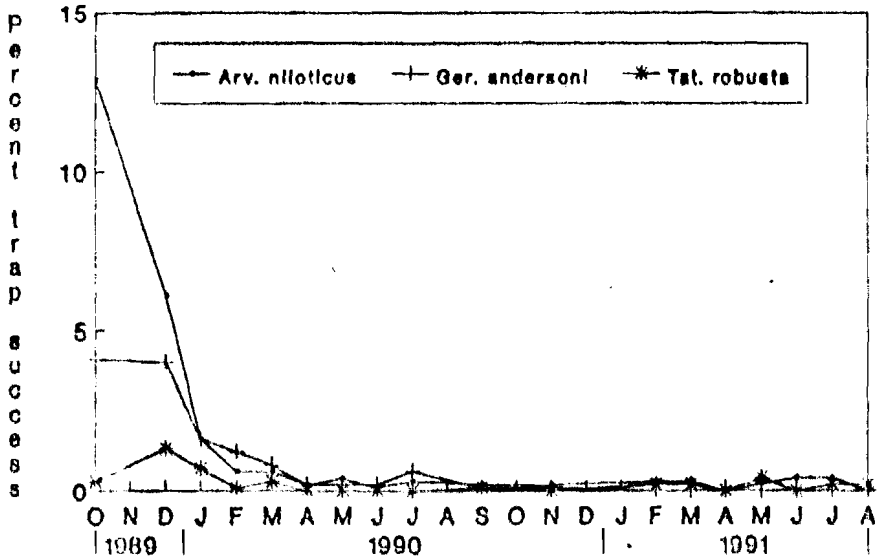

Fig. 8. Percentage of trapping success for three species of rodents from wadis near N'Gouri, Chad.

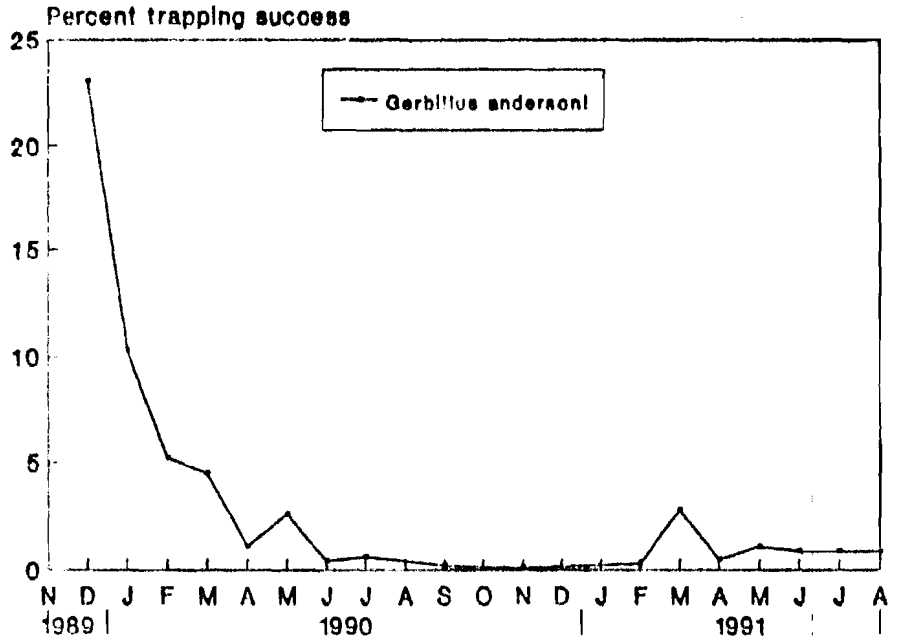

Fig. 9. Percentage of trapping success for *G. andersoni* from dunes near N'Gouri.

Table 4. Percentage of trapping success for three rodent species captured from recessional crops in the Karal area, Lake Chad.

Sampling dates	No. rodents	Effective traps	Percent trap success	No. each species			
				Ga	Pn	Msp	Unk
Aug 1990	22	941	2.3	10	8	4	-
Sep 1990	21	947	2.2	10	8	3	-
Oct 1990	14	535	2.6	4	4	5	1
Nov 1990	16	812	2.0	7	3	6	-
Feb 1991	3	853	0.35	1	1	1	-
Mar 1991	0	704	0.0	-	-	-	-
Apr 1991	4	754	0.53	1	1	2	-
May 1991	0	497	0.0	-	-	-	-
Jun 1991	2	480	0.41	1	1	-	-
Jul 1991	6	511	1.2	1	1	4	-
Aug 1991	2	267	0.75	-	-	2	-
Totals	90	7,301	1.3	35	27	27	1

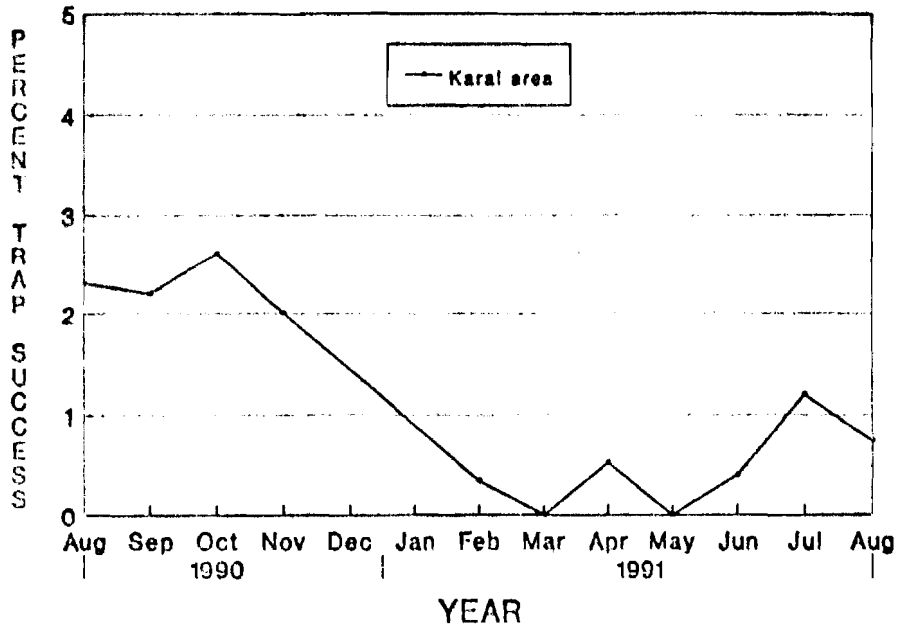

Fig. 10. Trapping success at Karal (all species).

d. Rainfall Data - Rainfall data collected from several stations in the Chad Sahel are shown graphically in Appendix III.

3. Rodent Crop Damage

Quantitatively assessing damage by rodents to agricultural crops is not easy, but needs to be done. Several methods for assessing rodent damage to cereal crops are reported in the literature, but little appears to have been done in assessing damage to root or vegetable crops. Rodent damage to cereal crops in the Sahel can be considerable at times, but damage to vegetable crops (tomatoes, for example) appears to be more significant. Rodent damage to cereal crops usually is best assessed immediately prior to harvest. In contrast, damage assessments in most vegetable crops should be made throughout the growing season.

4. Rodent Control Techniques

Diversity in both rodent pest species and agricultural crops in the Sahel compound the problem of effectively controlling crop depredations by rodents. Information on the intensity and timing of rodent damage, as well as on the annual reproductive cycles, is needed. In other words, information is needed on what crops should be protected and when, which rodent species cause damage and when, and how the pest rodent species can best be controlled.

The effective use of toxicants to control rodents requires both laboratory and field testing of selected candidate materials on the rodent species involved in crop damage problems. Zinc phosphide, a rodenticide that is widely used in the United States and has 37 registered uses, would be an excellent candidate material to use in the initial reduction of Sahelian rodent populations. Published toxicity information indicates that zinc phosphide should provide successful control of *P. natalensis* (Gill and Redfern 1979). Toxicity data provided by Suliman et al. (1984) of zinc phosphide against *A. niloticus* indicate that this species may easily be killed with low concentrations (0.2%) of the poison.

Studies of secondary hazards of zinc phosphide to nontarget animals (mammalian and avian predators) have shown that there is very little risk (Hegdal et al. 1981, Tkadlec and Rychnovsky 1990). Much of this is because avian predators normally do not eat the gut contents of captured prey. Even mammalian predators, in a majority of cases, were not killed by eating poisoned prey.

LaVoie (1988) did some testing of individually caged *A. niloticus* when offered 3% zinc phosphide baits. His findings (Table 5) showed that the poison at this level was extremely toxic to the rats, having killed all of them overnight. However, it should be noted that this level of toxicity is not necessary.

Table 5. Effects of 3% zinc phosphide given to *A. niloticus* overnight.

Sex	No. animals	Mean body wt (g)	Amount of bait offered (g)	Amount of bait eaten (g)	Mortality
F	3	115.7	1.0	<0.5	3/3
M	2	128.5	1.0	<0.5	2/2

Limited feeding tests were conducted in October 1990 using 1% zinc phosphide formulated with 1% peanut oil and applied to rice as the bait. Ten g of treated bait as the only food source were offered to individually caged rats for 1 night (about 16 hrs). Results were as follows:

Rat	Sex	Body wt (g)	Bait eaten (g)	Comment
Arvicanthis niloticus	M	155	1.9	dead
" "	F	84	0.5	survived
Rattus rattus	M	57	0.7	dead
" "	F	82	0.6	dead
Praomys natalensis	F	57	0.2	survived

The results agree with the findings quoted above. Although limited numbers of rats were used in these toxicity bioassays, there were enough to provide training to Project personnel in animal handling procedures, gavage techniques, dose level formulations and calculations, and bait formulations. Additional rats have been difficult to gather in a large quantity, due to their extremely low densities. As larger numbers of rats are accumulated, toxicity testing will be resumed.

Other excellent candidate materials are the anticoagulants warfarin and chlorophacinone. Toxicity data for both of these materials against *P. natalensis* and *A. niloticus* have been published (Gill and Redfern, 1977 and 1979). Normal concentrations of warfarin and chlorophacinone used in the control of Norway rats were found to kill both these species of African rodents.

Field tests of candidate bait formulations and toxicants will be carried out as soon as laboratory results are in hand. Bait preference trials to determine the most preferred bait ingredients from the locally available cereal grains have been completed, with millet being preferred over sorghum, rice, and maize.

5. Other Projects in Chad

Contacts have been made with a number of other organizations working in Chad, i.e., the Office for Rehabilitation through Training (ORT), CARE International in Chad, Famine Early Warning System (FEWS), SECADEV (Secours Catholique pour le Developpement), and AFRICARE. There are undoubtedly other organizations working in Chad, including a newly funded project of the Food and Agriculture Organization of the United Nations (FAO) to strengthen the CPS. These organizations will be contacted in the future.

The CRCRP has initiated a cooperative study with ORT in wadis in N'Gouri to assess the efficacy of two locally used types of traps (metal snap trap and pit traps) and one locally made bait station (clay drain pipe) baited with Klerat®[1] wax blocks. The study is being conducted with the farmers working these wadis through ORT agents who have been trained by CRCRP personnel in collecting biological data from all captured rodents and efficacy data of the control techniques.

B. Provide training and begin to develop guidelines for a long-term rodent control strategy.

1. Train Ministry Personnel

Training of Chad MOA/CPS personnel in rodent biology, ecology, population monitoring, and control has been an integral part of the CRCRP since before the Project's formal initiation in October 1989. For example, Dr. Mitchell, in his 1987 consultation to Chad (see Appendices I and II), trained 9 extension agents in bait formulation, and then trained 29 extension agents (13 in Abeche, 7 in Bokoro, and 9 in N'Djamena) in methods of applying baits and evaluating results. Likewise, Mr. LaVoie, in his 1988 consultation to Chad (see Appendices I and II), provided training to MOA personnel in safe, effective methods for warfarin grain bait application and evaluation in wadis.

Both Mr. LaVoie, in his 1989 consultation to Chad and Guinea-Bissau, and Dr. Wilson, in his 1989 consultation to Chad (see Appendices I and II), trained MOA personnel in rodent identification, trapping, autopsy, collection of biological data, and population monitoring methods. Since the initiation of Project field work in the N'Gouri area, training of counterpart MOA/CPS personnel assigned to the Project has been ongoing. Four MOA/CPS technicians have been trained to date. Further training of three of these technicians in both laboratory and field testing of toxicants with rodents was provided by Dr. Savarie in his October 1990 consultation to Chad (see Appendices I and II). Continued and expanded training of MOA personnel in various aspects of rodent

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

biology/ecology and control is anticipated throughout the life of the CRCRP.

2. Present Seminars/Workshops

Project personnel presented a 2-day workshop to 18 MOA/CPS technicians on November 26-27, 1990. Included in the workshop were presentations on rodent identification, biology, ecology, data collection, and population monitoring. Participants received hands-on experience in procedures for trapping, data collection, specimen preparation, and population monitoring.

3. Project Reports

In addition to the 19 trip reports resulting from DWRC consultations regarding rodent problems in the Sahel (see Appendices I and II), a Quarterly Report for the period from July 21 to September 30, 1990, was submitted to the MOA, USAID, and the DWRC in October 1990.

Several editions of "Rat Facts," a one-page informational sheet concerning the CRCRP, have been distributed to Chad/MOA, AID/N'Djamena, and DWRC personnel since September 1990. Each issue has been printed with one side in English and the other in French. The initial edition highlighted the Sahel and its need for rodent control. Subsequent editions have dealt with various rodent pests, rodent population monitoring, assessing crop losses due to rodents, diseases that rodents can transmitted to man, and methods for rodent control. In addition, technical reports summarizing various aspects of project research are being prepared.

4. Rodent Population Monitoring and Control

Rodent population monitoring in 8 wadis in the N'Gouri area was initiated by Dr. Wilson and Mr. LaVoie in October 1989. Rodent population monitoring was also initiated on 3 dune sites in the N'Gouri area in November 1989, as well as on additional wadi and dune sites in mid-1990. Similarly, rodent population monitoring was started in recessional agricultural sites in the Karal area in August 1990. Monitoring will be continued at these sites at least through the end of 1992.

Although the current monitoring methods have provided valuable baseline data, they are too intensive for future use. Therefore, simpler monitoring methods, statistically designed and based on data acquired through current intensive monitoring, will be developed. Once simple rodent population monitoring methods are determined, guidelines will be established and MOA/CPS personnel will be instructed on how to initiate and maintain long-term rodent population monitoring programs in representative Sahelian agricultural areas. The objective is to determine when rodent problems or population irruptions are likely to occur. Once the prediction is made, then the MOA/CPS should prepare to conduct

effective rodent control operations to avoid excessive rodent damage to crops.

C. **Organize laboratory and office space and facilities; obtain equipment and supplies.**

1. Office/Laboratory

The MOA/CPS agreed to provide office and laboratory space for the Project, but first these had to be renovated. Renovation took place after the Project Leader's arrival in July 1990. Renovation was completed in September 1990, and the Project occupied the office/laboratory space in mid-October. The space consists of two office/laboratory rooms plus two storage/animal rooms. Seven divided cage racks have been built for laboratory tests in the animal room, and "tank" holding pens have been proposed for keeping small numbers of free-roaming animals for simulated field testing.

A computer and printer was provided by USAID and was set up ready for use in April 1991. The computer will require an uninterruptible power supply, however, due to the extreme voltage fluctuations in N'Djamena. A unit was supplied, but it lacks the storage batteries needed to function properly. A considerable amount of office and laboratory supplies and equipment has been purchased and sent to the Project by DWRC (see Appendix IV). Numerous publications and reprints have been accumulated by the Project, and a computer program Pro-Cite will be used to catalog them.

2. N'Gouri

The Project rents a small compound with three rooms in the village of N'Gouri. These are used for living quarters by Project personnel during monthly visits of 4-5 days to the N'Gouri area, and they provide a place for storing traps and miscellaneous project supplies. These quarters have been upgraded to furnish shower facilities.

3. Karal

The Project has relied upon the hospitality of SECADEV, the Catholic Church's agricultural development organization, to provide room at no cost in their compound in the village of Karal. These facilities are minimal, however, consisting of two rooms with mud walls, tin roofs, and a cement floor. There are no bathing facilities, only an outdoor toilet.

An agricultural marketing project, supported by USAID, is presently constructing a building in Karal that will include guest rooms, electricity, and perhaps a water supply. Arrangements are being firmed up to allow Project personnel to use

these facilities in the future. This will greatly help while conducting Project work in the Karal area.

4. Vehicle

A Toyota Hi-Lux, 4-wheel drive, diesel, crew-cab pickup has been provided by USAID for the Project. This vehicle has proven to be adequate for Project needs for the field work. Vehicle service and repairs have been done as needed by the local Peugeot dealer, and diesel fuel has been contracted on an annual basis by bids with firms in N'Djamena. Diesel fuel has to be carried on up-country trips, since none is available once one departs N'Djamena.

D. TDY's and Future Work

1. Dr. J. Juan Spillett's 2-year appointment ends in June 1992. The actual PACD for this rodent activity under the AELGA Project is December 31, 1992.

2. In the interim time period, the Project intends to continue (a) population monitoring research, (b) comparative control trials with ORT, and (c) bait preference trials using wheat as a bait. In addition, the MOA/CPS has requested the Project to (a) implement a workshop in February 1992 and (b) identify external training opportunities for Chadian scientists. Also, depending on time, CPS personnel availability, and sufficient numbers of rodents, toxicant evaluations and food habit studies may be initiated. DWRC expects to provide two or three TDY's during FY-92 to assist in implementing these activities.

3. The rodent population monitoring, an integral part of the Project and one upon which a predictive model is to be based, has documented the lowest point in the population cycle of the Sahelian rodents. Due to drought conditions during 1990, there was no population recovery in late 1990, which should have occurred had rainfall been normal. The numbers of animals trapped each monthly monitoring trip have not been enough from which to draw conclusions regarding reproduction and population structure. The laboratory aspects of the Project work plan (bait preference trials, toxicity testing, bait formulation) also have not been realized because of the paucity of animals available when traps are set. Damage assessments in vegetable and cereal crops have not been feasible due to the low rodent densities; there are not enough rodents at this time to cause measurable damage. Once this kind of information becomes available, guidelines for acceptable, safe, economical rodent control can be developed.

4. One critical decision, which needs to be made and is an expected Project output listed in the PASA, is to decide in what context and how would it be best to continue rodent research activities. This decision will need to be made early in CY 1992 if the Project is to

maintain research continuity and fully realize the enormous logistical constraints that have been overcome in establishing and implementing the Project to date.

E. Literature Cited

Fiedler, L. A. 1987. An assessment of the current rodent outbreak in Sudan. Unpublished Trip Report, Denver Wildlife Research Center, USDA/APHIS/S&T, Denver, Colorado 80225-0266 U.S.A. 12 pp. and 2 appendices.

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Appendix I.

Consultations to Sahelian countries concerning rodent pest problems and development of the Chad Rodent Control Research Project by USDA/APHIS/S&T Denver Wildlife Research Center (DWRC) personnel from 1987 through 1991.

DWRC PERSONNEL	CONSULTING PERIOD	COUNTRIES VISITED
1. Fiedler, L.A.	Apr. 1-21, 1987	Sudan
2. LaVoie, G.K.	May 9-24, 1987	Chad
3. LaVoie, G.K. & D.J. Elias	May 27-29, 1987	Senegal
4. LaVoie, G.K. & D.J. Elias	May 30-June 6, 1987	Mali
5. LaVoie, G.K. & D.J. Elias	June 6-12, 1987	Burkina Faso
6. Keith, J.O.	July 13-Aug. 17, 1987	Sudan
7. Fiedler, L.A.	Aug. 16-Sept. 14, 1987	Sudan
8. Mitchell, G.C.	Oct. 10-Nov. 10, 1987	Chad
9. LaVoie, G.K.	Mar. 27-Apr. 28, 1988	Chad
10. LaVoie, G.K.	Jan. 29-Feb. 21, 1989	Senegal & Mauritania
11. Fiedler, L.A.	Apr. 23-May 12, 1989	Chad
12. LaVoie, G.K.	Oct. 8-Nov. 12, 1989	Chad & Guinea-Bissau
13. Wilson, J.	Oct. 11-Nov. 9, 1989	Chad
14. Bruggers, R.L.	Nov. 20-Dec. 8, 1989	Chad, Rome & Morocco
15. LaVoie, G.K.	Apr. 1-25, 1990	Chad
16. Fiedler, L.A.	July 22-Aug. 18, 1990	Guinea-Bissau
17. Savarie, P.J.	Oct. 7-31, 1990	Chad
18. Brooks, J. E.	Apr. 5-May 1, 1991	Chad
19. LaVoie, G. K.	Aug. 10-Sept. 4, 1991	Chad

References and Brief Summaries for Trip Reports Resulting from Denver Wildlife Research Center Personnel Consultations on Rodent Pest Problems to Sahelian Countries from 1987 through 1991.

1. Fiedler, Lynwood A. AN ASSESSMENT OF THE CURRENT RODENT OUTBREAK IN SUDAN, April 1-21, 1987. Unpub. Rpt., May 11, 1987. 12 pp. + 2 Appendices.

Assessed the 1986-87 Sudan rat outbreak. Tentatively described the problem and possible causative factors. Concluded rodenticide baiting was the best approach to limit rodent damage. Rodent outbreaks are associated with 2-4-year droughts, followed by normal or above normal rains. At least 4 rodent species (Arvicanthis niloticus, Praomys natalensis, Tatera sp., Jaculus sp., and probably Gerbillus sp.) involved. Emergency control programs usually are ineffective, because of lack of knowledge, time and expertise, as well as a lack of adequate political, financial, and logistical support.

2. LaVoie, G. Keith. CHAD. May 9-24, 1987. Unpub. Rpt., June 19, 1987. 10 pp. + 6 Attachments.

Confirmed reported high rodent densities and crop losses. Tentatively identified the major rodent species damaging various agricultural crops. Assessed present and predicted trends on rodent damage to agriculture products, and suggested possible short and long-term control measures.

3. LaVoie, G. Keith and Donald J. Elias. SENEGAL. May 27-29, 1987. Unpub. Rpt., June 30, 1987. 8 pp. + 6 Attachments.

Assessed the 1986-87 rat irruption in Senegal and suggested long-term control measures. At least 3 rat species (Arvicanthis niloticus, Taterillus pygargus, and Mastomys = Praomys sp.) of significant concern. Anticipated rodent populations would peak and decline in 1988. Local institutions do not have adequate resources to mitigate the irruption. Recommended use of 1% zinc phosphide (ZN3P2) baits in fields and warfarin where Zn3P2 not practical. But, available chlorophacinone should be used until Zn3P2 is available.

4. LaVoie, G. Keith and Donald J. Elias. MALI. May 30 - June 6, 1987. Unpub. Rpt., June 30, 1987. 7 pp. + 4 Attachements.

Assessed the 1986-87 rat outbreak in Mali and suggested control measures. At least 3 rat species (Arvicanthis niloticus, Mastomys = Praomys sp., and Gerbillus sp.) involved. A. niloticus populations may have peaked in early 1987. Anticipated populations of other species would peak in early 1988, and then decline to "normal". Local institutions do not have the resources to mitigate this irruption. Control intervention with rodenticides recommended, as well as a long-term rodent research program, followed by a rodent population monitoring program.

5. LaVoie, G. Keith and Donald J. Elias. BURKINA FASO. June 6-12, 1987. Unpub. Rpt., June 30, 1987. 5 pp. + 2 Attachments.

Concluded in an assessment of the reported 1986-87 rat outbreak in Burkina Faso that: Rodent populations are only slightly above normal, not in irruption numbers. Crop damage by rodents is around 2-3% of standing crops, and should be about the same in 1988. Control intervention could be cost effective, but local institutions presently lack the resources to respond both to "normal" crop depredations and future rodent irruptions. A rodent research program should be initiated.

6. Keith, James O. ASSESSMENT OF THE RODENT OUTBREAK AND THE 1987 ZINC PHOSPHIDE CONTROL PROGRAM IN SUDAN. July 13-August 17, 1987. Unpub. Rpt., August 20, 1987. 17 pp. + 1 Appendix & 17-page INITIAL ENVIRONMENTAL EXAMINATION.

The 1987 zinc phosphide (Zn_3P_2) rodent control campaign in the Sudan was evaluated, and a warfarin control program in villages was planned. Between June and August 1987, 1,300 metric tons of 1% Zn_3P_2 bait was applied to about 1 million "faddans" by the Sudanese Plant Protection Department (PPD) at a cost of 6 million Sudanese pounds. Rodent numbers were effectively reduced, but good populations remained and could increase by crop harvest time (Oct. - Nov.) - unless additional treatments are made both in fields and villages. Distribution of plastic bags of 1 kg of 0.025% warfarin bait to each household in villages, for a 3-4-week baiting program, was recommended. Thereafter, the PPD should collect unused baits and determine the efficacy of the program through observations by villagers and road-count monitoring by PPD personnel.

7. Fiedler, Lynwood A. TRAINING PROGRAMFOR RODENT CONTROL IN SUDAN VILLAGES USING WARFARIN RODENTICIDE. Aug. 16-Sept. 14, 1987. Unpub. Rept., Sept. 21, 1987. 15 pp. including Appendix A.

A training package, consisting of 6 training modules, was developed for use by Ministry of Agriculture - Plant Protection Department personnel to mix, package,distribute, and train villagers in the proper use of rodenticide bait (warfarin) in Sudanese villages because of a rodent outbreak. Short and long-term recommendations regarding rodent control also were made.

8. Mitchell, Clayton. CHAD. Oct. 10-Nov. 10, 1987. Unpub. Rpt., Dec. 31, 1987. 10 pp. + 1 Appendix.

Assessed rodent problems in Chad, conducted experimental field evaluations of warfarin grain baits, trained nine extension agents in bait formulation, and made recommendations for rodent control measures.

9. LaVoie, G. Keith. CHAD. Mar. 27-Apr. 28, 1988. Unpub. Rpt., May 20, 1988. 12 pp. + 3 Attachments.

Identified rodent pest species in irrigated and dryland agricultural areas, conducted cage and small plot rodenticide evaluations in irrigated "quadis" in the the N'Gouri area, and trained 17 agricultural extension personnel in rodent control measures in the Bongor area.

10. LaVoie, G. Keith. SENEGAL AND MAURITANIA. Jan. 29-Feb. 21, 1989. Unpub. Rpt., Mar. 30, 1989. 13 pp. + 3 Figures.

Rodent surveys conducted in 4 regions of the Senegal River Valley provided data on relative densities and relation and damage to crop types by dominant agricultural rodent pest species. Aryicanthis niloticus was the dominant rodent pest, with highest densities in rice fields and vegetable producing areas. Limited damage assessments indicated severe rodent damage to vegetable seeds and seedlings. Cost/benefits appear favorable for the development and implementation of national rodent control programs in Senegal and Mauritania.

11. Fiedler, Lynwood A. PLANNING FOR THE ESTABLISHMENT OF THE PROPOSED RODENT CONTROL PROJECT IN CHAD. April 23-May 2, 1989. Unpub. Rpt., Sept. 27, 1989. 9 pp. + Appendices A-D.

Suggested scheduling and procedures for implementing a rodent control project, as well as discussed project-related concerns, including housing, transportation, and logistical support.

12. LaVoie, G. Keith. CHAD AND GUINEA-BISSAU. Oct. 8-Nov. 12, 1989. Upub. Rpt., Jan. 10, 1990. 9 pp.

Provided field assistance to Dr. John Wilson in initiating a rodent population monitoring program near N'Gouri, Chad, and helped develop plans for the Chad Rodent Control Research Project.

13. Wilson, John. CHAD. Oct. 11-Nov. 9, 1989. Unpub. Rpt., Feb. 5, 1990. 57 pp., including 4 Appendices.

Selected study sites in the N'Gouri and Abeche areas and initiated long-term monitoring studies on rodent populations in "quadi" cultivations around N'Gouri, as well as conducted bait acceptability trials, and trained counterpart scientists in rodent identification, trapping, autopsy, and data collection methods.

14. Bruggers, Richard L. CHAD, ROME, AND MOROCCO. Nov. 20-Dec. 8, 1989. Unpub. Rpt., Jan. 10, 1990. 7 pp.

Discussed implementation activities and worked out budget considerations with USAID-Chad for the PASA Chad Rodent Control Research Project.

15. LaVoie, G. Keith. CHAD. April 1-25, 1990. Unpub. Rpt., June 4, 1990. 7 pp. + 3 Figs. & 1 Appendix.

Continued rodent population sampling and monitoring in the N'Gouri area with the Project Assisstant and technicians from the Crop Protection Services. Briefly reviewed Chad Rodent Control Research Project activities and concerns, as well as evaluated and rejected as new study sites 3 wadi and 4 dune sites in the N'Djamena-Bilala area near Lac-Fitry.

16. Fiedler, Lynwood A. RODENT PESTS IN GUINEA-BISSAU. July 22-Aug. 18, 1990. Unpub. Rpt., Oct. 29, 1990. 8 pp. + 2 Attachments.

Current research and possible future cooperative work on African rodents was discussed with rodent experts at the University of Antwerp in Belgium. Agricultural crops in Guinea-Bissau were examined for rodent damage potential, and rodents were trapped on 4 areas to determine species present and current infestation levels. Although Mastomys erythroleucus, Xerus erythropus, and Cricetomys gambianus were identified as pest species, it was concluded information still is needed in order to begin field trials of possible rodent control methods appropriate to Guinea-Bissau.

17. Savarie, Peter J. RODENT CONTROL RESEARCH AND TRAINING ACTIVITIES IN CHAD. Oct. 7-31, 1990. Unpub. Rpt., Nov. 30, 1990. 7 pp. + 1 Appendix.

Limited closed/open burrow trials on the field efficacy of zinc phosphide (Zn_3P_2) baits indicated that 1% Zn_3P_2 baits effectively controlled rodents. Limited feeding trials of caged rats with 1% Zn_3P_2 also were conducted, but results were inconclusive. No supplies of Zn_3P_2 rodenticides were found in the N'Djamena area, although brodifacoum, chlorophacinone, alphachlorophacinone, and aluminum phosphide were available. Training and technology transfer in toxicology of rodenticides was conducted with the Chad Department of Agriculture/Crop Protection Service personnel.

18. Brooks, Joe E. RODENT CONTROL RESEARCH AND DAMAGE ASSESSMENT ACTIVITIES IN CHAD. April 5-May 1, 1991. Unpub. Rpt., May 14, 1991. 12 pp.

With rodent densities very low due to a prolonged drought, there was no visible damage to vegetables; however, a guide for damage assessment methods in vegetable and grain crops was compiled. Two food preference trials were run in the laboratory, and a protocol for food and bait preference testing was prepared.

19. LaVoie, G. Keith. CHAD RODENT RESEARCH. Aug. 10-Sept. 4, 1991. Unpub. Rpt., October 1991.

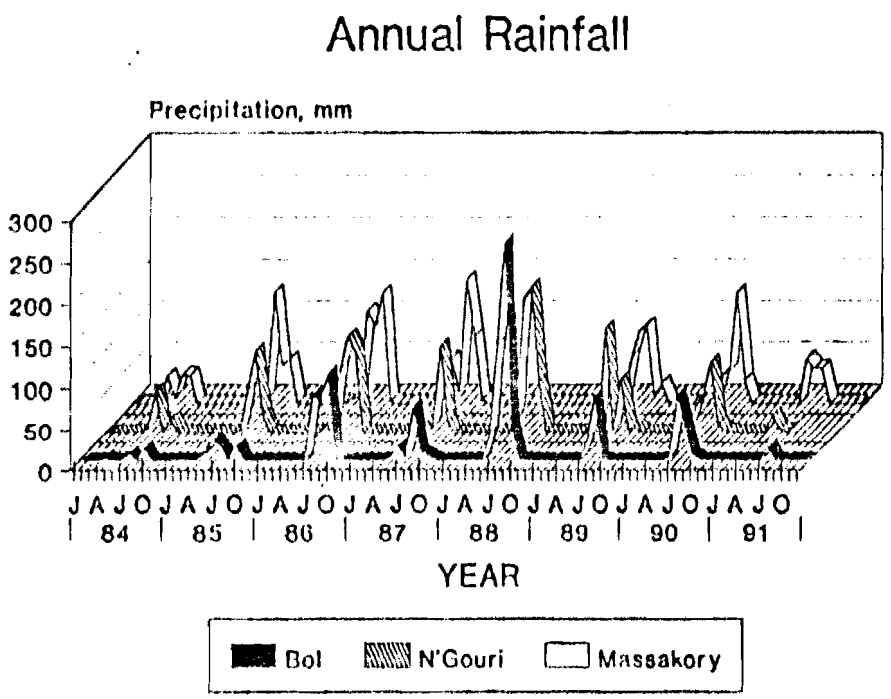
The objectives of this consultancy were to assist DWRC Project Leader Dr. Juan Spillett and Crop Protection Service counterparts in (a) monitoring Sahelian rodent densities, (b) initiating bait toxicology trials, (c) assisting in bait preference trials, (d) developing vegetable damage assessment methods, (e) and initiating a study to determine rodent feeding patterns from analysis of stomach contents. Data from monitoring rodent populations at two agricultural sites suggested that populations of all the main agriculturally important rodent species are increasing. These increases are due to improved habitat conditions resulting from the first good rains in over 2 years. The populations are not likely to result in major outbreaks, but they should provide animals needed for bait preference, rodential toxicity, and small, comparative field control trials, such as the recent initiated trial comparing the effectiveness of locally made steel rat traps, pit traps, and rodenticides.

Appendix III.

Rainfall Data for Various Areas in Chad

1984-1991

Data Provided By the Famine Early Warning System



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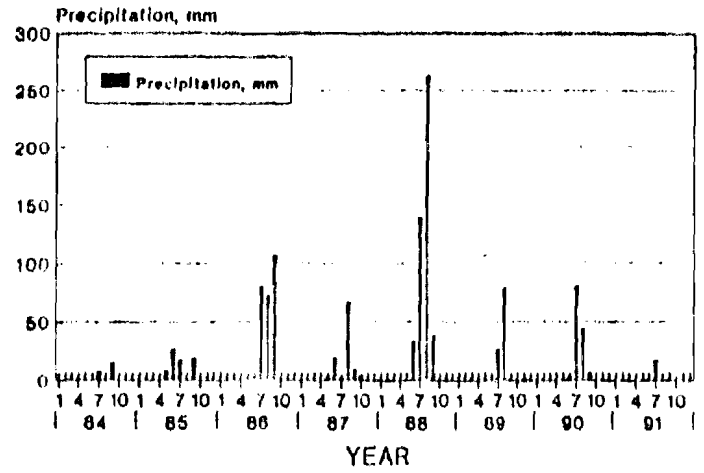

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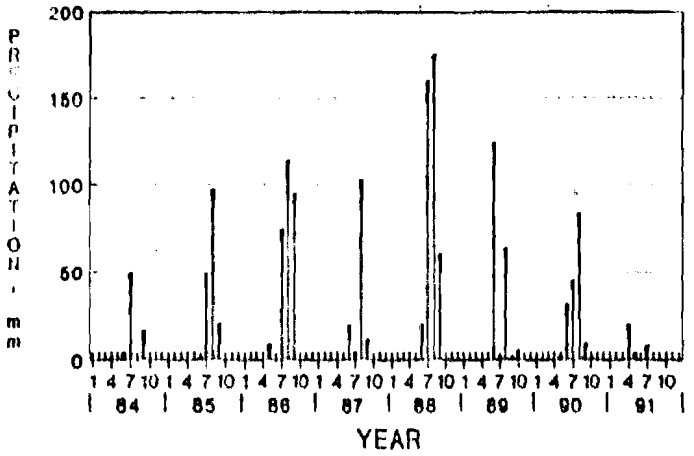
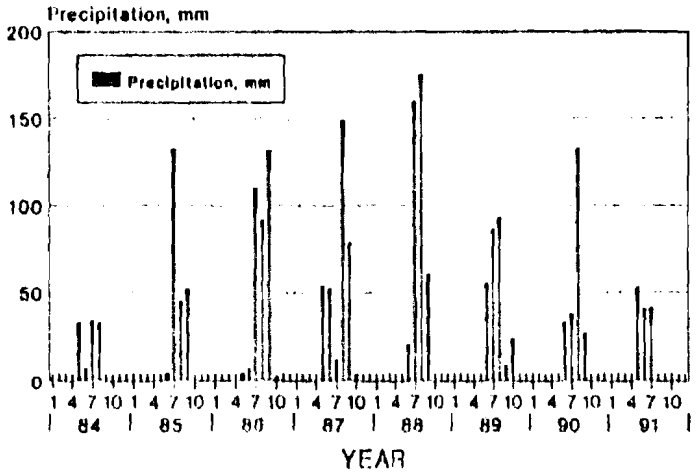


Massakory



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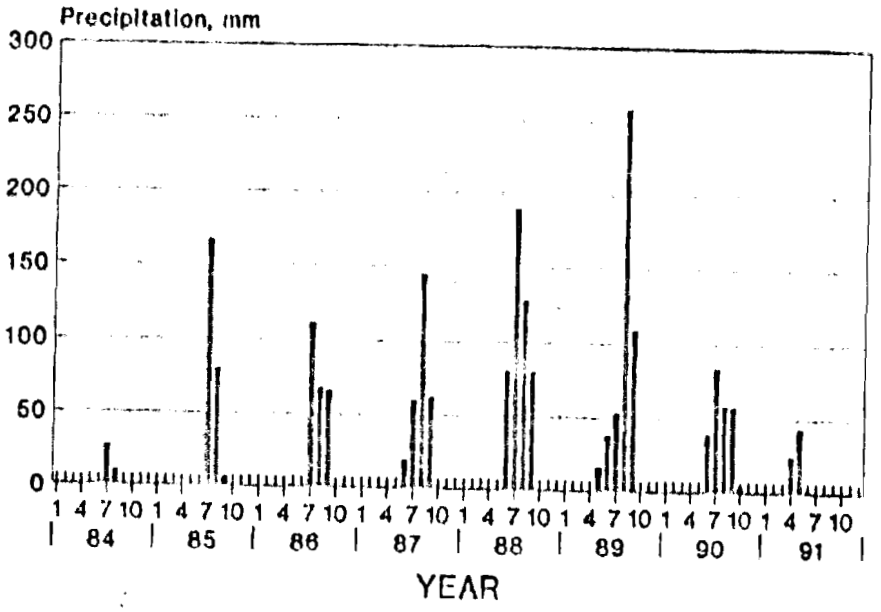
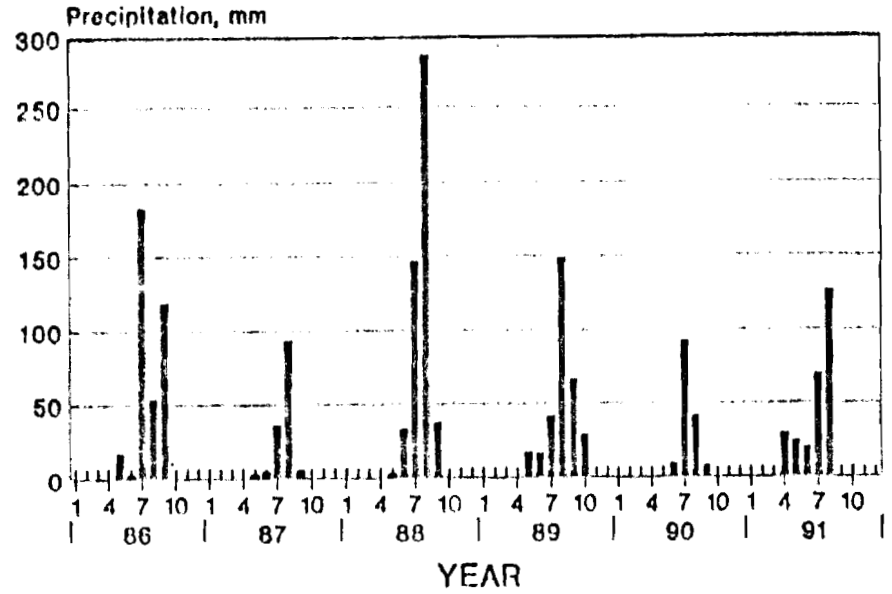
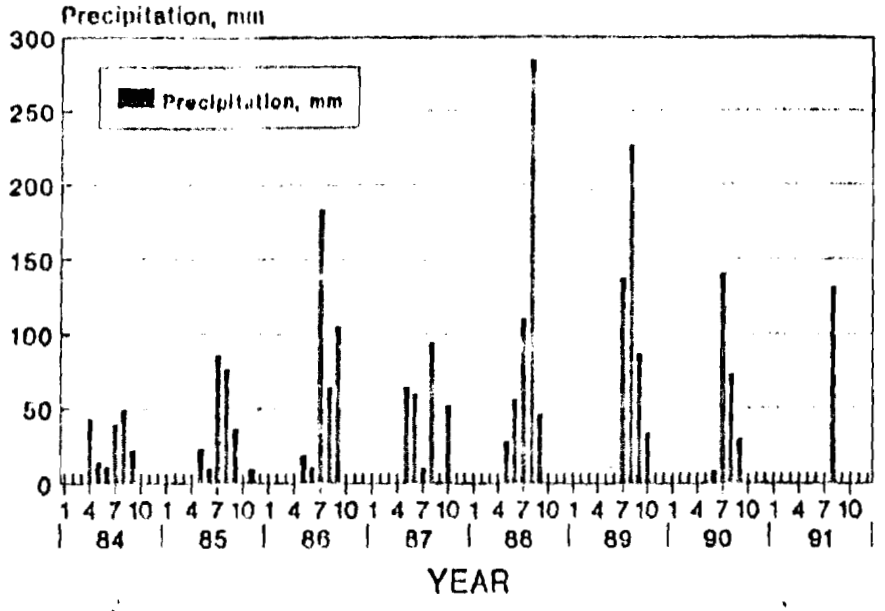


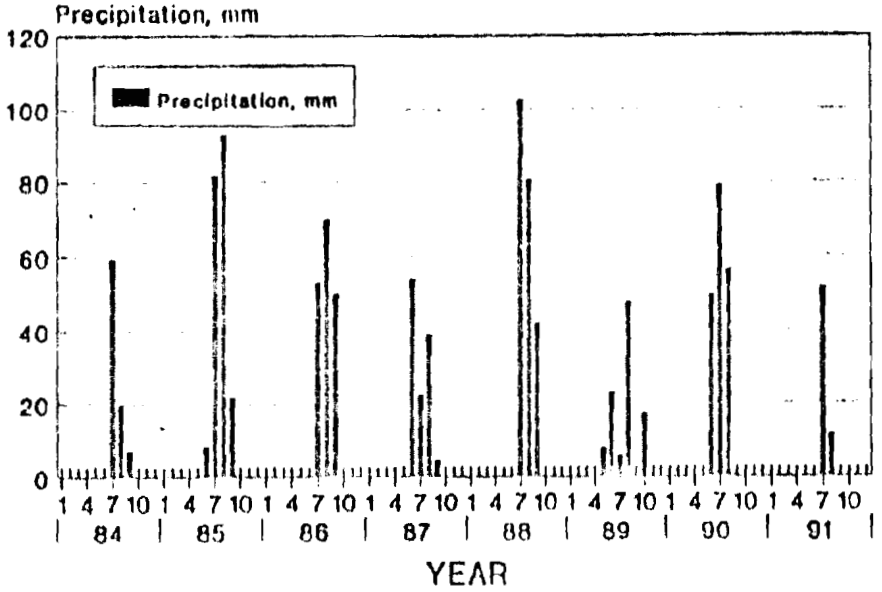
Abeche



Dougui



Mao



Appendix IV.

Chad Project--Purchases for FY 90-91
7/23/91

Total Costs: $ 13,562.97

Description	Serial Number	Brand	Source	Qty	Cost	Order Date	Unit	Unit Price	Method of Payment	DHHC Date Received	Date Shipped	Carrier	Received by Field Station
Rangefinder Model 1200	N/A	N/A	Forestry Suppliers	1	119.95	4/18/90	each	119.95	Visa	4/30/90	5/1/90	Reg. Mail	6/2/91
Rangefinder carring case	N/A	N/A	Forestry Suppliers	1	16.95	4/18/90	each	16.95	Visa	4/30/90	5/1/90	Reg. Mail	
Respirator filters	N/A	N/A	Forestry Suppliers	4	20.60	4/18/90	each	5.15	Visa	4/30/90	5/1/90	Reg. Mail	
Respirator, Comfo II	N/A	N/A	Forestry Suppliers	4	67.80	4/18/90	each	16.95	Visa	4/30/90	5/1/90	Reg. Mail	
Balance Model 396	N/A	N/A	Forestry Suppliers	1	86.50	4/11/90	each	86.50	Visa	4/30/90	5/1/90	Reg. Mail	
12 volt Refrigerator 23.7 qts (A-Car)	N/A	(A-Car)	Malaro B.V.	1	292.95	4/18/90	each	292.95	Visa	4/30/90	4/30/90	Reg. Mail	
Binoculars 7-15x, 35mm, 200mm	N/A	N/A	Forestry Suppliers	1	167.00	4/17/90	each	167.00	Visa	4/30/90	4/30/90	Reg. Mail	
Dissecting pan	N/A	N/A	Forestry Suppliers	2	10.50	4/17/90	each	5.25	Visa	4/30/90	4/30/90	Reg. Mail	
Dissecting kits, vari-case	N/A	N/A	Forestry Suppliers	4	56.40	4/17/90	each	14.10	Visa	4/30/90	4/30/90	Reg. Mail	
Heavy duty Spring scale	N/A	N/A	Forestry Suppliers	1	47.65	4/17/90	each	47.65	Visa	4/30/90	4/30/90	Reg. Mail	
All purpose Spring scale	N/A	N/A	Forestry Suppliers	1	18.00	4/17/90	each	18.00	Visa	4/30/90	4/30/90	Reg. Mail	
Tally meter	N/A	N/A	Forestry Suppliers	3	35.40	4/17/90	each	11.50	Visa	4/30/90	4/30/90	Reg. Mail	
1 Kw stepdown transformer	01F1009	N/A	Newark Electronics	1	235.48	4/18/90	each	235.48	EPO	5/3/90	5/6/90	Reg. Mail	
0.5 KW stepdown transformer	01F1008	N/A	Newark Electronics	1	128.71	4/18/90	each	128.71	EPO	5/3/90	5/6/90	Reg. Mail	
Wash bottle, 250 ml	N/A	N/A	Baxter Scientific	1	9.71	4/27/90	package	9.71	EPO	5/10/90		Reg. Mail	
Wide mouth bottle, 125 ml	N/A	N/A	Baxter Scientific	2	168.48	4/27/90	case	84.24	EPO	5/10/90		Reg. Mail	
Direct reading calipers	N/A	N/A	Baxter Scientific	2	37.80	4/27/90	each	18.90	EPO	5/10/90		Reg. Mail	
Graduated cylinder, 100ml	N/A	N/A	Baxter Scientific	2	14.86	4/27/90	each	7.43	EPO	5/1/90		Reg. Mail	
Graduated cylinder, 25ml	N/A	N/A	Baxter Scientific	2	11.38	4/27/90	each	5.69	EPO	5/1/90		Reg. Mail	
Graduated cylinder, 500ml	N/A	N/A	Baxter Scientific	2	25.34	4/27/90	each	12.67	EPO	5/1/90		Reg. Mail	
Tissue forceps, 1x2 teeth, 10"	N/A	N/A	Baxter Scientific	2	24.14	4/27/90	each	12.07	EPO	5/1/90		Reg. Mail	
Dissecting forceps, straight 6"	N/A	N/A	Baxter Scientific	3	18.96	4/27/90	each	6.32	EPO	5/1/90		Reg. Mail	
Dissecting forceps, curved 4.5"	N/A	N/A	Baxter Scientific	3	9.48	4/27/90	each	3.16	EPO	5/1/90		Reg. Mail	
Halsted artery forceps, 5"	N/A	N/A	Baxter Scientific	2	19.36	4/27/90	each	9.68	EPO	5/1/90		Reg. Mail	
Polypropylene funnel, autoclavable	N/A	N/A	Baxter Scientific	1	8.50	4/27/90	package	8.50	EPO	5/1/90		Reg. Mail	
Wide mouth jar, 1 pint	N/A	N/A	Baxter Scientific	2	135.66	4/27/90	case	67.83	EPO	5/9/90		Reg. Mail	
Dissecting scalpel, size 5	N/A	N/A	Baxter Scientific	2	76.90	4/27/90	box	38.45	EPO	5/1/90		Reg. Mail	
Kaye straight scissors, 6.75"	N/A	N/A	Baxter Scientific	3	29.70	4/27/90	each	9.90	EPO	5/3/90		Reg. Mail	
Micro spetula, w/o Teflon coating	N/A	N/A	Baxter Scientific	10	20.05	4/27/90	each	2.05	EPO	5/3/90		Reg. Mail	
Test tube drying rack, bench top	N/A	N/A	Baxter Scientific	1	24.50	4/27/90	each	24.50	EPO	5/5/90		Reg. Mail	
Large laboratory tray	N/A	N/A	Baxter Scientific	2	41.20	4/27/90	each	20.60	EPO	5/5/90		Reg. Mail	
Spring scale, 50g	N/A	Pesola	Forestry Suppliers	4	155.80	4/27/90	each	38.95	Visa	5/8/90	5/8/90	Reg. Mail	
Spring scale, 100g	N/A	Pesola	Forestry Suppliers	4	155.80	4/27/90	each	38.95	Visa	5/8/90	5/8/90	Reg. Mail	
Spring scale, 300g	N/A	Pesola	Forestry Suppliers	4	155.80	4/27/90	each	38.95	Visa	5/8/90	5/8/90	Reg. Mail	
Electronic analytical balance	2330	Ohaus	Ohaus Corporation	1	1320.69	5/2/90	each	1320.69	PO	5/29/90	5/30/90	Reg. Mail	
Electronic precision balance2100xgx0.01g	2858	Ohaus	Ohaus Corporation	1	989.69	5/2/90	each	989.69	PO	5/29/90	5/30/90	Reg. Mail	
Metric weight set 1000gx1g	N/A	Ohaus	Ohaus Corporation	1	49.10	5/2/90	each	49.10	PO	5/29/90	5/30/90	Reg. Mail	
Camera X-700.f/1.7/case	2835432	Minolta	Minolta Corporation	1	268.33	5/2/90	each	268.33	PO	5/30/90	8/9/90	Reg. Mail	8/24/90
Lens MD 200m 70-210mm,f/4,LS	11684225	Minolta	Minolta Corporation	1	194.78	5/2/90	each	194.78	PO	5/30/90	8/9/90	Reg. Mail	8/24/90
320 Flash	4160994	Minolta	Minolta Corporation	1	94.95	5/2/90	each	94.95	PO	5/30/90	8/9/90	Reg. Mail	8/24/90
Video camcorder VHSc	0951416	JVC	SoundTrack	1	899.00	5/2/90	each	899.00	PO	6/18/90	8/9/90	Reg. Mail	8/24/90
Pocket Filter PF	SIN 701670	Katadyn	Katadyn USA, Inc	1	146.30	5/2/90	each	146.30	PO	5/15/90	5/15/90	Reg. Mail	
Spare Filter PF-PFE	SIN 701771	Katadyn	Katadyn USA, Inc	1	73.15	5/2/90	each	73.15	PO	5/15/90	5/15/90	Reg. Mail	
10 Digit Pro Scientific caculator	N/A	Texas In.	Best	1	31.85	5/17/90	each	31.85	Cash	5/17/90	5/18/90	Reg. Mail	
Nalgeon bottles 16oz.	N/A	N/A	Ancare	36	109.80	6/25/90	each	3.05	PO	7/12/90	7/14/90	Reg. Mail	
Ball point water tubes	N/A	N/A	Ancare	36	70.20	6/25/90	each	1.95	PO	7/12/90	7/14/90	Reg. Mail	
Stoppers	N/A	N/A	Ancare	50	50.00	6/25/90	each	1.00	PO	7/12/90	7/14/90	Reg. Mail	
Sure lock bottle holders	N/A	N/A	Ancare	36	387.08	6/25/90	each	10.75	PO	7/12/90	7/14/90	Reg. Mail	
Havaheart mouse traps	W107	Victor	Woodstream/Ekco	1	29.50	7/11/90	carton	29.50	COD	7/19/90	Storage	N/A	
Rat glue boards	M319	Victor	Woodstream/Ekco	4	72.00	7/11/90	carton	18.00	COD	7/19/90	Storage	N/A	

Chat Project--Purchases for FY 90-91
7/23/91

Appendix IV. (Continued)

Total Costs: $ 13,862.97

Description	Serial Number	Brand	Source	Qty	Cost	Order Date	Unit	Unit Price	Method of Payment	DWMC Date Received	Date Shipped	Carrier	Received by Field Station
Easy set gopher traps	0610	Victor	Woodstream/Ekco	36	90.00	7/11/90	each	90.00	COD	7/19/90	Storage	N/A	
Museum special mouse traps	MSP (#165)	Woodstream	Woodstream	2	310.00	8/3/90	carton	155.00	Visa	8/24/90	8/24/90	Reg. Mail	
16"X5 Tomahawk collasable live traps	201	Tomahawk	Tomahawk Trap Co.	103	1283.38	8/23/90	each	12.46	PO	10/2/90	8/16/90	Reg. Mail	
Tow chain	N/A	N/A	Wal-Mart	1	25.16	11/29/90	each	25.16	cash	11/29/90	11/30/90	Reg. Mail	3/18/81
16"X5 Tomahawk collasable live traps	201	Tomahawk	Tomahawk Trap Co.	103	1712.02	1:/6/90	each	15.08	PO	N/A	8/16/90	Reg. Mail	
1 KW stepdown transformer	C1F1009	N/A	Newark Electronics	1	234.25	4/2/91	each	234.25	BPO	4/7/91	4/8/91	Reg. Mail	4/23/91
Electrical power strip	N/A	N/A	Wal-Mart	2	27.79	4/3/91	each	12.96	cash	4/3/91	4/17/91	Reg. Mail	
Garden hose	N/A	Swan	Target	1	26.99	3/19/91	each	26.99	cash	3/19/91	3/25/91	Reg. Mail	4/8/91
Cable hoist	N/A	N/A	Wal-Mart	1	16.43	3/11/91	each	16.43	cash	3/11/91	3/25/91	Reg. Mail	4/8/91
Gas syphon	N/A	3 in 1	Champion Auto	1	13.80	3/11/91	each	13.80	cash	3/11/91	3/25/91	Reg. Mail	4/8/91
Monitor to base cable, 8'	N/A	Wang	Wang Labs	1	28.00	4/2/91	each	28.00	Visa	4/5/91	Hand carried	Joe Brooks	
S-15 power cord, 8'	N/A	Wang	Wang Labs	1	19.00	4/2/91	each	19.00	Visa	4/5/91	Hand carried	Joe Brooks	
Garden hose	N/A	Swan	Target	2	53.98	4/61/91	each	26.99	cash	4/16/91	4/17/91	Reg. Mail	4/30/91
Smoke alarm	N/A	First Alert	Wal-Mart	3	31.64	5/16/91	each	9.84	cash	5/16/91	5/20/91	Reg. Mail	
Rechargable Screwdriver	N/A	Blk & Dker	Wal-Mart	1	29.94	5/16/91	each	29.94	cash	5/16/91	5/20/91	Reg. Mail	
Battery charger	N/A	N/A	Wal-Mart	1	25.96	5/16/91	each	25.96	cash	5/16/91	5/20/91	Reg. Mail	
Mop head	N/A	N/A	Wal-Mart	1	1.17	5/16/91	each	1.17	cash	5/16/91	5/20/91	Reg. Mail	
Mop head	N/A	N/A	Wal-Mart	1	1.47	5/16/91	each	1.47	cash	5/16/91	5/20/91	Reg. Mail	
Mechanical Homogenizer	N/A	VirTishear	Easter Scientific	1	1721.00	5/8/91	each	1721.00				Reg. Mail	
Fire Extinguisher	N/A	First Alert	Wal-Mart	2	27.78	5/8/91	each	13.89	cash	5/8/91	Hand Carried		
Drill bit sie	N/A	Blk & Dker	Wal-Mart	1	10.97	5/8/91	each	10.97	cash	5/8/91	5/20/91	Reg. Mail	
3/8" Rechargable drill	N/A	Blk & Dker	Wal-Mart	1	29.16	5/8/91	each	29.16	cash	5/8/91	5/20/91	Reg. Mail	
French Textbook (photo copy)	N/A	N/A	Mind Ex.U.	1	44.00	4/29/91	each	44.00	Visa	5/10/91	5/31/91	Reg. Mail	
Book, Mammels of Algeria	N/A	N/A	R.R Tech. Bookfinder	1	135.00	5/3/91	each	135.00				Reg. Mail	
Book, African Mammals,Vol. IIB	N/A	N/A	R.R Tech. Bookfinder	1	32.50	5/3/91	each	32.50				Reg. Mail	
Book, Collins, Birds of W. Africa	N/A	N/A	R.R Tech. Bookfinder	1	21.95	5/3/91	each	21.95				Reg. Mail	
Japanese catch traps	N/A	Japanese	Standard Trading Co.	72	604.08	5/30/91	carton	8.39	PO	7/2/91	7/10/91	Reg. Mail	
Tire repair kit	N/A	N/A	Wal-Mart	1	14.10	5/28/91	each	14.10	cash	5/28/91	5/31/91	Reg. Mail	
Clear Silicon	N/A	N/A	Hugh M. Woods	6	23.94	5/28/91	each	3.99	cash	5/28/91	5/31/91	Reg. Mail	
1/4" Hardware cloth	N/A	N/A	Hugh M. Woods	2	23.98	5/28/91	each	11.99	cash	5/28/91	5/31/91	Reg. Mail	
Cork board	N/A	N/A	Hugh M. Woods	1	12.99	5/29/91	each	12.99	cash	5/29/91	5/31/91	Reg. Mail	
Tin snips	N/A	N/A	Hugh M. Woods	1	9.99	5/29/91	each	9.99	cash	5/29/91	5/31/91	Reg. Mail	
Brown spray paint	N/A	N/A	Hugh M. Woods	2	6.98	5/29/91	each	3.49	cash	5/29/91	Hand Carried		