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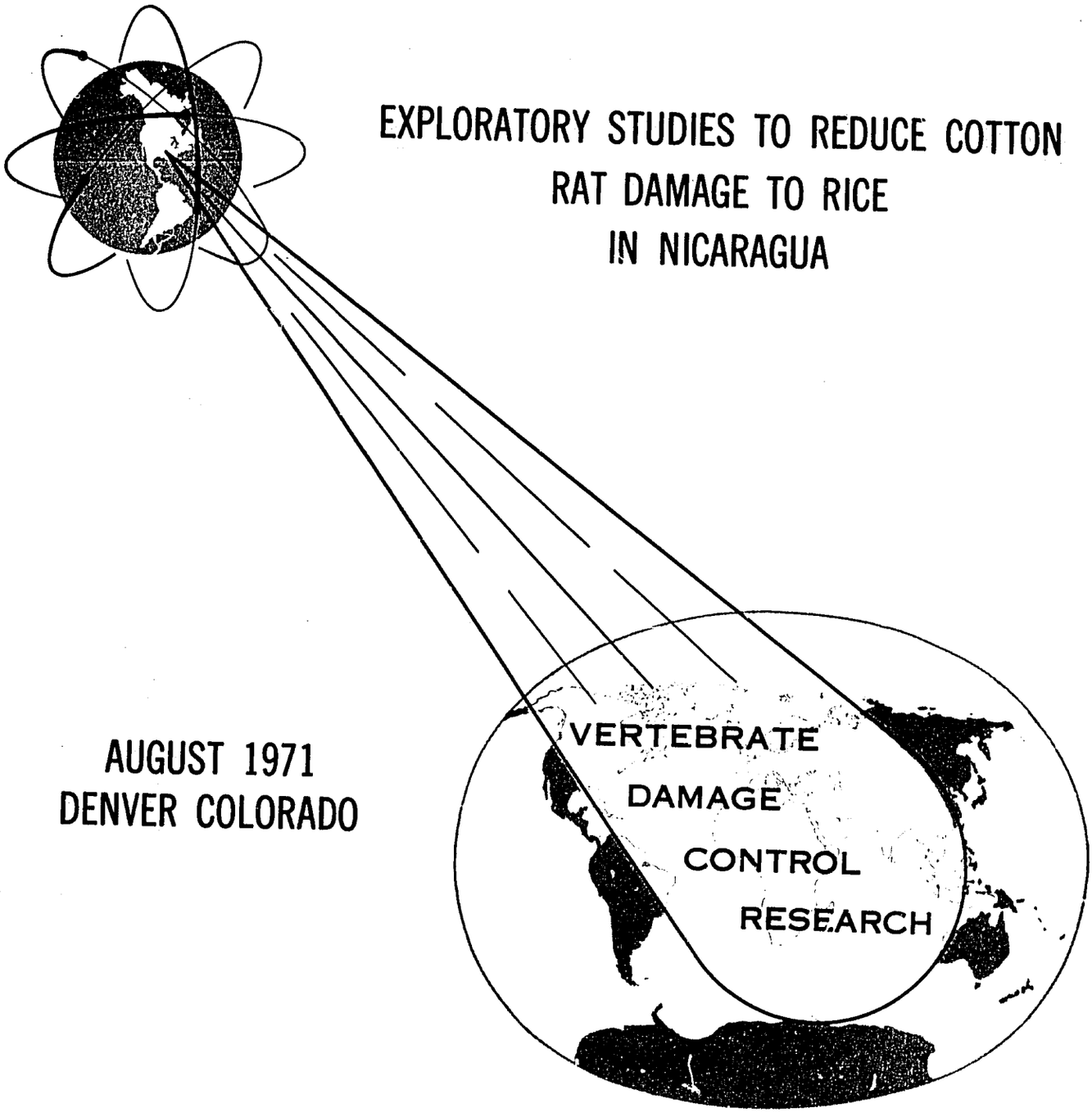

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EXPLORATORY STUDIES TO REDUCE COTTON RAT DAMAGE TO RICE IN NICARAGUA

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INTRODUCTION

Concern over severe rodent damage to rice and other crops in Nicaragua prompted the AID Mission in Managua to request assistance from the Denver Wildlife Research Center under the auspices of the USAID/USDI world-wide agreement for research on problems of vertebrate damage to agriculture (PASA RA[ID] 1-67).

Although no measurements or damage surveys had ever been made, estimates of damage to rice by rodents of the genus Sigmodon ranged from ten to fifty per cent. A preliminary assessment of damage measured in one ricefield near Managua in January 1971 revealed 26.5 per cent damage (see Appendix A). Based on these figures, Mr. Carl Koone (USAID Rural Development Officer) estimated annual losses at approximately two million dollars in rice alone. A safe and effective technique for preventing this damage is urgently needed.

Three techniques are presently in general use by rice growers in an effort to reduce rodent populations. These are (1) Racumin bait, (2) Endrin bait, and (3) Endrin and molasses spray. The effectiveness of these techniques has never been measured. It may be assumed that these materials are not effective as they are being used, but the problem continues in spite of regular and frequent applications. Also, Endrin applied as a spray is hazardous, and, because of its persistence, is considered an undesirable environmental contaminant.

The studies reported here were conducted within a 2-week period between April 26 and May 10, 1971. The work was done on Finca El Triunfo,

which is approximately 60 kilometers from Managua, Nicaragua. This farm consists of 2,000 manzanas or 4,444 acres (1 acre = 0.45 manzanas). During the dry season, about one-half of the area is in irrigated rice but all is in rice production during the wet season.

PROCEDURES

Acceptance Tests

Tests were first run to determine the best accepted bait carrier for the toxicant. This test consisted of three consecutive 24-hour feeding periods with consumption measured at the end of each period. Nineteen animals were held in a 10 x 10-ft aluminum sheeting enclosure covered by poultry screening. The sides of the enclosure were buried approximately 8 inches in the ground. About 4 inches of gravel and soil were spread over the floor of the enclosure to provide soft earth into which the animals could burrow. Dry grass and weeds were also scattered about the enclosure to provide cover. Nine candidate carriers were randomly placed in aluminum feeding dishes which were tacked to three boards on the floor of the enclosure. Student's t-test was used to analyze the data obtained.

Population Comparison

A series of single traplines with 30 traps each at 10-meter intervals set for one night were used to obtain an estimate of comparative population density in each of five habitat situations. This requires the assumption that the catch is proportional to the population. Victor 4-way rat traps were used with peanut butter and rolled oats as bait.

Data on the sex of all animals captured were recorded to obtain an estimate of the male/female ratio. No attempt was made to estimate age classes.

Field Tests

Two field tests using zinc phosphide as the toxic agent were conducted. A 2 per cent (by weight) bait formulation of 94 per cent active zinc phosphide was used in both tests. No correction factor was applied to account for the 6 per cent inactive ingredients. Corn oil was used as an adhesive. Approximately 75 milliliters of corn oil per 10 pounds of puntilla (broken rice) gave the best results.

The first of the zinc phosphide tests was run in a barren (harvested and burned) ricefield. The site selected for this phase was part of a larger field containing approximately 40 manzanas or 89 acres. The field had been harvested in late January and then burned. It had not been plowed and the dikes had not been destroyed. The surface of the ground was covered by cracks and fissures, some of which were 30 inches deep. One half (approximately 20 manzanas) of this field was baited with zinc phosphide-treated puntilla at the rate of 1.34 pounds bait per acre or 2.98 pounds per manzana (approximately 12 grams zinc phosphide/acre). Bait spots containing approximately 10 grams of bait were placed at 5-meter intervals along major dikes and canals and at 8-meter intervals along intermediate dikes and along a line parallel to and half way between the intermediate dikes.

The second zinc phosphide test was conducted in a field of growing rice. This field was roughly triangular in shape, bounded by roads on

two sides and a major canal on the third side. The entire field consisted of 25 manzanas. A major levee divided the field into two parts of 12 and 13 manzanas. The 13-manzana portion was randomly selected as the test plot and the 12-manzana area served as the reference plot. The rice was approximately 45 days old at the time of treatment and had not reached booting stage. It was a variety called Huma from Puerto Rico and this was allegedly the first time it had been grown in Nicaragua. The dike on the outside edge of the field had been treated with Endrin bait approximately 5 days prior to initiation of this test. This test plot was treated with approximately 2.31 pounds of bait per manzana (.96 pounds/acre). Bait spots were placed every 5 meters on major dikes and every 8 meters on intermediate dikes.

One field test using Racumin as the control agent was conducted. It was established in the second half of the 40-manzana barren field described earlier. The Racumin bait formulation currently in use at Finca El Triunfo was used in the study. The bait is mixed at the rate of 1 part Racumin concentrate (0.6%), 1 part sugar, and 19 parts carrier (broken rice). It is then sealed in plastic bags which are filled by hand and contain about 30-40 grams of the mixture. As they are applied, the plastic bags are dipped into molasses which allegedly acts as a rodent attractant. Approximately 2,200 packets were distributed along the dikes at 5-meter intervals (about 9 pounds bait per manzana). The local practice is to periodically repeat this application, but only one application was made in this test.

A field of approximately the same size and physical appearance to the zinc phosphide/Racumin test plots and located directly across an access road served as a reference plot for the barren field tests.

Treatment effect was determined by comparing trapping results. Each plot was evaluated with three lines of 30 traps each with traps placed at 10-meter intervals and set for 3 consecutive nights. Victor 4-way rat traps were used with peanut butter and rolled oats as bait.

RESULTS AND DISCUSSION

Acceptance Test

Locally captured rats (*Sigmodon* sp.) were offered yucca, carrot, potato, rice, corn, sorghum, jicaro, platano, and bean. Free water was available. Results are summarized in Table 1. Analysis of the data shows that acceptance of potato was significantly higher than rice, and that acceptance of rice was significantly higher than all other candidates. However, rice was chosen over potato as the bait carrier for the following reasons: (1) it is less expensive, (2) it is more readily available, (3) it more easily prepared and treated with toxicant, and (4) because the bait can be prepared in advance and held for several days before using.

Population Comparison

Results of the trapping efforts are summarized in Table 2. Though it would not be safe to draw many conclusions from so limited data, it is obvious that the area supports a high population of cotton rats. Trap

TABLE 1. Consumption of candidate bait materials by cotton rats*

	Grams consumed													
	A	B	C	Day 1	A	B	C	Day 2	A	B	C	Day 3	Overall Total	$\bar{X}$
Yucca	0.00	0.95	9.40	10.35	10.49	0.30	1.52	12.31	31.56	6.76	29.95	68.27	90.93	30.31
Carrot	0.00	0.20	0.00	0.20	2.40	3.17	0.00	5.57	3.10	4.62	5.95	13.67	19.44	6.48
Potato	15.15	0.00	0.00	15.15	26.78	39.79	43.86	110.43	45.89	42.92	11.32	100.13	225.72	75.24
Rice	10.70	2.50	19.60	32.80	30.60	16.50	21.60	68.70	20.20	9.50	20.10	49.80	151.30	50.43
Corn	8.00	0.00	2.80	10.80	2.00	12.60	5.00	19.60	8.40	12.90	6.60	27.90	58.30	19.43
Sorghum	1.10	0.00	0.30	1.40	2.00	19.20	2.40	23.60	12.70	4.20	5.70	22.60	47.60	15.87
Jicaro	0.70	0.00	0.40	1.10	4.30	4.40	0.00	8.70	0.00	0.80	0.00	0.80	10.60	3.53
Plantano	1.10	1.40	1.60	4.10	4.37	5.00	3.92	13.29	5.69	4.05	6.46	16.20	33.55	11.18
Bean	0.40	4.00	1.80	6.20	0.70	3.60	1.30	5.60	0.00	0.60	1.30	1.90	13.70	4.57

*Moisture loss of succulent materials was measured and adjustments were made.

TABLE 2. Number of cotton rats captured on five habitat types using 30 traps each for 1 night

Site description	Total animals	Male	Female	Per cent trap success
Irrigated growing rice	20	8	12	66
Barren field - dike perpendicular to green rice field	19	8	11	64
Barren field - dike perpendicular to gravel road	22	12	10	74
Plowed field	4	1	3	14
Woods - scrubby woodland, cactus, small trees, dry grass	12	4	5*	40

*Three animals had been partially eaten by scavengers and sex could not be determined.

success ranged between 14 per cent for the plowed field to 74 per cent for one of the "barren" fields. The mean trap success for the five areas was 51 per cent.

The relatively low trap success for the plowed field suggests that the process of plowing has a reductional effect on animal numbers. This could be confirmed by measuring the population prior to plowing and again after plowing or by monitoring the fate of several animals carrying miniaturized transmitters. It also appears that the scrubby woodland adjacent to the farm land supports a lower population of cotton rats than the barren fields or fields with a growing crop of rice.

There was a slightly higher number of females (38) captured than males (33). A similar ratio existed on the baited and reference plots (Tables 3 and 4). A total of 495 animals were captured where sex could be determined. Of these, 182 were males and 313 were females resulting in a male/female ratio of 1:1.72. This relatively high female ratio will have a positive influence on maintaining a high population density. Of the females examined, none were found pregnant, though some of the males appeared to be in breeding condition.

On the two reference plots for the field baiting studies, the third day trap success was 52 per cent of the first day catch. This relatively high trap success following 2 days of removal is another indicator of a high animal density.

TABLE 3. Results of post-treatment trapping on barren field test plots

Treatment	Total animals	Male	Female	Per cent trap success
Reference				
Day 1	50	9	41	56
Day 2	36	6	30	40
Day 3	23	9	12*	26
Total	109	24	83	41
Zinc phosphide				
Day 1	5	0	5	6
Day 2	3	2	1	4
Day 3	3	1	2	4
Total	11	3	8	4
Racumin				
Day 1	57	18	39	64
Day 2	55	28	27	62
Day 3	41	10	31	46
Total	153	56	97	57

*Two animals had been partially destroyed by scavengers and sex could not be determined.

TABLE 4. Results of post-treatment trapping on ricefield test plots

Treatment	Total animals	Male	Female	Per cent trap success
Reference				
Day 1	60	25	35	67
Day 2	45	17	28	50
Day 3	34	18	16	38
Total	139	60	79	52
Zinc phosphide				
Day 1	10	4	6	12
Day 2	15	5	10	17
Day 3	6	5	1	7
Total	31	14	17	12

Field Tests

Two days after treatment, three rows of 30 traps each were set for 3 nights in the barren field zinc phosphide plot and the barren field control plot. Two lines were randomly located on intermediate dikes and one line was purposely set along the main canal associated with the field. The effectiveness of the zinc phosphide treatment was measured by comparison of the trap success ratio between the treated and reference plots. The baiting produced a 90 per cent reduction in the cotton rat population. Results of the baiting tests are summarized in Table 5.

Five days after treatment, three rows of 30 traps each were set for 3 nights in the barren field Racumin plot. These results were again compared to the results obtained in the barren field reference plot. No reductional control was achieved as a result of this treatment. Although only a single application of Racumin was made, the fact that a single application of zinc phosphide bait resulted in a marked reduction indicates that it is more economical, at least in terms of time and labor. An examination of the plastic bags the day after application revealed that about half of them had been penetrated by rodents. The amount of bait consumed, however, was slight compared to the amount remaining. There was sufficient bait available to maintain feeding at that same rate for several consecutive days.

TABLE 5. Comparison of difference in numbers of animals trapped on treated plots and untreated reference plots

Treatment	Number of rats captured on treated plot	Number of rats captured on reference plot	Per cent difference
Zinc phosphide* barren field	11	109	-90
Racumin** barren field	153	109	+29
Zinc phosphide* ricefield	31	139	-78

*Trapping initiated 2 days after treatment.
**Trapping initiated 5 days after treatment.

The morning following baiting a dead hawk was found on the zinc phosphide treated site. This bird could have been killed by feeding on rats intoxicated by the zinc phosphide bait. However, remains of other dead birds that had died weeks before were not uncommon thoughout the entire farm.

Two days after treatment, three rows of 30 traps were set for 3 nights in both the growing rice zinc phosphide test plot and the growing rice reference plot. Again, two lines of traps were randomly located on intermediate dikes and one line deliberately set along the main canal associated with the field. Comparison of trapping results indicates a 78 per cent reduction in the cotton-rat population on the zinc phosphide plot. Although the reductional control in this test was lower than that achieved in the barren field test, 24 of the 31 cotton rats caught in the treated area were caught on the main canal, even though this was only one-third of the total traps involved. This would indicate that rats were crossing the canal and entering the treated area from a barren field on the other side of the canal. On the reference plot, 72 of 139 cotton rats (52%) were captured on the canal.

The relatively high trap success (Table 4) achieved in the ricefield reference plot indicates that little reductional control was accomplished by baiting with Endrin around the periphery of the field approximately 5 days prior to initiation of this test.

CONCLUSIONS

The densi / of cotton rats in the ricefields of Nicaragua is high. It appears that these agricultural sites support higher populations than the adajcent wooded areas. Plowing and perhaps other land preparation does have a reductional effect on the populations.

Rice (puntilla) treated with 2 per cent zinc phosphide effectively reduces cotton rat populations when applied during the dry season and under the conditions similar to this study. The reductional control resulting from the use of the zinc phosphide bait far exceeded that of the Racumin bait test. However, a single baiting and a delay of only 5 days from the time of baiting until the test site was trapped, may have contributed to the lack of reductional control measured on tho Racumin plot

There were numerous birds observed on most of the farms visited. It is quite likely that many seed-eating birds (doves) will be killed if zinc phosphide treated rice is used extensively in agricultural areas. Birds of prey could also become victims of accidental poisoning by feeding on intoxicated animals. Another potential problem concerns the carrion-feeding birds.

RECOMMENDATIONS

(1) That: Additional studies be scheduled to learn more about the biology of the cotton rats in agricultural areas of Nicaragua. This would include population trends, movement patterns, and the effects of agricultural practices on density and movement.

(2) That: The zinc phosphide formulation as used in these studies be tried, under supervision, in several areas before recommendations for general use are made. The effectiveness should be measured and close observations made concerning the effect on nontarget species--primarily birds.

(3) That: The hazards to birds be determined and that procedures be developed to minimize the problem before general use of zinc phosphide baiting is permitted. This may be accomplished by packaging the bait or otherwise reducing hazard to seed-eating birds, early morning patrolling to keep away birds of prey (the morning after baiting), and by recovering surface-killed animals to keep them from being consumed by carrion-feeding birds.

(4) That: Additional field studies be conducted to compare the relative effectiveness of zinc phosphide and current reductional control procedures (Racumin).

(5) That: The use of Endrin as a rodent control agent be discontinued. The hazards associated with its continued use far outweigh any possible benefits.

(6) That: Damage surveys be conducted to more accurately define the cotton rat problem in rice and other agricultural crops.

(7) That: A representative from the Banco Nacional de Nicaragua attend the Vertebrate Damage Control Workshop to be held at the Denver Wildlife Research Center starting in early September 1971.

ACKNOWLEDGMENTS

We wish to extend our appreciation and thanks to those persons who participated in these studies or through whose efforts they were made possible. Special thanks are due the staff and personnel of the finca "El Triunfo" where the studies were carried out. They readily made their facilities and personnel available to us. Mr. Carl Koone and his staff in the rural development office of the AID Mission were instrumental in getting the program started and the cooperation of the Technical Assistance Division of the Banco Nacional de Nicaragua is most appreciated.

Appendix A

ASSESSMENT OF RODENT DAMAGE
Finca Finlandia
(Dr. Donoso Montealegre)
January 30, 1971

Conditions and Procedure:

A single field containing about 50 manzanas (85 acres) of rice (3-4 weeks from harvest) was divided into two parts and examined for rodent damage. The first half was reported to have "heavy" damage and the second half "medium" damage. Sampling consisted of four transects of 100 hills (plants) for a total of 400 hills for each half of the field. A table of random numbers was used to select location of the transects and plants within rows were taken at 7 meter intervals. The plants were examined for total number of tillers and for the number of tillers cut by rodents. These figures were recorded and used for calculating the degree of damage in the two portions of the field.

There were some obvious differences in the field conditions and the stage of rice development. In general, the first one-third of the field ("heavy damage area") was semi-dry whereas the last two-thirds had standing water. Also, portions of the rice in the center one-third was less mature than that of the remainder of the field. These factors may have contributed to the differences in degree of damage.

Participants:

Dr. Donoso Montealegre	Owner of Finca
René Bojorge D. William Bird F. Alfonso Eger I. Victor Mora V.	Banco Nacional de Nicaragua
Nelson B. Kverno	Denver Wildlife Research Center

Results:

	1st Half	2nd Half
No. tillers cut	1134	358
No. tillers not cut	2148	1990
Total tillers	3282	2348
Percent tillers cut	34.6	15.2
Percent hills damaged	79	37

Entire Field

Percent tillers cut	26.5
Percent hills damaged	58

Appendix B

The results of another test were received just prior to stapling of this report. The data relate to another aspect of the problem and, therefore, are presented as an attachment:

COMPARATIVE BAIT ACCEPTANCE STUDY

by

Everardo Vogel, Rene Bojorge, and Donald J. Elias

INTRODUCTION

The Problem

One of the objectives of any toxic baiting program is the development of a bait that is readily accepted by the target animal. Another is the development of an application technique which will serve to make the bait available and effective for a reasonable period of time in order to achieve the desired results.

This study was conducted to determine the effect on bait acceptance of various treatments, additives, and packaging materials.

PROCEDURES

This study was carried out on the finca "El Triunfo" located in the jurisdiction of Tipitapa, Department of Managua, in Nicaragua. Twenty locally captured rats (*Sigmodon* sp.) were held in a 10 x 10-ft aluminum sheeting enclosure covered by poultry screening. The sides of the

enclosure were buried approximately 8 inches in the ground. About 4 inches of gravel and soil were spread over the floor of the enclosure to provide soft earth into which the animals could burrow. Dry grass and weeds were also scattered about in the enclosure to provide cover. Eight candidate bait treatments were offered to the animals in the enclosure. One hundred grams of each were randomly placed in small aluminum feeding dishes which were fixed to each of three feeding boards (three replications) on the floor of the enclosure. Free water was available. The test consisted of three consecutive 24-hour feeding periods with consumption measured at the end of each period. The student's t-test was used to analyze the data obtained.

RESULTS AND DISCUSSION

Consumption of the candidate bait materials is summarized in Table I. Analysis of the data shows that acceptance of hulled rice treated with vegetable oil was significantly higher than all other treatments. There was a very definite reduction in acceptance between loose samples and those contained in plastic bags (Fig. 1). This indicates that the use of plastic bags would significantly reduce acceptance and thus offset any possible benefits such as protection of the bait from adverse weather. Molasses apparently has no value as an attractant. Both plastic bags and molasses are currently used in rodent control programs in Nicaragua.

TABLE I. Grams consumed of candidate bait treatments

	Description of Treatment	Total Day 1	Total Day 2	Total Day 3	Daily $\bar{x}$
I	Untreated hulled rice	29.00	52.50	65.00	48.83
II	Hulled rice treated with vegetable oil	42.00	43.00	102.00	62.33
III	Hulled rice treated with molasses	41.00	16.00	78.00	45.00
IV	Untreated hulled rice in plastic bags	0.00	3.00	8.00	3.66
V	Hulled rice treated with vegetable oil in plastic bags	10.00	10.00	11.00	10.33
VI	Hulled rice treated with molasses in plastic bags	2.5[illegible]	0.00	2.00	1.50
VII	Untreated hulled rice in plastic bag treated with vegetable oil on outside	1.00	1.00	0.00	0.66
VIII	Untreated hulled rice in plastic bag treated with molasses outside	0.00	0.00	3.00	1.00

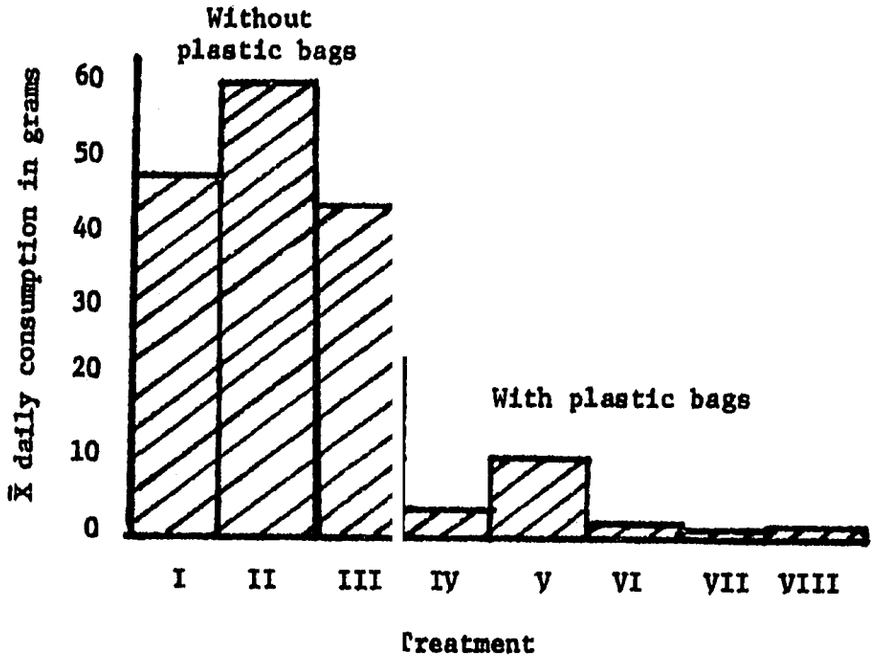

Fig. 1. Comparison of average daily consumption of candidate treatments.