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RODENT CONTROL IN SENEGAL: PRESENT PROBLEMS, FUTURE NEEDS*

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The obvious problems of communication associated with second and third hand translation from primary sources of information may have resulted in serious misinterpretations of the observations or comments of local workers. I accept full responsibility for the inclusion of any such erroneous information.

Introduction

For approximately two seasons following the drought in the Sahelian Region of Africa, rodent populations of several species have been increasing to levels considerably above those previously known by local authorities and beyond any previous occurences in the memories of old men in rural villages. The phenomenon is unusual in that several species of rodents seem to be involved. This suggests a relationship to the improvement in habitat quality following the drought, rather than the cyclic pattern of periodic increase and sharp decline frequently observed with some rodent localized studies in Senegal by the mammal ecologists of ORSTOM would suggest a usual pattern of annual decline of field rodent populations below the level at which serious crop damage could occur, as evidenced by the problems reported with wet season crops in some areas last year.

The most immediate problem in Senegal and adjacent countries is the protection of existing crops during the remaining three and one-half months of the dry season. Movement patterns of the several problem species are uncertain under these conditions, however, localized immigration of rodents from uncultivated or post-harvest areas to remaining croplands, garden plots, and rural food stores may be anticipated as the dry season progresses. During the wet season, localized redistribution of populations may occur along with increased mortality and a decline in visible rodent activity in field areas may be apparent. Protection of newly planted seeds and emergent crops will be particularly important during this time.

Longer range projections are difficult, given the limited information available on previous patterns of crop

damage by rodents in the Sahelian region. Certainly, the present situation should be viewed as extraordinary. Depending on weather, and a variety of other factors, rodent populations may decine to ordinary levels after this season or may fluctuate at generally high levels for several seasons. Extension and stabilization of agriculture, particularly in the small garden plots around villages and on irrigated areas in the Fleuve Region may be expected to provided increasing areas of favorable rodent habitat and these areas may have continuing problems. It should also be apparent that rural people will be more aware and concerned about rodent damage for many years after the present outbreak. If the government's control program has even moderate success in village areas, the demand for rural assistance with rodent damage will surely increase even if actual rodent populations decline.

In the tropical areas of Southeast Asia, similar enlargement of planted areas and the development of intensive year-round agriculture, based on irrigation and rapid-growing crop varieties, appear to have transformed the rodent damage problem from one of periodic outbreaks of single species to patterns of chronic loss in which rats routinely destroy an average of 5% or more of the annual crop production before it leaves the field. It may not be unrealistic to expect similar changes in the relationships of rodents to Sahelian agriculture.

Pest Species

Rodents are a natural factor in the Sahel environment, preceding, no doubt, man's agricultural activities. Generalized extermination of these problem species over an entire range of

natural habitats is neither practical, feasible, or desirable. Instead, control efforts must be directed specifically toward situations where the rodents are pests. The program goals, in any case, should be protection of crops or reduction of damage, not simply killing rodents. Any control methods should be chosen, evaluated, and used with this important distinction in mind.

In Senegal, three principal groups of rodents appear involved in damage situations:

- Arvicanthis niloticus - commonly observed in field areas because it remains active during daylight hours. It can be recognized by its yellowish brown, grizzled pelage, adult weight ranging about 150 g, and tail shorter than combined length of head and body. Farmers refer to this species as "black".
- Taterillus pygargus - commonly occupies burrows and becomes active only at night unless disturbed. Pelage color ranges from brown to orange-brown (in younger animals) on back and sides and whitish gray beneath. Tail is longer than the combined length of head and body; weights of adults range about 40-50 g. Villagers call this species -and probably other similar appearing small rodents- "white".
- Mastomys Sp. - at least two species of this group apparently occur in Senegal; the group is still undergoing systematic revision. Coat color may be gray to reddish gray and has a soft appearance. Tail length is generally about the same as that of head and body. Adult weights may range about 75g.

Generally, these species occur in a variety of habitats with A. niloticus appearing to be the most generally distributed. A. niloticus appears to be the most important species involved in crop damage in the Fleuve area, while T pygargus may be a more significant pest in peanut growing regions, particularly after harvest. The two species of Mastomys tend to be separated in distribution on wet and drier areas. Other species such as Praomys tullbergi, Cricetomys gambianus, and Tatera gambiana are also reported in increased numbers in agricultural and garden habitats.

Types of Damage

A variety of types of rodent damage were observed during my visit and additional reports of other damage were collected. The following list represents damage situations I encountered or heard from reliable observers:

- Manioc (Cassava) - Severe damage to manioc plantings were observed at two areas north of Rufisque and one north of Tivaouane. Rodents dig or burrow at the base of the plant and gnaw into the root, often severing it completely. Both large and small plots of manioc had a high incidence of damaged plants. The tops of recently planted cuttings had been gnawed in one area. Damage tended to be distributed in patches --low in some sections, high or nearly complete in others.

- Rice - Most rice in the areas I visited had been harvested, however the post-harvest fields I examined near the Savigne Forest area and near Ross-Bethio still had considerable rodent activity in fields and on dikes. At Ross-Bethio many nests of A. niloticus remained in the fields. Construction of these 15-25 cm spherical masses of finely shredded vegetation probably accounts for considerable plant

destruction in grain fields in addition to the material that is consumed. In an irrigated section of seed farm within the SAED Delta Area a farm manager reported a harvest of 48 tons of rice on 250 hectares (192 kg/ha) where a yield of 375 tons (1.5 ton/ha) would be expected. The rodents, presumably A. niloticus were observed to enter the flooded fields readily.

- Groundnut (peanut), maturing - most groundnut had been harvested in November and I observed no growing fields; however, damage to maturing crops has been widely observed. In one section visited near the Savigne Forest, a 15 hectare field was reportedly invaded by A. niloticus and destroyed in October, about 3 weeks before harvest, when a large rice area located directly across the Lampsar River (a tributary of the Senegal about 100 m wide at this point) was harvested.

- Groundnut (peanut), harvested - Groundnuts are often left in the fields to dry for a considerable period after harvest. Before being transported to Dakar for processing they may be held for a further length of time at open storage depots. During these periods of unprotected drying and storage, rodent losses continue. One or more of the rodent species -most likely only T. pygargus stores groundnuts in its burrows. Villagers may quickly recover significant quantities of stored groundnuts by opening burrows in such areas. Mr. Diarra, Departmental Agricultural Officer at Louga surveyed underground groundnut storage in 4 villages using five 25 m^2 plots per village. He estimated 2000 rodent burrows/hectare containing 35 kg of stored groundnuts per hectare. This amounted to about 6% of the groundnut production of these villages, according to his calculations. In one area near Louga it was reported, that of a 600 kg/ha groundnut harvest, rodents had stored 100 kg/ha underground, while in another area in the same district villager

villagers reported loss of most of the groundnut crop after harvest.

- Growing Millet and Sorghum - Most millet and sorghum had been harvested in the areas I visited; however, at areas a short distance east of Dagana, we observed young millet with only minor damage apparent, but some rodent activity. Nearby, in a sorghum field 3-4 weeks before harvest, rodents (possibly Mastomys and/or young A. niloticus) climbed plants to feed on developing heads, although this type of damage was minor. More serious in this area was damage to stalk bases at ground level, possibly by adult A. niloticus, which caused the entire stalk with its grain-bearing head to fall. Incidence of this damage was moderately high.

- Harvested Millet - In the area east of Thies I observed field storage of millet in stocks constructed by laying parallel rows of stalks with the heads placed inward, then piling one row a top another. These piles were foci of considerable rodent indent activity, with burrows under the piles and vicinity and connecting runways worn deeply into the soil.

- Wheat - Wheat damage was described at several areas in the Fleuve, although most had been harvested. In the SAED Delta area, it was reported that rodents had caused much pre-harvest damage. It was also reported that rodents eat newly planted seeds, particularly around field perimeters. Several farm managers reported they were not planting wheat this season because of the probable losses to rodents. Very recently planted wheat at SAED Dagana appeared to have little damage, but those familiar with the area anticipated problems with rodents moving to these fields when other areas were harvested.

- Seedbeds, tomatoes - Many villages in areas near the large tomato farms, maintain seedbeds on small plots and provide seedlings for farmers. At Bokhol village near Dagana, the few remaining seedbeds were receiving considerable damage, probably by A. niloticus; however, damage was reported reduced on much of this area using a wax-block rodenticide provided by SAED.

- Small plot vegetable: Tomatoes, potatoes, beans, cabbage, carrots - damage to small vegetable plots was seen in most areas visited where gardening is practiced. Depending on the age of plots, either vegetative growth or the edible fruit itself was damaged. Such garden plots received heavy rodent pressure because they are usually surrounded by large uncultivated areas from which rodents move to feed. A. niloticus probably accounts for much of this type of damage. Garden plots will probably be under increasing pressure from rodents as the dry season progresses.

- Plantation or truck farm vegetables: tomatoes, peppers, melons - Much of the planted area observed both in the vicinity of Rufisque and in the Fleuve involves vegetables, particularly tomatoes, peppers, and melons grown on large plots for processing or export. These crops are sometimes grown in rotation with groundnuts or wheat. These areas represent sizable investments in land clearance, irrigation, fertilizer, and pesticides. The losses encountered during the past 1 1/2 - 2 years presumably represent serious reductions in yield for these larger operations, although production figures were not generally made available. In crops such as tomatoes and peppers where much bare soil is maintained during plant growth, heaviest damage apparently occurs around field

perimeters, although in the Savigne area I observed many cut tomato stems in the interiors of large fields. In crops such as melons, where vegetation covers most of the soil area, damage is said to be more generally dispersed through the fields. These large operations which are best equipped economically to deal with pest damage problems have generally undertaken some type of anticoagulant baiting activity, some with reported success, others with less satisfactory results. Virtually all managers of such operations that I met mentioned difficulties in obtaining sufficient supplies of rodenticides for their planned operations. Newly cleared areas, still surrounded by large tracts of uncleared forest apparently presented the most difficult situations for controlling damage and managers generally reported their control efforts unsatisfactory.

- Sugarcane - increasing areas of sugarcane are being planted in the Fleuve region, around Richard Toll. Rodent damage was reported, and I saw examples of stalk damage with the typical pattern of gnawed internodes; however time did not permit examination of field areas. It should be noted that an important aspect of rodent damage to sugarcane is that the gnawing of stalks allows the introduction of souring organisms, typically causing a greater loss of sugar content than the physical damage by rodents.

- Village houses - visits to a few houses confirmed that these are also occupied by rodents, probably *Mastomys sp.* in the area visited, but possibly also *Mus musculus* or *Rattus rattus*. No estimates of food losses are available, but under somewhat similar conditions in Nepal, Dr. Stephen Frantz, Johns Hopkins University, estimated that rodents consume about

65 kg/year/dwelling - the approximate food consumption of one child.

- Irrigation Dikes - I did not observe seriously damaged dike systems, although the behaviour of A. niloticus in enlarging cracked ground and the burrowing behaviour of I. pygargus and Mastomys would certainly make this possible, particularly in areas where soils are loose and sandy. On one 50 m section of 2 m wide dike in the SAED Delta area, I observed about 30 A. niloticus as I walked. Heavy rains during the wet season will presumably aggravate this problem unless affected dikes are repaired.

- Drip irrigation systems and sprinkler hoses - Government of Senegal reports heavy damage in some reforestation areas, and notably the loss of 10,000 seedlings on a 25 hectare area at Mbidi. Damage to citrus and guava trees by girdling has also been reported. I observed some girdling of isolated papaya trees near Rufisque and of small neem trees along the highway to Thies. Attempts had been made here to protect trees by encercling them with chlorophacinone tracking powder (0.2%). Girdling of unidentified trees bordering harvested groundnut fields near Louga appeared associated with burrows of the ground squirrel Xerus erythropus; however, I. pygargus burrows were present and many A. niloticus were observed in adjacent fields. I heard reports in the Dagana area of A. niloticus climbing large Acacia trees, but no instance or damage was observed.

- Natural and second growth vegetation - as far as can be determined from brief observations and by discussion with the ecologists of ORSTOM, rodent populations have also increased to unusual levels in many of the non-agricultural habitats and forest reserves and might be expected exert

influences there, for example, in the reduction of browse and grasses available to cattle and wild grazers. I noted in several areas, evidence of extensive rodent feeding on wild leguminous shrubs, grasses, and forbs, particularly the sandbur Cenchrus bifloris. Nonetheless, control operations in such areas are not indicated except in perimeters around agricultural areas.

Land Area Involved.

Lacking detailed information about seasonal areas planted to various crops, I am unable to personally assess the overall distribution of damaged and potentially damageable areas. About 55% of Senegal's 76.000 square miles are classified as agricultural, much apparently in grazing area and small gardens. Government of Senegal surveys made in December, 1975 of agricultural lands having or expected to have rodent problems estimated that 315.000 hectares (about 1,5% of Senegal's land area) fell into this category. About 95.000 hectares were estimated to have dry season crops suffering damage or damaged dikes requiring immediate attention in the next 1-3 months. Given the considerable rodent activity I observed in most habitats and the statistic indicating involvement of nearly three-fourths of the population in agriculture, these projections seem conservative. Of course, prediction of the wet season infestation is difficult from the present perspective, since what occurs will depend partially on changes in the rodent populations and partially on the effectiveness of the planned control program. I consider it unlikely that sigrificant numbers of Senegal's rodents are moving or will move across borders to adjacent countries. Rather, other country problems are

related to the same general changes in rodent populations that are occurring throughout the Sahelian region.

Planned Actions by the Government of Senegal.

The Government of Senegal has planned a massive program of rodent control on the areas projected in the survey. The basic objectives of this program are:

- to protect presently growing crops
- to permit successful growth of wet season crops
- to preserve expensive dike installations from damage by burrowing
- to clear agricultural areas of rats
- to avoid expansion of rat populations in the interior areas where most of the groundnut crop is grown.

The program to accomplish these objectives involves essentially four phases:

- emergency action to protect growing crops
- intensive population reduction on harborage areas at the close of the dry season
- protection of wet season crops
- organization of medium term activities to improve control methods and reduce costs in the context of an on-going crop protection program.

The scope of present planning is directed principally toward the first three activities along with provisions for training for government agricultural personnel, distribution of materials, and rural incentives (particularly food-for work) to gain local participation.

Rodent control methods planned for use in the national program may be categorized as physical and chemical. The physical control program presently planned includes organization of drives or battues in the crop areas as well as on livestock areas and uninhabited lands in the problem region. Incentives to gain participation are planned in the payment of bounties: 1 kg of rice for 10 rodent tails, or 1 kg of millet, sorghum, or corn for 5 tails. Limited use of flame throwers is also planned for burrow clearance. The physical control program is estimated to require 13,760 tons of rice or 27,520 tons of millet, valued in the range of 1,238,400,000 F.CFA (at Dakar retail price/kg) or approximately $5.5 million (US).

Chemical methods to be employed revolve principally around the use of commercially prepared anticoagulant bait (see table 1) in two single applications. Program cost estimates, prepared with the assistance of an FAO consultant, are based on two treatments of 95,000 hectares during the dry season with 7.5 kg/ha, and two treatments of 315,000 hectares during the wet season with 4 kg/hectare at an estimated cost of 300 F.CFA ($1.35 U.S. ca.) per kilo, or a total materials'cost of 1,183,500,000 F.CFA or approximately $5.3 million (US). The costs for prepared bait (300 F.CFA) used in these estimates is approximately 75% of the cost of similar baits sold in Dakar retail markets.

The decision to utilize primarily, prepared bait (factory formulated on grain) is apparently based on experience with satisfactory use of these materials on some of the large commercial production farms in Senegal and on the necessity for rapid program implementation. This decision adds

considerable cost to the program, since a major proportion of the costs are tied up in the grain bait carrier, factory formulation, and transportation.

The use of such material also presents overwhelming logistics problems compared to distribution of anticoagulant concentrates and preparation of bait from local grain at point of use. Since no efficacy tests or local experience on any scale exist for farm-formulated bait and tremendous time pressures exist for immediate program implementation, the logic of using formulations that have proven satisfactory in Senegal is undeniable.

Technical Comments on Rodent Control Methods.

Bounty payments for rodent tails or carcasses: Although this approach is still used and, indeed, recommended in some areas of the world, the prevailing opinion among rodent control specialists is that such an approach makes little effective contribution to protection of crops. In fact, this practice often directs the attention of "bounty hunters" away from croplands toward brush areas where animals are more concentrated and easier to capture quickly. Even with incentive payments, affected farmers often lose interest in the hard work of capturing rodents, particularly when other agricultural tasks must also be performed. Some consideration might be given to devising appropriate mechanisms of focusing rural attention on physical approaches to remove rodent in specific crop fields and adjacent harborage areas, to retard reinvasion, and to improve crop storage conditions. This might be done by basing food-for-work incentives on time spent rather than rats collected.

Anticoagulant baits: The anticoagulants function by disruption of blood clotting mechanisms, causing animals to die from internal blood loss. The same family of materials are used as human drugs when reduction of blood clotting ability is desired - for example, in the treatment of heart disease. They require several days to act, and rodents must generally consume several doses. Death times for Rattus rattus consuming these materials are more toxic than others, and may have one-dose effectiveness on some species. Chlorophacinone is probably in this category. Nonetheless, since all the materials act slowly, animals generally continue to eat for several days before developing the initial toxic symptoms.

The single treatments planned for the national program may represent inefficient use of these materials. In dense populations competition among animals for use of bait points may result in major portions of a population not receiving regular doses for several days. This effect may be aggravated if some rodents in a population are shy of new food sources; most of the bait may be consumed by others before these animals receive effective doses. Two separate treatments of infested areas would not necessarily solve this problem since rodents may recover from anticoagulant intoxication if bait is unavailable for one or two days -then the whole physiological process must start again when baiting is resumed.

Use of bait stations: Protective boxes, cans, huts, or baiting tubes may be helpful in protecting bait from children, birds, dogs, and domestic stocks, as well as protecting it from rain. The latter factor may become critical during the wet season because direct exposure to rain may leach the toxic

chemical from baits making them ineffective. Similarly, wet bait may rapidly become unpalatable to rodents. Openings or access to stations must be large enough so that rodents enter freely. Only simple, low-cost local materials should be used in their construction.

Sustained baiting: An effective approach to using anticoagulant rodenticides to reduce damage by *Rattus* sp. to rice, corn, coconuts, and vegetables in Southeast Asia might be tested in Senegal. It involves the establishment of permanent baiting stations on cropland subject to rat damage and adjusting the number of stations to the degree of infestation each week. Stations may be removed after harvest unless crops are stored in fields. This approach has the advantage of continously protecting croplands regardless of rates of reinvasion. I believe this approach might be extremely helpful on some of the areas I observed in Senegal. Ideally, it might be tested here during the wet season, after a stable supply of rodenticide has been developed and dry season operations have been completed. Based on local costs in the Philippines, in tests where rats were the limiting factor in rice production, the equivalent of about 500 F.CFA/ha. was sufficient to protect rice crops for an entire season. A description of this program used by agricultural extension workers for training farmers is included as an Appendix.

Plastic bait packets: Formulated bait is sometimes packaged in small plastic bags to protect bait from moisture; I have seen some materials of this type in use in Senegal. Rodents investigate the bags, then chew through them to get the toxic bait. Such products may be very useful in extremely

wet areas. However, there is considerable indication that packaging in this manner significantly reduces bait consumption by field rodents. Tests by Wildlife Research Center personnel in Nicarauga, for example, indicated that bagging, depending on formulation reduced bait consumption by factors of about 5 to 50 from that of loose bait prepared from hulled rice and vegetable oil. The packaging process may also add a considerable cost increment to the bait formulation. Controlled tests should certainly be done before they are used extensively.

Paraffin blocks: Anticoagulant bait is frequently mixed with paraffin and cast as blocks or pellets. This may reduce costs if bait carriers required are more expensive than paraffin (generally not the case). In some situations, blocks are considerably easier to handle than loose bait and local preparation may be possible. The blocks generally retard bait deterioration under moist conditions; however, many types soak, crumble, and become unpalatible if they become thoroughly wet. Unless high melting-point waxes are used, blocks may melt and become unpalatible when exposed in fields in hot regions. Local tests should be conducted before such formulations are used on a large scale.

Poisonous tracking powders: Tracking powders may be effectively used to control rodents in some situations. They may be particularly useful in situations where food is so abundant that bait is not readily accepted. Rodents get powder on their feet and fur, then ingest toxic quantities of material in the process of grooming. Tracking powders use higher chemical concentrations than baits and may often be a more expensive approach. Effective field use of powders

is difficult, particularly under rainy conditions. The principal use of tracking powder (0.2% chlorophacinone) that I observed in Senegal was the encirclement of neem trees planted in reforestation areas along highways. Baiting might be tested as an alternative in these situations. Repellent paints or solutions containing the fungacide, tetramethyl-thyramdisulide, might be tested as well as the repellent plastic screening used in some countries to protect seedlings on tree farms.

Acute toxicants: These materials may have a role in the Senegal program, despite the frequently voiced concern about safety and bait shyness. Such compounds might be particularly useful in reducing reservoir populations at the close of the dry season harvest. Zinc phosphide, is problably the most widely used acute rodenticide available and should be tested on the local problem species. Generally, this material does not present major secondary hazards to non-target animals. It is actually less toxic than some of the chronic rodenticides, and could reduce treatment costs considerably since much less bait material would be required. It should always be used by trained personnel. If tested, single treatments followed by use of chronic rodenticides would avoid the problem of bait shyness. Prebaiting for 2-3 days with untreated bait may help increase the effectiveness of this material.

A new acute rodenticide, RH-787, might be tested with local grain base baits for potential future use. This material should also present minimal hazard if used by trained personnel. At the present time, RH-787 concentrates are available only for experimental uses. Commercial bait formulations are available in small packets. 20

Biological control: At present no techniques involving sterilants, diseases, parasites, introduced predators, or deleterious genes exist which are suitable for use or consideration in field rodent control in Senegal. Advice to the contrary shpuld be viewed critically. Research on several such methods is being carried in various parts of the world on related rodent species.

Safety

Any widespread use of any pesticide signal increased attention to safety and it is desirable that the Government of Senegal include programs for training farmers and agricultural workers in its planned campaign. Everyone, particularly village children should be warned not to handle bait and containers used for baiting should be marked "poison" and used for no other purpose. Bait should be stored in marked or locked areas and great care should be taken to avoid any accidental use as human food. Dog, sheep, goats, cattle, and other domestic animals should be kept away from baited area. Persons taking part in baiting operations should wash thoroughly when operations are complete. If major baiting activity is to take place around villages, it may be useful to brief rural doctors on the symptoms and treatment of anticoagulant intoxication, and to ensure that medical clinics have vitamin K available.

Suggestions for Non-Chemical Emergency Measures.

The time required for procurement and distribution of anticoagulant bait may be too long to protect many of the garden plots and stored food which are presently being damaged.

Prior to the initiation of baiting programs several approaches might be tested to try to reduce this damage:

- Clear debris and weeds from fields and clear brush from surrounding perimeters of 25 to 50 meters.
- Clear away thorn-bush fences that surround some fields. These collect blowing leaves and debris and serve as harborage and burrowing locations for the rodents. This practice might require increased attendence to keeping stock animals away from gardens.
- Kill rodents living in burrows in the gardens and surrounding perimeters, by digging open burrows, if necessary. Fill in burrows and resume operations whenever new activity is noted.
- Clean village yards, piling material off the ground to reduce rodent harborage.
- Store grain, food, and other material in houses being damaged by rodents on racks or tables away from walls where rodents can gain easy access.
- Pile millet, other grain, or groundnuts being dried or in field storage on racks or platforms a few inches of the ground to reduce rodent access.
- Dig trenches around large storage piles which cannot be raised from the ground.

Such projects might be undertaken by village children or under a foo-for-work incentive. These and other approaches should be tried on a small scale to test their usefulness before being generally recommended.

Rodents and Disease.

Rodents or their ectoparistes may transmit a variety of diseases to man. The potential for [illegible]

increased whenever rodents and men are in close contact, particularly if many rats are dying or being killed. Under such circumstance, fleas, mites, ticks, or lice may leave the dead animals to occupy new hosts. Diseases borne by some ordent species include plague leptospirosis, murine typhus, salmonellosis, and rat bite fever. I have no information on the potential of A. miloticus, Mastomys, I. pygargus or other Senegal species as vectors or reservoirs of these diseases. This should be checked at once, and consideration might be given to the inclusion of epidemiological surveys within the scope of the national campaign. Rural doctors should be briefed on the symptoms and treatment of rodent-borne disease and a reporting network established. People should be advised not to handle live or dead rats during the campaign. Burrows should be opened to search for dead rats after poisoning. Rats dying on the surface near inhabited areas should be removed with gloves or implements and burned or buried away from houses and areas frequented by humans.

An Effective Program for the Future.

Planning should be initiated for a more compréhensive program of evaluating the effectiveness, cost, and suitability of various rodent control techniques for the Sahelian Region and for training more agricultural officers in the techniques of methods evaluation and operation. Such a program might be approached on a regional scale, with Senegal becoming a primary site for training and preliminary field trials. Existence of other plant protection projects might provide a means to accelerate the development of necessary information and personnel to help evolve and support broadly

base, on-going programs of low-cost, effective pest control for the Sahel countries.

Types of Studies and Training Activities Required.

Although a more comprehensive plan for acquiring needed information could be drawn, I wish to mention a few examples of the types of fied evaluation activities and training programs that might prove most helpful in realizing the short-term and long-term objectives of the Government of Senegal rodent control program:

- evaluation of local bait carrier materials and formulations for various damage situations;
- development of efficient bait handling methods and systems of field baiting to minimize materials use;
- evaluation of methods of pretecting trees, drip-irrigation systems, and irrigation dikes from rodent damage;
- evaluation of cultivation systems, field preparation, and crop rotation schemes for reducing rodent losses on a permanent basis;
- development of appropriate systems for reducing rodent losses under rural storage conditions;
- evaluation of chronic field losses and cost evaluation of various control methods;
- local training in basic rodent control techniques, program evaluation, and safe materials handling for rural workers and village leaders;
- short-term (3-6 months) technical training in field evaluation techniques and operational program management for advanced government agricultural workers (potential source of training: Rodent Research Center University of the Philippines

- post graduate training in economic biology of pest vertebrates for personnel who might lead on-going control programs (potential source of training: Environmental Studies Center, Bowling Green State University, Ohio).

Summary

The Sahelian region has suffered for two seasons following the drought from extraordinarily high rodent populations involving several species. Some of the rodents involved occupy most major habitats; their visibility have raised rodent control from an "unimportant" agricultural activity to a focus of national attention in the context of an emergency program to protect crops. The program planned for Senegal would involve the use of more than 2 billion F.CFA or about $10 million (US) in prepared rodenticides and grain incentives during the next 8-9 months. Clearly this kind of effort, if possible at all economically and logistically, cannot be sustained for long or repeated periodically, and work must be undertaken to develop effective control methods using a local materials base. Efficient operation of a large agricultural implementation program require numbers of trained personnel --in this situation, trained in the specific techniques of effective rodent damage reduction. Talented government personnel in Senegal are making great efforts to carry out a successful program and additional training is planned in the course of the field campaign in rural areas. However, the magnitude of the problem and the need for quick action to protect remaining dry season croplands will probably make the shortage of trained personnel a critical factor in the initial dry season program. Various

environmental sanitation methods should be tried to reduce damage to small garden plots and village food stores -- perhaps as an alternative or in conjuction with planned campaigns. Local authorities should be briefed on pesticide safety and treatment of accidental poisoning, and arrangements should be made for epidemiological assessment of the potential for rat-borne disease transmission. As soon as possible, evaluation studies and training programs should be organized on a regional basis to make effective rodent control a permanent part of Sahelian agriculture.

APPENDIX A

Table 1.

Materials* proposed by the Government of Senegal for use in the national rodent campaign (table abstracted from GOS program proposal).

Commercial Name	Chemical Name	Formulation
BARAKI-RIZ	Chlorophacinone	0.005% bait
RACUMIN	Coumatetralyl	0.0375% bait
CAID	Chlorophacinone	0.075% bait
CAID	Chlorophacinone	0.025% tracking powder
TOMORIN	Coumachlor	1% tracking powder
RATILAN	GEIGY 23123	0.05% bait
WARFARIN	Coumafene	0.025% bait
SUPER-TURAGIL	Coumafene	0.005% bait
QUICK	Chlorophacinone	0.005% bait
SOVI	Crimidine	0.1% bait

* Use of unverified names of commercial materials for identification purposes only without recommendation or endorsement.

RAT CONTROL IN RICE FIELDS

Adapted from "The Philippine Recommends for Rice — 1976" and specially reproduced for the MASAGANA 99 Rice Program.

Joint Recommendations of the Bureau of Plant Industry; the College of Agriculture, University of the Philippines at Los Baños; the Rodent Research Center[1/]; and the Philippine-German Crop Protection Programme[2/].

For many years, rats have been a persistent problem of rice growers throughout the Philippines. Field damage by rats costs the nation millions of pesos every year (Figure 1).

Nearly all rice farmers suffer some rat damage, although extent of losses vary. Based on cut tillers at harvest, average losses are approximately four per cent. Each year some farmers suffer very heavy damage, even total losses at times. Fortunately, such occurrences are rare. A typical hectare of rice land may have an average of 20 to 200 rats, but some areas adjacent to swamps, marshes or waste areas may have as many as 10,000 rats per hectare.

Your chances of having heavy damage (over 10 per cent) on your farm are less than 1 in 10. If you plant near areas where rats can live between crops (for example, coconut groves, wasteland, or irrigation canals), your chances of having heavy damage are usually greater. Even under these conditions, the baiting method outlined in the following pages has been consistently successful.

Rat control is an essential investment, which requires money, time, and effort. Under most circumstances, only the equivalent cost of approximately one cavan of [illegible] per hectare (two to four) is enough to protect your crop.

KINDS OF RATS

Approximately 30 kinds of rats occur in the Philippines. Only two, Rattus rattus mindanensis and Rattus argentiventer, are serious pests in major rice-growing areas. These two types are difficult to recognize separately. In some regions, Rattus exulans and Rattus norvegicus attack rice crops. It is not possible, at present, to recommend different control measures for the different species. Most rat control methods affect whatever species is living in your field.

TYPE OF DAMAGE

Most farmers are familiar with rat damage. Rats may cause extensive damage to seedbeds. Shortly after transplanting, the seedlings are eaten. Oftentimes adjacent seedlings in a small area may be affected. As rice becomes older, rats cut tillers and eat portions of the developing head. This damage is dispersed throughout the field and is difficult to see unless the plants are examined closely.

When rat populations are relatively low, rat damage tends to occur along the dikes. During heavy infestations, more damage occurs in the paddy interior, resulting in "eat-outs." As rice heads mature, rats feed on individual grains, often remaining at one plant for sometime. After harvest, small piles of hulls can be seen on the paddy where rats have been feeding.

RAT CONTROL

The topic of rat control is a popular one among farmers, professional agriculturists, and laymen. Nearly everyone has a favorite theory or story about a new method or procedure that will work in any situation. In fact, no single control method can be used everywhere. In evaluating different methods, it is important to remember that the objective is to reduce crop damage. The number of rats you kill is not so important; it is the number that remain in your paddies that reduce your yield. Other factors, such as cost, practicality, safety for humans and animals, and environmental side effects, are also important to consider when a particular control method is chosen.

GENERAL MEASURES

Several general agricultural practices may be helpful in reducing potential rat problems. Cutting weeds along dikes and canal banks and adjacent waste areas, particularly several weeks before transplanting and during the early stages of rice growth, removes cover which rats need to survive. Transplanting at about the same time as your neighbors may reduce your chances of heavy damage. Fields maturing much earlier or much later than the surrounding crops often have very heavy rat damage and control measures at this stage are usually not successful. Killing rats at any time by any method may be helpful, but for the farmer who wants to protect his crop, there is no substitute for continuous rat control throughout the crop period! In areas with extremely high rat populations, baiting, with acute poisons before seedbedding or transplanting, is also desirable.

SUSTAINED BAITING

Chronic poisons provide a means of carrying on continuous rat control with very little cost and labor compared to some of the other methods. These bait materials are used at low concentration, so the amount

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1/ The Rodent Research Center is a cooperative research and training center supported by the Bureau of Plant Industry, the University of the Philippines at Los Baños, the National Economic and Development Authority, the National Science Development Board, the National Food and Agriculture Council, and the U.S. Agency for International Development.

2/ The Philippine-German Crop Protection Programme is an integrated crop protection program of the Bureau of Plant Industry assisted by the German Government.

of chemical is small. Rats must eat poison bait every day for several days, usually less than a week, before they are killed.

Because the symptoms develop slowly over a period of days, rats usually die in their burrows or in other protected areas. Many people like to count dead rats after poison baiting. This usually is not possible with chronic poisons. If bait is being consumed and you replace it regularly, you are killing rats! Your efforts will be rewarded by reduced damage. After 10 to 12 weeks of baiting you can expect to have reduced the rat population in and around your rice farm (see Figure 2) so that you can be assured of a good crop.

COSTS ARE LOW

The major costs of sustained baiting with chronic toxicants are for the bait carrier and for the time required to visit the bait stations regularly. Approximately 10 kilos of bait material is the most that is required under usual conditions to protect one hectare of rice for the entire crop. The labor required is approximately 1 man-hour each week throughout the crop. Many suitable chemicals are available. The costs of chronic toxicant enough to treat 10 kilos of bait range from ₱1.50 to ₱15.00 depending on the material used, the source of supply, and the area of the country.

MATERIALS TO USE

Chronic toxicants require bait material, a chemical concentrate and bait containers. Most grains can be used for bait material: choose one which is available or can be obtained at low cost in your region. Many farmers have obtained good results using low-quality milled rice or rice shorts. Do not use rough rice (palay), because rats remove the hulls and do not ingest much of the toxicant.

Many chronic toxicants are available in the Philippines as concentrates. Ratoxin, Racumin, Tomorin, Diphacinone, and Liphadione are examples of commercial chemicals which are available at agricultural stores. Prices and package sizes vary considerably, but all of the materials have similar action. When comparing prices, note that some concentrates can be used to prepare more bait material than others. To determine the actual cost of chemical in a finished bait, divide the retail cost of the concentrate by the number of kilos of bait to be treated. Read the label carefully so you can follow the manufacturer's instructions.

Local materials can usually be obtained at little or no cost for making bait stations. Sections of bamboo with nodes at middle or ends, one liter cans, or discarded one quart oil cans, opened on both ends, make good containers. Under very wet conditions, it is sometimes desirable to use larger bait stations which afford maximum protection from the weather. In areas with many rats, it is important to use enough stations to allow all animals easy access to bait (see Figure 3).

PROCEDURES

It is important to have bait material available to all rats throughout your field from planting until rice grains ripen. Because only a limited number of rats can feed at a single bait container, the number of containers must be proportional to the number of rats damaging your fields.

The following methods, tested under Philippine conditions, will help you relate the intensity of your control efforts to the potential damage to your crop. These procedures are recommended as a guide for your operations.

1. Mix the recommended concentrate with the bait material. Using more chemical than recommended does not improve control and will only increase your expense.

2. Select five baiting locations for one hectare of riceland to be protected. The locations should be at least 50 meters apart for good coverage. Containers can be placed on or along dikes, or supported above water level in the paddy. Other good locations to place bait containers are dike intersections, canal banks, or old threshing mounds.

3. Begin baiting as soon as your fields have been transplanted. Place one container at each location and put 6 tablespoons of bait inside. After three days, check the bait containers. If all of the bait has been eaten, at one location, place two additional containers and place 6 tablespoons of bait in all three, check again in 3 to 4 days. If the bait is gone, place 3 additional containers at the locations where this happened and maintain approximately 6 tablespoons of bait in each.

4. Continue to check the bait containers twice a week. If rats continue to consume most of the bait at some of the locations, place increasing amounts of bait in each container. A one liter can will hold up to 18 tablespoons. Try to anticipate increases in consumption so that bait will be left in the containers each time you check; add additional full containers if necessary. This is important. If bait is not available after rats have learned to come to the stations, there may be heavy feeding on nearby plants.

5. Remove and replace bait that becomes moldy or excessively wet.

6. Because the few remaining rats, less than 10 per cent of the original population, will prefer the developing grains to the bait, baiting may be stopped at least two weeks before harvest unless bait consumption remains high. When bait consumption begins to decline, some of the stations at each point may be removed.

WHAT TO EXPECT

Usually, bait consumption will increase rapidly sometime during the period 3 to 6 weeks after transplanting. This is the period when rats are moving into your paddies. Do not be alarmed by this rapid increase. Continue to replenish the bait and consumption will generally level-off or decline. If your neighbors are also practicing rat control, the increases will not be as great. When rice heads mature, bait consumption usually drops off sharply because there only are a few rats remaining. Although the remaining rats concentrate their feeding on grain heads, pre-harvest damage should be minimal. Remember that chronic toxicants work differently from other materials. Don't become discouraged if you don't find dead rats; they die in their burrows.

SAFETY

All agricultural pesticides are poisons and should be used carefully. Store pesticides in clearly labelled [illegible]

containers out of reach of children and pets. Do not use mixing cans or spoons used to measure pesticides for any other purpose. Mix chemicals outside your house. Do not breathe the dust or vapors. Do not eat, drink, or smoke while handling chemicals. Wash your hands thoroughly each time you finish your work.

Chronic toxicants are relatively safe compared to other pesticides. They cause breakdown of the blood clotting process and animals usually die from internal bleeding. If treated bait or concentrate is accidentally eaten, take the person to a doctor or clinic immediately. Treatment for poisoning with chronic toxicants consists of oral doses of Vitamin K, and in some cases, blood transfusion.

COOPERATIVE RAT CONTROL

When a farmer uses chronic poisons, the protective effects of baiting usually extend outside his farm for as much as 200 meters in each direction. Particularly during the first 5 weeks after transplanting, rats from peripheral areas will be attracted to bait containers. If your neighbors also practice sustained baiting, your results will be improved and everyone's costs will be reduced.

TECHNICAL HELP

These recommendations have been approved for implementation beginning in mid-1975 under the national rice production program — MASAGANA 99. Farmers qualifying for MASAGANA 99 loans or supervision may contact MASAGANA 99 rice extension technologists or participating banks for additional details.

For additional advice on rat control or for help in securing rat control materials, consult a Bureau of Plant Industry pest control officer or MASAGANA 99 rice extension technologist.

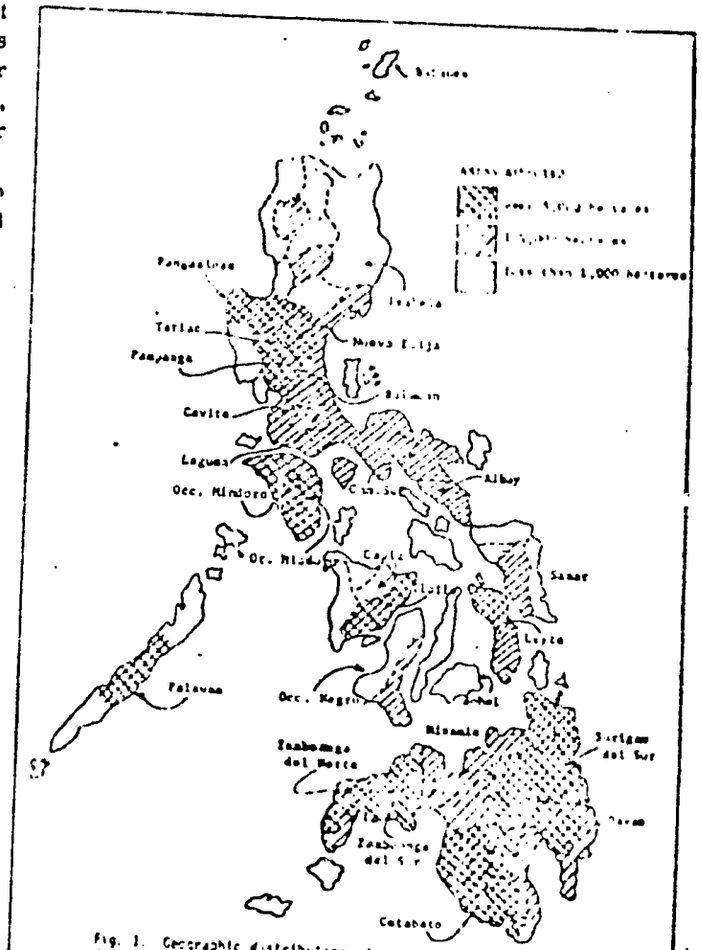

Fig. 1. Geographic distribution of provinces with high rat damage or high rat population levels.

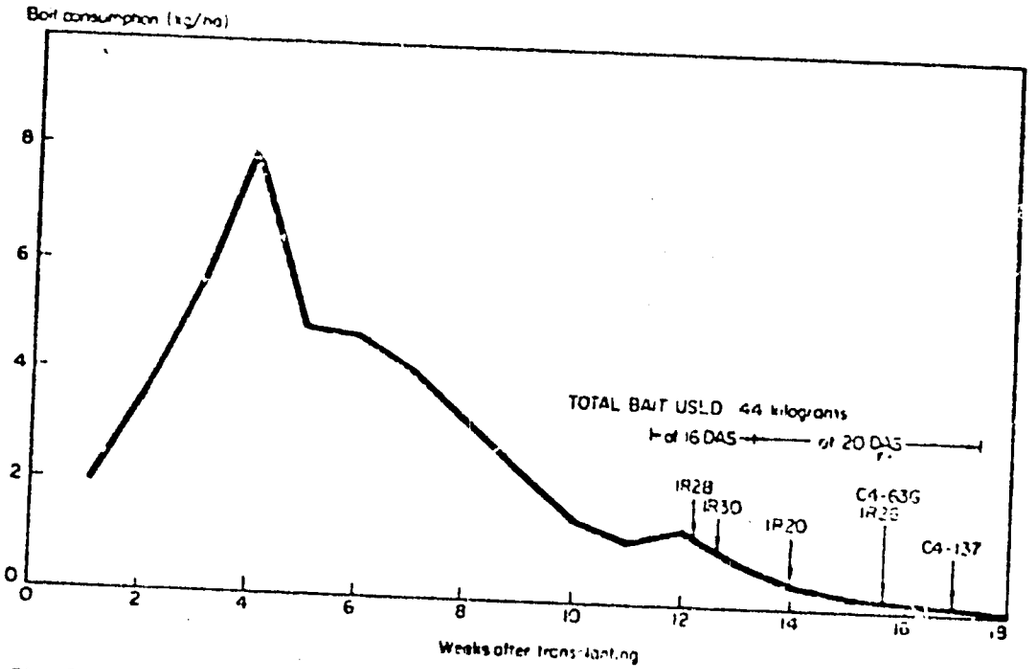

Fig. 2. Pattern of bait consumption on small farms using sustained baiting in an area with a high rat population. Most control situations should require less bait. (Low bait consumption after ten weeks of sustained baiting indicates that little or no damage is likely to the developing rice crop which usually is ready for harvest from 12 to 15 weeks after transplanting.)

DAS = days after sowing. Wetbed seedlings of rice varieties that mature in 105 to 110 days should be transplanted at 16 DAS, later maturing varieties at 20 DAS.

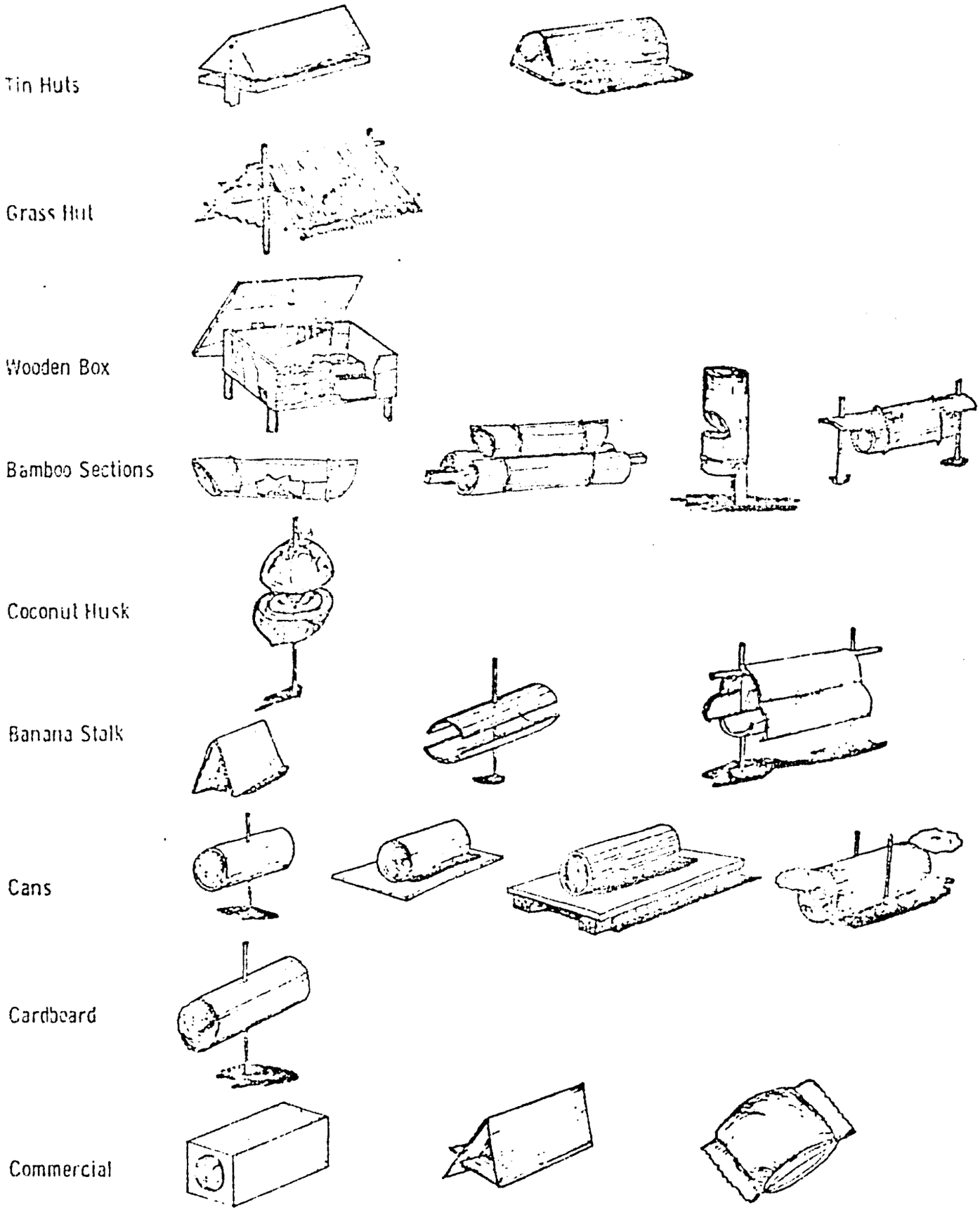

Fig. 3. Rat baiting stations for rice farms. (Local materials can usually be obtained at little or no cost for making baiting stations.)