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13. Control of Ricefield Rats 8/

The ricefield rat is one of the major agricultural pests in the Philippines. It damages rice in all growth stages -- from germinating seeds to the panicle-bearing plants. It also attacks harvested rice piled in the field for drying, stored threshed rice, and hulled rice in retailers' bins. Otanes and Sison (1952) observed that rats also damage corn, sugar cane, coconut, peanut, sweet potato, pineapple, and other crops. Consider the damage to the rice crop alone. Mangahas (1965) reported a total harvest of 90,158,700 cavans of unhulled rice in the Philippines for the crop year 1962-63. A conservative estimate of 10 percent reduction in the annual rice yield through rat infestation (Sanchez and Alfonso, 1966) indicates a loss of 10,017,633 cavans for this single crop year. This loss, valued at about ₱160,282,128 at prevailing market prices, exceeds the annual rice shortage of the Philippines.

Presently, the overwhelming emphasis in rat control is on killing rats through the use of rodenticides and, to some extent, mechanical devices. The widening and worsening state of infestation of our agricultural areas indicates the need for more effective control programs. Israel has controlled a serious rodent pest through improved agronomic practices (Bodenheimer, 1949). There are reports on the permanent control of rats by reducing available harborage. Similar approaches could be employed in the Philippines (Alfonso, 1963).

As with other pests, a thorough knowledge of the life history, reproduction, habits, behavior and environmental requirements of field rats is essential for formulating effective measures to control them.

8/ Authored by Asst. Professor P. J. Alfonso of the U.P. College of Agriculture; Messrs. J. L. Morales and J. F. Sumangil of the Bureau of Plant Industry.

Different Rat Species

There are about 30 rat species and subspecies reported in the Philippines.

However, the great variation in color types and patterns exhibited within a population of rats (of a species or subspecies) has led to a confusing situation in rat taxonomy. Workers seemingly do not agree on the identity of the common field rats (De Jesus *et al.*, 1960; Otanes and Sison, 1952; Sumangil, undated). This has led to the notion that both *R. r. umbriventer* Kellog and *R. r. mindanensis* Mearns are probably synonymous to *Rattus r. argentiventer* Robinson and Kloss which represents more than 95 percent of rats caught in upland and lowland ricefields (Sumangil, undated).

For practical purposes, however, pending the settlement of this controversy, only two species are considered true pests of agricultural crops and therefore worth describing.

The most destructive of these is the common ricefield rat (*Rattus rattus umbriventer* Kellog), which causes more than 90 percent of local destruction. It is a medium-sized rat usually measuring 10 to 12 inches from tip of nose to tip of tail.

Often mistaken as young of larger rats is the small (about 7 inches) bush rat (*Rattus exulans* Peale), which is characterized by two pairs of inguinal mammary glands. This species comprises 10 to 20 percent of the rat population in upland rice areas.

Physical Characteristics

Rats have poor eyesight but they possess very sensitive senses of smell, hearing, and touch. Whiskers (vibrissae) and guard hairs (elongated hairs in their short fur) are contact structures that guide them in the dark.

The rat's chisel-like front teeth (incisors) grow continuously but their normal length is maintained through constant use.

Life History

Rats may live more than three years in cages but hardly reach one year of age in the field. This is due to the innumerable hazards which rats have to face in nature.

Ordinarily, there is one female for every male rat, and at the age of 1.5 to 5 months the female is ready to reproduce. The gestation period (mating to delivery) is about 21 days, with about 8 young born at delivery. In another 21 days the young are weaned and became self-supporting and independent. The female rat reproduces 4 times a year on the average. On the average the adult female weans 10 young per year (Note: There is a very high incidence of mortality before weaning age).

The frequency of reproduction varies from one region to another. Where food and climate are uniform, rats breed throughout the year. Where there are distinct changes in climate and food (rainy and dry season in the field) rats tend to reproduce only during the rainy season and with limited or no reproduction during the dry season. Hence, the rat population in some areas may tend to be cyclical or seasonal in nature.

Habits and Behavior of the Ricefield Rat

Movement and migration

Rats usually move about and feed at night. Rats belonging to established communities may travel as far as 100 m from their nests, while most local movement are estimated to be within the limits of 20 to 40 m. Most of these are foraging excursions for food.

Migration is a movement wherein a rat travels long distances without returning to its original home. This happens where its environment is unfavorab altered, as when destroyed by fire or flood.

Food preferences and feeding habits

Rats have an exceptional liking for rice plants, rice grains, and green corn. Other food items such as shelled corn, cassava, and fruit serve as secondary food. Laying mash can serve as good bait for rats infesting rice fields.

They are great gnawers or nibblers, seldom eating their food in the same setting.

Harborage preference

Rats converge in areas where the best foods are available and in harborage (vegetation) which give them adequate cover from severe climate and predators and where there is ample space for easy movements.

Burrows and burrowing habits

Ricefield rats are great diggers. They dig only for breeding purposes and rarely use abandoned holes by other rats. The pregnant rat usually closes itself inside the burrow with soil and opens the burrow only after the young are capable of limited movements.

The Anatomy of a Rat Infestation

Let us consider a newly opened homestead claimed from virgin forest. There are no more trees harboring bird, mammal, and reptile predators of rats. No longer is there a tree canopy cutting off the sun's rays from the forest floor and limiting the floor vegetation (the roof and shelter of rats). Now the opened area has a luxuriant grass-and-shrub cover punctuated by small plots of rice

and other crops -- conditions ideal for a rat population build-up. Assuming the presence of new rats, either residents or migrants, at the beginning, the rat population now increases until it reaches a maximum limit (the holding capacity of the area) and then levels off.

There are three population forces that determine whether the population will increase, decrease, or remain stationary. These are: (1) reproduction, a force for increase; (2) mortality, a force for decrease; and (3) movement, a force for increase or decrease depending upon the direction of movement.

These population forces, moreover, are directly affected by certain environmental factors called regulatory factors, among which are: (1) available food, (2) water, (3) harborage or shelter, (4) available space or "elbow room," (5) predation, and (6) competition.

At any given time, the population is controlled or held back by any one of the regulatory factors called the limiting factors. Man may control rat infestation by using the limiting environmental factor that is easiest to manipulate. This could be food, shelter, or space depending on the case. Predation and competition cut down the population density. Predation includes the action of cats, viruses and humans against rats. Hence, snaptraps and rodenticides are just manifestations of human predation on rats. Competition refers to the struggle between individual rats of a population for the available food, space, harborage, or mates. It is important to realize that predation and competition are intense and severe only when the population density is high. This explains why rat poisons and traps, as well as predators such as birds, cats, and dogs, are initially effective when the population is high, and become inefficient after the population has been lowered.

Some salient points brought to focus:

1. Killing rats in the field through poisons, traps and other means is not the most effective control method. Preventing the rat population build-up is a more logical control approach.

2. A good control program involves a sustained action on any one or combinations of the regulatory factors most easily manipulated by man, thereby maintaining an effective regulatory factor and a consequent light infestation.

3. Killing rats through human and predatory action cannot effect lasting control. It often simply reduces the rat population to an optimal level for maximum growth and reproduction. Lasting control may be effected by lowering the holding capacity (population potential) through the manipulation of the regulatory factors. Hence, constant weeding of paddies, dikes and surroundings is a more useful control practice than poisoning in a weedy field. Denying rats access to stored grains and other foods during the dry season can effectively prevent a rat build-up the following season.

4. Rodenticides and other devices for killing rats should be employed in conjunction with control efforts that prevent a rat build-up.

The Practice of Rat Control

Determining the presence of rats

Look for rats and rat signs such as burrows, runways, droppings, foot prints or rat tracts, gnawings and crop damage (Fig. 48).

A rat burrow is a simple or complex tunnel with one or more openings usually located on the elevated paddy dikes. The ground around a burrow entrance is bare.

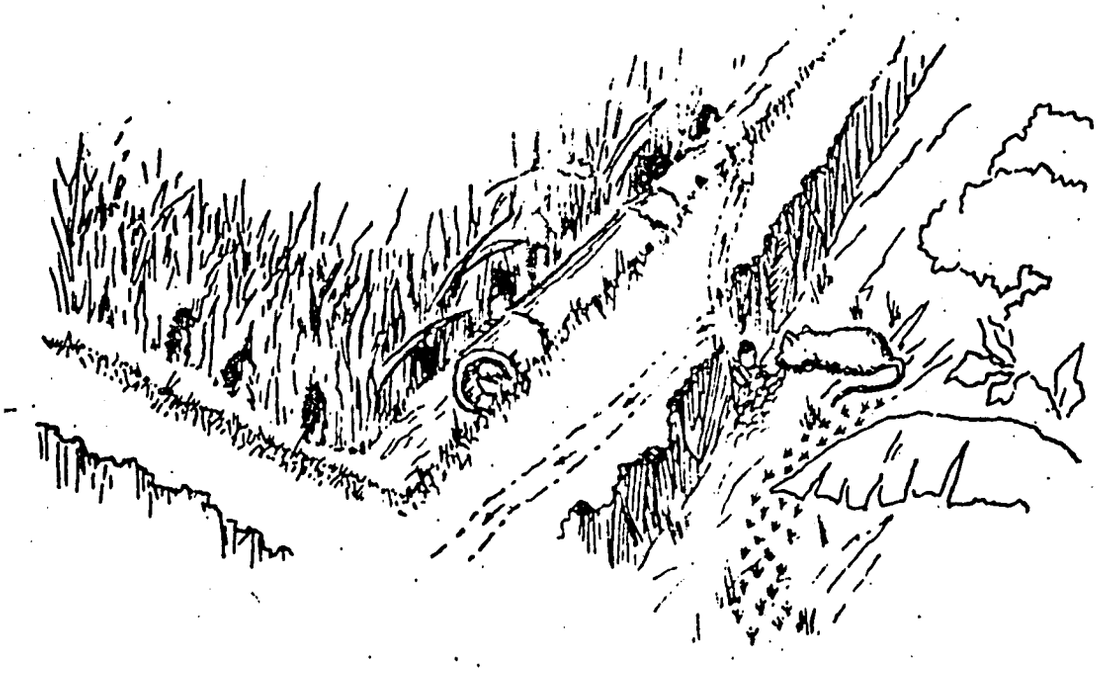

Fig. 48. Determining the presence of rats.

Rats move about a field through fixed trails with or without cover of vegetation. These trails (or runways when under vegetation) can easily be recognized by the absence of anything growing on them, and the presence of such rat signs as rat tracts, droppings, and nibblings.

Applying control measures.

Reducing food sources. The rat is omnivorous and feeds on cereal grains, succulent plant parts, weed seeds, insects, snails, etc. Obviously, weedy or idle farm areas provide not only excellent shelter for rats but also an abundant food source. Reducing available food requires the practice of clean culture. Weeds and other superfluous vegetation means more plant food material and more insects and other animals for rats. Reducing these food sources, including spilled grains and unharvested crops, invariably cuts down the rat infestation.

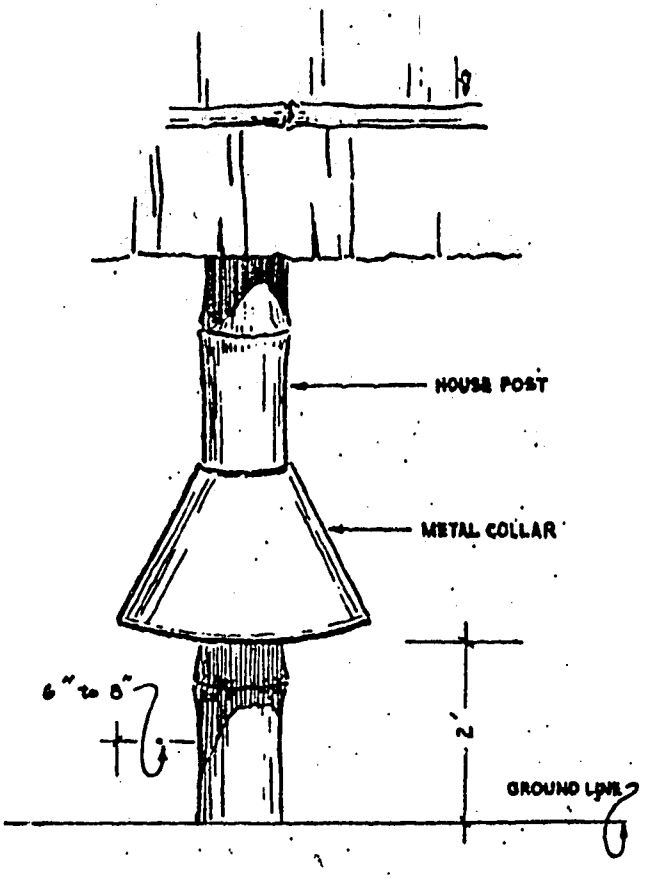

Fig. 49. Rat-proofing.

Rat-proofing. Rat-proofing of farm plots and farm houses and "bodegas" is actually another way of reducing the available food source for rats. A rice paddy may be rat-proofed by metal fencing or by the use of an electric fence. The expense entailed in rat-proofing rice paddies makes the practice impractical except under unique situations such as protecting a certified seed propagation plot or an expensive research crop. Rat-proofing farm houses and "bodegas," however, is a useful practice. Place metal collars (rat guards) around each house post at least 2 ft above the ground (Fig. 49). Farm granaries or "bodegas" should have concrete floors and walls and rat-proof doors to keep out rats.

Reducing harborage. As mentioned, removal of weeds cuts down food supply as well as available harborage or shelter. Idle farm areas closer than 100 m from a cultivated rice plot provide a source of rat infestation through

movement. Hence, adjacent areas to a rice farm must be weeded or cultivated to keep down the weeds.

Dense piles of farm wastes like rice straw, coconut husks and corn stalks provide good cover for rats. Such piles should be burned or hauled to a distant place.

In situations where the above-mentioned control practices cannot be employed (as in areas where the tilled acreage is smaller than the untilled acreage, or in a farming area where neighboring farmers do not practice clean culture) traps, rodenticides and other devices for killing rats should be used.

Killing field rats. Field rats may be killed in three general ways:

1. By mechanical means. Snaptraps baited with coconut meat or other palatable tidbits may be used in catching some of the rats in an infested field. "Blanketing" is employed in areas where sufficient manpower is available. An infested area of about 1/8 to 1/4 Ha is surrounded by men forming a rough circle. They cut the vegetation, working towards the center of the circle, thereby driving the rats toward the center. When the circle has been reduced to a size about 2 to 4 sq m, then the milling rats in the little circle are clubbed, gassed or caught by gloved hand. The procedure is repeated to cover a large area within a day.

2. By chemical means. Available rodenticides (Table 36) may be classified into two groups:

(a) Acute poisons - those that cause death shortly after ingestion. Sodium fluoroacetate (Compound 1080), thallium sulfate, zinc phosphide, and norbormide (Raticate) belong to this category.

(b) Slow-acting poisons - those that induce death after several days of ingesting the poisons. Presently this group includes only the

TABLE 36. Common rodenticides and some of their characteristics.

Poison	Lethal dose (mg/kg)	Bait concentration (percent)	Relative effectiveness	Acceptance of bait	Odor	Taste	Deterioration of bait	Mode of Action	Hazard	Antidote
Warfarin	1	.025	Excellent	Good	None	Slight	None	Internal-bleeding	Slight	Vitamin K blood transfusion
Sodium fluoroacetate (1080)	5	1 oz/28 lb	Good	Good	None	Slight	Slight	Paralysis of heart and central nervous system	Extreme	None
Zinc phosphide	40	1.0	Good	Good	Strong	Strong	Strong	Heart paralysis, liver damage	Moderate	Copper sulfate before emetic
Thallium sulfate	25	1.5	Good	Good	None	Slight	None	Gastro-intestinal, kidney, endocrine, respiratory damage	Extreme	None reliable
Antu	8	1.5	Good	Good	Slight	Moderate	Slight	Pleural effusion	Moderate	None
Arsenic	100	3	Fair	Fair	None	Moderate	None	Affect kidney alimentary tract, nervous system	Moderate	Milk of magnesia milk of water
Red squill	500	10	Fair	Fair	Moderate	Strong	Moderate	Heart paralysis	Slight	Vomiting
Strychnine	6	0.6	Fair	Fair	None	Strong	None	Convulsion asphyxia	Moderate	Charcoal in water & cedative

anti-coagulants like warfarin, coumarin, racumin and related compounds.

Most acute poisons have two drawbacks: firstly, they are sources of danger to humans, pets, livestock and wildlife; secondly, rats rapidly develop an aversion (bait shyness) soon after exposure to acute poisons. Norbormide is found to be a specific toxicant to the Rattus group, hence, safe to people and animals other than rats. However, this rodenticide is still being tested under Philippine conditions.

Warfarin and other anti-coagulants do not have the two drawbacks inherent to acute poisons. The danger to man, animals, and wildlife is much less than that of acute poisons. Moreover, the slow action of warfarin poisoning prevents the rats from developing bait shyness, thereby affecting a high percentage of mortality. Sustained baiting with warfarin has been found to be effective for periods up to two years.

Controlling field rats with warfarin rat bait. In Taiwan, a successful nation-wide rat control campaign was effected with warfarin (Horng, 1959). Similar local successes have been achieved in the Philippines.

The warfarin bait mixture. Mix one part (by weight) commercial warfarin concentrate (1% warfarin) to 40 parts rice middling (binlid) or ground corn. In mixing, first add the warfarin to two parts grain and mix thoroughly, then add four parts grain and mix thoroughly again, etc. In this way a thorough mixture is assured.

Baiting stations and prebaiting. Place bamboo baiting tubes (Fig. 48) along side of paddy dikes at about 10-m intervals. In

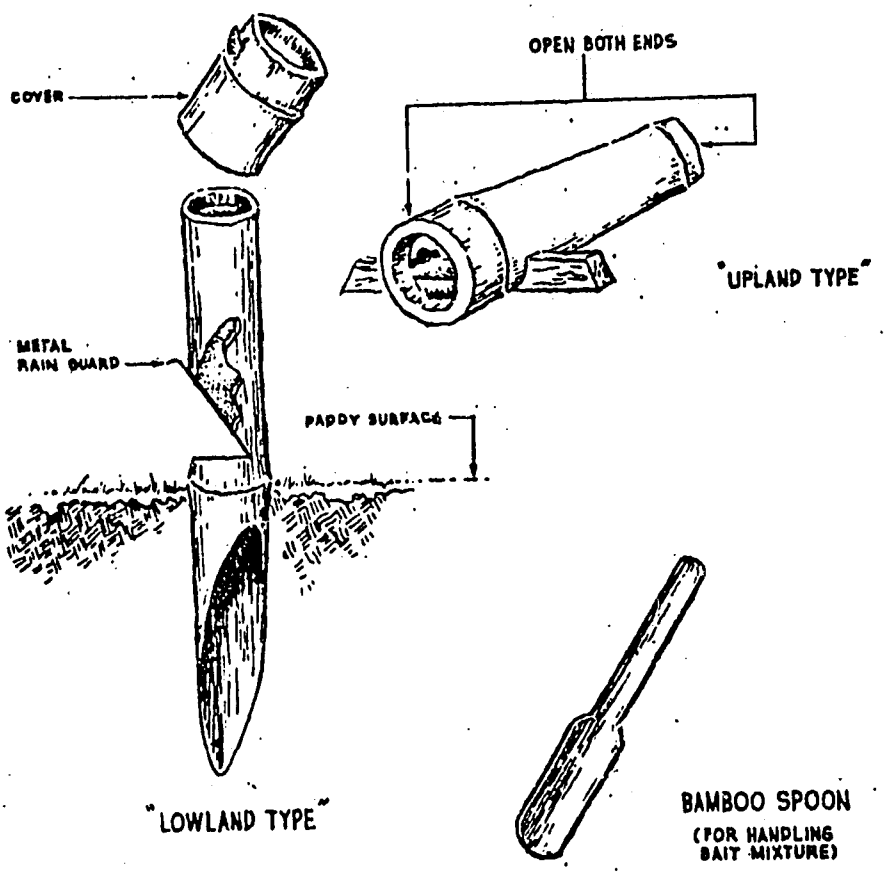

Fig. 50. Types of bamboo baiting tubes. (Note bamboo spoon for handling bait mixture).

upland areas, locate the bamboo tubes along runways and near burrows. Bamboo tubes protect the bait from the elements, do not scare off rats, are readily available and inexpensive (Fig. 50).

For the first few nights, place 50 to 200 g fresh, untreated rice or corn bait in the baiting tubes. The nightly grain consumption will gradually increase and then level off. This prebaiting technique serves to familiarize all the rats in an infested field to the bait, and to provide an estimate of the rat population. It has been found that a field rat consumes on the average about 10 g of grain bait per night. Hence, prebaiting could provide an estimate of the rat population.

Poison baiting. After 3 to 5 days of prebaiting, replace the untreated cereal with the warfarin bait mixture using the same cereal base as the prebait cereal.

Place in each baiting tube an amount of poison bait double that of the maximum prebait nightly consumption. Hence, if the prebait consumption peaked at 50 g per night, place 100 g of warfarin in each baiting station.

Check the baiting tubes every other day for freshness of bait, and replenish the bait when little is left in the bamboo tube. The utilization of all the bait in a bamboo tube means that an insufficient amount of bait was placed.

Maintain the baiting stations for at least 7 to 10 days or until the bait take is nil, indicating that all the rats are already dead.

Considering that rat migrants from neighboring farms will eventually move in and re-infest the area, it is a good control practice to leave a few bait stations operational at all times to control re-infestation.

The use of sodium fluoro-acetate (Compound 1080). Compound 1080, a very potent poison, is hazardous to the farmer and his family, his livestock, and many valuable wildlife species. The appalling decimation of bird and mammal species in areas where Compound 1080 has been intensively used in rat control, not to mention the many fatalites suffered by farm folks and livestock, should make the farmer wary of the injudicious use of Compound 1080 Only under calamity conditions, as when thousands of hectares of maturing crops are endangered by heavy rat infestation, may the massive application of Compound 1080 be

considered justifiable. Only BPI is authorized to handle Compound 1080. It operates poison bait factories which prepare cereal baits impregnated with Compound 1080. Farmers may exchange an equal amount of unhulled rice or corn grain for treated bait at the poison bait factories.

3. The use of calcium cyanide. Where active rat burrows are found in the rice field, calcium cyanide (Cyanogas or Cyanolime) may be applied. A rat duster is employed to pump the poison into the rat burrow. All gassed burrow openings are covered with soil.

Evaluating Baiting Success

Check for rat signs such as active burrows and runways, fresh droppings and gnawings, and new crop damage. Compare these post-operation findings with those obtained before baiting. The differences would indicate the degree of success of the baiting operation.

Requisites of an Effective Poisoning Program

1. Contiguity

A rat campaign must systematically cover a large area to control effectively the infestation and prevent immediate re-infestation. This means that a whole barrio or, preferably, a whole town should undertake a rat campaign in all the farms within the barrio or town. A few non-cooperative farmers will create "rat-reservoirs" of their untreated farms which will serve to re-infest the whole area.

2. Intensity

Sufficient labor and material must be employed to cope with the infestation on an area-wide basis. This requires planning, stock-piling of

poison bait, and an efficient task force.

3. Timing

A rat campaign during the height of the infestation which usually coincides with harvest time will kill many rats but will prove futile in the protection of the harvest. The best time to conduct a systematic rat campaign is towards the end of the dry season when vegetation (food and harborage) is low and the rat population is lowest. Poison baits at this time encounter little competition from other food sources and are most effective. The rats killed also constitute a big percentage of the low prevailing population, hence, a long period of respite will be enjoyed by the farming community before the rat population could build up to a destructive level again.

4. Continuity

An off-and-on campaign means an off-and-on interest for crop protection. A sustained, year-round campaign to hold down rat infestation implies thoughtful planning for the future and continuing concern for rat control. Campaign posters, periodic reminders to practice clean culture, sustained warfarin baiting of untilled areas or potential rat reservoirs, and similar activities could help keep a farming community relatively rat-free.

5. Organization

As rat control is a community movement and not an individual's effort, a smooth and functional organization should be created and maintained. It could be the barrio council or a special rat control organization, but the main thing is to keep the organization active and efficient in the sustained effort against rat infestation.

Why Rat Infestation Persists

Despite the continuous efforts to control the pest, rat infestation persists for the following reasons:

1. There are vast uncultivated grasslands in the Philippines which serve as harborage for rats and where they multiply unmolested.

2. Protein food, such as insects, snails, etc., abundant in rivers and lakes, hastens rat multiplication.

3. Deforestation caused by "kaingineros" and continuous logging cause decrease in population of rat predators (natural enemies).

4. Climatic conditions in the Philippines favor rapid multiplication of rats.