CHAPTER 5

METHODS OF RODENT CONTROL

F.F. Sanchez and E.A. Benigno

The variety of methods being used for rodent control could be classified broadly into chemical, physical and biological (Table 5-1). Some of these methods will be discussed separately.

No single method may be applicable to all field conditions. Extension workers and farmers should be familiar with the different individual methods and the available alternatives in drawing up control strategies. Important considerations for choosing one or combination of methods in an integrated rat control program include: species present, species causing or likely to cause damage, value of crop or commodity to be protected, probability of damage, value of potential damage, possible control methods to be employed, cost and performance of each method, size of area to be covered and interactions or side-effects of potential methods in a particular cultural-ecological situation (Fall, 1974).

National surveys hinted that some form of rodent control is better than no control at all, except in areas with very low infestation level (Table 5-2).

Generally, these data indicate significantly lower damage in areas reporting off-season control or in crop-baiting than in areas with no organized control efforts. A combination of these two control programs seemed to be more effective than any of the single programs in further reducing rat damage.

CHEMICAL CONTROL

The variety of chemical materials currently used in control programs or available experimentally could be classified by convenience into acute toxicants (quick acting, animal dies soon after ingestion of poison), chronic toxicants (slow acting, takes a few to many days for death to occur), fumigants, chemosterilants, attractants and repellents.

Acute Toxicants

Acute toxicants have a long history of use in protecting growing rice from rodent damage in Asia. In the Philippines, they have been widely used in the past in area-wide, dry season population reduction programs. During

Table 5-1. *Summary[1] of existing and potential control methods of rodents (Fall, 1974).*

Type/Method	Ricefield[2] application attempted	In current field use	Visible results	Cost: Materials	Cost: Labor
PHYSICAL					
Field barriers	+	+	some	high	moderate high
Trapping	+	+	yes	moderate	high
Digging or flooding burrows	+	+	yes	none	high
Drivers	+ (adjacent waste areas)	+	yes	none	high
Frightening devices	+	+	no	low	low
CHEMICAL					
Acute toxicants	+	+	yes	moderate	low
Chronic toxicants	+	+	no	moderate	moderate to high
Toxic sprays	0	0	Materials hazardous for field use		
Toxic dusts	0	0	Materials hazardous for field use		
Fumigants	+	+	some	low to moderate	high
Chemical repellents	x	0	no	unknown	
Chemosterilants	x	0	no	unknown	
BIOLOGICAL					
Release of predators or parasites	—	0	no	unknown	
			(Techniques uncertain, undesirable side effects possible)		
Release of lethal gene carriers	—	0	no	unknown	
Reduction of carrying capacity	—	0	no	unknown	
				(techniques uncertain)	
Reduction of reservoir areas	+	+	no	none	high

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Table 5-1. (Continuation)

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<tr><th rowspan="2">Type/Method</th><th rowspan="2">Ricefield[2] application attempted</th><th rowspan="2">In current field use</th><th rowspan="2">Visible results</th><th colspan="2">Cost</th></tr>
<tr><th>Materials</th><th>Labor</th></tr>
<tr><td>BIOLOGICAL</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Field sanitation</td><td>+</td><td>+</td><td>no</td><td>moderate</td><td>high</td></tr>
<tr><td>Habitat barriers</td><td>x</td><td>0</td><td>no</td><td colspan="2">unknown</td></tr>
<tr><td>Trap crops</td><td>x</td><td>0</td><td>some</td><td colspan="2">unknown</td></tr>
<tr><td>Uniform plantings</td><td>+</td><td>+</td><td>no</td><td>none</td><td>″ none</td></tr>
<tr><td>Induction of movements</td><td>—</td><td>0</td><td>some</td><td colspan="2">unknown</td></tr>
<tr><td>Biosonics and ultrasonic</td><td>—</td><td>0</td><td>no (techniques uncertain)</td><td></td><td></td></tr>
<tr><td>OTHERS</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Bounty system</td><td>+</td><td>+</td><td>yes</td><td colspan="2">variable</td></tr>
<tr><td>Crop insurance system</td><td>x</td><td>0</td><td>no</td><td colspan="2">unknown</td></tr>
<tr><td>Eating rats</td><td>+</td><td>+</td><td>yes</td><td colspan="2">unknown</td></tr>
<tr><td>Appeasement</td><td>+</td><td>+</td><td>yes</td><td colspan="2">variable</td></tr>
</table>

[1] This list is intended for information purposes only; inclusion of any control methods does not constitute recommendation or endorsement. No control method should be used without information on its effectiveness and effects in the proposed situation on the problem species.

[2] Key to symbols: + = yes; 0 = no; x = possible, not evaluated; — = speculative, not evaluated.

Table 5-2. Three-year mean (1970-1972) provincial damage as affected by rat control practices. The number of paddies reporting type of control is enclosed in parenthesis (Sanchez et al. 1973).

Province	Rat control practice				Statistical significance
	Off-season	In-crop baiting	Off-season control & in-crop baiting	None	
Albay	—	0.57 (119)	—	3.17 (39)	HS
Bohol	0.28 (7)	—	—	0.25 (93)	NS
Bulacan	2.30 (60)	—	1.46 (30)	—	HS
Camarines Sur	1.61 (10)	0.43 (70)	0.38 (30)	—	HS
Iloilo	0.61 (10)	—	—	0.46 (303)	NS
Negros Occ.	0.48 (10)	—	—	0.77 (10)	HS
Nueva Ecija	0.87 (78)	—	—	—	—
Pampanga	3.60 (79)	—	0.98 (6)	2.44 (10)	S

HS — Highly significant difference
S — Significant difference
NS — No significant difference

the short duration of the campaign, spectacular piles of dead rats are collected and taken as evidence of the effectiveness of the rat control campaign. The real effectiveness of the population reduction program from the standpoint of crop protection is quite doubtful because crops are usually planted several months later. Because rats have high reproductive potential, damaging populations recover rather quickly. Post-harvest baiting is also a questionable practice under patchy irrigated situations since rats continue to move to better cover when the fields they occupy are harvested. Control efforts are better initiated during the early active growth of the rice crop when it is very susceptible to damage.

Extreme care should be exercised in the use of acute toxicants like zinc phosphide. Whenever possible, relatively safer materials like the anticuagulants should be substituted for more hazardous acute toxicants.

Acute toxicants are very popular among farmers in the control of rats affecting growing rice. However, farmers usually do not take action until there is observable damage and by that time, it may be too late to save the crop. Cereal baits mixed with acute toxicants are placed in small piles along paddy dikes or near burrows on it (paddy dikes) in attempt to control the rats. Evaluations of this approach show that using zinc phosphide applied three times during the cropping season in small situations, was practically useless in protecting the rice crop (Table 5-3). Poor bait acceptance was the major factor limiting the effectiveness of acute rodenticide baiting.

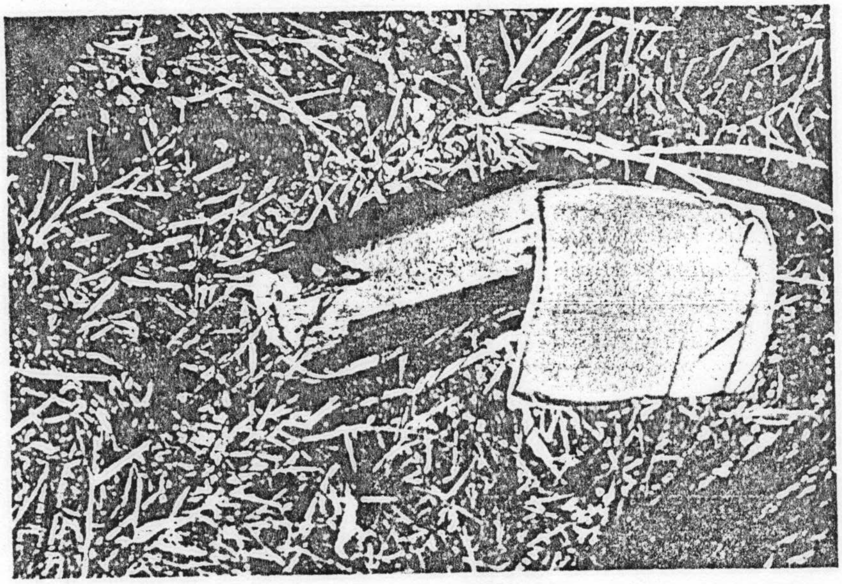
"Torpedo Baits": Zinc phosphide mixed with rice shorts ("binlid") and wrapped in banana leaves.

Farmer throwing baits into the field in the early evening.

Table 5-3. Effect of multiple baiting with zinc phosphide on activity of R. r. mindanensis *as indicated by censuses with tracking tiles, and on damage to rice at harvest (West et al. 1972).*

Replication	Time of Baiting (Weeks After Transplanting)			Percent Activity (Tracking Tiles)					Percent of Rice Tillers Cut (9-Paddy Ave.)
	1st	2nd	3rd	Before 1st Baiting	Between 1st & 2nd Baiting	After 2nd Baiting	Before 3rd Baiting	After 3rd Baiting	
1. Treated	10	11	16	87.7	48.4	39.8	57.0	51.8	6.0
Reference*				83.6		77.2	58.6		14.5
2. Treated	5	6	13	77.6	44.5	63.2	52.3	63.8	12.1
Reference*				75.8		83.2	78.9		4.1
3. Treated	6	7	14	30.2	41.9	24.2	63.3	82.7	4.0
Reference*				41.7		44.7	50.0		1.5
4. Treated	9	10	14	75.4	42.0	82.0	57.6	65.6	1.7
Reference*				84.4		63.3	54.3		3.8
5. Treated	6	7	13	91.4	88.3	86.7	86.5	68.1	2.7
Reference*				89.4		93.3	86.7		3.8
6. Treated	6	7	13	76.6	66.4	76.2	82.0	65.5	3.4
Reference*				98.4		93.8	74.8		3.9
Mean									
Treated				73.1	55.2	62.0	66.4	66.2	5.0
Reference				78.8		75.9	67.2		5.3

*Activity estimates on the reference areas were not made between the first and second, and after the third baitings because reference estimates had been made only 5 days earlier.



Farmers also use banana stalks as holders of zinc phosphide and other baits.

Chronic Toxicants

With the advent of anticoagulants or chronic toxicants, notable success in protecting growing rice from rat damage has been achieved. These materials characteristically inhibit the clotting mechanism of the blood causing hemorrhages throughout the body and affected animals literally bleed to death. Other notable properties of chronic toxicants are their effectiveness at relatively low concentrations and slow toxic action, which usually take several days to manifest. Thus, "bait shyness" is unlikely to occur and prebaiting is unnecessary.

Several anticoagulant rodenticides are commercially available in Southeast Asia. Experience in the Philippines has shown that sustained baiting with these materials (warfain, coumatetralyl, coumachlor, chlorophacinone and diphacinone) throughout most of the growing period of the rice crop can significantly reduce rat damage on small farms (one to several hectares) at very reasonable cost. When carried out on individual farms, the beneficial effect of baiting extends for considerable distance from the treated areas. A baiting program in a one-hectare rice area could be expected to beneficially affect the adjacent farms. Likewise, it has also been shown, in supervised programs of sustained baiting with chronic toxicant involving large areas of rice land, that substantial protection from rat damage can be obtained.

Baiting with an anticoagulant rodenticide has also been shown to be cost-effective in corn, coconut and sugarcane. It has yet to be demonstrated in most other crops; however preliminary results indicate that similar baiting techniques would be equally effective.

Bait material other than rice shorts ("binlid") can be used, but it should be readily accepted by the rat, should be mixed well with the rodenticide, and not be prone to excess degradation by humidity and/or biological agents. In the southern Philippines, corn grit are more available and cheaper than rice shorts, as acceptable bait material. The bait material must be more palatable to the rat than the protected crop. Where doubt exists, laboratory and field choice tests comparing the consumption of different offered bait materials by rats should be conducted.

The continuous use of the same anticoagulants through the years may eventually lead to the development of resistant rats. Warfarin resistance in rats results from mutation (or inherited change) that leads to a chemical change in the liver that in turn permits the continued use of vitamin K in the synthesis of blood clotting factors. In *R. norvegicus* resistance is due to a single automosal dominant allele (Greaves and Ayres, 1967) while in *R. rattus* and *M. musculus*, resistance is polygenic. Mode of inheritance and mechanism of resistance probably differ with species.

New anticoagulants such as difenacoum and brodifacoum have been developed to control warfarin resistant rats. Brodifacoum, many times more toxic than warfarin, is effective at a single dose although its mode of action is the same as other anticoagulants. Our initial field studies show that this is well accepted as loose rice bait although a wax bait may be safer to use.

Fumigants

The most common fumigant is phosphine gas. It is used under situations where rodents occupy burrows in paddy dikes and in ships and warehouses. In ricefields, its use is limited by cracks in the burrows especially during the dry months. Another serious shortcoming is that it only kills rats inside the burrows so that the cleared area is an easy subject to reinvasion from the surrounding fields. A further limitation is the danger of inhalation of a toxic dose of gas during the operation.

Chemosterilants

The use of chemosterilants or anti-fertility agents in rodent control offers interesting possibilities for development. But none of the currently

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available compounds have shown sufficient effectiveness to merit more than a passing interest because of temporary effect and a tendency to induce bait aversion.

If and when effective chemosterilants are discovered and developed, their utility in protecting growing rice, may still be doubtful if used alone. Baiting during the relatively short crop periods would result in a serious time lag before beneficial effects of chemosterilization could be realized, while treatment of reservoir populations in post-harvest fields or non-agricultural areas would add considerable cost and would no doubt require application over wide areas. If chemosterilants are used in large scale, the many potential hazards and side effects must be subjected to lengthy, critical evaluation. The lack of detailed knowledge about the biology, ecology and behavior of rodent species necessary to utilize chemosterilants efficiently would undoubtedly complicate the picture.

When suitable chemosterilants become available, they might be very useful as a countermeasure against anticoagulant-resistant rodent populations like those which have been developed in Europe and the United States. Conceivable resistance could be checked or at least delayed by using anticoagulants and chemosterilants alternately or by some other sequence or combinations. Another purpose in using chemosterilants is to keep the rodent population down, after population reduction by rodenticides.

Attractants

At least some species of rodents utilize the sense of smell for many behavioral purposes like locating food and mates and recognition of predators or toxic substances. The important behavioral property of olfaction in rodents offers possibilities for exploitation for the control of this important group of pests. Theoretically, an attractive odor in baits should increase the chance of a rodent species finding the poisoned biat. Attractant odors could drastically reduce the amount of baits normally needed in rodent poisoning programs by improving the efficiency of bait exposure.

Repellents

Repellents constitute a potentially low-hazard alternative to toxic rodenticides. The use of repellents for rodents have met with limited success because of minimal activity in this field of research. Most have been tried as repellents in runways and burrows aimed at discouraging rodent activity. Compounds like nicotine sulfate, lime sulfur, sodium silicofluoride, creosote and coal tar have been tried with little success. The use of repellents to protect growing rice from rodent damage is an area that remains unexplored. However, farmers claim that ricefields treated with endrin insecticides are not bothered by rats. Broadcasted seed rice treated with endrin has been reported, although unsupported by experimentation, to be spared from rodent damage as evidenced by good crop stand in treated areas. Also pine seeds treated with thiram, aldrin and dieldrin for reforestation purposes in the Philippines were satisfactorily protected from rodent damage in laboratory trials (Dalmacio, 1974). Although many of these materials are no longer suitable for field use, other safer materials might be developed and tested if such an approach could be used to advantage.

Some Practical Considerations in the Use of Rodenticides

Many of the practical problems encountered in the control of rodent pests in agricultural crops are similar to those of other crops. Some of the more important problems are:

1. Toxicity considerations

When pesticides are used in agricultural areas, every precaution must be taken to protect humans, livestock and the environment. This is particularly so with rodent control. Highly toxic rodenticides are extremely poisonous to all vertebrate animals, while many pose secondary poisoning hazards. If we wish to evaluate the hazards associated with the use of a particular material, we should consider the following factors: 1) possible residue problem 2) hazards to applicators and farm workers (3) effect on beneficial species and wildlife 4) accumulations in the soil and 5) any run-off problems which may result in the contamination of bodies of water such as streams and lakes.

2. Pest Species

Control measures should ideally be based upon a knowledge of the bionomics of the particular pest (biology, ecology and behavior). When using rodenticides, we have to consider all the aspects of pest bionomics which may be exploited to advantage. In this regard, biological control could perhaps be introduced to increase the effectiveness of control programs based primarily on chemicals. Biological and chemical controls complement each other when utilized with a full knowledge of the species involved and of the effect of the rodenticides on both pests and beneficial species.

3. Choice of formulation

The choice of particular formulation should be influenced by such factors as cost, safety, convenience, availability and cultural acceptability, as well as by its effectiveness. Under conditions of heavy rainfall during the moonsoon months, it may be desirable to use wax bait blocks or bait in plastic packets to improve their keeping quality. From the point of view of low cost and convenience, loose cereal baits are often the most suitable since they can be easily prepared from grain materials and poison concentrates.

4. Sociological considerations

In addition to having an understanding of the behavior of pests, we should also become better versed in the behavior of humans, since this understanding may well influence the success or failure of a crop protection program. When a program is designed, it should take into account the culture of the people, their agricultural practices and local economics, together with any other factors which may lead to an improved acceptance of new approaches.

Need for new rodeticides

Despite an increasing interest and activity in developing new rodenticides and the recent introduction of several promising new materials, there is still a critical and continuing need to develop safe and effective control agents. With the increasing use of anticoagulant rodenticides for agricultural rodent control in Southern Asia and elsewhere, genetic resistance to these materials is becoming a potentially serious problem. Since these chemicals are the mainstay of the present chemical technology for rodent control, the lack of suitable chemical alternative is a matter of considerable concern. The search for new chronic rodenticides should be concentrated on the production of materials which differ from the anticoagulants in their mode of action.

PHYSICAL CONTROL

Physical control methods include those that involve direct killing or exclusion by mechanical means. Some of the methods resorted to in Southeast Asia are destruction, flooding, burning or smoking of burrows, trapping, drives, use of frightening devices and use of barriers. For the protection of growing rice, use of field barriers appear to be the most practical despite the disadvantage of cost. Experience in the Philippines have shown that the use of traps (500/hectare) could achieve large population reduction within a few days but could also be repopulated by immigration within two weeks. Electric or metal-sheet fences may be useful means of protecting crops from rodent damage under some conditions; e.g. protecting experimental plots. However, they are expensive and difficult to install (Table 5-4). Unless carefully, maintained they may be completely useless, as rats readily burrow under fences or cross electric fences when the current is off or when the unit is shorted. Some types of electric fences present serious hazards for humans and domestic animals.

The concept of field barriers is appealing because it is a control method focused directly on the object of protecting the crop. Cheaper, improved barriers might find wider use than the types currently available.

Table 5-4. Estimated construction and operating expenses (Philippine pesos) for the nonlethal electric fence during two cropping periods per year based on a 0.1875-ha trial (₱1 = US $.358 in 1979) (Bruggers, 1979).

	1-ha plot		5-ha plot	
Materials	1st year	2nd year	1st year	2nd year
Fence charger	3,000	0	3,000	0
Recharging battery cost	80	80	80	80
New 12V battery	596	0	596	0
Used 12V battery[a]	75	0	75	0
Wire	79	0	178	0
Lumber	151	0	340	0
Plastic mesh net	408	408	918	918
Varnish	88	0	198	0
Labor[b]	200	200	450	450
Total cost (₱)	4,677	688	5,835	1,448
Income				
70 cavans[c]/ha, ₱60/cavan	8,400	8,400	42,000	42,000
Required potential rat damage to offset investment in fence	55.7%	8.2%	13.9%	3.3%
Mean	31.9%		8.6%	

[a]To be used as a replacement when new battery is out of service during recharging.

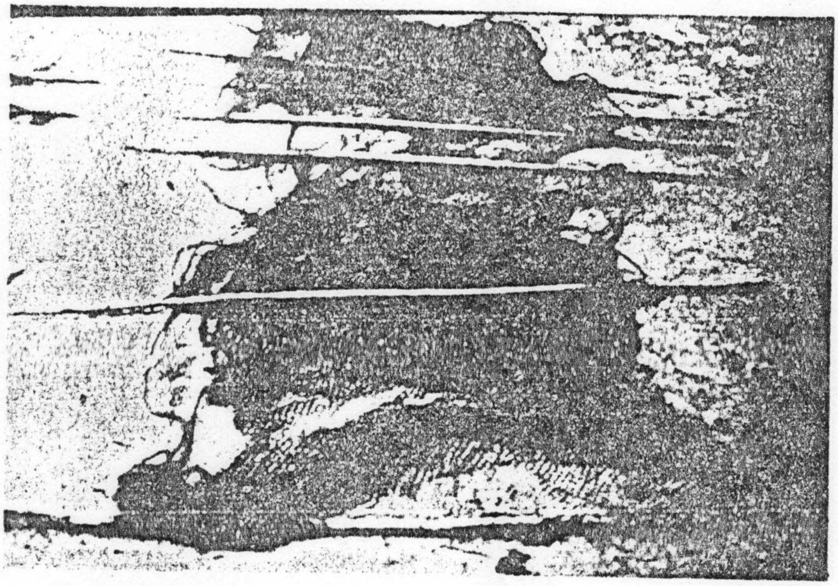
[b]Labor = construction labor only; maintenance or daily checks of 30 min per 400 m of fence not included.

[c]One cavan = about 50 kg.

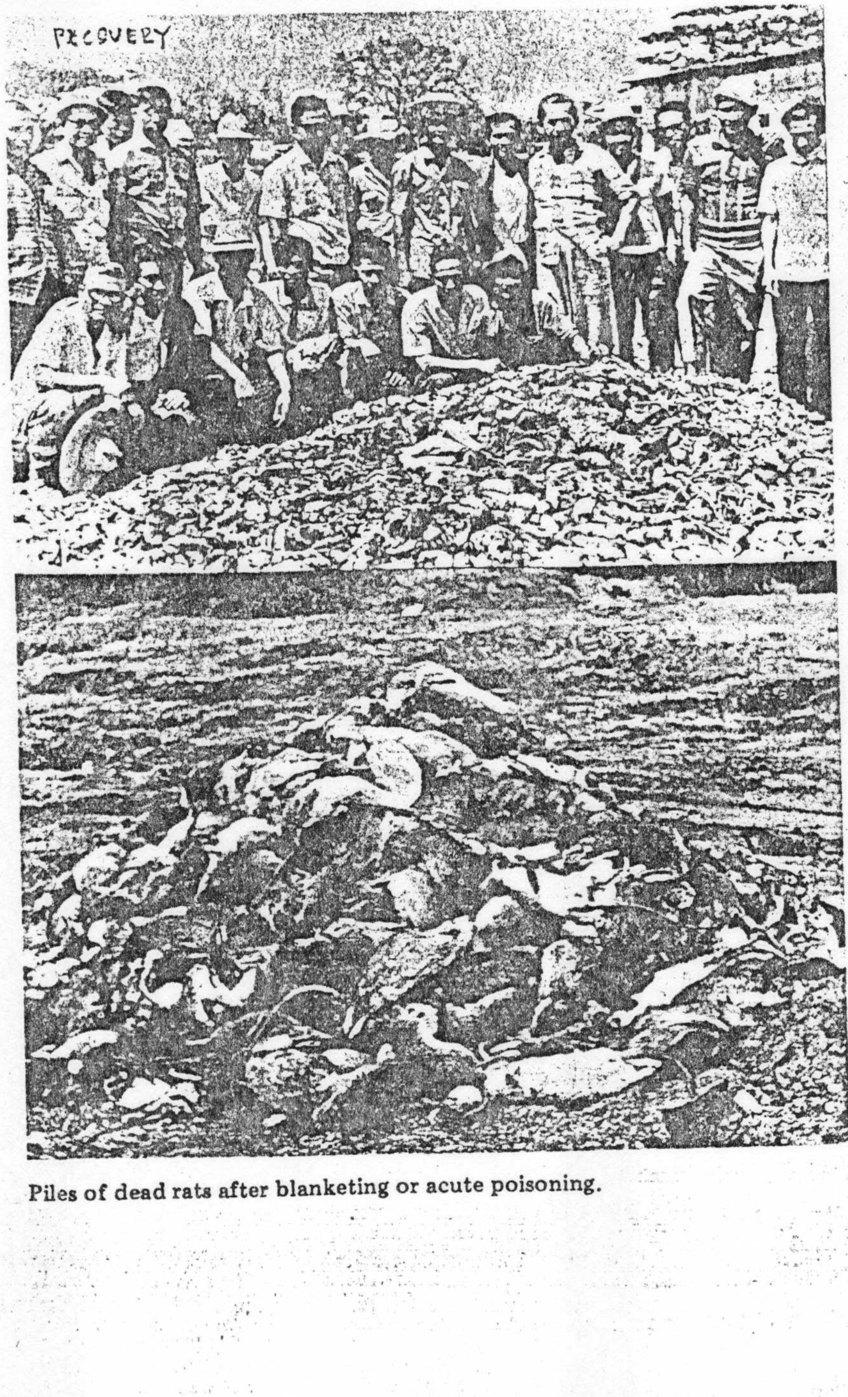
OFF-SEASON MASSIVE RAT CONTROL OPERATIONS

As provided by the "Rat Extermination Law" (Act 3942), all able-bodied citizens aged 16 to 60 years are required to render service in the killing of rats during rat outbreaks.

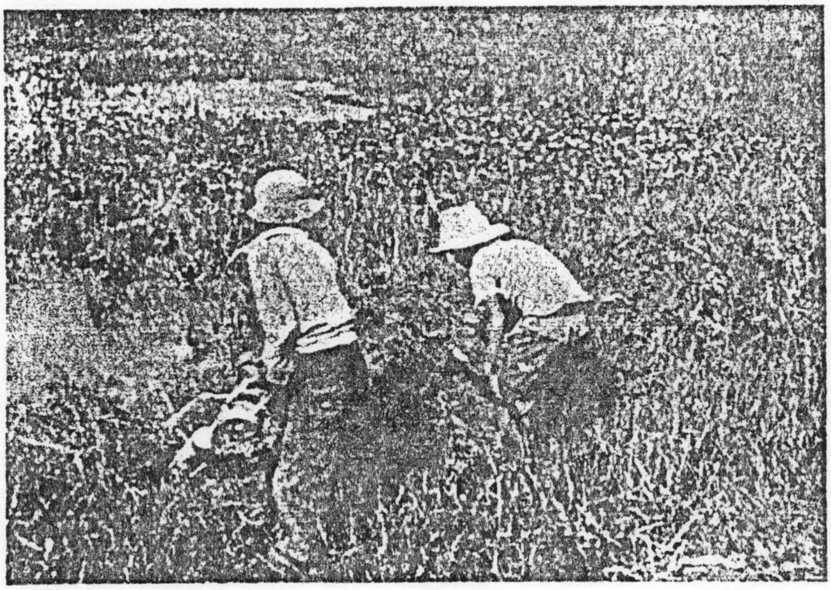
"Blanketing" or drives. With hand tractors, sticks and bolos, farmers in community clean up areas suspected to contain high rodent population.



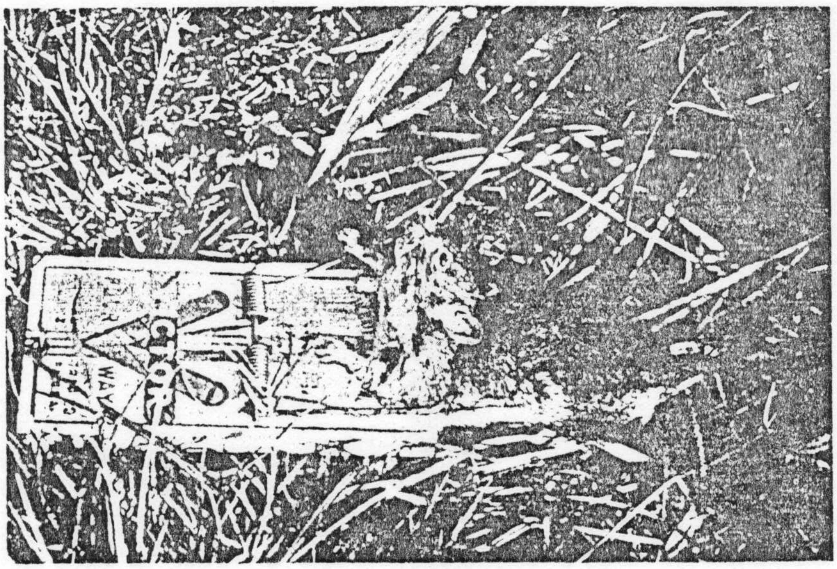
"Blanketing" can be done by a few individuals using fish nets to fence rats. By this method live rats for the laboratory can be collected rapidly as compared to live trapping.



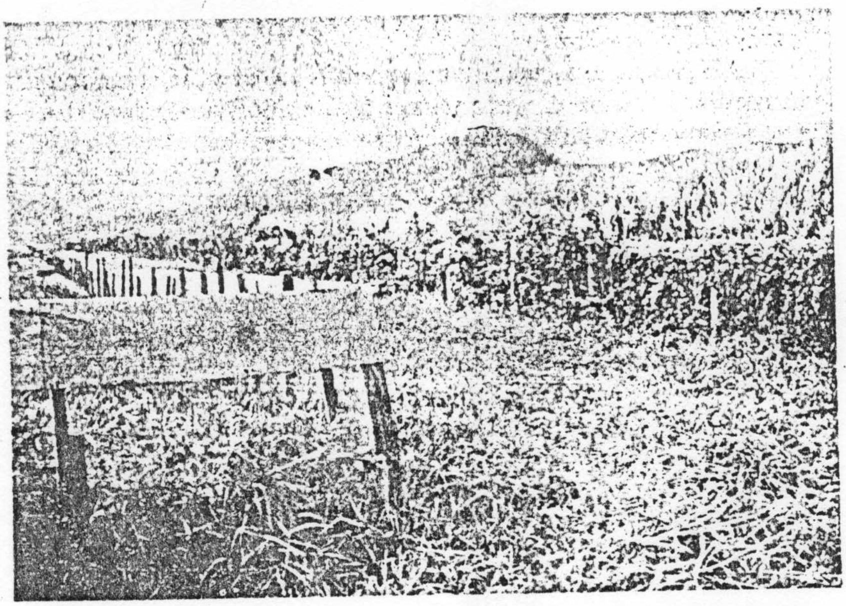
Piles of dead rats after blanketing or acute poisoning.



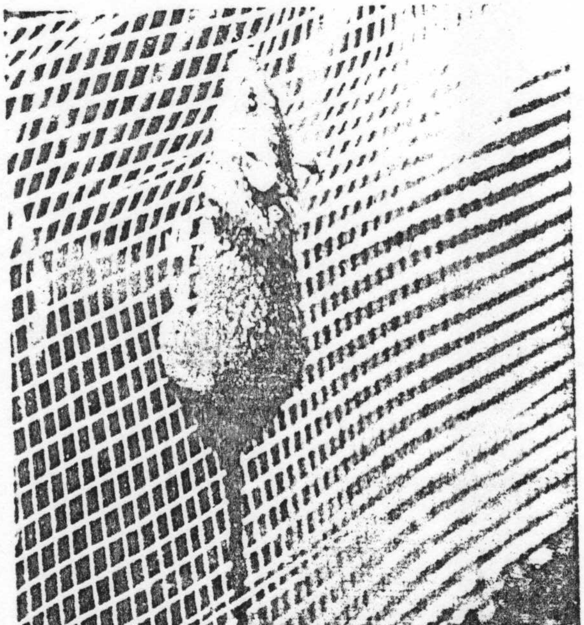
Gassing and digging burrows.



Rat caught by a snap trap.



Fences (electrical or non-electrical) serve as physical barriers between crop and wasteland.



Rat caught on electric fence.

BIOLOGICAL CONTROL

Fall (1977) considers ecological control as a more appropriate term than biological control for vertebrates. It includes predation, disease and parasitism, genetic manipulation, reduction of carrying capacity and sanitation, and resistant varieties. There are dangers in the introduction of predators, like the mangoose, as they may become pests themselves. It may be better to encourage local predator populations of owls, hawks, eagle-kites, cats, monitor lizards and snakes. In general, natural populations of these predators are low relative to the rodent prey population. What may be done is to provide good habitats for these predators like building bird houses to increase the number of owls, *Tyto alba,* in oil palms in Malaysia (Lenton, 1980). These birds prey on *R. tiomanicus, R. argentiventer* and *R. exulans.* Predation, however, has to be complemented by chemical control.

On the other hand, use of diseases and parasites has but temporary effects on the population as rats can easily adapt and become resistant. Most of the potential infective agents like salmonella also produce disease in man and are therefore unsafe for use.

Genetic manipulation through radiation-induced mutations have been tried on *R. r. mindanensis* and *R. argentiventer* (Medina, et al. 1973). More researches on inducing lethal genes and sterile male strains need to be done before this approach can become practical for field use.

Reduction of rat harborage through clean culture and narrower dikes to reduce burrow space for breeding females have been recommended to effect longer-lasting population control (Alfonso, et al. 1965; Sumangil et al. 1970). Habitat manipulation to reduce carrying capacity and increase competition may work well in urban rat control but have limitations in agricultural fields. Fall (1977) observed that the growing rice can provide sufficient food and cover to sustain large rat populations irrespective of dikes, weeds and adjacent harborage. He suggested that the "clean culture" and habitat manipulation should be considered only as desirable supplements to other methods as rodenticide baiting in crop protection.

Rats have been observed to show preference to certain varieties when these are planted side by side. However, there are no truly rat-resistant varieties as there are insect and disease-resistant varieties. Given no choice, rats damage any variety.

Synchronous or homogenous planting of rice within the same general area reduces the time when favorable food and shelter are present. Thus the rodent population and damage are more evenly distributed. A single farm planted early or late offers food and shelter when the surrounding rice fields are unattractive (lacking shelter and food) and are more susceptible to severe damage. If the susceptible dough stage of corn coincides with the harvesting

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of the adjacent rice fields, the corn fields are also susceptible to rat damage. The burning of sugarcane fields abruptly moves rodent populations to adjacent crop areas that become susceptible to acute rodent damage. Although sometimes unavoidable, planting times, as a cultural practice, should be scheduled so that the susceptible crop stage will not be vulnerable to potential severe rat damage.

A field may be deliberately planted earlier (as a trap crop) than the regular crop with the purpose of attracting rodents into this field. Once the rats are concentrated in this field, more intensive and/or acute control measures (e.g. and blanketing) can be effectively applied. This way, fewer rats remain when the regular crop reaches its susceptible stage. Theoretically trap cropping has some potential as a control strategy but it has not been practiced.

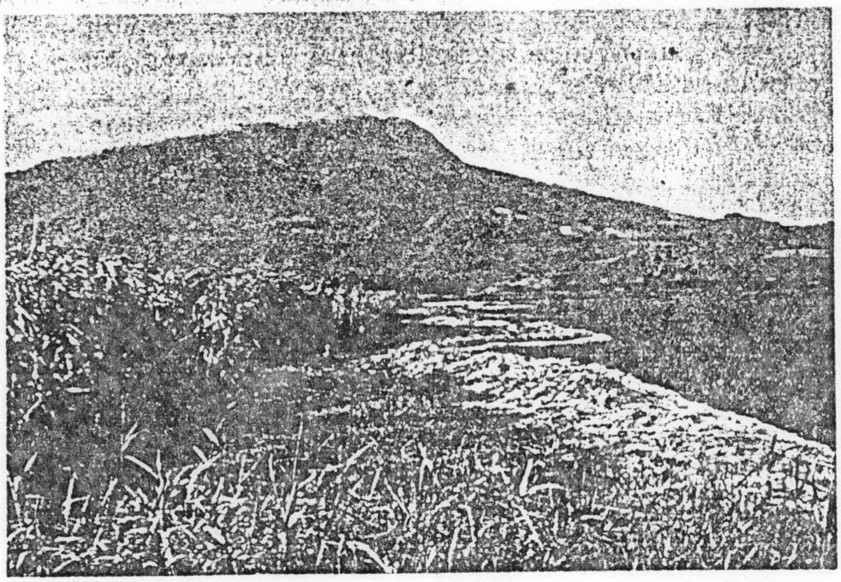
OTHER METHODS

Crop Insurance

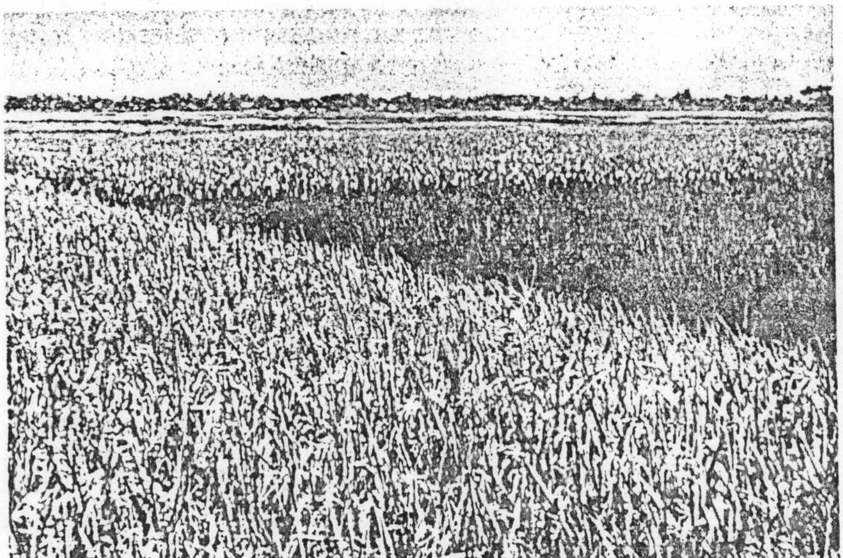
The Philippine Crop Insurance Corporation was created by Presidential Decree No. 1467 in 1978. The concept is to give farmers something to fall back into in case of crop failures due to natural calamities, typhoons, floods, droughts, earthquakes and volcanic erruptions or serious plant disease and other pest infestations. It is meant to stabilize farmers' income and, at the same time, improve the financial position of agricultural lending institutions and reduce the government's burden to undertake massive relief measure whenever natural disasters occur. Initially, only rice is covered but it is expected to cover other crops like corn. Farmer-members of Masagana 99 are automatically insured.

The cost of insurance or premium has been set at eleven percent (11%) of the sum insured, shared as follows: 7.5% government premium subsidy, 2.0% farmer and 1.5% lending institution. Total loss is compensated to the extent of the actual production cost while partial loss is computed from the proportion of the shortfall of the actual yield from the guaranteed yield for the province. For indemnity purposes, any loss exceeding 90% of the guaranteed yield is considered total loss while losses of 10% or less is considered as no loss (Phil. Crop Insurance Corporations, 1981).

It is quite difficult to assign "risks" to losses due to pests, especially rodents, as rat damage is very variable even between two adjacent fields. Based on our national surveys, 9 out of 10 fields have measurable rat damage. The magnitude of risks is in the order of fields near marshes or swamps grasslands or forest, of uncultivated fields, of fields near river banks or water transport dike of weedy and clean fields (Table 5.5).



Ricefields adjacent to tall grasses, wastelands and marshlands have greater risk of rodent damage.



Non-uniform planting promotes "island effect" — rodent populations concentrating in the paddies with the most susceptible stage of the crop (booting to maturity). More intensive and/or acute control measures should be applied in fields with the susceptible crop.

Table 5-5. Thr
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Province
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Bohol
Camarines Sur
Cotabato
Iloilo
Albay
Bulacan
Cotabato
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Table 5-5. Three year average (1970-1972) seasonal damage in paddies adjacent to different types of habitat. The number of sample paddies under each condition is enclosed in parenthesis. (Sanchez et al. 1973).

Province	Adjacent Habitat			Statistical significance
	Rice field	Uncultivated land	Water transport dike	
		Dry Season (Mean % Damage)		
Albay	0.67 (58)	1.85 (15)	0.66 (26)	HS
Bohol	0.22 (11)	0.27 (80)	0.19 (9)	HS
Camarines Sur	0.42 (94)	0.39 (6)	—	HS
Cotabato	2.18 (108)	—	4.97 (294)	HS
Iloilo	—	—	10.62 (3)	—
		Wet Season (Mean % Damage)		
Albay	1.04 (56)	4.74 (13)	1.37 (29)	HS
Bulacan	2.23 (70)	—	—	—
Cotabato	3.17 (285)	2.75 (3)	4.11 (9)	HS
Iloilo	0.26 (302)	—	—	—
Negros Occ.	0.72 (36)	0.93 (7)	0.17 (4)	HS
Nueva Ecija	1.89 (150)	—	—	—
Pampanga	4.60 (60)	—	1.68 (40)	HS
Pangasinan	7.36 (107)	9.91 (11)	5.66 (47)	HS

NS — No significant difference
HS — Highly significant difference
S — Significant difference

Sample paddies adjacent to uncultivated lands generally received more damage than those surrounded by ricefields and those adjacent to water transport dikes. Paddies completely surrounded by other rice paddies and those adjacent to water transport dike had about the same intensity of damage.

Monthly variations of rat occurrences in different places of the country have also been mapped out (Benigno and Menguito, 1983).

With a national rat damage average of less than 1% in recent years (1978-79), only a few farmers would be paid by the insurance company. Nevertheless, crop insurance should be viewed as a kind of "safety net" when everything else fails.

Rats as Food

There was a time when people were encouraged to eat rats ("STAR" meat) to help control infestation and to augment people's protein requirements. Rats are now socially acceptable as food in many rural areas of the Philippines; rat barbecues are also sold openly in some areas. Our researchers have even produced good tasting rat sausage (50% rat meat + 50% pork fat) that prolongs the shelf-life without refrigeration of the "STAR" meat in villages. With this technology, farmers could catch rats during population peaks and process them for consumption during lean months.

Collection of rats for food is analogous to intensive snap trapping or poisoning with acute toxicant for short period of time. Such an activity, however, has been ineffective as far as reduction of crop damage is concerned (West et al. 1972; Sanchez et al. 1973). The practice of catching rats for food is also quite incompatible with poisoning or baiting as farmers are wary of the probable effects of poisons. The suggested alternative is the use of non-lethal physical barriers (e.g. rat fences made of poultry wire and galvanized sheets) to isolate uncultivated areas such as marshlands from ricefields. By placing such barriers along ricefield — marshland interfaces, rats could be kept in the marshes for food and out of ricefields to reduce damage.

Bounty System

Paying cash rewards for dead rats as evidenced by tails or heads may be useful in calling public attention to a rat problem but is ineffective in reducing crop damage. This has been previously practiced a number of times in many countries but rodent pest problems continue unabated (Fall, 1977). Catching rats is usually practiced during harvest time when the damage has already been done. The bounty system becomes expensive as population levels increases; thus,the corresponding amount involved could be better used to support a more effective rat control program.

EVALUATING CONTROL METHODS

It is important to know whether or not a control program has been effective. Commonly used data for assessment are the following: catch (traps, drives, burrows flushing etc.), activity (tracking tiles, electronic devices) damage and bait consumption (plain or poison). In field experiments, statistical tests (ANOVA, t-test) are used to test differences among control methods before and after treatment. Kaukeinen (1979) reviewed some census methods for evaluating efficacy of rodenticides as well as rodent control operations. According to Kaukeinen, efficiency of a control method relative to pre-treatment level is computed as: 100—[(post treatment census data/pre-treatment census data) x 100] = % reduction. The census periods should be

Laborers p

"Star" m

Laborers preparing rat carcasses for dinner.

"Star" meat being dried under the sun for future use.

of identical length: a minimum of three consecutive days of census data or an average for each trial phase. At least two independent census methods should be used to generate adequate data. Kaukeinen (1979) suggested that percent reduction values for two or more methods be averaged and further supported by concluding snap trapping. Sample data are presented in Tables 5-6 and 5-7.

Data on bait consumption of an anticoagulant compared to a warfarin standard can also be used to detect developing resistance in the field. Drummond and Rennison (1973) and Rennison (1977) used regression analysis based on number of bait points with takes (consumption) and on the total weight of the bait consumed in determining rodenticide field efficacy and developing resistance. In census baiting, it is important to reduce chances of rodent neophobia to new foodstuffs or new food containers during the trial and to change competition for existing foodstuffs (Kaukeinen, 1979). In addition, it is important to know if such reduction is large enough to justify further use of a control method. A simple measure of economy is the cost/benefit ratio. Cost should include manpower, equipment and interest on loans while benefits due to treatment should be measured in terms of the value of the product that the farmer or producer is selling.

Table 5-6. Example of summary on census methods used for determining the interior control of Norway rats in an Illinois poultry house[a] (Kaukeinen, 1979).

	Reduction in rodent activity revealed		
Census method	Before treatment	After treatment	Percent reduction
Census Bait Consumption, g			
Total Consumption	2137.8	173.9	91.9
Average per point	11.9	0.1	99.2
Max 3 days total	1213.4	154.7	87.3
% Active points	82.6	13.4	83.8
Avg. take per active point	14.7	5.3	63.9
Tracking Data			
Total minimum tracks	2746.0	425.0	84.5
Average per point	152.5	23.6	84.5
Max 3 days total	971.0	202.0	79.2
% Active points	93.1	33.9	63.6
Tracks per active point	16.3	7.1	56.5

[a]Census periods, 10 days each; treatment period, 9 days, using 33 bait stations replenished daily to 300 g.