CHAPTER 3

Current Control Strategies

' The principal of the cultural control of rats is the purposeful manipulation of the environment to make it less favourable to rats, thus exerting economic control of the rats by reducing their numbers and crop damage.' — Lam Yuet-Ming (1990)

The strategies adopted for managing rodent pests in agricultural systems vary from country to country in Southeast Asia. Differences are related to which species are the main pests, the type of crops, the method of cropping in the case of rice (e.g. dryland, irrigated, upland, deepwater), the availability and affordability of rodenticides, the infrastructure of pest management (including extension), the level of knowledge on the basic biology of the main pest species, and the social and political structures within a country.

In this chapter we will consider the national and local strategies adopted to control rodents in rice crops in Indonesia, Laos, Malaysia, the Philippines and Thailand.

Rodenticides provide the basis for the current management strategies in most countries. Much has been written about the use of rodenticides and their efficacy under field conditions in Southeast Asia (e.g. Wood and Liau 1977; Buckle et al. 1979; Benigno and Sanchez 1984; Fiedler et al. 1990; Meehan 1984; Wood 1984a; Lam 1985; Sanchez and Benigno 1985a; Lam et al. 1990b; Sumagil 1990; Buckle 1994) and integrated management schemes based on the use of rodenticides have been trialed in Peninsula Malaysia and Central Java (see Buckle et al. 1985 and Buckle 1990 for reviews).

High cost/benefit returns have been demonstrated in a number of studies aimed at evaluating chemical control of rodents in Southeast Asia (e.g. Wood 1971; Buckle and Rowe 1981; Lam et al. 1986; Lam et al. 1990b). However, the success of these management operations generally require a series of bait applications. The challenge facing wildlife managers is to convince growers to continue bait applications after growers begin to perceive a drop in rodent activity (see Lam et al. 1990b).

In the immediate future, rodenticides are likely to play an important role in any integrated management strategy directed at reducing the impact of rodent pests. Because of the extensive literature that exists on rodenticides and their use, we will not be considering chemical control in any depth, instead we refer interested readers to the above papers.

3.1 National Strategies for the Control of Rodents

3.1.1 Indonesia

National rodent training courses are conducted infrequently (last one was in 1988) by the Jatasari laboratory of the Directorate of Food Crop Protection. There is not a well structured national rodent control program. Basically, the extension of rodent management focuses on advising farmers on which poisons to use and how to use them. As in the Philippines and Malaysia, the second generation anticoagulants are recommended to the farmers. The farmers however, prefer to use zinc phosphide because of the higher cost of anticoagulants and the tangible results provided by zinc phosphide (dead rats near the bait).

A community based program of rat control is incorporated in the FAO inter-country program for the development and application of integrated management in rice growing in South and Southeast Asia (van Elsen and van de Fliert 1990). This program has only recently been implemented but has had little input from vertebrate population biologists. The program was implemented in areas with chronic rat damage and appears to have been successful in reducing losses (van Elsen and van de Fliert 1990).

3.1.2 Laos

At the national level, control of rodents is the responsibility of the Department of Agriculture and Extension. At the provincial level, control of rodents is the responsibility of staff from Agricultural Services. There is no coordinated national rodent control program.

3.1.3 Malaysia

National management and extension program

The main method for rat control is the use of chemicals. As in the Philippines, farmers prefer to use zinc phosphide (cheap; dead rats are visible) even though MARDI and the Department of Agriculture recommend the use of wax blocks of brodifacoum (a second generation, one feed, anticoagulant). Regardless of which chemical is used, the strategy is the same. Baits are placed every 10 paces in the open (about 60 bait stations per ha). If a rat problem was evident during the harvest of the previous season's crop, then baiting is recommended once a week for eight weeks after planting of the next rice crop.

Rodenticides are subsidised by the Malaysian Government. The farmers obtain the rodenticide on credit at a subsidised cost from a co-operative. The farmer pays for the poison after he has harvested and sold his crop.

A physical barrier interspersed with multiple-capture traps, is another recommended method of rat control. This method is generally used in regions where rat damage has been typically high. The use of these barriers is based on reports from field officers from the Department of Agriculture who monitor the level of crop damage by rodents. Control operations are recommended when greater than 15% of hills of a standing rice crop are damaged by rats.

The MARDI researchers we spoke to identified farmer apathy as the main impediment to effective control of rats. Apart from there being many farmers who do not follow the recommended baiting schedule (they tend to stop baiting after 2 to 4 weeks), others show a lack of basic farm hygiene practice (e.g. no synchrony in planting crops; surrounds of crops are weed infested) or do not even plant crops because they are more interested in biding their time until the urban sprawl reaches them so that they can sell their land.

3.1.4 The Philippines

A Rodent Research Center was established at the University of the Philippines at Los Baños in 1968. This Center became part of the National Crop Protection Center (NCPC) when it was established in 1976. Benigno (1985) provides a brief history of the establishment of these centers and of the support provided by international bodies.

The main function of these centers was to provide training of field officers, and undertake extension and research. There are four tiers of information flow on pest management in the Philippines. The base level is the Barangay (village level), followed by the municipality, province and then the Bureau of Plant Industry (BPI) in Manila. Field officers are employed by the BPI and are referred to as Pest Control Officers (PCOs). The PCOs are attached to municipalities.

National management and extension program

A national rice production program, MASAGANA 99 (M-99), was instigated in 1975. This program included a national rodent management program. If farmers had a rodent problem they had access to free technical help and to a non-collateral credit program which provided bank loans for purchase of rodenticides. The latter was only available if they followed the M-99 program. This recommended management program, which was based on sustained use of anticoagulants placed strategically in bait stations, is detailed in Appendix 1.

The BPI also developed, in parallel, a surveillance and early warning system (SEWS). Information was channelled annually to the BPI at Manila. This information was used to assess rat problems on a national scale. The SEWS system was not operational in 1992. The onus is now on PCOs to report any significant rodent problems.

The adoption of the M-99 rat control program in Laguna the year after it was proclaimed was low. Only 12.5% of farmers adopted the recommended control, and then only in part, and only 18.5% were aware of it (Dizon 1978). Two reasons were suggested for this low adoption rate: one was that farmers considered 5 to 20% damage by rats to rice tillers was not sufficient for control action; the other that there was a poor information flow despite PCOs being trained to extend the M-99 program (Dizon 1978). In Bulacan, initial adoption rates of M-99 by farmers were high but fell rapidly over the next 5 years (Ocampo 1980).

In the 1990s, the M-99 program is still current yet it appears that the rate of adoption is very low. Another cause for non-compliance in recent times was the 4-tier system of information flow. If a farmer reported significant rat damage, access to rodenticides under the M-99 program required approval from the BPI. By the time this approval was given, the rodenticides provided were too late for effective and economic control.

In summary, the M-99 program has been in operation for over 15 years yet does not have a high adoption rate by farmers. The crucial information that is required is whether this is a result of poor extension and implementation, or whether the control methods are perceived as inappropriate by the farmers.

Rodent research personnel

Research on rodents at the NCPC was linked closely with the Denver Wildlife Research Center (USDA, Colorado, USA) from 1968 to 1983. The main result of this collaboration between USDA and NCPC was the development of the national 'sustained baiting strategy' which was adopted as part of M-99. During this period four Masters theses and two PhD theses were produced. Unfortunately, once qualified, most of these people moved away from rodent research. Since 1983 the level of research has declined. At the NCPC in 1992, there was one scientist with extensive rodent research experience and, at the time, this scientist was working primarily on insect pests.

Training of Pest Control Officers

The training program of Pest Control Officers (PCO) was based at the NCPC. The program concentrates mainly on insect and weed problems. In 1992, the training program of a PCO covered 3 weeks of which 3 hours were devoted to rodent management.

3.1.5 Thailand

Control is implemented by officers of the Animal Pest Section of the Plant Protection Service of the Department of Agriculture. There are 30 Plant Protection Service Units and each unit is responsible for usually 2 of the 73 Provinces in Thailand. Each province has 10 districts and there is one agricultural officer in each district. Therefore there are 730 district officers that report back to the PPS units.

If a severe rodent problem is reported, the relevant PPS unit will recommend to the Department of Agriculture that rodenticides be distributed to farmers. The rodenticide is free to farmers, but not to private oil palm plantations. For single applications, zinc phosphide is recommended to farmers. When continuous chemical use is required, pulse baiting using anticoagulants is recommended.

Training of Plant Protection Service staff

Rodent control courses lasting 3 to 4 days are held for PPS staff. These courses are presented by the Agricultural Zoology Research Group at Bangken. This research group also provides an input into training courses provided for international programs on integrated pest management. However, the emphasis on vertebrate pests in these programs is usually low.

3.2 Concluding Remarks

Both Malaysia and the Philippines have national rodent control programs in place that have low adoption rates by farmers. We have provided possible reasons why this may be the case. The suggestion of farmer apathy may be a convenient explanation for pest control officers and researchers who have in place a management strategy. However, the problem of farmer perception in relation to rodent management has been given scant, if any, attention.

Inadequately considering farmer practices, and overestimating their skills are thought to account for the lack of success of IPM programs against insects and weeds in developing countries (Brader 1979; Heong et al. 1992). Perhaps a similar argument can be applied to rodent management programs. An interesting template for tailoring management programs for the end user, the farmer, is presented by Norton and Heong (1988).

CHAPTER 4

Ecology of the Major Pest Species

'Considering that rodent research and rodent control are continuous processes, we cannot afford to allow the extinction of rodent research centres. If national governments are unable to support rodent research, International Organisations should find funds to maintain research on these global pests.' — Ishwar Prakash (1990)

4.1 Previous Research in Indonesia

Early studies of the biology of the rice field rat, *Rattus argentiventer*, and the problems they cause in Indonesian rice fields, were conducted by van der Meer Mohr in the 1920s and van der Goot in the 1930s and 1940s (cited in van der Laan 1981). They reported that these rats require food rich in starch and that breeding is influenced by the quality and availability of food. The favoured nesting sites are the banks of rice fields. The first young (10 to 12 in a litter) are born approximately 10 days before the rice crop is ready for harvest. Occasionally, rats suddenly migrate in masses to other crops and cause high levels of damage. The reason for this sudden migration was not stated.

Van der Laan (1981) provides a diagrammatic cross section of a typical burrow and nest of the rice field rat in a bank of a rice field. The burrows are shallow and consist of two entrances, a nest site and a blind-ending gallery for an emergency exit. Despite the nest sites being located on the edge of the rice field, rat damage is typically concentrated in the centre of a rice bay (or sawah) (van der Laan 1981).

From these early studies of rat damage, shortening of the harvest period was recommended as an important cultural control measure (van der Goot 1937, in van der Laan 1981) and planting two or more crops annually was identified as exacerbating the problem (Grist and Lever 1969). This was at a time when growing two crops per year was an exception rather than the rule.

From our talks with various scientists and examining literature in two libraries (BIOTROP & BORIF), we are aware of only one reasonably detailed ecological study of rats in rice crops in Indonesia. This was a study on *R. argentiventer* near Jatisari on Java during 1985 to 1992. The study was by Japanese scientists and was supported by JIKA. Some of these findings appear in a training manual for rodent management (used at Jatisari Forecasting Center), and some information on the breeding and population dynamics of rats is presented in Murakami et al. (1990).

Further information has been gathered by scientists at SURIF during their studies on rodent control methods. Data on the number of rats captured during trapping programs at SURIF are presented in Figure 4.1. This shows that, over a six-year period, rodents were generally more common in the latter part of the dry season than during the wet season. No information was available on trapping effort, which may have been greater during the dry season. Nevertheless, these data give some indication of the prevalence of rodents over the year.

There is currently also an ecological study of rats in south Sumatra conducted by Ir Rochman from BORIF. The study is in a trans-migration area where there is a diversity of crops with rice being the main crop. The emphasis is on the degree of damage to various crops and the efficacy of poisons. The close proximity of 'other crops' (especially vegetable crops) has resulted in *Rattus exulans* causing just as much damage to rice crops as *R. argentiventer*.

4.2 Previous Research in Laos

Virtually no research on rodents has been conducted in Laos. The emphasis is on extension of management techniques developed in other countries. Staff from Agricultural Services in Vientiane occasionally hold training courses for people from the Districts. However, they are only trained in methods to control lowland rats.

Some information is available on the farmers' perception of rodents as pests of rice crops. This information has been gathered as part of general surveys on farmer perceptions of constraints to growing rice (see Table 2.3).

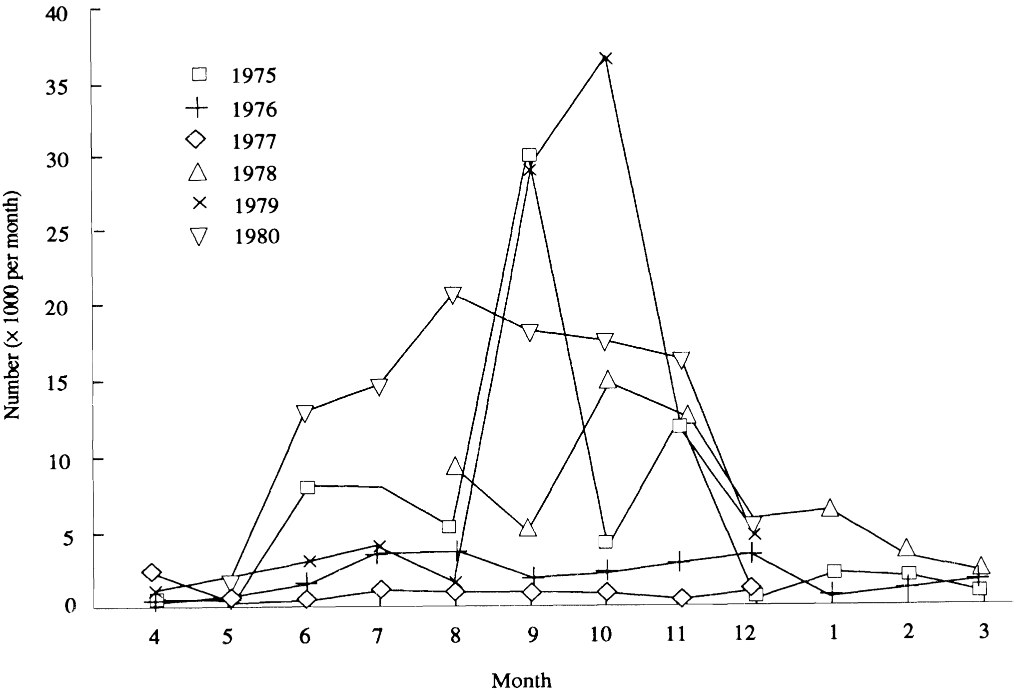

Figure 4.1 Number of rats caught per month at Sukamandi between 1975 and 1980.

4.3 Previous Research in Malaysia

Most of the research effort on understanding the population biology of rats in Malaysia has been on the rice field rat *R. argentiventer*, and the wood rat, *Rattus tiomanicus*. The extent of published information on various ecological parameters on these and other rodent pest species in Malaysia is summarised in Table 4.1.

The studies by Wood and Liau on the wood rat provide the best coverage of the biology and population dynamics of a rodent species in Southeast Asia (Wood 1984b, Wood and Liau 1984a, b). However, many gaps in our knowledge of the population ecology of the wood rat remain.

Detailed and extensive studies of the breeding biology of the rice field rat have been made (e.g. Lam 1980, 1983). The most important finding for the management of this species is that breeding corresponds to the milky and ripening stages of the rice crop (Lam 1983). On single-cropped farms, female rats only breed once per year. In areas where two crops are produced per year there are two main breeding seasons, each of approximately three months. Also, there is an indication that male rats are sexually mature at an earlier age in double cropped areas (Lam 1983). Together, these findings indicate that rat populations are well adapted to take advantage of changes in the timing of the availability of a high quality food resource. Double or even triple cropping (as is becoming common in areas such as the Mekong River delta in Vietnam, see Chapter 2) will substantially increase the annual productivity of a population of rats and hence increase their depredation of rice crops. Similarly, depredations by rats are higher in a district where there is asynchronous planting of crops because this will increase the period during which ripe crops are available as a food source, which in turn will extend the breeding season of rats.

Little is known about the habitat use, dispersal patterns or home range of *R. argentiventer*. This information is essential for knowing where and how far apart poisons should be placed, for developing better farm management practices and for assessing the likely transmission rates of potential biological control agents.

Table 4.1 Summary of the extent of published information on various ecological parameters of the major rodent pests in rice crops in Malaysia. Information was assigned to one of five categories (see footnote).

	Rattus argentiventer	***Rattus tiomanicus***
Abundance	+++[1,2]	++++[3]
Habitat use	–	+[3]
Breeding	+++++[4,1]	++[3]
Survival	–	++++[5]
Age structure	+++[6,1]	++++[5]
Diet	–	+++[5]
Predator/prey	–	++++[7,10]
Disease	–	–
Taxonomic status	–	–
Species interaction	–	–
Damage 'in-crop'	+++[1,8,9]	–
Damage 'postharvest'	–	–

Note: – = no information; + = anecdotal reports; ++ = restricted to a single sample/survey; +++ = restricted to one or two growing seasons or a long-term data set not calibrated against other measures; ++++ = extensive data collection of calibrated measures over at least one year; +++++ = extensive study with replicated high quality data collected over at least one year.

[1] Wood (1971), [2] Lam et al. (1990a), [3] Wood (1984a), [4] Lam (1983), [5] Wood and Liau (1984a), [6] Lam (1988), [7] Lenton (1980), [8] Buckle and Rowe (1981), [9] Buckle et al. (1985), [10] Smith (1994).

Nor do we know whether interactions with other species of rodents influence the habitat use and population dynamics of the rice field rat or vice-versa. The latter knowledge is important because management strategies developed specifically for the rice field rat may help another rodent species to develop pest status.

The effect of barn owls on populations of *R. tiomanicus* in oil palm plantations has been the subject of an interesting series of studies. These will be considered further in Chapter 7.

4.4 Previous Research in The Philippines

During the 1970s and early 1980s the National Crop Protection Center undertook a number of studies investigating certain aspects of the ecology of the main rodent pests. These studies were often conducted as part of postgraduate studies undertaken at the University of the Philippines, Los Baños. Investigations were made into crop preferences of various rodent species, reproductive measures, habitat and dietary preferences, and movement into and out of crops. The results of much of this work are summarised in Sanchez and Benigno (1985a). However most of the work undertaken at the NCPC concentrated on the interaction between rodents and rodenticides. Virtually all the research effort on understanding the population biology of rats in the Philippines has been on *R. r. mindanensis*. The extent of published information on various ecological parameters on these and other rodent pest species in the Philippines is summarised in Table 4.2.

In common with *R. argentiventer* in Malaysia, the best information available on *R. r. mindanensis* is on factors that influence its breeding. Again, breeding is linked with the ripening stages of the crop and, in areas where two crops are produced per year, there are two breeding seasons (see Fall 1977).

There is some information on the habitat use of *R. r. mindanensis* (Sumangil 1990; Libay and Fall 1976) but there is much we do not know. Of most interest is the report by Libay and Fall (1976) of high densities of rats in marshland adjacent to rice fields in Luzon. Rat drives along the fringes of the marshland indicated densities in the vicinity of 10 000/ha . The authors contrasted the chronic crop losses experienced in most rice-growing regions in the Philippines with the rat 'outbreaks' that historically have occurred in areas adjacent to wide marshlands. This study emphasises the variation that can occur in the population dynamics of rat populations in different habitats, and the potential influence of non-rice habitats on the densities of rat populations in adjacent rice fields.

A recently completed radio-telemetry study of movements by R. *r. mindanensis* on rice farms near Calauan in southern Luzon, indicated that home-range size depended on the synchrony of crop development within a local region: rats 'tracked' crops once they became milky-ripe. The average home range for male rats was approximately 0.6 ha just prior to or postharvest and 1.8 ha during the milky-ripe stage. The average home range for female rats was approximately 0.3 ha just prior to or postharvest and 0.8 ha during the milky-ripe stage. Home range size also increased with age of the rat. Linear movements of >275 m by 7 of 12 rats occurred on 17 occasions when the crop was milky-ripe. Only one of 30 rats covered such a distance just prior to or postharvest (Singleton et al. 1993; unpublished data).

Table 4.2 Summary of the extent of published information on various ecological parameters of the major rodent pests in rice crops in the Philippines. Information was assigned to one of five categories (see footnote).

	Rattus rattus mindanensis	*Rattus argentiventer*	*Rattus exulans*	*Rattus norvegicus*	*Rattus* spp.
Abundance	+++[1]	–	–	–	–
Habitat use	++[2]	–	–	–	–
Dispersal	++[3,4]	–	–	–	–
Breeding	+++[5]	+++[6]	–	–	–
Survival	–	–	–	–	–
Age structure	–	–	–	–	–
Diet	++++[7]	–	–	–	–
Predator/prey	–	–	–	–	–
Disease	–	–	–	–	–
Taxonomic status	+++[8]	–	–	–	–
Species interaction	+[9]	–	–	–	–
Crop damage					
— at IRRI	++[10]	–	–	–	–
— elsewhere	+++[11,12]	–	–	–	–
Postharvest damage	–	–	–	–	++[13]

Note: – = no information, + = anecdotal reports ; ++ = restricted to a single sample/survey; +++ = restricted to one or two growing season or a long-term data set not calibrated against other measures; ++++ = extensive data collection of calibrated measures over at least one year; +++++ = extensive study with replicated high quality data collected over at least one year.

[1] Kumer (1985), [2] Libay and Fall, (1976), [3] Lavoie et al. (1971), [4] Sanchez (1971), [5] Marges (1972), [6] Sumangil et al. (1980), [7] Tigner (1972), [8] Sanchez and Benigno (1985b), [9] Uhler (1967), [10] Ahmed et al. (1987), [11] Fulk and Aktar (1981), [12] Benigno (1979), [13] Aganon (1981).

4.5 Previous Research in Thailand

There is little published information available in the scientific literature on rat research in Thailand. There is, however, an active research group on vertebrate pests in the Thailand Agricultural Zoology Research Group. Research on rodent pests of agriculture is conducted by this group but in recent years much of the focus has been on field trials of the efficacy of various rodenticides (Table 2.11). We are aware of one population study conducted on *R. argentiventer* in rice crops, however we have seen no details of this research.

4.6 Concluding Remarks

Research on the population ecology of pest species of rodents provides the essential framework for developing management strategies (see Redhead and Singleton 1988b; Singleton and Redhead 1990). Unfortunately, most of the population research on rodent pests in tropical countries simply consists of studies that examine the effectiveness of a particular poison. These studies contribute little to our understanding of the factors that regulate or limit field populations, or the mechanisms that generate a population outbreak. If we had this knowledge, we would most likely be able to improve substantially the efficiency of chemical use. This would achieve the double goal of making rat control cheaper and reducing the amount of chemicals in the environment.

Malaysia and the Philippines have the best published information on the biology of rodent pests of agriculture in Southeast Asia. Even in these countries however, there are large gaps in our knowledge of the population ecology and general biology of the rat species that cause the major losses to agriculture.

Unfortunately, the gaps in our knowledge are far greater in the other countries in Southeast Asia. This is particularly so in Laos where one cannot proceed beyond the identities of the major pest species of rodent. Although more is known about the basic biology of rodents in Indonesia than in countries like Laos, we could find only two proceedings from conferences (Rochman 1987; Murakami et al. 1990) and one training manual (Anon. 1992) with published information on the population ecology and habitat use of rats in agricultural lands.

Until more basic research on the population biology and habitat use of rodent pests is conducted in countries such as Indonesia and Laos, an improvement in the efficiency and cost effectiveness of rodent control will continue to be a dream rather than reality.