Ridding rice of rats

Roger Beckmann

In Southeast Asia many farmers consider rat damage the main factor limiting increases in rice production. ACIAR project scientists have looked for the best approach to rodent control in the region, and they have come up with some simple but revolutionary answers.

When we think of serious crop pests, it's usually insects that come to mind first. That's understandable—worldwide, insects undoubtedly cause huge losses. For decades, we have been mesmerised by their antics, and used considerable ingenuity and resources in combating them. But perhaps as a result we tend to forget that in many parts of the world the most serious crop pests—and the ones that are often worst to live with—are not insects at all. They are our mammalian cousins the rodents, and they are often far harder to control than insects.

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Rodents are widespread pests, but their effects are particularly bad in the tropics. Consider these worrying statistics:

- Rats are the number one preharvest pest of rice in Indonesia, where about 17% of the annual production of rice is lost before harvest. This is enough rice for 20 million Indonesians—all going to rats!
- In Vietnam, rodents are one of the country's top three agricultural problems.
- In Laos, rodents are the second most important agricultural pest in mountainous regions, and the one over which farmers feel they have the least control.

In several Southeast Asian nations, farmers now consider rodents (not insects, weeds or lack of soil fertility) to be the main factor limiting increases in rice

Preparing the rice crop in Indonesia, where rats are the number one preharvest pest.

Roger Beckmann is an Australian freelance science writer. Photos supplied by project staff.

Rats have damaged the tillers on these rice plants.

production. The situation is also bad in Africa. In Tanzania, during rodent population eruptions, rats can eat more than 80% of the planted maize seeds in an area. And, of course, the impact of rodents doesn't stop once the crop is harvested. They happily consume and contaminate stored produce too. There are few estimates of postharvest damage, but experts consider it could be as high as the preharvest losses.

Add to this the potential for many diseases to affect humans living in crowded conditions close to large populations of rats and mice, and it's possible to see why rodents are as bad, if not worse, than our insect enemies.

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Rodents are fast breeders and can quickly take advantage of favourable conditions. The size of a population can vary rapidly, tending to boom and crash in line with food supply and other environmental factors. Often, the life cycle is closely connected to the development of the crop plant in the area. But even when rodent populations are small, local effects can act to funnel or concentrate the pests so that one or a few farmers suffer catastrophic losses even though average loss figures for the year may be low.

Australia is also a chronic sufferer from intermittent rodent 'plagues'; during population booms, the house mouse becomes a major pest in rural areas of southern and eastern Australia with country folk sometimes enduring what is described as a 'moving grey carpet' of mice that enters houses and damages vehicles and machinery as well as crops. In Queensland, canefield rats have become a significant problem for the sugar cane industry.

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Unfortunately, traditional control strategies for rodents are often far from effective. Chemical methods are widely used, but resistance has developed to many of the staples, the costs can be high and these highly toxic poisons pose a threat to other species and to humans.

Knock, knock, who's there? Too many mice at a piggery in Queensland, Australia.

But there is some good news in what is rightly described as the war against rodents. ACIAR is now funding its third project on rodent pests in Southeast Asia. Coupling local expertise in the partner countries of Indonesia (and more recently Vietnam and Laos) with a team from CSIRO Wildlife, project leader Dr Grant Singleton has demonstrated that the best approach to the rodent problem is to apply ecologically-based management. This means understanding the close connection between the pest and its food supply, and managing the problem continuously even when the pests seem scarce. It is a radical shift from the previous approach which relied on dealing with a problem once it appeared.

Building a better rat trap?

There are plenty of ingenious ways of killing rats and mice. The aim of the ACIAR project, therefore, was not merely to 'build a better trap' or to find a better poison. Indeed, there is increasing demand in developing countries for rodent control strategies that either have less reliance on chemical rodenticides or can better target their use. This is because rodenticides are costly, can cause poisoning of a wide range of other species, and conflict with growing domestic and international marketing requirements for 'clean, green' agricultural produce.

Instead, the project set out to discover how to manage an ever-present problem in the most effective, efficient and achievable manner, using appropriate trapping methods when warranted.

In their desperation to be rid of a devastating problem, farmers have often resorted to dangerous or simply ineffectual measures

The important point is to use trapping and killing effectively. But in their desperation to be rid of a devastating problem, farmers have often

There are many ingenious rat traps, such as this bamboo trap from southern Vietnam.

The trap on which the trap barrier system (TBS) is based.

A lure, a barrier and a trap

In many developing countries, farmers protect their crops from invading rodents by using plastic fences as barriers to deflect the animals away from the crop. This system is quite effective for the individual farmer, but the result is that the pests simply disperse into neighbouring crops. For every gram of harvest saved in the protected field, another is lost elsewhere. Across a whole village, therefore, the barrier method scarcely reduces losses at all—unless applied by everyone. And then the neighbouring village suffers.

Malaysian researcher Mr Lam Yuet Ming developed a population-reducing variation on this method for protecting rice, by making small holes inside the plastic barrier just above the irrigation water, and adding permanent trap cages on the other side. Rodents enter through the holes at night, when they are most active, and are trapped and removed the following morning.

Setting up a trap barrier system in Laos.

resorted to dangerous or simply ineffectual measures. An example of the former is rigging up a wire carrying mains electricity a few centimetres above the water on the edge of a rice paddy. It kills rats approaching the crop by night, but has also caused fatalities to villagers. The ineffectual approach is exemplified by the folk belief that a large male rat, made chronically irritable by having his anus sewn closed, will keep other rats away from the crop.

The ecological view of the rodent problem builds on the idea of integrated pest management, a concept familiar to readers of *Partners*. But, as Grant Singleton puts it, 'we try to place a stronger emphasis on ecological research and on a systems approach to management'. And this seems to have been the key to their success in finding village-based ways of keeping rats at bay.

Other approaches

The TBS is not the whole focus of ACIAR's latest project (AS1/1998/036). One purpose of the project was to build up expertise in the region; it has succeeded admirably as there is now a National Rodent Laboratory in Indonesia. The whole issue of rodents and their management has been brought to the attention of scientists and governments in the region—and the effectiveness of the novel approaches has been made known at the farm and village level too.

There have been 10 training programs (in-country and in Australia) run by the CSIRO Rodent Research Group during the course of the two main ACIAR projects. And in Vietnam, collaborators from the Institute of Agricultural Sciences have produced a booklet on rodent management based on the outputs of the ACIAR-sponsored work in the Mekong Delta region.

The Rodent Research Group (within CSIRO Wildlife and Ecology) has set up an international rodent pest network, coordinated by email and with a regular newsletter appropriately entitled 'War against Rats!'. About 100 people have subscribed to the network, representing some 56 institutions in 27 different countries.

Australia has benefited by the creation of a decision-support system for farmers and extension workers combating mice. Called MOUSER, the CD-ROM contains information and management options.

New approaches to the rodent problem are coming from CSIRO in the form of a project to develop an immunocontraceptive vaccine, distributed either in a species-specific virus or in baits, which would sterilise the pests.

This is known as the trap barrier system, or TBS to practitioners. When properly built and maintained (with daily rat removals) it can reduce the rat population in an area.

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However, setting up the plastic fencing and traps is time-consuming and costly, and Dr Singleton has discovered that the method is only economical in a setting where crop losses are greater than about 30%. But for particularly attractive crops—for example, those that ripen after other food sources have finished—the method is worthwhile. In these cases, where rodents are concentrated on one crop because others have already been harvested, any losses would be high enough to warrant the investment in the protection.

The trap barrier system with associated trap crop (TBS + TC) in the Red River Delta of Vietnam.

But what of the staple crops, usually sown and harvested at the same time across a region? As farmers try to fit in more harvests, so the rodents receive more food and therefore breed more. For example, in parts of the Mekong Delta the rat problem has increased over the past decade, mainly because farmers have succeeded in growing three rice crops a year which has simply brought about three breeding seasons for the pests. Farmers see rats swimming across rivers to reach their crops, and naturally blame the country or region 'on the other side' for the rat problem. But, in fact, rats track the availability of food, crossing boundaries and borders first one way and then the other according to ripening times of the crops.

This movement suggests an answer. If rats home in on a crop from some distance, then an early-ripening crop would act as a lure. This idea had never been fully evaluated, so Dr Singleton and his colleagues experimented by setting up an early rice crop (called a trap crop or TC) in West Java, with a trap barrier plastic fence around it. The rats can be caught in the traps and disposed of.

Encouraging results

'We were very pleased with the results,' Singleton reported. 'The allure of the rice crop, planted just three weeks earlier than surrounding crops, attracted rats, which entered the barrier traps. There was thus a sort of halo of protection, which extended for about 200 metres around this crop. It was certainly worth the effort.'

The 200-metre protected zone covered 16 hectares of productive plantings

Indeed it was—the 200-metre 'protected' zone covered 16 hectares of productive plantings. Economic analysis

revealed that the benefits of the trial outweighed the costs by about 20:1. Yield increases in the surrounding crops ranged from about 0.3 to 1.0 tonne per hectare.

The effect of the whole system (TBS+TC) was most pronounced during dry seasons, and thus its cost-effectiveness was greatest then. In the wet, when rat population densities in the area are lower, the zone of protection was less. Grant Singleton believes the technique is likely to be effective across a wide range of different rice-growing systems.

The bottom line

In developing Asian nations, the halo of protection covers an area that is beyond what an average family farms. Therefore a community-based approach is needed to get the very best results. An agrarian village in Indonesia usually cultivates about 75–100 ha, with individual families generally tending 0.5 to 2 ha. Assuming one trap crop attracts rats from 10–16 ha, then five to ten such set-ups would be needed to protect an entire village's rice.

The cost of materials and labour to build one 25 x 25 metre TBS with 10 cage traps varies considerably between countries. (The cost of the TC is ignored as its crop is harvested as a normal crop.) In Indonesia it comes to about US$44.75 but, if done properly, the whole system of traps and barriers should last for four seasons. In Vietnam the cost is only slightly higher. In both cases, there is the potential to offset some of the expenditure by using the rats. In Vietnam, the captured live rats are often sold and some of the plastic sheeting is re-used.

The traps are the most expensive part of the system, and in Indonesia staff at the Research Institute for Rice have devised some novel ways of reducing trap costs by recycling tins previously used for cooking oil or biscuits.

Here is the day's catch from the TBS + TC setup in west Java, Indonesia.

Government support

In Indonesia and Vietnam the results of the TBS+TC system have been promising enough for governments to take an interest. There is a great determination to deal with the rat problem, but up until now governments have often only acted when there is an acute outbreak and people complain. With high population densities, a bounty scheme is often put in place to reward people for each rat caught. Whilst popular, there are many disadvantages with this approach. For a start, pest populations are robust. They simply eat more (because there are fewer of them to share the available food) and therefore breed more. Studies have shown that at least 50% of the animals in an area must be removed before there is any significant long-term effect on the population. (And, of course, removal from a small area has no effect, as the rats re-colonise from elsewhere.)

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Secondly, bounties can be seen as an ongoing source of income, encouraging people simply to harvest rats rather than eradicate them. There has been little evaluation of the effectiveness of bounties as a control strategy, other than a count of bodies removed.

Thirdly, the time and effort spent in catching and presenting animals during times of high population density could be better used on prevention at other times. And, finally, the schemes themselves are open to fraud and abuse, because of the money involved.

Results from the ACIAR project suggest that governments would do better putting their money into organising TBS+TC systems across rice-growing regions. With full coverage, conscientious maintenance and regular rat removal, the pest population would eventually decline across an entire region.

The TBS established for upland crops at Luang Prabang, Laos.

And it seems that this is becoming a reality. The system has already gained considerable recognition. There is much interest in the TBS+TC concept in Vietnam. In the Mekong River Delta the first tests took place in early 1997 and just over a year later there were already more than 100 TBS+TCs established across five provinces of Vietnam. Laos is also interested, although the system would need to be modified as many areas of the country use slash-and-burn agriculture.

Following the on-farm trials conducted by Dr Singleton and a team led by Drs Sudarmadji at the Research Institute for Rice in Indonesia, TBS+TC technology has been widely adopted in Indonesia, particularly in Java, South Sulawesi and some of the farming regions of South Sumatra. Experimental farms that have high value trials and seed stocks have also reported good results using TBS+TC. The early results on this broader scale have been encouraging—so much so that the National Farmers Association of Indonesia has begun a national rodent campaign based around the use of the TBS+TC.

Like any new technology, TBS+TC can have its drawbacks. There is a high initial cost, considerable labour, and the need for regular maintenance, as the fence needs to be checked daily. There are other potential problems too—for example, the mechanics of planting an early trap crop and its potential to attract a concentration of bird and insect pests at a time when there is little other food available.

As well, other species can get caught in the traps. And the black plastic used for the fencing needs proper disposal or recycling after its useful life is over. It is also important to encourage the humane and hygienic use or disposal of the trapped rats.

However, most of the existing attempts at rat control have similar or worse problems.

The challenge now is to encourage rapid transfer of the technology to the village level, bearing in mind that both its economic and practical effectiveness will vary with circumstances.

Speed is important here. As Singleton aptly puts it: 'with another billion mouths to feed in Southeast Asia by 2025, losing just 10% of a crop to rodents is going to lead to food shortages and even loss of life'. Hopefully, continued research and its application at the front line of this war will ensure that never happens.

ACIAR RODENT CONTROL PROJECTS

Animal Sciences 1

Project AS1/1994/020 Management of rodent pests in Southeast Asia

Countries: Indonesia, Laos, Malaysia, Vietnam

Organisations and Leaders:

Australia: CSIRO Wildlife and Ecology (Dr Grant Singleton)

Indonesia: Research Institute for Rice (Drs Sudarmadji)

Laos: National Agriculture and Forestry Research Institute (Mr Bounneuang Douang Boupha)

Malaysia: Universiti Putra Malaysia (Prof Dato Dr Sheikh Omar Adbul Rahman)

Vietnam: National Institute of Plant Protection (Dr Tran Quang Tan)

Project AS1/1996/079 Management of rodent pests in Vietnam (small project)

Country: Vietnam

Organisation and Leaders:

Australia: CSIRO Wildlife and Ecology (Dr Grant Singleton)

Vietnam: Institute of Agricultural Sciences of South Vietnam (Quy Hung Nguyen); National Institute of Plant Protection (Le Van Thuyet)

AS1/1998/036 Management of rodent pests in rice-based farming systems

Countries: Indonesia, Laos, Malaysia, Vietnam

Organisations and Leaders:

Australia: CSIRO Wildlife and Ecology (Dr Grant Singleton)

Indonesia: Central Research Institute for Food Crops (Andi Hasanuddin)

Laos: Department of Agriculture and Extension (Khamhung Anonh)

Malaysia: Universiti Putra Malaysia (Sheikh Omar Abdul Rahman)

Vietnam: National Institute of Plant Protection (Le Van Thuyet)

Ecology-based Management of Rodent Pests

ACIAR has published a new book on ecologically-based rodent management, with contributions from many of the top scientists in Australia and the region.

The genesis of this book was a common concern on the lack of progress in rodent pest management over the past 20 years in both developing countries and elsewhere. This has occurred despite the advent in the 1970s of sophisticated chemical rodenticides and effective strategies for their use. What has been lacking is a solid understanding of the biology, behav-iour and habitat use of the respective species we are attempting to manage. This book has four broad aims: to raise the profile of the importance of basic research for developing effective, applied management of rodent pest; to argue the need for an ecologically-based approach; to raise the profile of rodent pests management in developing coun-tries and to spark interest in prospective students in a challenging but rewarding field of endeavour.

Singleton, G.R., Hinds, L.A., Leirs, H. and Zhang, Z. (ed) 1999. ACIAR Monograph No. 59, 494 p. Price $A45.00 plus postage and handling.

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