

Non-chemical Control of Rodents in Lowland Irrigated Rice Crops

Use of the Community Trap Barrier System

Rodents are a major agricultural pest across much of Southeast Asia. Pre-harvest rodent damage is increasing in many lowland irrigated rice crops as farming systems change towards multiple cropping and shortened fallow periods. The Community Trap Barrier System described in this note provides a cost effective, environmentally friendly method for managing two of the major rodent pests in lowland irrigated rice crops.



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Rodents in rice crops

Rodents are a significant element of ricefield ecosystems in all parts of Southeast Asia. In many areas, several different species can be found living in and around the fields. Species that feed on the tillering, flowering and seeding rice plants are classed as 'rodent pests'. However, other species probably feed on invertebrates and weeds in the ricefield, and may be neutral or even beneficial to rice production.

Rodents are a chronic problem for smallholder farmers of rice in Asia, causing substantial losses.

Under traditional, small-holder rice farming systems, rodents generally cause chronic production losses in the order of 5-10% per annum. Over the last few decades this figure has risen dramatically, most noticeably in places where annual cropping frequency has increased. Today, it is not unusual for rice farmers to report chronic yield losses of 15-30% per annum, with occasional extreme losses of 50-100%. In many areas, farmers actually abstain from planting during certain seasons because of the expectation of severe rodent damage. This 'foregone' crop is rarely taken into account in estimates of lost productivity due to rodents.

Many farmers and extension agencies have turned to chemical solutions including acute poisons, anticoagulants and bioagents. These all carry significant economic costs and, if used inappropriately, can kill non-target animals and have a negative effect on human health and the environment.

The Community Trap Barrier System or CTBS method has been developed as a non-chemical method of rodent control for lowland irrigated rice cropping. This method has been tested and found to be effective in reducing rodent damage in lowland irrigated rice cropping systems in Indonesia and Vietnam.

The major rodent pests

The single most destructive rodent pest across much of Southeast Asia is the Ricefield Rat, *Rattus argentiventer*. In Thailand and Vietnam, and possibly in



The ricefield rat is the single most destructive pest of rice crops in Southeast Asia.

southern Laos and Cambodia, this species often coexists with the Lesser Ricefield Rat, *Rattus losea*. Both of these species dig burrows and are often found living in and around the edges of rice fields.

The two ricefield rats appear to be absent from northern Laos and the central and northern Philippines (*R. argentiventer* occurs on Mindoro and Mindanao Islands). In these areas, members of the *Rattus rattus* species complex are the major agricultural pests. Other rodents found in and around rice fields that may contribute to chronic damage include the Pacific Rat (*Rattus exulans*), the Norway Rat (*Rattus norvegicus*), and various species of *Mus* (true Mice) and *Bandicota* (Bandicoot Rats).



These crops have suffered heavy rodent damage, concentrated in the centre of each field.

Physical Barriers and Trap Barrier Systems

There is a variety of physical methods available to farmers, ranging from simple woven or plastic barriers designed to deflect rats from growing crops, through to complete enclosures, most often erected around stored grain. These 'barrier systems' sometimes incorporate traps or snares set across gaps or 'doorways' – hence the term Trap Barrier System or TBS. Lam Yuet Ming, of the Malaysian Agricultural Research and Development Institute, developed the TBS concept for lowland irrigated rice.

Over the past 5 years, with support from ACIAR, Lam's concept has been refined and tested at a number of experimental sites in Indonesia and Vietnam. The main developments have been as follows:

1. incorporation of a 'trap' or 'lure' crop to draw rats to the TBS;
2. development of minimum specifications for construction and maintenance of a TBS; and
3. use of the TBS technology as the foundation of an **integrated and community based approach** to rodent pest management.

The result is the Community Trap Barrier System method or CTBS which works best, and is most cost effective, when adopted by an entire farming community.

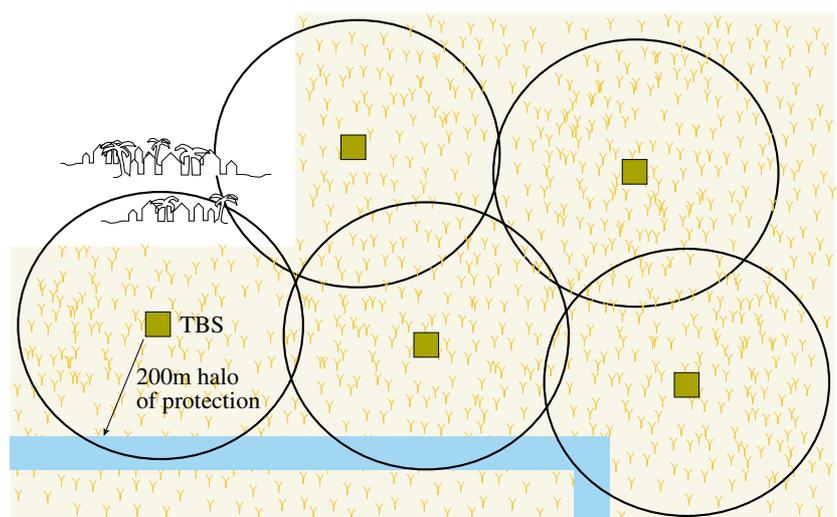
How a CTBS works

The basic unit of a CTBS is a square or rectangular trap barrier system measuring 20-50 m square and enclosing an appropriate 'lure' crop. An encircling, water-filled moat leads rats toward specific, mounded entrances, each of which is defended by a multiple capture live-trap capable of holding a large number of rats. The 'lure' crop that has proven most successful to date is an early-planted rice crop, established 2-3 weeks ahead of the surrounding crop.

Because the lure crop actively draws rats from surrounding fields into the CTBS, it provides a halo of protection around the trap. Results from field studies show that this 'halo effect' can extend as far as 200 m in each direction, depending on the location of other CTBS and features such as major canals and villages.



A multiple capture live-trap. The design of the cone is critical - it must allow rats to enter but not escape.



With careful placement, a small number of CTBS units can protect a large area of crop. Note that the CTBS halos overlap potential source areas for rodents such as major canals and a village.

A single CTBS can therefore protect a surrounding crop area of 10-15 ha.

Where the total cropping area is much larger than 10 ha, more than one CTBS will be needed. This is because rats can move hundreds of metres in search of food and will continually reinfest a protected crop from any unprotected zone nearby.

Breeding biology and movements of Ricefield Rats

The CTBS works to control rodent damage by exploiting the link between the growth of the rice crop and the breeding biology of the two ricefield rats.

Breeding in ricefield rats appears to be triggered by the maturation of the rice plant itself, with females first entering oestrous 1-2 weeks prior to maximum tillering. After a short pregnancy of 3 weeks, litters of up to 18 pups (average of 11-12 pups) are produced. The pups grow rapidly and are ready to breed at 6 weeks of age. Adult females are able to fall pregnant again within a few days of giving birth, and therefore can produce three litters during the generative phase of the rice crop – a total of 30-40 young rats for each original female by harvest time.

The number of breeding seasons per year is also linked to the number of cropping cycles. A single rice crop per year results in one rat breeding season, two crops results in two rat breeding seasons etc.

Following harvest, rats will feed on any spilt or missed grain. Once this is exhausted, many rats will abandon the barren field in search of food. If

surrounding fields have also been harvested at around the same time, many rats will either starve or be forced to move to non-crop habitats. This increased movement exposes the rats to predators, causing further mortality.

In general, an extended fallow period, coupled with rat control activities in the non-crop habitats at land preparation, will lead to a rapid decline in the local rat population. Periods of widespread flooding, such as occur in the major delta areas, can also cause rat populations to collapse as food and shelter become scarce.

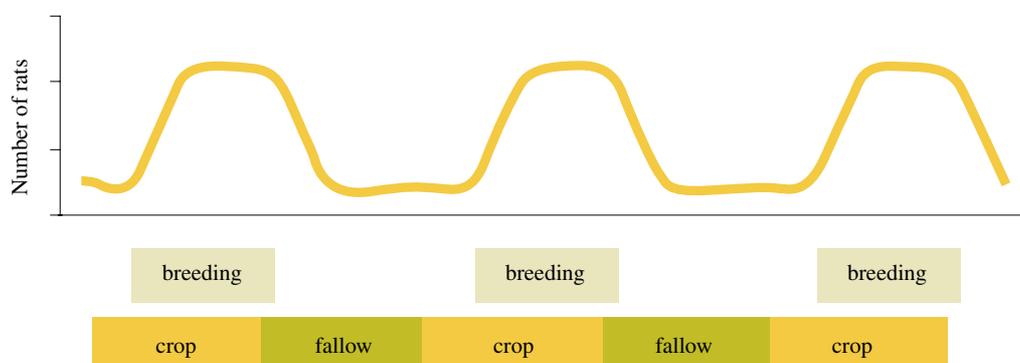
Where harvest is staggered by more than one or two weeks within a single cropping area, the rat population will move from field to field, causing increasingly severe damage in the later-harvested crops. Even more critically, rats born during the early part of the cropping season will themselves be old enough to start breeding before harvest is completed. This can produce a sudden explosion in rat numbers. Instead of one female producing 30-40 young, she and her offspring will produce 100-120 young.

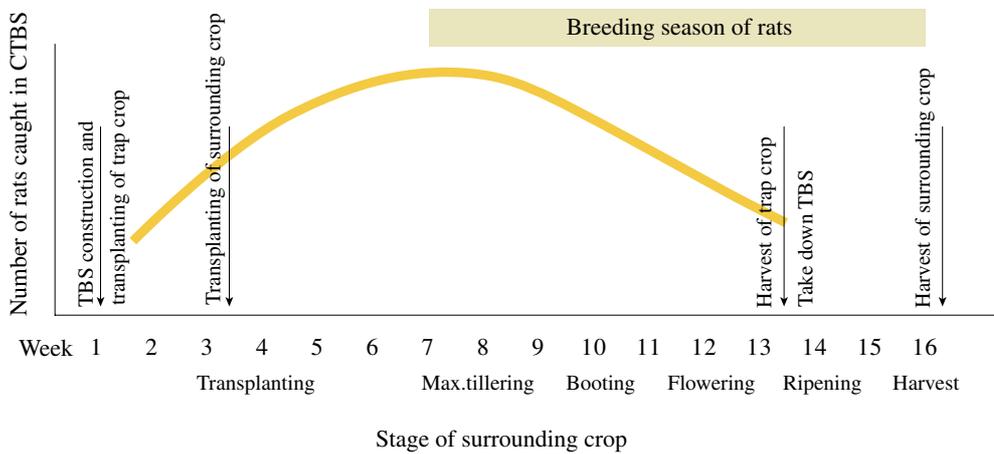
Why a CTBS works

The CTBS works by removing females from the population **before or during** the breeding season. This slows the rate at which the rat population can grow. Every female removed from the population before her first litter is weaned (at the milky stage of rice) is equivalent to killing 30-40 rats just prior to harvest.

A successful CTBS should catch moderate numbers of rats through to the time when the surrounding crop reaches

When harvest is staggered by more than two weeks, the season's young themselves begin to breed and rat numbers will increase dramatically.





Summary of rat captures in an effective CTBS in relation to the growth stages for the surrounding rice crop and the breeding season of ricefield rats.

the milky stage, with fewer captures after then. A CTBS that catches large numbers of rats towards the end of the cropping season has either been ineffective early in the cycle, perhaps due to poor construction or maintenance, or is located close to crop or non-crop habitats where rat numbers have not been controlled using complimentary methods (see “Other control measures”).

Building and maintaining a CTBS

The CTBS is built from readily available materials and is simple to erect. However, for a CTBS to work properly, these technical specifications should be met:

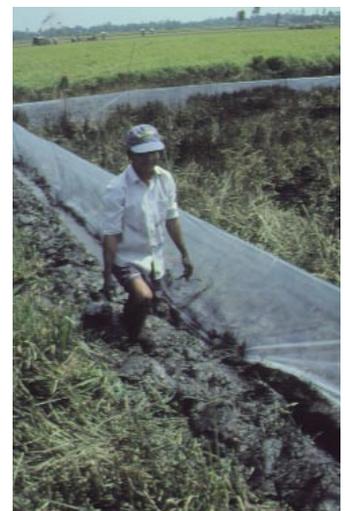
Materials:

- plastic for barrier fence (stronger material will resist damage, withstand high winds and be reusable for several seasons);
- bamboo or wooden stakes to support the barrier and traps;
- string or wire to maintain an erect barrier;
- stapler and staples to fix plastic to string or wire;
- multiple capture live-traps; and
- kill traps for use within the ‘lure’ crop.

Construction:

- select an existing 20 to 50 metre square plot within the ricefield;

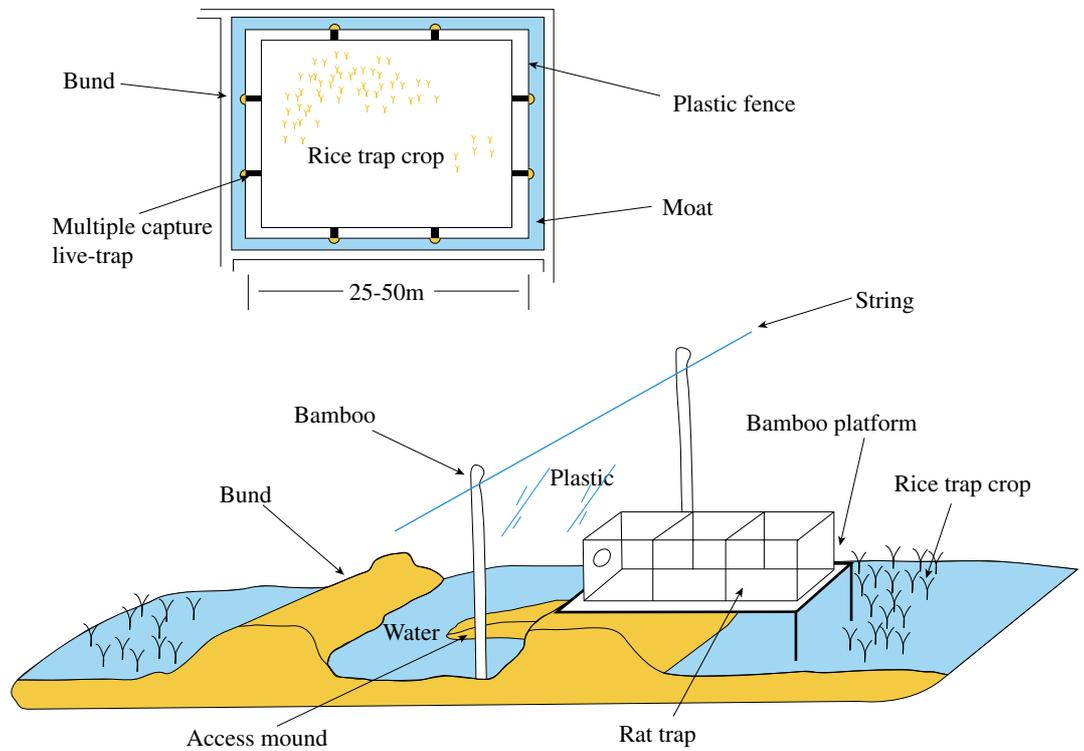
- use stakes and string/wire to erect and secure the fence around the plot, making sure that it is dug at least 10 cm into the ground and stands at least 60 cm above the ground;
- dig or widen existing channels to construct an encircling moat at least half a metre wide;
- install at least two multiple capture traps along each side (these must be held tightly against the fence, with no holes or gaps that might allow rats to bypass the traps);
- construct earth mounds partway across the moat, leading to traps;
- place kill traps along the inside of the fence to catch any rats that have penetrated the barrier; and
- plant the lure crop 2 to 3 weeks before the surrounding crop is planted.



A CTBS under construction. The plastic must be dug 10 cm into the soil to stop rats crawling under the fence.



This CTBS now awaits planting of trap crop and construction of moat around the outside perimeter.



Maintenance:

- empty the traps early each morning (dead rats left in the traps will discourage other rats from entering);
- check the plastic barrier for holes each day and either repair these or install extra traps;
- keep the moat free of grass (rats can use this to climb over the fence);
- cover the traps with straw and provide food (e.g. cassava) to keep rats in good condition; and
- if unable to check the CTBS for a few days, place straw in the entrance of the traps.

Special attention must be given to the fence, moat and trap entrance. Note:

- fence held flush against trap by sticks;
- trap held above water level and covered with straw;
- low mound gives access to trap entrance but does not stop water flow in moat; and
- fence and moat are kept free of overhanging grass.

Applicability

The CTBS method is currently recommended for use in lowland irrigated rice crops, and should prove most successful and cost-effective when the following conditions are met:

- crop damage from rodents is expected to be 10% or higher in a particular season;
- the individual CTBS units are well-constructed and maintained;
- multiple CTBS units are installed across entire field areas;
- cropping is synchronised and there is a fallow period spanning at least several weeks;
- the CTBS complex is effectively managed at a group or community level; and
- there is no other locally available source of high quality food for rats up to the milky stage of the 'lure' crop.

Adaptations of the CTBS method might also prove applicable to the protection of upland or rain-fed rice crops, and to protection of other crops. However, less is known about the ecology of rodent pests in these habitats, and there may be other constraints such as availability of water to plant early 'lure' crops. Further research into these and related issues is ongoing.





Active rat burrows in a bund between two recently sown rice crops. Wherever possible, bunds should be kept to a maximum of 30 cm high and wide, as this will reduce opportunities for nesting.

Other rodent control measures

The CTBS method will be most effective when combined with the following rodent control measures and practices:

- keep bunds as low and narrow as possible (less than 30 cm wide) to make it difficult for rats to burrow;
- search for rat burrows during the tillering stage and take steps to eradicate pest rodents (digging, fumigation, kill-trapping);
- keep major irrigation channels free of overgrowth and check regularly for evidence of rodent infestation (burrows, tracks and runways);
- clean up cut straw and other debris around fields or spread thinly;
- clean up any grain spills at harvest; and
- synchronise planting of crops – within 2 weeks of each other.

Benefits and costs of CTBS

The decision of whether or not to use the CTBS method for rodent control should be made by comparing benefits to costs. Because the benefits of using a CTBS will extend over 10-15 ha, the costs involved should also be shared across all members of the CTBS management unit, whether that is a group of farmers or a wider community.

Benefits

The major, direct benefit of the CTBS method is increased rice yield resulting from improved crop protection over a large area. Controlled field experiments in Indonesia and Vietnam have generally shown increases in rice production of 0.3-1 tonne/hectare within the 200 m 'halo' area. The highest yield increases were obtained where rodent numbers in the general vicinity were high and severe damage was observed in nearby, unprotected areas. In such cases, the direct economic benefit from increased rice production has outweighed the costs of the CTBS by a factor of at least 10:1. The CTBS is unlikely to be cost effective where anticipated yield loss is less than 5%.

Other important benefits of the methods are:

- captured rats can be sold or used according to local customs and demands;
- reduced use of chemicals (cost savings and environmental benefit);
- fewer rats around villages after harvest will reduce the risk of rodent borne diseases such as leptospirosis, rat typhus and plague;
- non-target animals can be released; and
- no residues remain in the system after the structures are removed.

The CTBS works best when adopted by an entire community and can result in benefits worth ten times its cost.

Costs

The main costs involved in CTBS construction are:

- purchase of materials;
 - plastic
 - stakes
 - string or wire
 - traps
- labour for construction; and
- labour for maintenance.

In Indonesia and Vietnam, the cost of materials for each CTBS unit is around US\$25-50. However, since most of the materials can be reused for 2-4 seasons, the cost per cropping cycle is considerably lower. Importantly, these costs should

Materials can be reused for up to 4 seasons, providing long term benefits.



One nights capture from a CTBS in West Java. Each female rat caught early in the cropping cycle is equivalent to catching 30-40 rats around harvest time.

also be shared among those benefiting from crop protection within the individual CTBS halo or a wider CTBS system.

Indirect costs may include a slight yield loss as a result of the space occupied by the CTBS itself, or due to rats that enter the CTBS and are not immediately removed. The lure crop may also attract birds and insect pests if it is the first food available in the area.

If the CTBS is well-built and maintained, these losses should be easily offset by the increased yield in the surrounding crop.

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