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Non chemical methods for rodent control

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Abstract
Rodents are still one of humanity's biggest annoyances. For thousands of years, they have destroyed infrastructure, stored food and crops. They are also harbours for fatal human illnesses like typhus and the plague. Now a days rodents are also destroying cars we use and other vehicles. The order Rodentia is one of the most widely dispersed fauna throughout the world. Managing rodents is generally done by chemical methods which include anticoagulants (single dose and multiple dose), fumigation and contact dust. Apart from these methods significant control can also achieved by some of the non-chemical methods such as sanitation and exclusion, snap traps, electric traps, live-capture traps, rubber ring traps, bait stations, good nature traps and glue traps.

Keywords: Rodent, rat, nonchemical, rat traps

Introduction
Over 2700 species of rodents have been identified, within the Rodentia order comprising 42% of all mammal species (Aplin *et al*. 2003; Macdonald, 2001) [3, 22]. In pursuit of food and shelter, rats and mice frequently break into houses, farms and warehouses. Man has brought rats and mice to every part of the world, where they contaminate or eat vast amounts of food and cause structural damage.

One among the biggest pests in the world, rats wreak havoc on agricultural productivity everywhere they go (Prakash, 1988; Buckle and Smith, 2015; Elias and Fall, 1988; Marsh, 1988; Fiedler, 1994; Singleton, 2003) [27, 6, 11, 15, 14, 30]. Stenseth and his co-workers in the year 2003 [31] estimated that fewer than 10% of rat species are major pest species in agricultural and urban settings.

According to Hansen *et al*. (2016) [20], rodents are one of the most destructive mammalian pests, resulting in significant pre-harvest losses globally. Rodents damage crops by over 30% a year worldwide (Singleton, 2001) [29]. About 20% damage to maize plantation, 34 to 100% loss of young wheat and 34% loss of barley was reported in Western Kenya (Gadisa *et al*., 2016) [18]. Estimates show that Ethiopia loses 15-40% of its oil seed and pulses, 13-29% of its root crops, 9-48% of its coffee and 21-60% of its cotton crop to pest rodents (Amera and Abate, 2008) [1]. According to Mariadoss and his co-workers 2020 [23] peninsular India loses 28% of its productivity, Andaman Nicobar and Lakshadweep Islands loses 45% of their productivity in coconut due to damage caused by rodents.

Almost any crop that is grown anywhere in the world is susceptible to being destroyed by rodents, including cotton, cereal grains, potatoes, vegetables, sugarcane, alfalfa, tree fruits, and many more (Witmer *et al*., 2022) [34].

Rat damage to ripening rice crops in Asia, Africa and Latin America can be an exceptionally severe agricultural problem. Estimation of economic losses caused by rodents is difficult to estimate because of complex patterns of growth and recovery of plants related to the developmental stage when damage occurs (Fall 1977; Fall 1980; Buckle 1994) [12, 13, 7]

In addition to causing crop loss, rodents are also the cause of human illnesses such rat-borne typhus, plague, hantavirus infections and arenavirus infections (Meerburg *et al*., 2009) [25]. There are at least 80 known zoonotic illnesses that rodents can spread (Singla *et al*., 2014) [28].

Rodents were carriers of parasites that caused the Black Death (*Yersinia pestis*) which resulted in death of 20 million people from 1347 to 1350 in Europe (Cantor, 2001) [8]. They are also

responsible to transmit leptospirosis, a disease with a global distribution that has had major impacts in Indonesia, Thailand, Vietnam, Australia and the Pacific Islands in recent years (Tangkanakul *et al*., 2005; Tubiana *et al*., 2013) [32, 33]. Rodents are mostly controlled by Rodenticides- which are poisonous chemicals and have its side effects. Most common rodenticides include

1. Anticoagulant Rodenticide (E.g.difenacoum, brodifacoum, bromadiolone)
- Multiple Dose Anticoagulant Rodenticides
- Single Dose Anticoagulant Rodenticides
2. Fumigation (Aluminium Phosphide tablets)
3. Contact dusts

Rodenticides, whether chronic (i.e. anticoagulants) or acute, are poisons and should be treated as such and at all times. Certain rodenticides may have a greater harmful effect on people or non-target animals than others and some non-targets may be less impacted by them than others. Rodenticides are a variety of poisons that are used to kill rodents. Rodenticide baits are not only poisonous to rodents, but also to any mammal or bird that eats them. As a result, non-target animals who eat the bait or swallow a poisoned rat or mouse face a significant chance of poisoning.

Non chemical Rodent Control Measures

Sanitation and Exclusion

The majority of rodent infestation situations can be resolved without the need for poisoning the pest animals. The majority of issues can be avoided by following good hygiene and isolation protocols. All living things have three basic needs: food, water and shelter. If any of these are taken out, the animal will have to go. Rodent pest harbourages can be greatly reduced by clearing out garbage such as abandoned large appliances, piles of waste lumber or rubbish, used feed sacks and dead palm tree fronds. Long-term storage of stacked firewood provides a sanctuary for all commensal rodents. These food sources for rodents can be eliminated by properly storing pet food and seeds. Plastic containers are chewable and should not be used. Gather and remove fruit from the backyard's trees and orchards, as well as fallen vegetables from the garden.

Apart from reducing rats, the primary benefit of sanitation is that it has a significant impact on human health. Maintaining good hygiene also reduces the risk of human disease transmission from rodents and other vectors. Maintaining good cleanliness has the drawback of requiring a lot of labour and man-hours. Clean farming practices will also helpful in removing nesting opportunities for rodents or at least make possible nesting sites less attractive. One method is to enforce rodent proofing in godowns is to use structural materials to close off, protect and prohibit access for rats so that rats can be prevented from climbing or entering through doors, windows, ventilators, floors, walls and rooftops.

Snap traps

Snap traps come to mind for most people when they think of a mouse or rat trap. They were among the first traps with a high rate of success. Though novel choices may be more efficient, snap traps often harm rats and mice rather than giving a swift and painless finish. Additionally, it is very easy to harm yourself when putting it together. The term "building a better mousetrap" gained popularity for good reason. People were unsatisfied with these traps even when they were fairly new to the market. Snap traps have the benefits of being easy to use, reasonably priced and reusable. But it has also disadvantages of causing easy misfire, more prone to injure rather than kill rodents and can trigger when setting up.

A study was conducted by Herawati and Purnawan (2021) [26] at Yogyakarta and West Java in Indonesia from 2018 to 2020 to determine the effectiveness of snap traps on capturing the rodents. They checked the captured animals in the early morning and collected them for identification and sexing. In the late afternoon they continued with cleaning of the traps and put in the new same type of bait. They found that mainly three rat species namely *Rattus argentiventer, Rattus tanezumi, Bandicota indica* was trapped of which a total of 517 animals were obtained with the proportion of the two sexes was almost the same (45.45% males: 54.40% females). Regarding trapping rate of success, Yogyakarta denoted average values (21.38% in the first trapping and 26.04% from the second trapping) compared to West Java which was only accounted for half of them (11.31% and 11.24% from the first and second trapping, respectively).

Electric Traps

Electric rat traps can be powered by the electrical system in the home or by separate batteries. Rodents enter the trap to investigate the lure you've set inside. At this point, the rodent's heart will be stopped by a large enough electric shock delivered by the trap. Advantage of this trap is that it can be reused but after each usage, it must be cleaned, cleared and reset. The most significant disadvantage is of ethical concerns. If you've ever experienced a small electric shock, you'll know that it's not a pleasant feeling. To be effective, an electric trap must deliver a high voltage charge to a rat or mouse.

Live-Capture Traps

Rodents are caught alive in live-capture traps. One of the most important drawbacks of this traps are that if you don't check on the traps once or twice a day, rodents may suffer unnecessarily. If this is not done, a rodent may end up imprisoned without access to food or water. Advantages of using live capture traps is that they are cost effective and easy to use and setup. Several live-trapping techniques have been developed and put into use to date, with varying levels of efficacy (Corrigan and Moreland, 2001) [10].

When it comes to rodents, the most widely used techniques are of box-style wire mesh or traps made of full metal sheets, such as Sherman, Tomahawk and Havahart traps (Hice and Velazco, 2013) [21]. Triggering mechanisms are almost always placed inside and must be stepped on or pulled with some force in order to close the trap. Such traps have either one or two entrances. Anthony *et al*. (2005) [2] the trap will spring once they're inside and the rodents will be unable to escape.

Rubber Ring Traps

Rubber ring traps use a lure to entice rats. A rubber ring will snap into place around its chest or neck once they enter the trap. The ring instantly contracts leading to death. Every time the trap is used, it must be attended to and cleaned. Once supply of rings has been depleted, it must be reloaded with new ones. Advantages of using Rubber ring traps is cost effective and have relatively quick kill of the targeted animal and the cons of using this trap is that it typically requires maintenance after every use.

Bait stations

Bait stations work by enticing rodents into ingesting harmful substances. Bait stations and other poisonous options should

usually be avoided. After the rodent has endured for several hours or perhaps days, the mechanism of action will usually take full effect. Worse, the substance may be eaten by pets or even children instead of the targeted mice or rats. As a result, it can represent a serious threat to everyone in a home. Bait stations pose a significant danger to pets, other animals and children and cause secondary poisoning risk of other animals through predation

Goodnature Traps

Rats are drawn into good nature traps by pleasant bait. The moment the animals step into the trap, it begins to operate. Once the rodent's head is in place, a CO_2-powered piston will fire. This guarantees that the procedure is both quick and painless. The trap will automatically reset once it has been activated. To attract a rodent's attention, the trap uses an Automatic Lure Pump (ALP). This ALP only need replacement every six months. Though the goodnature traps are more costly when compared to the other options, they are always in use and do not require resetting with an active CO_2 canister. It quickly becomes a cost-effective choice when the cost is averaged over the entire term of operation. Some of the goodnature traps such as Goodnature® A24 rat+stoat self-resetting traps are extensively used in several countries and environments, especially on islands (Carter *et al*., 2016; Gronwald and Russell, 2022; Baldwin *et al*., 2022) [9, 19, 4]. Major advantage with Goodnature trap is that it is Quick kill and also requires maintenance once for every six months of operation, higher initial cost pays itself off over time. At the same time high initial cost is its disadvantage when compared with others.

Glue traps

Glue traps (also known as glue boards or sticky traps) offer some benefits and drawbacks. They're harmless, cheap and don't require any particular equipment to use. One drawback of glue traps is that, in contrast to snap traps, they may not always kill the rat quickly. Many studies were conducted to know the effectiveness of glue traps, (Fitzwater, 1982; Marsh, 1983; Frishman, 1992) [16, 24, 17] from the past, but major concern regarding the use of glue traps is that using adhesives create a welfare concern as we can see the struggle of rat to come out. The more they struggle to get off the trap, the more stuck they become. Rodent can be separated from the glue trap by applying oils such as old cooking oil, vegetable oil, olive oil, canola oil etc.

Table 1: Advantages and disadvantages of different control strategies to manage rodents (Brown *et al*., 2017) [5]

Method	Advantages	Disadvantages
Barriers - plastic fence	Protects small areas of crop, for example, rice nurseries	Takes time and effort to set up. Plastic only lasts 1 or 2 seasons
Barriers - trap-barrier system (TBS)	Can capture a large number of rats. Can protect large areas of rice (10-15 ha)	Takes time and effort to set up. Needs to be planted 2-3 weeks earlier than surrounding fields. Needs a community-based approach for best results
Habitat management	Increases predation risk	Needs to be applied at the right time. Takes effort to apply herbicides or slashing. Conflict with conservation
Crop synchronisation	Reduces length of rat breeding season	Needs coordination among neighbouring farmers (>100 ha)
Sterility control	None known	Bait delivery difficult
Reproductive inhibitors	None known	Bait delivery difficult
Hunting	Can be conducted at any time Large numbers can be killed when hunting as a group Source habitats can be targeted	Group hunting takes time and effort to organise
Ecologically based rodent management (EBRM)	Positive benefit: cost ratios	Requires coordination at community scale

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