Developing pesticide-free rodent control for southern Africa

Rodent populations cause devastating damage within African communities devastating growing and stored crops, carrying disease and damaging personal possessions. ***Steven Belmain*** *reports on the ECORAT project, in which a consortium of largely African researchers, worked with communities in Tanzania, Namibia and Swaziland to develop sustainable and ecological strategies to manage and reduce and rat populations.*

'Nature has sent the rats to our homesteads by thousands, and farmers are being eaten off the face of the earth by them.' This quote from HC Bartley's 1911 book *Studies in the Art of Rat Catching* was informed by a career catching rats and rabbits in England. The book became an invaluable manual for those managing rat problems in english schools. But Bartley's message fell out of fashion with the advent of the anti-coagulant rodenticides which were quickly seen as the ultimate solution to rodent pest problems throughout the world.

These days rodenticides are still important but are no longer a panacea. For small-scale subsistence farmers throughout the tropics they are often either too expensive or locally unavailable. Individual landholdings may be small requiring farmers to work with their neighbours to have any effect on the overall rodent population. Also, many of these farmers fail to appreciate the differences between chronic rodenticides (the anti-coagulants) and acute rodenticides (such as, zinc phosphide) favouring the cheaper acute rodenticides.

These days research on rodent management focuses on integrated approaches with management strategies aiming to understand the behaviour and breeding patterns of different rodent species and to use this knowledge to identify problems and solutions. The ECORAT project is doing this in three African countries, Swaziland, Tanzania and Namibia. The project brings together scientists and small-scale farming communities to evaluate problems caused by rats and to test potential cost-effective, sustainable solutions.

Rat poisons in southern Africa

Surveys carried out in 2009 as part of the ECORAT project showed that most African farmers still used poison as their main method of rodent control. Although many different products are officially registered for use in southern African countries, the main commercial products sold contained either coumatetralyl, difethialone or bromadiolone. Other anticoagulant compounds were rarely found in markets or mentioned as used by farmers. The acute poison zinc phosphide was readily available in Tanzania, although its use is supposed to be restricted. Other acute poisons, not officially registered as rodenticides, were commonly available in local markets and widely used by farmers. The most widely used is the nematicide aldicarb. Nowhere in Africa is this product officially sanctioned as a rodenticide, but it is illegally sold as a rat poison, and even for killing dogs or other mammals. In many African countries aldicarb is used by criminals to poison guard dogs. It has also been used to poison wildlife such as vultures and has been implicated in accidental and intentional human poisonings. Some African countries have tried to restrict its availability, but it has commercial uses, particularly in citrus orchards, to control nematodes. Illegal selling of aldicarb and other highly toxic compounds will likely continue without concerted educational programmes that highlight the dangers and provide viable alternatives.

The use of acute poisons for killing rats is highly problematic as their rapid action means that many rats feel sick before they have eaten a lethal dose. These rats can quickly become behaviourally resistant to food baits laced with acute poisons. But acute poisons continue to be used because they are cheap. Farmers also believe they are effective as dead rats will be found near the poison the next day. They do not realise they have probably only killed a small percentage of the rats which fed from the bait and are therefore, unlikely to notice much change in the amount of damage caused by rats.

Chronic rat poisons work by interfering with blood clotting. However, when a farmer uses an anticoagulant, it is unlikely that there will be any dead rats nearby the next day. The anticoagulant takes 24 to 72 hours to work, and so, most rats die in their burrows. This fuels the farmers' perception that anti-coagulants do not work. These misconceptions can only be overcome through farmer training and awareness campaigns to educate farmers about rodent behaviour and correct poison usage.

Although anticoagulant rodenticides can work well in reducing rat populations, there continue to be major problems with their use. They are relatively expensive and often incorrectly used. Many small-scale farmers buy small amounts and sub-lethal dosing is commonplace, leading to resistance development. Subsistence farmers often buy poison when the population of rats is at its highest. They often do not coordinate with their neighbours, and so, the amount of poison used is far below that required to have any impact on the rat population. In essence, most rat poison usage by small farming communities is ineffective, fuelling resistance development and non-target poisoning.

Indigenous rat management

Rodents cause a myriad of problems for African households. Bubonic plague continues to be a problem in parts of Tanzania and

The break-back traps are easy to use. *Photo: Steven Belmain*

Tracking tiles. Sooting of ceramic tiles (top) and calculating rodent activity by counting the number of grid squares marked by rodent foot prints (bottom). *Photo: Steven Belmain*

is endemic in many African countries, leading to thousands of human plague cases each year. Diseases such as lassa fever, leptospirosis, typhus and food contamination caused by rats means that their disease burden, alone, makes rodents one of the most important problems facing African families. Nearly any crop can be damaged by rats. In any year a farmer may face crop losses of 5-20% but this can approach 100% during an outbreak, reaching epidemic proportions through aseasonal rainfall or other environmental changes. And rat damage does not stop when crops are harvested. Many subsistence farmers continue to suffer serious losses to their grain when stored on farm in containers which are not rat-proof. Rats also enter homes, destroying clothes, blankets, and other personal possessions such as mosquito nets.

Despite this serious damage, most African farmers do little to control rats. Repeated unsuccessful attempts have ingrained a sense of apathy and defeatism. And small scale farmers are not always able to quantify the damage and loss caused by rats. They have never experienced life without rats and often cannot assess how much grain is lost over several months of storage. For most farmers success is having a few dead rodents as opposed to noticing that they have more food or that their families are in better health. Most subsistence farmers simply do not have access to the knowledge and tools required to successfully tackle their rat problems. For these reasons, indigenous rat management can be largely depicted as *ad hoc*, uncoordinated acute poison use.

The ECORAT way

From January 2007 to December 2009, the ECORAT project carried out research on rodent ecology (including population dynamics, habitat utilisation), rodent biology (taxonomy, breeding) and rodent-human interactions (disease risks, spatial proximity). They studied local agricultural communities' knowledge, attitudes and practices with respect to rodents and rodent control, the current cost of rodent damage and the costs/benefits of rodent control. The multidisciplinary research consortium was drawn from institutions in Namibia, South Africa, Swaziland and Tanzania, with central technical input provided by the Natural Resources Institute of the University of Greenwich in the United Kingdom (see box).

The ECORAT project was relatively unique in basing its research within rural agricultural communities and studying how rodents affect peoples' livelihoods. The scientific team worked closely with farmers and homesteaders to understand rodent ecology within and around their homesteads and fields. A range of techniques were used to collect baseline ecological knowledge on the temporal and spatial dynamics of rodent populations within rural African farming communities. These techniques included habitat surveys using removal trapping, capture-mark-recapture grids using Sherman traps, and radio tracking of individually tagged animals.

Preliminary findings

This work showed that rodent population dynamics can be extremely complex. It showed that rural agricultural communities consist of a mosaic of different ecological habitats, with different rodent species occupying different habitats and causing different problems. The research emphasised that to tackle rodent problems it is first necessary to understand the local landscape ecology. This means examining the relationships between these mixed mosaic habitats and seasonal processes such cropping cycles and rodent population changes and the kinds of damage that different rodents species make. Capturing the complexity of ecological processes at the landscape level is not easy, but the research has given insight into some of the biophysical and socioeconomic factors that will allow rural farming communities to sustainably manage rodent populations.

It is hard to generalise across sub-Saharan Africa, but our comparative three-country study has allowed us to define where and when certain rodent control practices may or may not be effective. We wanted to evaluate whether intensively trapping rodents in and around African homesteads could effectively reduce rodent populations and the damage caused. By European or American standards, rodent trapping is labour intensive, while poisons are relatively cheap. However, the economics are reversed in most developing countries, with the cost of labour much lower than that of poisons. Rat traps require an initial outlay to buy, but can last many years, killing many more rats than would have been killed by an equivalent money's worth of poison. The main challenge is to trap intensively enough over a large enough area to significantly reduce the rat population.

Village studies

Building on baseline information collected about rodents and rural African farmers, the ECORAT team started a community intervention programme. This was carried out in 12 villages across the three countries; half of the villages followed their indigenous rodent management practice (typically this was occasional *ad hoc* use of acute poisons) and half followed the ECORAT method which involved intensively trapping rodents and preventing rodent access to food sources. The villages were roughly the same size, consisting of about 200 homesteads, and the entire village was involved in the project.

Kill trapping was organised at the community level, with traps rotating around the community to share the costs. This ensured that the rodent population was reduced sufficiently to limit the effects of immigration back into the intervention zone.

The scientific team monitored and compared the indigenous and ECORAT methods by assessing changes in rodent numbers and rodent damage, particularly assessing differences in grain loss during storage. The number of rats killed by intensive trap-

Figure 1. Changes in rodent numbers in study villages

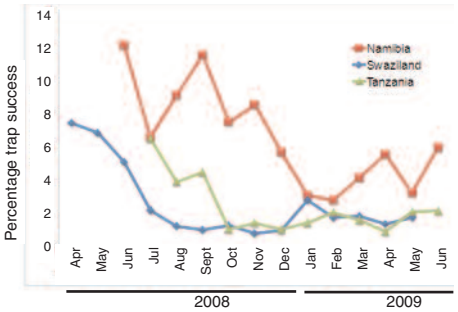
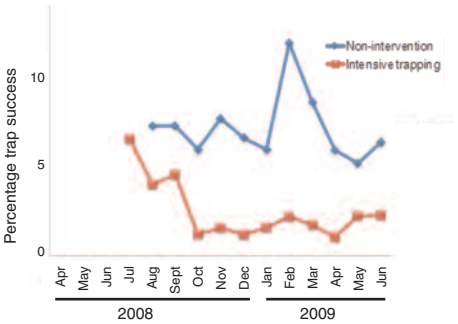


Figure 2. Comparison of ECORAT and indigenous rat control in Tanzania



More rats were trapped in villages following the indigenous management practice showing that more were present. Crucially, trap success was similar in the two groups at the start of the experiment in July/August 2008, that is, all villages had a similar starting population of rats.

New rodent-proof drying crib for harvested maize built in Swaziland. Strips of metal are placed around each leg, which is too slippery for the rats to climb over. *Photo: Steven Belmain*

ping in the six ECORAT villages was compared to monthly monitoring of the rat population in the six indigenous villages by three nights of kill trapping in a small number of homesteads. Tracking tiles were also used to monitor changes in rodent numbers. These monitor rodent activity by recording their footprints on a small soot-covered ceramic tile (see photo this page). Ten homesteads in each village (both indigenous and ECORAT) had tracking tiles placed in their homes for three consecutive nights each month, allowing a comparison of rodent activity between the villages following their own indigenous rodent management and those following the ECORAT intensive trapping method.

To assess differences in rodent damage, sacks of grain were placed in ten homesteads in each village in the place normally used to store grain after harvest. Each month the sacks were weighed and samples taken to check for partially eaten grains and rodent faecal contamination.

Intensive trapping worked well in the villages in Swaziland and Tanzania, both in terms of reducing rodent populations and reducing damage levels (Figures 1 and 2). However, it seemed less effective in Namibia. We suggest two possible reasons for this related to landscape ecology. Firstly, there are differences in village structure and density of housing. Not all farming villages have the same layout. In Tanzania homesteads tended to be relatively close to each other in compact villages surrounded by crop fields, whereas communities in Namibia were more spread out with agricultural fields between homes. The Swaziland communities were somewhere in between. The trapping intensity was affected by this difference. There was more of a chance of rodent immigration into homesteads from fields and forest in Namibia. Tanzanian homesteads, which are closer to each other, were better protected as potential migration from other households homesteads was significantly reduced because all the homesteads were trapping. Due to lack of time, we were unable to evaluate whether increasing the trapping intensity in Namibia would result in reductions similar to that shown in Swaziland and Tanzania.

Secondly, different species predominated in different countries. In both Tanzania and Swaziland, homesteads were affected by *Rattus rattus*, with *Mastomys natalensis* only found in surrounding fields. However, in Namibia, *Rattus rattus* were not present in homesteads, which may have enabled greater numbers of *Mastomys natalensis* to migrate into Namibian homesteads from surrounding fields. Despite these comparative differences, Namibian communities still found the community-based intensive trapping to be beneficial and improved their livelihoods in a cost beneficial way.

Feasibility

Daily trapping with one or two kill traps was not considered too labour-intensive. Households normally had plenty of labour on hand to set traps each evening and check the traps each morning, delegating the role to a particular member of the family. Because the traps rotated around the community, it was not even necessary for each household to pay the full price of a single trap as the cost was shared. A cost-benefit analysis carried out with the communities indicated that the benefits of trapping (more food, less disease, fewer people bitten by rats, less damage to household goods) far outweighed the costs of the ECORAT scheme (labour, traps, organisation).

The ECORAT project requires communities to work together. This was not a problem in the ECORAT project areas, and we speculate that it would not be a problem in most close-knit rural communities where everyone knows each other. However, it may be a challenge in some contexts. Community-wide ECORAT action would certainly become more of a problem in larger townships and urban squatter camps where there is less of a community identity and social capital is generally much lower. In these more urbanised situations, it seems likely that rodent management should be organised within local authority government structures responsible for public health and pest management.

The principles of ecologically-based rodent management employed in the ECORAT project are simple: 1) know your enemy; 2) know your end user; 3) know your local ecological context; and 4) ensure action at the appropriate time and scale.

In the case of rural farming communities in southern Africa, the ECORAT project has shown us implementation is not simple, requiring significant community organisation and education, along with knowledge of the rodent species present and the habitat complexity. We believe delivering ECORAT-style rodent management to all subsistence farmers in Africa and Asia is possible, but will require concerted efforts to raise the awareness of policy makers about the problems rats cause to people's livelihoods and how rats can be sustainably and cost-effectively controlled.

Further information about the ECORAT project is at http://www.nri.org/ecorat

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