Population Dynamics of Rodent Pest Species in Upland Farming Systems of Lao PDR

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ABSTRACT

Rodents are a significant problem to farmers in upland agricultural systems in Lao PDR. They are considered as the second most important pest after insects because they are the least controlled. There is little known about the factors that influence the breeding activity or changes in population numbers of the main rodent pest species in Lao PDR. There are a minimum of 21 species of murid rodents in Lao PDR, with six considered as important crop pests, among them being *Rattus rattus*. The other species generally cause little crop damage and are important for their conservation value in the upland forests. Trapping data revealed that the population abundance and breeding activity of rats changed over time in response to the availability of food resources. Peaks in population abundance in the field occurred during the harvest of wet season crops. Rodents then moved into village habitats, where population abundance was high during the fallow and early growing stages. Breeding activity was evident at all stages in the village, with a peak during the fallow stage, when abundant food was available in village stores. Little breeding was observed in the field during the fallow period, increasing to only moderate levels during the growing and harvesting stages. The village habitat is considered as an important habitat for rodents. Management needs to be focussed on limiting the movement of rodents between villages and fields and this needs to be conducted prior to the onset of breeding activity in the field.

Key words: abundance, breeding, movements, *Rattus rattus*, rice, management

INTRODUCTION

Rodents are a chronic agricultural problem in most areas of Lao PDR with sporadic outbreaks in upland agro-ecosystems. Rodents are considered as the second most important pest of upland farmers (after insects), but they are the pest type over which farmers claim to have the least control (Schiller *et al*., 1999). The severity of damage varies from year to year and between localities with estimates of 5-10% in non-outbreak years (Khamphoukeo *et al*., 2003; Schiller *et al*., 1999; Singleton, 2003). The irregular rodent outbreaks are sometimes responsible for extreme crop losses of 30-100%, occasionally leading to localised or widespread famine (Douangboupha *et al*., 2003).

The cause of these outbreaks appears to

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be associated with unusual climatic conditions and/ or the flowering and seeding of certain bamboo species. These outbreaks are attributed to *nuu khii* rodents (literally meaning "rat of bamboo flower") and farmers clearly distinguished the outbreaks from the problem of chronic damage by rodents to crops.

The upland farming systems of Lao PDR are changing rapidly in response to a range of factors including the rapid increase in population, government pressures on restricting shifting cultivation and competition from new economic opportunities. The population of Lao is approximately 5 million and is increasing at a rate of 2.5% per annum, which is one of the highest growth rates for any country in SE Asia (UNESCAP, 2006). More than 80% of the population are living in agricultural households, and about 40% of the population are fully or partially involved in shifting cultivation in the upland environment. Sixty-five percent of these families depend on shifting agriculture for their livelihoods. With this increase in pressure on the agricultural system, it is likely that the impacts on livelihoods from pests, weeds and diseases will increase.

The upland environment of Lao supports a rich array of rodent species, the great majority of which do little or no damage to crops (Khamphoukeo *et al*., 2003). Of the 21 species of rats and mice found in this habitat, six appear to be important as pest species in crop production areas, with *Rattus rattus* also a significant pest in village storage areas (Khamphoukeo *et al*., 2003). One of the issues of managing rodents in Lao is that there are a number of rodent species that are important for forest conservation (Aplin *et al*., 2006). These species inhabit the upland forests and they are insectivores or frugivores and do not cause damage to the field crops.

There is little known about the population dynamics of the main pest species in the upland farming system of Lao (Khamphoukeo *et al*., 2003). For management purposes, it is important to understand the factors that influence the commencement and cessation of breeding, the proportion of females breeding, and changes in abundance, so that management actions can be conducted at an appropriate time, rather than waiting for damage to occur. In lowland irrigated farming systems in Indonesia and Vietnam, the main rodent pest species, *Rattus argentiventer* and *R. losea*, are influenced by the development and growth of the main rice crops (Leung *et al*., 1999; Brown *et al*., 2005). It is not known whether rodents respond in the same way in the upland rain-fed farming system of Lao, where the pest species are different and where there is a mix of upland crops grown amongst regenerating forest and bamboo thickets.

This paper reports on the population dynamics and breeding activity of rodents in Luang Prabang Province in order to understand how the rodent populations respond to food resources, including seasonal patterns of abundance. This information will assist in developing appropriate management practices to reduce the crop damage caused by rodents.

MATERIALS AND METHODS

The study was conducted from December 1999 to September 2002 at Hadsoua village, Pak Ou District, Luang Prabang, which was representative of upland villages in this province. There were about 60 households in the village which comprised about 265 people. The agricultural area consisted of 60 ha of upland crops and 3.3 ha of lowland rice crops, interspersed with patches of forest or regrowth with a mixture of trees, shrubs and bamboo thickets. The upland crops were primarily upland rice, maize and Jobs' tear, but there was also some vegetable and root crops (cassava, melons, cucumber etc.). Most crops were planted at the beginning of the wet season in April each year and harvested from

September through to December. Lowland rice was planted in May and harvested in September and October.

Live-trapping of rodents was conducted every month in five key habitats (upland crop, upland rice, lowland rice, regrowth forest and the rice storage area within village), giving a total of 34 trapping sessions. Traps were set for four consecutive nights. Three different kinds of traps were used: (1) trap-barrier systems (TBS; plastic drift fence set with four multiple capture wire cage traps) set in upland crops and around rice-grain stores in the village; (2) single capture cage traps set in upland rice and forest; (3) kill traps (combination of rat sized, mouse sized, and local snare trap) set in upland rice, lowland rice, upland crop and forest habitats. There were 10-20 traps of each type set in each habitat for a total of 312 trap nights per trapping session. Because of the low capture rates, all rat captures in all field habitats were combined.

Each captured rat was identified to species level, sexed and measurements taken for body weight (g), head-body length (mm) and tail (mm), ear (mm) and hind-foot length (mm). These measurements were used in species identification, but also provided data on the age structure of the rodent population.

Data on the breeding performance of adult females was obtained from necropsies of animals from the regular trap lines, but was supplemented with animals dug from burrows or collected from the field. The condition of the uterus was examined (evidence of recent pregnancy, ready to mate, pregnant, inactive) after Aplin *et al*. (2003). Data on the proportion of adult females in breeding condition (pregnant) is presented in Figure 2. Because of low capture rates, data was pooled for the fallow period, main growing season and the harvesting stages for the main wet season crops.

RESULTS

Changes in abundance

The majority of captured rats in all habitats were identified as *Rattus rattus* (~95%), with small numbers of *Bandicota indica* and *Mus* spp. taken in the field habitats. No rats were captured in the regrowth forest, possibly due to the availability of other food resources in this habitat. Captures in field and village habitats appear to fluctuate in response to cropping activities (Figure 1). Numbers of rats were

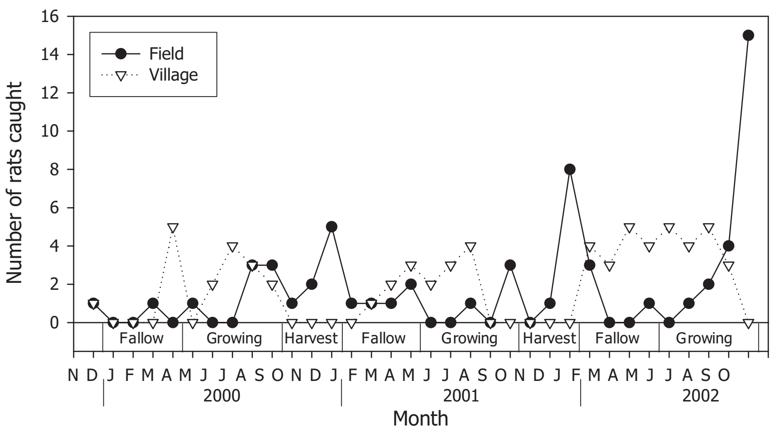

Figure 1 Change in population abundance of rats captured per month from field and village habitats at Hadsoua, Pak Ou District, Luang Prabang, December 1999 to September 2002. There were 312 traps set in five habitats (upland rice, upland crops, lowland crops, forest and village).

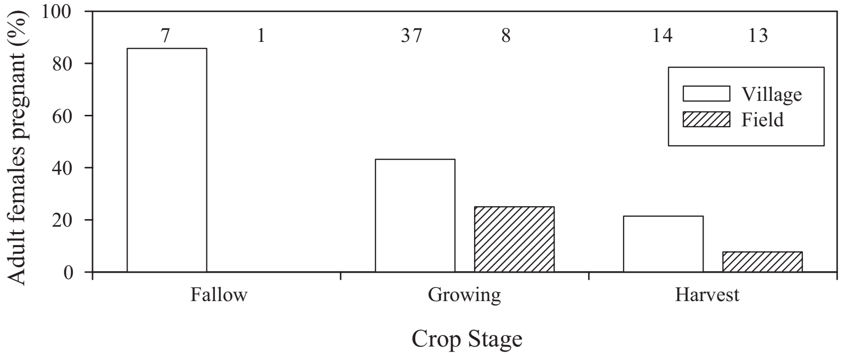

Figure 2 Percentage of adult female rodents in breeding condition from village and field habitats during different crop stages (fallow: January-April; growing: May- September; and harvesting: October-December). Numbers at the top of the figure refer to the sample size of adult females examined in each period.

generally higher in the fields than those in the village during the latter stages of the growth of the crop, until after harvest. There was a subsequent increase in population abundance of rats, presumably due to their dispersal. In village habitats, rats were abundant for a short time after harvest. Densities remained relatively high in this habitat throughout the mid growing period of the main wet-season crops.

Changes in breeding activity

The pregnancy rate of rats was higher in the village compared to the field habitats (Figure 2). In the village, the pregnancy rate was high during the fallow period (~85%, sample size of adult females $n = 7$), declining through the growing period (~45%, $n = 34$) to the harvesting period (~20%, $n = 14$). In the fields, there were few pregnant females trapped during the fallow period ($n = 1$), then relatively low percentages breeding during the growing (~25%, $n = 8$) and harvesting period (~10%, $n = 13$).

DISCUSSION

Rodents appeared to move between habitats in response to the availability of food resources. The growing crops provided food resources for rats and protected them from predators. After harvest, the grain was transported to grain stores in the villages. Shortly after harvest, the abundance of rats decreased in the fields and increased in the village area. This corresponded with the lowest seasonal pregnancy rate of females in the village. Therefore it was assumed that the population increase in the village was due to rodents moving from the field into the village. In other farming systems, rodents were known to have moved in response to changes in the availability of food resources (Jacob *et al.*, 2003; Brown *et al.*, 2005). Hadsoua farmers believed that rats moved each year after harvest from the field into the village which corresponded with this result (Figure 2). This was supported by a small-scale radio-tracking study in the final year of this study, with one example of an adult female rat moving from upland field to village habitat after harvest (K. Aplin unpublished data).

Only one adult female rat was caught in the fields during the fallow period indicating that there was little-to-no breeding during this time. There was some breeding during the growing and harvesting period of the upland and lowland crops. In general, the breeding season for rodents in agricultural fields is closely linked to the maturity of crops (Leung *et al.*, 1999; Jacob *et al.*, 2003;

Brown *et al*., 2005). From the study, breeding occurred throughout the year in the village habitat where adequate food and shelter were probably also available throughout the year. However, the breeding rate for adult females was the highest in the village after harvest, when abundant grain was available in the village stores. Because breeding occurs throughout the year in the village, this habitat represents a potential source of rats that can reinvade the surrounding fields when conditions became suitable. This flexible life strategy displayed by *R. rattus* is similar to that of *Mus musculus* living in commensal farm environments in the United Kingdom (Pocock *et al*., 2004).

These findings indicated that the effective management of rodent populations should focus on reducing the rodent population and potential damage to grain through intensive trapping, habitat manipulation and protection of grain stores in the village after harvest of the main wet season crops. Furthermore, if the abundance of rats in the field could be reduced prior to the onset of the main breeding season, then it is likely that levels of damage to crops could be minimised.

In developing rodent management practices, the key pest species need to be carefully selected because some rodent species are important members of the natural forest community and provide an important ecological service (Aplin *et al*., 2006). It is therefore important to minimise the use of indiscriminate poisoning with rodenticides (currently used with limited regulation) and instead concentrate on targeted control, including the use of trap lines to intercept rodents migrating between habitats around harvest, but also coordinated village campaigns using trapping, digging up burrows, cleaning up piles of wood and reducing suitable habitats for rats.

In addition to village rat-controlling campaigns, the better protection of grain stores to limit access of village rats to pivotal food resource was recommended. This could be done by limiting access to the store itself, with shielding of the supporting poles or creating walls and a roof that were rat-proof. At Hadsoua, a trap-barrier system of plastic or reused fertilizer bags sewn together, plus the addition of multiple-capture wire cage traps placed at openings in the barrier, was effective in catching rats trying to access the grain stores. This system had the dual benefits of protecting the grain store and catching rats at the same time

A strong emphasis on village rodent control would not only reduce the rodent damage to stored grain, but also limit the spread of rodent-borne diseases to humans and livestock. Rodents have been identified as the carriers of human diseases such as the plague (*Yersinia pestis*), rat-borne typhus, neuro-angiostrongyliasis, hantaviruses and arenaviruses (Mills, 1999). Rodents also transmitted leptospirosis, a disease with a global distribution that is considered to have had a major impact in Indonesia, Thailand, Vietnam, Australia and the Pacific Islands in recent years (Tangkanakul *et al*., 2005). It is important to reduce these health risks because of their potential impacts on the livelihoods of rural families.

In conclusion, the main pest rodent species in the upland farming system of Lao PDR (*R. rattus*) was responding to changes in the availability of food resources provided by the upland crops. Rodents moved into the village environment after harvest. It was likely that the village habitats were important source habitats from which rodents could reinvade the surrounding fields when conditions were suitable. It is important to develop rodent control strategies to reduce the population abundance of rats before they move between village and field habitats and for farmers to work together as a community. Such an ecologically-based community approach to rodent management has been successfully applied in lowland, irrigated rice agroecosystems in

Vietnam (Brown *et al*., in press) and in Indonesia (Singleton *et al*., 2005).

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