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Integrated rodent management in outbreak-prone upland rice growing areas of Northern Laos

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ABSTRACT

An integrated rodent management program was tested in outbreak-prone areas in three provinces of the Northern uplands of Laos (Luangprabang, Phongsaly, Houaphanh). In each province, it was replicated in six villages and associated upland rice fields; six neighboring villages served as negative controls. The program started end of 2010 and aimed at protecting the wet season rice harvest of 2011 against rodent damage. Rodent control techniques included sustained trapping, rodent-proofing of grain stores, rodent hunts and village sanitation campaigns, and biological rodent control using the protozoan parasite *Sarcocystis singaporensis*. The measures were embedded in a community approach, which was coordinated by provincial and district agricultural officers. Compared to the control villages, which showed on average 10.9% rat damage to ripening upland rice before harvest in 2011, and to the situation of the previous year (12.8%), rat damage was significantly reduced to an average of 4.3% in rice fields of the treatment villages. The incidence of rat-infested rice storage huts dropped significantly from an average of 86% in 2010 to 3.5% in 2011 in the treatment villages. Villagers from Houaphanh culled a total of 73,088 rodents over a period of about nine months, which included mainly black rats (*Rattus rattus*). Because the program phased out before harvest in 2011, potential losses due to rodents were predicted based on yield-damage relationships of the crop year 2010. The predicted average reduction of yield loss for 2011 was 55%, or 417.6 kg ha^{-1}, in the treatment villages when compared to the controls. The program implemented principles of ecologically-based rodent management (EBRM), the components of which are discussed. In conclusion, EBRM could be helpful in stemming as what was observed as high chronic rodent populations in the uplands of Laos. True outbreaks will require development of a suitable forecast system.

1. Introduction

The livelihood of villagers in the uplands of Northern Laos is highly dependent on shifting cultivation agriculture and rice is the single most important food in Laos (Schiller et al., 2001). While the yield potential of traditional rice varieties may range between 3 and 3.5 t ha^{-1} without addition of fertilizer (Boualaphanh et al., 2011), rain fed rice is often grown for one season on hills with steep slopes where yields can be extremely low, ranging between 0.4 and 0.9 t ha^{-1} (Roder, 2001). Factors contributing to this include erratic rainfall and increased cropping intensity (Saito et al., 2006), general soil fertility and weed problems related to slash-and-burn practices (Roder, 1997), and rodents. Farmers cited rodents as a major constraint for growing rice in the uplands (Roder, 2001; Schiller et al., 1999). Recent historical analyses have documented that the Northern uplands of Laos experienced episodic rodent outbreaks with devastating effects in the past, when the entire harvest could be lost to rodents (Douangboupha et al., 2010). There is now scientific agreement that this is a regional phenomenon involving also neighboring countries and there exist linkages between bamboo masting events, rodent outbreaks, and famine (Normile, 2010). However, also during non-outbreak periods rodent problems persist in form of chronic infestations in Northern Laos (Douangboupha et al., 2003). Various rodent species are involved in the outbreaks (Douangboupha et al., 2010), but black or house rats

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(*Rattus rattus* Linnaeus) have been identified as a major pest species (Brown and Khamphoukeo, 2007). Recent molecular characterizations based on mitochondrial DNA place black rats from Laos under lineage II of what has been termed the *Rattus rattus* -Complex (Aplin et al., 2011), while other authors address these populations in Laos as the Asian house rat, *Rattus tanezumi* Temminck (Pagès et al., 2013).

To strengthen a selection of Northern upland villages in rodent management and protect the wet season rice of 2011, an integrated rodent management program was implemented as part of a long term measure, the Northern Uplands Development Program (NUDP). NUDP set out to improve land management and agricultural productivity in some of the poorest provinces in Laos, namely Luangprabang, Houaphanh, and Phongsaly (NUDP, 2015). Rodent control deemed especially urgent, because outbreaks threatened food security in the program area right from the start in 2010 (World Food Programme, 2009). The program integrated strategies of ecologically-based rodent management, or EBRM (Singleton et al., 1999), including community-based practices (Brown and Khamphoukeo, 2010; Palis et al., 2007) with campaigns of biological rodent control (Jäkel et al., 2006). The design of the program was experimental, as negative control villages were included to determine the impact of the actions. It was expected that the results of this relatively large-scale approach could be helpful in addressing future rodent problems and improve food security in the Northern uplands.

2. Materials and methods

2.1. Selection of target villages

The rodent management program was repeated in three provinces of the Northern uplands of Laos, namely Phongsaly, Luangprabang, and Houaphanh (PS, LP, HP), in three districts each. To identify suitable villages, a rapid community appraisal (RCA) was conducted in 231 villages, comprising about 14,000 households (HHs), all characterized by a high poverty status. In each village eight male and eight female farmers of different levels of income were interviewed with regard to rodent management. Parameters assessed included crop cultivation area, rice yield, damage and losses due to rodents, frequency of observations of rodents, villagers' motivation and rodent control practices. Thirty-six villages, 12 from each province, were finally selected based on comparable conditions regarding abundance of rodents (high frequency of observations), damage to rice (high losses), and willingness among farmers to engage in rodent control activities (medium to high motivation). Four each of the selected villages were located in the same village cluster of a district and considered a unit, two being randomly allocated as treatments and two as controls. This resulted in 18 villages (927 HHs; 709 ha upland rice) being assigned to the treatment group and 18 villages (1124 HHs; 1024 ha upland rice) serving as negative controls (Fig. 2). The negative control villages were about 11 km (median) away from each randomly assigned treated counterpart in the same district showing similar agricultural and natural habitats.

2.2. Design of the rodent management program and monitoring of implementation

The program was implemented over a period of about one year (start in October 2010), and included monitoring of parameters of rodent infestation and progress in community-based rodent management (Fig. 1). Conceptually, it followed a two-track approach: first, implementation of community-based rodent management in the villages and associated rice fields through a combination of sustained trapping (i.e., repeated application of snap traps over extended periods in different habitats and seasons), rodent proofing of the poles of rice storage huts (using metal guards), and rodent hunting and village sanitation with participation of the whole village; second, protection of upland rice fields by campaigns of biological rodent control using the parasitic protozoan *Sarcocystis singaporensis*, which is native to Southeast Asia (Jäkel et al., 1999).

Villagers of the treatment villages of HP volunteered in counting all rodents that were killed by snap traps, community hunts, and biological rodent control. In each village, a monitoring committee instructed fellow villagers and distributed forms for recording of culled rodents, which were re-collected on a monthly basis. Rodent carcasses were recorded under biological control, if they were not caught in a trap or killed by hunting, collected between nine and 15 days after application of rat bait, and showed typical signs of disease (bleeding or presence of dried blood around the nose and the eyes; Jäkel et al., 2006). Farmers revisited the places where they had applied rat bait to check for carcasses or moribund rats, which are usually apathic and can be sometimes observed in the open (Jäkel et al., 1999). Rodent species were identified following the taxonomic guidance of Aplin et al. (2003), and Lao names of rodents related to scientific nomenclature according to Aplin et al. (2006) and Bergmans (1995).

Nine agricultural officers (one from each district) of the Provincial and District Agriculture and Forestry Offices (PAFOs and DAFOs) supervised and monitored the rodent management activities of the villagers. They were trained in general rodent management and the specific methods applied in the program. In the negative control villages and associated rice fields no rodent control activities were conducted. Farmers followed their traditional practice. Treatment villages were provided for free with the necessary supplies of snap traps, metal guards, and rat bait on top of their already existing rodent control tools. Requirements for traps for each village were calculated based on the number of HHs and area of upland rice.

Locally contracted, independent interviewers interviewed farmers with regard to their common rodent management practices and application of the newly introduced techniques within a survey that was conducted separately from the monitoring activities of the program. The survey mainly focused on the economic situation of upland farmers while certain information points were assessed by differential phrasing of similar questions to check for the plausibility of the responses. In each district, 18 farmers were randomly selected for interview from residents lists of the treatment villages, which resulted in 54 interviewees province^{-1}.

2.3. Rodent proofing of rice storage huts

Metal guards were cut out of flat zinc sheets and usually 100 cm long. They were fitted to all poles of a rice storage hut in a way that protection extended to the higher part of the poles. A 30 cm–50 cm wide metal collar was added on top of each guard. Shorter poles were fitted with wider collars. Additionally, villagers removed parts of trees that were above or in contact with the storage huts, and lumber, animal feed, or livestock that was usually kept below. Holes in the walls were repaired. Rice was occasionally stored in metal wire cages, which was affordable for a minority of villagers only.

2.4. Biological rodent control

Commercial rat bait containing the parasitic protozoan *S. singaporensis* was provided by the local pest control operator General Service Lao (GSL) and applied as described previously (Jäkel et al., 2006). Two campaigns were conducted before, and one during the main rice growing season (Fig. 1). In each campaign, villagers