Table 3.

Numbers of rats (and other animals) captured in three villages by early wet season (EWS) trap crops[a], organised rat hunting[b], and individual digging of bunds[c].

Village	Size of EWS trap crop (m)	TBS trap crop					No. of villagers hunting rats	No. of rats captured by hunting	Rats killed by digging burrows in bunds
		Rat	Snake	Frog	Crab	Bird			
Bot Slok	50 × 50	9	5	10	1	9	39 (night) 50 (day)	8 (night) 40 (day)	52
Veal	85 × 75	2	4	7	10	1	30 (day)	10 (day)	0
Chrok Metes	40 × 35	7	4	6	3	1	25 (day)	0 (day)	0

[a] The table indicates the number of rats captured by trap crops from June to September 1998.

[b] Villagers hunted rats before the beginning of the wet season on a single day in April 1998. In Bot Slok, rats were also hunted the night before the daytime hunt.

[c] Villagers dug and killed rats in the bunds of rice fields other than the EWS crop from July to September 1998.

The EWS crops fared poorly, yielding an average of 0.6 t/ha. Average yields (n = 239 crops) in this area are 2.0 t/ha for early maturing rice varieties in the dry season, and 0.7 t/ha for late maturing varieties in the wet season (including fields with zero yield due to drought or pests) (Jahn et al. 1996). Yields were reduced by drought, weeds, and rice bugs (*Leptocorisa oratorius*). On average, 40% of the grains were empty (primarily due to rice bug feeding), an additional 27% of the grains were partially filled or had rice bug damage. On average, only a third of the grains were intact and undamaged. The scarcity of water allowed a variety of weeds to take over EWS fields. The weeds gave rice bugs a place to breed and feed until the rice reached the milk stage, which rice bugs prefer. The EWS crop was the only available milk stage crop in the village, so rice bugs were concentrated there at higher than usual levels. The EWS crop itself ripened unevenly due to the puddling of water in parts of an otherwise dry field. This asynchronous development raised the effective density of rice bugs in the fields as they moved from one patch of milk stage rice to another. An attempt to save the EWS crop in Bot Slok from rice bugs with insecticide was unsuccessful. The farmers said that they would not try to grow an EWS crop again.

There were advantages and disadvantages of each of the rat management techniques (Table 4). Traps and baits are both used already (but techniques could be improved); rat fences are not used in the wet season because they are too expensive. From discussions with farmers we found that the cost of a rat fence is prohibitive, based on private costs and returns. In fact, the cost of the fence may exceed the value of the crop in some cases in the wet season. A TBS, like plain trapping, requires continuous supervision, both to check its integrity as well as to remove any rats caught. We saw remains of a rat fence in one village—the technology had been tried already, considered and discarded. Other problems encountered included: poor quality poisons; the need to time baiting operations to avoid poisoning domestic animals; the need to monitor traps regularly; damage to plastic fences from wind and cattle; the requirement for supervision of the TBS; and the danger of theft of the traps and plastic.

We can improve the effectiveness of baiting and trapping by paying attention to the quality of materials and training in techniques. But we see little that we can do to improve the cost-effectiveness of plastic fences — the major problem is the high cost in relation to the value of the losses associated with rat damage. The traps were effective for catching *B. indica*, but less effective for *R. argentiventer*. The latter was the only species captured in rice bunds.

The justification for early rat management (when populations are low) suggests the use of a trap crop. Although it may be technically feasible to plant a crop out of season just to catch rats, this would need to be done at a community level. However, in Svay Teap, villagers were reluctant to participate in communal activities. They pointed out that during the Khmer Rouge period they were forced to produce rice communally with terrible results.

The TBS is used most extensively in Cambodia by dry season farmers growing irrigated rice. Some farmers are currently experimenting during the EWS with modern

Table 4.
Comparison of technologies used in the rat management farmer participatory research in Svay Teap District, Svay Rieng Province.

	Baiting	Traps	Hunts	Trap–Barrier system
Initial Cost	Medium	Medium	Low	High
Labour requirements	Low	Low	Medium	High
Effectiveness	Low	Medium	High	Low
Durability	Days	Years	Unknown	A season
Reliability	No	Yes	Yes	No
Economies of scale	No	No	No	Yes (cost/t depends on field size and shape)
Provides information about rat populations	No (?)	Yes	Yes	Yes
Requires continuous monitoring	No	Yes	No	Yes
Environmental hazard	Yes	No	No	Yes
Gender impact	Primarily men's work	Primarily men's work	Men, women and children	Men and women
Health impact	Unknown	No	No	No
Compatibility with farming system	No (Livestock)	Yes	Yes	No (Livestock)
Complexity	Medium	Low	Low	High
Adaptability	Farmers modified the bait stations	Novel trap designs were well accepted	Adapted to include dogs in the hunt	Difficult to modify, but possible use as fish fences
Relative disadvantage	Some rat spp. are bait-shy; presence of cattle reduces effectiveness of pre-baiting	Traps do not target rats which attack rice crops; theft	Non-target species are also caught (although some of these may be used as food e.g. frogs, snakes)	High cost; high complexity; need for continuous monitoring; incompatible with cattle in the farming system; theft
Popularity	Individuals	Individuals	Basis for social interaction	Initial interest, but this dissipated

rice varieties to produce a short duration crop before transplanting traditional varieties in the normal wet season. Normally, such early-maturing IR varieties are grown in the dry season along receding rivers or with irrigation. The EWS crop provides food at a time of expected food shortages (just before the rains), and it overcomes a persistent problem with a drop in the germination rate of traditional seeds stored for a long period (from one dry season to the next) (Mak 1998). These modern rice varieties are potentially of high value because they are higher yielding than traditional varieties and produce rice at a time when the food supply is low. EWS crops are scattered and at particular risk from rat damage; perhaps because they are out of season. If a TBS is to be used at all in the Cambodian wet season, it would be with these EWS crops. However, even here the value of the crop does not appear to justify investment in a rat fence. Exceptions are situations where the potential yield is relatively high and the risk of rat damage is also very high. Under these circumstances, the benefit-to-cost ratio of a TBS plus trap crop was high in West Java, Indonesia (Singleton et al. 1998). The value of a TBS depends on: its cost and the number of seasons it can be used; the value of the crop it protects; the severity of the risk of rat damage; and the social mechanisms available for valuing externalities and incorporating these into private decisions.

In Bot Slok, burrow digging killed more rats than the TBS, but in the other two villages farmers did not notice any burrows in bunds. Due to its proximity to the forest, scrub, and uncultivated land, Bot Slok probably has greater rat problems.

Before the farmer participatory research (FPR), farmers were mainly concerned with reducing rat numbers during an outbreak. After the FPR, farmers said they were actively committed to preventing rat population increases. Farmers also began to see the usefulness of community rat control, and the need to organise for more successful rat management. Farmers made an effort to participate in all aspects of the FPR, however a facilitator was required to organise and motivate farmers.

Farmers preferred working in small groups, which were more efficient because they could share ideas and consult each other. Farmers working in small groups expressed greater confidence in the process than did those in large groups.

Use of participatory methods meant that we were able to find out more about the nature of the rat problem in Svay Teap, and the constraints to its solution, much more quickly than if we had simply imposed pre-defined experimental trials. The design of appropriate procedures for rat management in Cambodia cannot be separated from the social and economic circumstances of the problem-owners. This is best incorporated in the research process through the active participation of farmers.

Acknowledgments

We thank the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Centre for International Agricultural Research (ACIAR) and IRRI for information on rat management. We are grateful to Mr. Tuy Samram, Mr. Numa Shams and the rest of the CRS staff for assistance in facilitation and funding of this

project. AusAID (Australian Agency for International Development) funded the CIAP contributions to the farmer participatory research. We are indebted to Dr. Luke Leung for his contribution to our understanding of the rodent pests of Cambodia. Finally, we appreciate the participation of Ms. Kul Saram, Mr. Sons Chheng, Mr. Pech Saron, Ms. Chao Sophal and the hundreds of other rice farmers involved in this research.

REFERENCES

Anon. 1996. Vital signs. Asiaweek May 3 1996, 60.

CIAP (Cambodia–IRRI–Australia Project) 1998. Annual research report 1997. Phnom Penh, CIAP.

Cox, P.G., MacLeod, N.D. and Shulman, A.D. 1997. Putting sustainability into practice in agricultural research for development. In: Stowell, F.A., Ison, A.R.L., Holloway, R.J., Jackson, S. and McRobb, S., ed., Systems for sustainability: people, organizations and environments. London, Plenum Press, 33–38.

Jahn, G.C., Pheng, S., Kiev, B. and Pol, C. 1996. Farmers' pest management and rice production practices in Cambodian lowland rice. Baseline Survey Report No. 6. Phnom Penh, Cambodia–IRRI–Australia Project.

Jahn, G.C., Kiev, B., Pheng, S. and Pol, C. 1997a. Pest management in rice. In: Nesbitt, H.J., ed., Rice production in Cambodia. Manila, International Rice Research Institute, 83–91.

Jahn, G.C., Pheng, S., Kiev, B. and Pol, C. 1997b. Pest management practices of lowland rice farmers in Cambodia. In: Heong, K.L. and Escalada, M.M., ed., Pest management of rice farmers in Asia. Manila, International Rice Research Institute, 35–52.

Javier, E. 1997. Rice ecosystems and varieties. In: Nesbitt, H.J. , ed., Rice production in Cambodia. Manila, International Rice Research Institute, 39–81.

Leung, L.K.P. 1998. A review of the management of rodent pests in Cambodian lowland rice fields. A consultancy report for Cambodia–IRRI–Australia Project. Canberra, CSIRO Wildlife and Ecology.

Mak, S. 1998. Rainfed lowland rice and agricultural change in Cambodia. PhD Dissertation, School of Agriculture and Rural Development, University of Western Sydney, Hawkesbury, Australia.

Singleton, G.R., Sudarmaji and Suriapermana, S. 1998. An experimental field study to evaluate a trap–barrier system and fumigation for controlling the rice field rat, *Rattus argentiventer*, in rice crops in West Java. Crop Protection, 17, 55–64.

18. Rodents in Agriculture in the Lao PDR — a Problem with an Unknown Future

John M. Schiller, Bounneuang Douang Boupha and Onechanh Bounnaphol

Abstract

Rice accounts for more than 80% of the cultivated land area in the Lao People's Democratic Republic (PDR). Rodent problems are mainly (but not exclusively) associated with rice cultivation. Rainfed lowland rice accounts for about 70% of the area and 76% of production. Rainfed upland rice accounts for about 21% and 14% of the area and production, respectively. Smallholder producers in the main rainfed lowland rice-growing areas of the Mekong River Valley generally do not rate rodents as a major pest problem and consistently rank rodents very low among potential production constraints. Conventional trapping techniques are generally capable of giving satisfactory control. In the upland environment, however, smallholder producers regard rodents as their most important pest, and the rodent problem second only to weeds as the overall most important constraint to production. It is also the production constraint over which they have least control. The severity of the problem varies with locality and between seasons. Complete loss of upland rice crops on a localised basis, with famine conditions resulting, is not unusual. Conventional trapping techniques do not give adequate control in the uplands. Often areas of lowland cultivation in the narrow valleys of the more mountainous regions can also be devastated by the movement of rodents from adjacent upland areas. Official policy is to actively discourage the use of rodenticides as a means of rodent control in both the upland and lowland environments. However, there is increasing use of uncontrolled imports of rodenticides, particularly in the upland environment. Little is currently known about the species and ecology of rodents in the uplands of the Lao PDR.

Keywords

Rodents, rice, Lao PDR

INTRODUCTION

AGRICULTURE IS THE principle economic sector in the Lao People's Democratic Republic (PDR), accounting for about 52% of real output. About 80% of the population live in rural areas and are engaged in agriculture. Rice is the most important crop, contributing about 60% of total agricultural production and accounting for about 80% of the cultivated area. More than 90% of rice is grown under rainfed conditions during the annual wet season. The rainfed lowland ecosystem accounts for about 70% of the area and 76% of production; the rainfed upland environment accounts for about 21% of the area and 14% of production. Less than 10% of total rice production is traded. National policy is aimed at achieving a greater level of rice self-sufficiency by the year 2000 by raising total production by about 25% to approximately 2.1 million t.

Because of the national importance of rice, most information available on rodents relates to their effects on rice cultivation (Lao-IRRI 1992, 1996; Khotsimuang et al. 1995), however most of this information is of a secondary nature. There have been few attempts to understand and quantify the significance of the problem, and little research done to develop appropriate management strategies. Singleton and Petch (1994) documented some of the perceptions and data on the rodent problem in the upland rice environment. Data on rodents related to the rainfed lowland and irrigated environments have been collected as part of general surveys of pests and weed infestation problems (Khotsimuang et al. 1995; Lao-IRRI 1996; Rapusas et al. 1997).

This chapter reviews the magnitude of the rodent problem in the different agro-ecosystems of Lao PDR, and what we know about the biology and management of rodent pests in the upland environment where they are an important constraint to rice production. It also discusses future issues that are likely to influence the dynamics of rodent populations in Lao PDR.

RODENTS IN THE RAINFED LOWLAND ENVIRONMENT

More than 70% of the area under rainfed lowland rice cultivation is in provinces adjacent to the Mekong River in the central and southern agricultural regions of the country. Rodents are present throughout this area. However, a 1993 survey of farmer perceptions of production constraints, in nine districts of seven provinces in the Mekong River Valley, indicated that in most districts rodents were not regarded as a significant production constraint (Khotsimuang et al. 1995). In a ranking of 11 potential production constraints, rodent damage was ranked among the three least important factors in seven of the nine districts; in the remaining districts, rodents were never ranked higher than seventh in relative importance (Figure 1). In 1994, a separate survey considered farmer observations of various pests in areas of lowland cultivation in Vientiane Municipality and the provinces of Savannakhet and Champassak in central and southern Lao PDR. In only one district (Nasaythong) of Vientiane Municipality did a significant number of farmers (30%) report observations of rodents as a pest (Table 1).

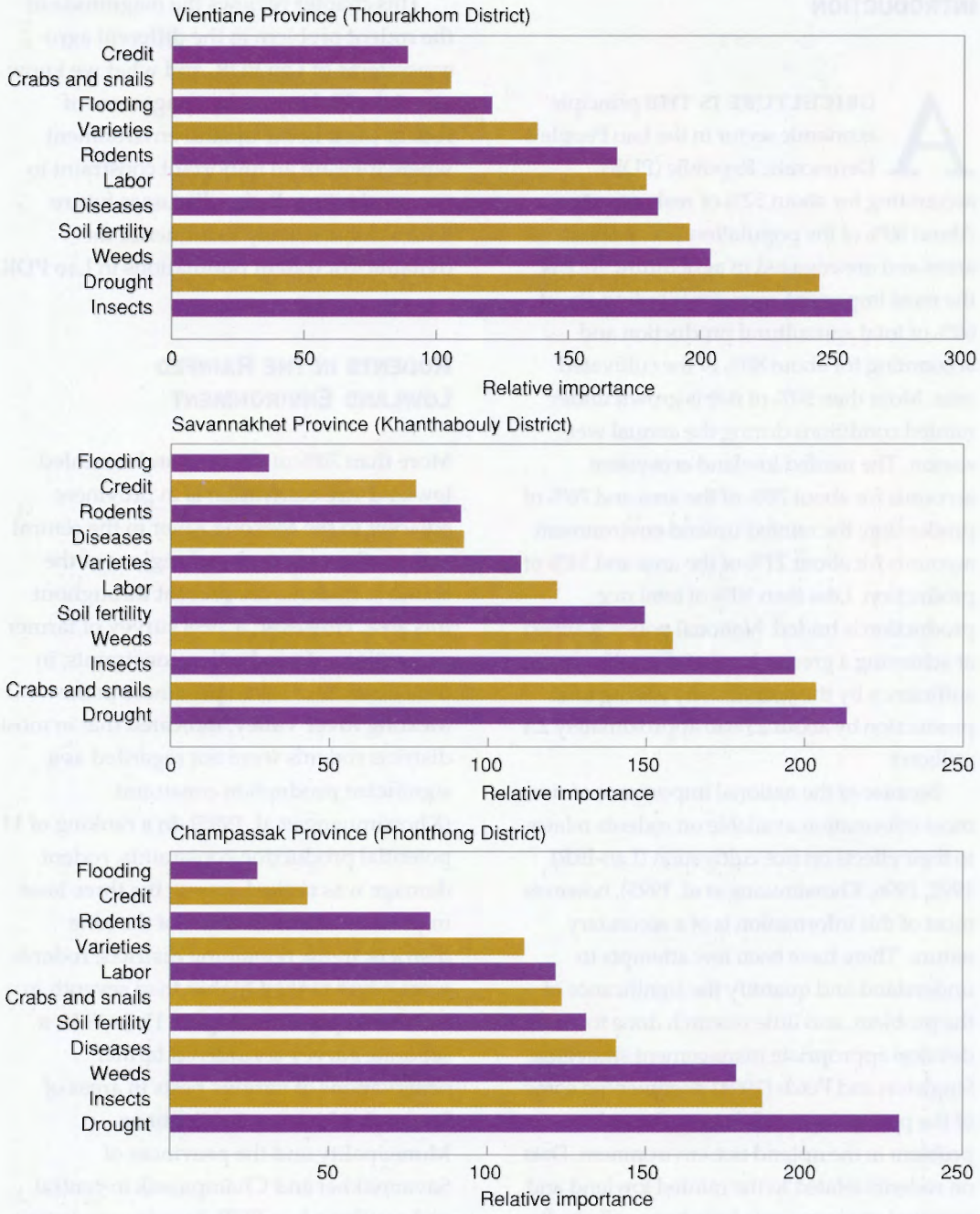

Figure 1.
Farmer perception of the relative importance of different production constraints in the rainfed lowland environment in selected provinces of Lao People's Democratic Republic (Khotsimuang et al. 1995).

Table 1.
Pests that attack rice plants as reported by respondents in a survey of rainfed lowland environment (Raspusas et al. 1997).

Pests	Provinces (Percentage of farmers reporting)															
						Vientiane Mun				Savannakhet			Champassak			Total
	Luang Namtha	Oudomxay	Luang Prabang	Sayabouly	Xieng Khouang	Nasaythong	Saythany	Vientiane Province	Borikhamxay	Saybouly	Champone	Saravane	Champassak	Pakse	Sanasombourne	
Leaf feeders																
Armyworm	0	0	0	3	0	7	0	0	0	8	2	0	0	0	0	20
Cutworm/worm	5	11	6	3	0	5	3	0	0	5	3	7	0	3	4	55
Caseworm	0	0	1	0	0	5	2	0	0	0	1	0	5	0	0	14
Leaffolder	9	6	4	7	0	5	1	0	0	13	3	17	3	0	0	68
Whorl maggot	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	4
Rice skipper	3	0	0	1	0	0	0	0	0	1	0	0	0	0	0	5
Grasshopper/locust	20	23	19	12	0	23	16	4	1	8	0	3	0	0	0	129
Thrips	0	0	5	1	0	4	10	1	0	3	9	0	3	6	10	52
Brown planthopper	0	3	3	2	0	2	8	3	0	3	0	19	0	2	14	59
Whitebacked planthopper	0	6	0	0	0	0	0	0	0	0	0	0	2	1	7	16
Green leafhopper + zigzag leafhopper	0	2	2	1	0	1	0	0	0	0	0	0	3	0	0	9
Stem feeders																
Stemborers	0	7	25	4	0	23	15	25	8	30	2	6	3	3	2	173
Gall midge	0	10	9	15	0	0	0	4	8	22	3	1	5	0	20	97

Table 1. (Cont'd)

Pests that attack rice plants as reported by respondents in a survey of rainfed lowland environment (Raspusas et al. 1997).

Pests	Provinces (Percentage of farmers reporting)															
						Vientiane Mun				Savannakhet			Champassak			Total
	Luang Namtha	Oudomxay	Luang Prabang	Sayabouly	Xieng Khouang	Nasaythong	Saythany	Vientiane Province	Borikhamxay	Saybouly	Champone	Saravane	Champassak	Pakse	Sanasombourne	
Grain feeders																
Rice bugs	1	1	14	4	0	28	7	24	2	8	1	6	0	2	2	100
Mole crickets	0	3	3	1	0	0	4	2	0	0	0	0	0	0	0	13
Ants/termites	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	3
Other pests																
Rats	1	0	3	4	0	14	9	0	0	0	0	0	1	0	0	32
Crabs	0	0	3	0	0	6	6	0	5	20	8	1	0	2	8	59
Birds	0	0	1	1	0	1	3	0	0	0	0	1	0	0	0	7
Diseases (blast, sheath blight, false smut)	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	4

However, the level of losses was not indicated and most farmers reported that they were able to manage the problem (Rapusas et al. 1997). The main rodent species encountered in the lowland environment have been identified as *Rattus argentiventer*, *Rattus norvegicus*, *Rattus exulans* and *Bandicota indica*.

In areas of rainfed lowland rice cultivation in the narrow valleys of much of northern Lao PDR, rodents can cause a significant, but as yet unquantified, level of damage. These areas are usually adjacent to forest regrowth and areas of upland cropping, which harbour high endemic rodent populations (Figure 2). As the lowland rice crops ripen, the rodents move from these forested areas into the rice crops. Early maturing rice crops in this environment are particularly targeted. The rodent species responsible for this damage are believed to be the same as those responsible for losses in upland rice crops, however the species have yet to be identified.

Photo: J.M. Schiller

Figure 2.
Lowland rice field adjacent to forest regrowth and areas of upland cropping which harbour endemic rodent populations.

Rodents in the Irrigated Environment

A 1995 survey of farmer perceptions of production constraints under irrigated conditions in nine administrative districts extending over five provinces and Vientiane Municipality, in central and southern Lao PDR, found that rodents were not listed as a significant production constraint in any of the districts surveyed (Figure 3). The highest ranking in three districts was seventh in the list of 11 constraints; in two districts rodents were ranked as the least important production problem (Lao-IRRI 1996). As in the rainfed lowland environment, smallholder farmers generally reported that they could adequately manage the rodent problem encountered under irrigated conditions. As in the rainfed lowland environment, small areas of dry season irrigated rice crops in the narrow valleys in northern Lao PDR can be targeted by rodents from adjacent upland areas; losses under these conditions can be substantial.

Rodents in the Upland Environment

In the early 1990s, surveys undertaken of farmer perceptions of production constraints to upland rice cultivation in several provinces of the northern agricultural region of the country indicated that rodents were regarded as the most important pest in the uplands (Lao-IRRI 1992). Smallholder upland rice farmers rated rodents as being second only to weeds as the overall most important constraint to upland rice cultivation (Figure 4). The nature of the upland environment lends itself to high endemic rodent populations (Figure 5).

Provinces which have reported significant rodent problems in the uplands are shown in Figure 6. These problems have been further highlighted in recent area-specific surveys. McLaren (1996) reported rodents to be the most consistently reported pest among production constraints (Table 2) in parts of Luang Namtha Province adjoining the Chinese border. (Birds and wild pigs were also often a cause of damage to upland crops.) In the 1998 wet season, parts of Houaphanh Province, on the border with Vietnam, reported losses exceeding 30% of the upland rice crop due to a 'population explosion' of rodents and subsequent damage to the main wet season crop; more than 1,000 ha was totally destroyed (M. Phouthavong, 14 September 1998, pers. comm.). Agricultural officials from this province report that there have been four such outbreaks over the period 1968 to 1998; all were apparently associated with the wet season flowering and fruiting of particular species of bamboo, as discussed below. Unusually dry years are also associated with higher levels of rodent damage in upland areas.

The damage by rodents to upland crops is not confined to rice, however reports of such damage most often relate to rice. This is because of its significance in the uplands, where it accounts for more than 75% of cultivated area, and more than 80% of calorie intake of people living in this environment. The rodent problem is regarded by upland farmers as the production constraint over which they have least control.

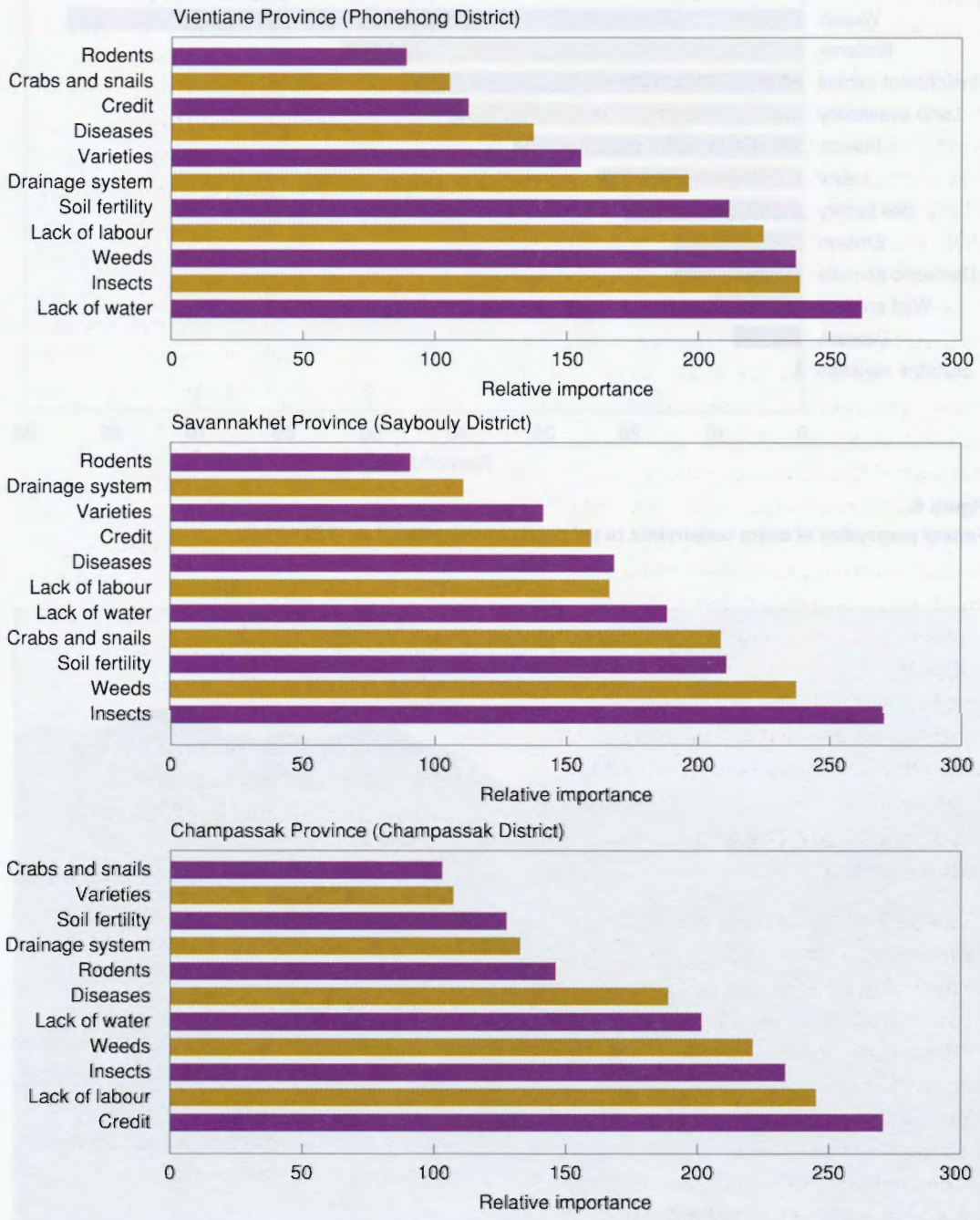

Figure 3.
Farmer perception of the relative importance of different production constraints in the irrigated environment in selected provinces of Lao People's Democratic Republic (Lao-IRRI 1996).

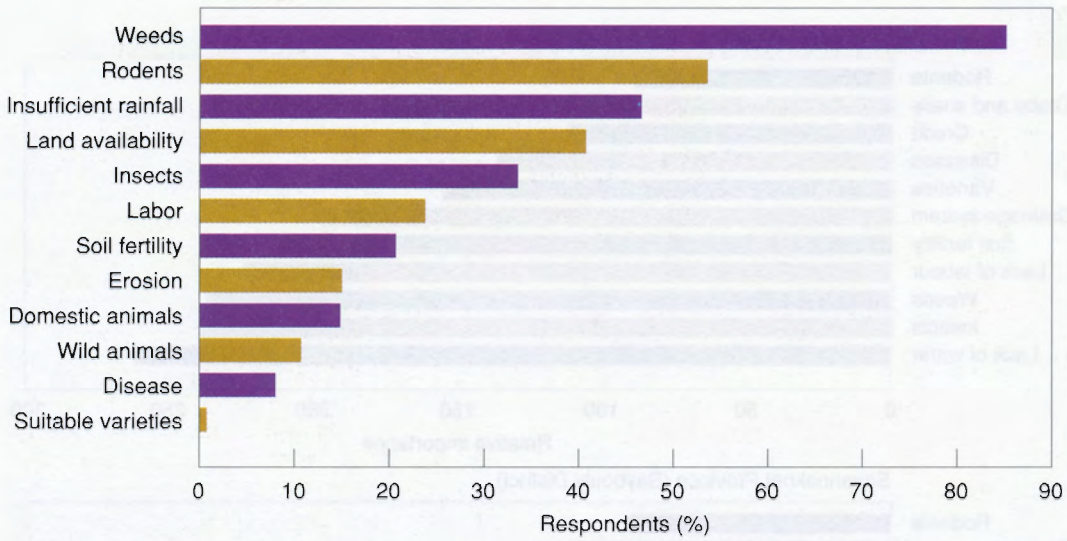

Figure 4.
Farmer perception of major constraints to upland rice production (Lao-IRRI 1992).

Photo: J.M. Schiller

Figure 5.
Typical appearance of the upland environment, the nature of which lends itself to high endemic rodent populations.

Table 2.
Main production constraints to rice production in villages of Luang Namtha District of Luang Namtha Province (McLaren 1996).

Village/Ethnicity	Total families	Land area (ha)		Main production constraints
		Lowland	Upland	
Namthung/Thai Leu	175	135	0	Low prices Lack of knowledge Lack of seed
Ban Phoung/Thai Dam	166	109	5	Low prices Rodents Lack of land
Namngen/mainly Thai Dam	383	192	15	Lack of land Pests (snails, crabs,birds, rodents) Low prices
Houaidam/Khamu Ou	60	6	29	Low fertility Damage by livestock Low prices
Nateuil/ Khamu Ou	83	2	30	Weeds Rodents Low fertility
Tintok/ Khamu-Hmong	37	1	32	Birds, rodents Weeds Low fertility
Hat-Ngao/Hmong	87	13	82	Lack of land Weeds Diseases
Lakkhammai/Ikaw	37	4	32	Lack of land Lack of seed Damage by pigs
Namkhon/ Lao Huay	28	11	20	Damage by pigs Rodents Birds
Namke/Lao Huay	21	6	15	Weeds Diseases Birds, rodents
Xuanya/ Lao Huay	14	8	2.5	Flooding Damage by livestock Low prices
Total	**1091**	**481**	**262.5**	

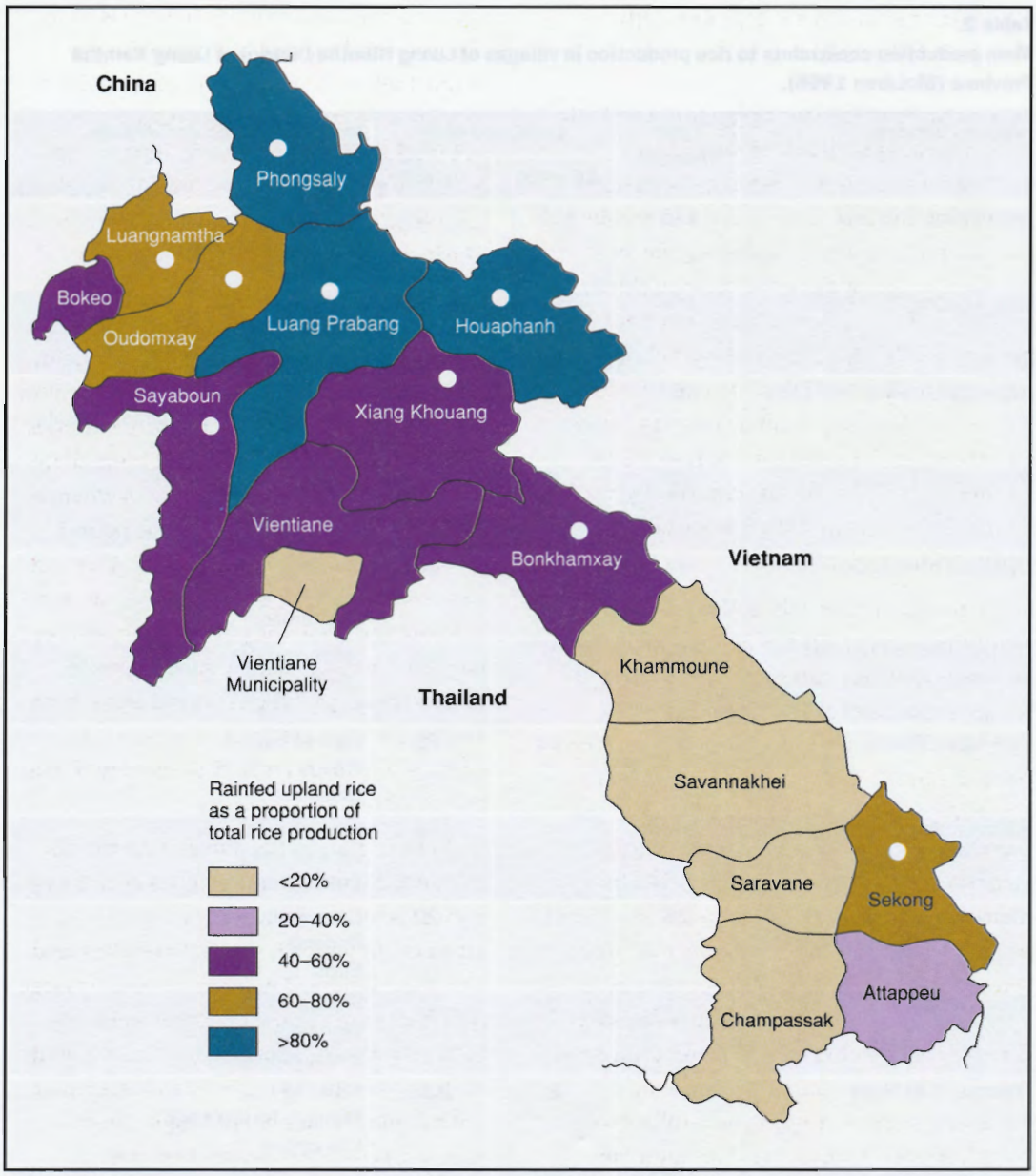

Figure 6.
Provinces of the Lao People's Democratic Republic which have reported significant rodent problems in the upland environment (•)

Characteristics of the Upland Rodent Problem

Although farmers in the uplands of Lao PDR have a good knowledge of the rodent problem in local terms, little has been done to characterise and understand the problem in a scientific sense. Grain losses due to rodent damage in the uplands are a chronic annual problem. Annual losses have not been properly quantified but are believed to account for at least 15% of the rice harvest. As almost all upland farmers have an annual rice shortage, the losses due to rodents can significantly aggravate the chronically poor nutritional status that is a feature of most upland households.

At irregular intervals, conditions that favour massive eruptions of the upland rodent population can result in localised losses in excess of 50% of the rice crop. Occasionally farmers lose 100% of their crop. For example, in 1991, several villages in the northern province of Luang Prabang reported the total loss of their wet season rice crops (Singleton and Petch 1994). In almost all instances, these population eruptions are associated with the mid-wet season flowering and fruiting of certain species of bamboo. The bamboo is found in areas of regenerated forest where it can be a sub-climax vegetation form following a period of 'slash-and-burn', generally rice-based, shifting cultivation. Although the species of bamboo associated with these rodent population explosions are known in local terms, a botanical characterisation has yet to be made. Flowering and fruiting of the bamboo is reported to take place in July (following the opening wet season rains in May); fruiting is followed by the death of the bamboo. Increased rodent activity is soon observed and rapidly builds up during August when the bamboo fruit provides a regular food supply for the rodent population. Following the fruiting of the bamboo, the rodents then move into upland rice crops and other upland annual crops. The harvesting of the earliest maturing upland rice varieties commences in early September. This usually corresponds to a period of heavy wet season rain and yields of these early varieties can be lower than for later maturing varieties. The early varieties are usually grown to help meet immediate household rice needs in situations where a chronic rice deficit is usual in the period prior to the harvest of the main wet season rice crop. The damage to rice crops does not only occur during the period approaching harvest. Damage is sometimes reported prior to heading, when rodents move from nearby forested areas. In particularly serious cases, a rice crop can be destroyed within a couple of nights.

In the uplands, the damage to crops is associated with two main types of rodents, both of which are well known to upland farmers but which have yet to be classified. The most serious damage is caused by large numbers of mice-sized rodents weighing between 65–80 g. However, the movements of these 'nuu khii' is usually in association with a smaller number of larger-sized rodents, possibly of another species. Columns of 'nuu khii' are reported to move into crops, following individual or a small numbers of the larger animals. Singleton and Petch (1994) have suggested that the larger rodent might be the rice-field rat, *Rattus argentiventer*, and the smaller one possibly a species of *Mus* (*M. caroli* or *M. cervicolor*).

This needs confirmation with taxonomic studies.

The rodent problem in the uplands of Lao PDR appears to be shared in the uplands of the neighbouring countries of Vietnam, Myanmar and Thailand. Only in Thailand is there some knowledge of the biology of the rodent species living in this system (see Boonsong et al., Chapter 16).

Rodent Control Measures in the Lao PDR

Lowland rainfed and irrigated environments

Trapping techniques developed by Lao farmers, in combination with a number of cultural practices, are usually employed in most areas of lowland rice cultivation (lowland rainfed and irrigated). These techniques are generally regarded as being effective and are carried out throughout the year. Often the trapped animals are eaten or sold in local markets. There is relatively little use of rodenticides, although rodenticides are often available in local markets. If rodenticides are purchased and used, it is usually to protect early maturing rice varieties, which can be targeted by both birds and rodents. A 1994 survey of pesticide use by lowland rice farmers in 11 provinces in the north, central and southern regions of Lao PDR indicated that less than 2% of respondents were using rodenticides at that time (Rapusas et al. 1997). The only rodenticide reported as being used in the lowlands was zinc phosphide. Until about 1990, the main source of rodenticides was Russia. More recently, the Japanese government has provided rodenticides on a regular annual basis under that country's development assistance program, based on requests from the Lao government. It is generally recognised that the level of rodenticide use has recently increased from the levels indicated by the 1994 survey. Much of this increase has taken place in lowland areas in the north of the country, using rodenticides originating from China; the active ingredients of these rodenticides have not yet been determined.

Upland environment

As in the lowland environment, upland farmers have developed a number of control techniques based on the use of various types of single-capture traps, snares and pitfall traps to help control the rodent population. Occasionally, trained dogs are also used to hunt and kill rodents. These techniques are used all year round but with increased intensity as the upland rice crops approach maturity. The effectiveness of the techniques is probably limited, as they usually target only the rice crop, whereas the rodents often move from adjoining forested and fallow areas into the rice crop. In those years when upland rodent populations erupt, conventional trapping and catching techniques have little impact. Following significant crop losses due to rodents in 1991 in the northern Lao province of Luang Prabang (Singleton and Petch 1994), rodent control committees were established at the provincial and district levels. These committees had several functions: to estimate rodent damage, to conduct eradication campaigns, to encourage and train farmers in the use of traditional and new control methods, to evaluate new methods of control, and to develop incentive and awareness campaigns. During the 1991

outbreak, a bounty on rodent tails was offered as an incentive for both reducing the rodent population, and to provide financial support for households who lost part of their rice crop. The effectiveness of this type of program has been difficult to assess as it has been implemented when rodent populations are already at a high level, and when much of the damage has already been done. In Southeast Asia, the implementation of bounty systems is a typical response by provincial governments to severe rodent problems. Lao PDR, however, cannot learn much from its neighbours regarding the impact of such bounty schemes, as their effectiveness has not been assessed (see Singleton et al., Chapter 8).

The chronic nature of the rodent problem in the uplands provides a ready market for rodenticides. Despite an official government policy discouraging their use, the use of rodenticides in the uplands is increasing. Most are originating from China, from which there is easy access to the northern provinces of Lao PDR for an increasing number of agricultural inputs. No statistical information is yet available on rodenticide use in the uplands, however their increasing availability in local markets reflects an increasing demand. The active ingredients in these rodenticides is unknown. Apart from the danger to non-target animals (the cat population has been eliminated from most northern provinces, due to their consumption of poisoned rodents), there is increasing concern about their impact on human health, with increasing reports of human fatalities due to accidental poisoning.

Future Management of the Rodent Problem in Lao PDR

A number of factors will influence both the direction of future research on the rodent problem in Lao PDR and the development of effective management control strategies; significant among these are the following.

Changes in upland agriculture

The current system of slash-and-burn shifting cultivation that predominates in the uplands favours the maintenance of high endemic rodent populations and makes it difficult to implement effective control not based on the use of rodenticides. National policy for the future development of the uplands of Lao PDR is based on a move from these cultivation practices to more ecologically sustainable agro-forestry and forestry-based systems. This change may facilitate easier management of the endemic rodent populations in the uplands. However, it is also recognised that significant changes in agricultural practices may bring changes in rodent behaviour. Monitoring of the rodent population ecology will therefore be an important component of monitoring the impact of the proposed changes to traditional agricultural practices.

A reduction in the area cropped to rice in the uplands is also proposed, from about 164,000 ha in 1997 to 58,000 ha in the year 2000. It is now recognised that, in absence of demonstrated alternative agricultural technologies for the uplands, a reduction of this magnitude will be difficult to achieve. Nevertheless, a gradual but continued reduction in the area under upland rice cultivation can be expected. The cessation of 'shifting cultivation' practices, combined

with the allocation and management of the uplands by villages and individual households in these villages, aim to provide a basis for more responsible and sustainable forms of land use in the uplands. Land allocation in key northern provinces under the new national guidelines commenced in 1996. The official policy is for approximately 100,000 of the 300,000 households believed to be dependent on shifting cultivation to be allocated land for the adoption of more sustainable forms of land use by the year 2000. The community-based agricultural systems that are aimed to be the cornerstone of this development may provide a basis for better management of rodent populations in the uplands. Future rodent research should focus on these systems.

Pesticide registration and distribution control

Almost all pesticides used in Lao PDR are imported. Only small quantities of botanical pesticides are produced locally. Authority for the import of pesticides is with the Department of Agriculture and Extension, within the Ministry of Agriculture and Forestry. In the late 1980s and early 1990s, pesticide imports were often in the form of development assistance. As discussed earler, some rodenticides (mainly zinc phosphide) are still being supplied by the Japanese government under its development assistance program. Some of the pesticides observed in local Lao markets are theoretically not marketed in developing countries by producers. The open borders with Thailand, Vietnam and China mean that not all pesticides sold throughout Lao PDR are approved imports (Rapusas et al. 1997). Potent rodenticides originating from China have become readily available in markets of provinces in the north of Lao PDR without appropriate import approval. Attempts are also being made to introduce other types of rodenticides that are regarded as potentially pathogenic and dangerous to humans and their livestock into the Lao market. A proper evaluation system capable of alerting Lao officials to the potential dangers of approving the import of certain types of pesticides has yet to be put in place. It can be expected that attempts will continue to be made to seek approval for the import and sale of pesticides that are currently banned in more developed countries. Farmer education on the potential dangers from the abuse of pesticides, including rodenticides, is also needed as a matter of urgency.

Extension services and agricultural technologies for the uplands

The extension services of the Lao PDR are in an early stage of development. In the upland environment, few technologies have been demonstrated to be capable of meeting the national objective of ecological sustainability while also meeting the food and income needs of upland farmers. The interdependence of the development of the extension services and the availability of appropriate agricultural technologies for the uplands is recognised and being reflected in research planning for the uplands. The development of community-based rodent management programs will need to be undertaken within the context of an effective extension service.

Priorities for Future Rodent Research in the Lao PDR

Although it is recognised that smallholders in both the upland and lowland environments have a good knowledge and understanding of the rodent problem in their respective environments, little has been done to characterise the problem in a systematic way as a basis for the development of better rodent management strategies. There is little in the way of rodent expertise in the research and extension fields in the Lao PDR. In addition to meeting the need for training of Lao scientists and extension workers, a number of areas of short and medium term research priority have been identified:

- Identification of the different rodent species in all production environments.
- Quantification of economic losses due to rodents for the major food crops.
- Characterisation of existing control measures and assessment of their effectiveness.
- Studies of the population dynamics and habitat use of rodents in the upland environment.
- Characterisation of current use and possible abuse of rodenticides, and formulation of recommendations for better control over their registration, import, distribution and use.
- Development of community-level rodent management strategies for the upland environment.

Research initiatives in several of the above areas are scheduled to be initiated in 1999.

Acknowledgment

Some of the data referred to in this report was collected with support provided through the Swiss Agency for Development and Cooperation to the Lao National Rice Program through the International Rice Research Institute.

References

Khotsimuang, S., Schiller, J.M. and Moody, K. 1995. Weeds as a production constraint in the rainfed lowland rice environment of the Lao PDR. Proceedings of 15th Asian–Pacific Weed Science Society Conference, Tsukuba, Japan, 444–454.

Lao-IRRI (International Rice Research Institute) 1992. National rice research program 1991. Annual Technical Report, 156p.

Lao-IRRI 1996. National rice research program 1996. Annual Technical Report, 296p.

McLaren, A. 1996. Integrated rural development project, Luang Namtha Province ALA/LAO 93/94: report on a production systems study, Luang Namtha Province, 107p.

Rapusas, H.R., Schiller, J.M. and Sengsoulivong, V. 1997. Pest management practices of rice farmers in the rainfed lowland environment of the Lao PDR. In: Heong, K.L. and Escalada, M.M., ed., Pest management of rice farmers in Asia. Manila, Philippines International Rice Research Institute, 99–114.

Singleton, G.R. and Petch, D.A. 1994. A review of the biology and management of rodent pests in Southeast Asia. ACIAR (Australian Centre for International Agricultural Research) Technical Report No. 30, 65p.