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Source: Mountain Research and Development, 27(1) : 40-47

Published By: International Mountain Society

URL: https://doi.org/10.1659/0276-4741(2007)27[40:MPRDAE]2.0.CO;2

Mountain Research and Development Vol 27 No 1 February 2007: 40–47

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Rice, the staple crop in northern Laos, has traditionally been grown in shifting cultivation systems (upland rice). Government policies and increasing population pressure have resulted in declining productivity of this system. Farmers need alternative and sustainable rice production systems to meet their rice needs. One alternative is the production of rice in flooded, terraced fields (montane paddy). This option is not new; however, farmers are developing these montane paddy fields much more now than in the past. The objectives of the study were to understand why farmers have begun developing montane paddy, the effect of paddy rice production on farmer livelihood activities, and the economics and costs associated with developing paddy land. The survey focused on 9 highland villages in northern Laos. In all villages, farmers reported declining upland rice yields. Between 1998 and 2002, the paddy area in these villages increased by over 240%. The main reasons cited for developing new paddy area were higher yields and less labor involved in paddy rice production. Paddy farmers had better rice security, grew more cash crops, owned more livestock, and had higher income. A cost–benefit analysis of developing paddy area suggests that paddy development is a good investment. Further research is required in identifying suitable areas for continued development, and accessing the environmental and social impacts of paddy development.

Keywords: *Shifting cultivation; upland rice; montane paddy; lowland rice; food security; land use policy; Laos.*

Peer-reviewed: *August 2006* ***Accepted:*** *November 2006*

Introduction

Laos is the most mountainous country in Southeast Asia: 35% of its surface area has 8–30% slopes and 54% features slopes steeper than 30% (FAO 2006). The highlands are in the north and along the Lao–Vietnamese border; they are home to a large number of ethnic minorities, forests, and wildlife. Rice, the staple food crop, is grown in 2 principal ways in these highlands (Figure 1). First, on sloping, unbunded fields (referred to as *upland rice*); and second, in flooded soils in valley bottoms and on terraced hillsides (referred to as *montane paddy*).

In Laos, upland rice is primarily grown in shifting cultivation systems and is sustainable when low population pressure makes it possible to have long fallows between crops (Fujisaka 1991). However, as in most of highland Southeast Asia, shifting cultivation systems are being transformed by rapid and far-reaching political, economic, and environmental changes (Fox et al 1995). Much of this transformation is driven by national land tenure policies: the nationalization of forestlands and efforts to increase control over upland resources by central governments (Chun-Lin et al 1999). The highlands of Laos are no exception. In the early to mid 1990s, a government land allocation policy was enacted to protect forests. This limited the area where farmers could grow their upland crops. In most cases, farmers were allocated 3 to 4 upland fields. Using their traditional system of rotation this only makes it possible for them to have a 2- to 3-year fallow period, which is not sustainable (Saito et al 2006); farmers argue that it has resulted in food shortages and poverty (ADB 2001; Thongmanivong and Fujita 2006).

With declining upland rice yields, farmers must find alternative means of growing rice. Poor infrastructure prevents surplus rice from southern Laos from being transported to the north. Furthermore, markets and infrastructure are not sufficiently developed to allow highland farmers to grow cash crops to sell and then purchase rice. Developing new paddy area and/or increasing paddy productivity are alternative solutions. Government and development agencies (ie donors and NGOs) have developed irrigation schemes in the large flat areas (typically 10 contiguous ha or more) for paddy production. Such areas are limited and most have been developed.

However, the focus of this study is on the smaller areas (<1 to 10 ha) that are being developed by farmers into paddy land. The objectives of the study were to understand 1) why farmers are developing montane paddy, 2) the effect of paddy rice production on farmer food security and livelihood activities, and 3) the economics and costs associated with developing paddy land.

Methodology

Study location

The study was conducted in 3 districts: Phonsay, Pak Ou (Luang Prabang province), and Namo in Oudomxay province. These districts are typical of the highlands of northern Laos in that most farmers are upland rice farmers and they need to address land use and food security issues as a result of the land allocation policy. Within these districts, 9 villages were identified (Table 1) based on the following criteria. First, the village had to be predominately inhabited by Lao Leu or

FIGURE 1 A montane paddy rice field in the study village of Hatxoua (Luang Prabang province) just after transplanting. Note in the background the patches of upland rice fields, fallow vegetation, and forests on the mountainsides. (Photo by Bruce Linquist)

TABLE 1 Overview of montane paddy holdings in the 9 villages surveyed in 2003. In some of the villages, several ethnic groups were represented (LL=Lao Leu; K=Khamu). (Source: village level survey)

Province (District)	Village	Main ethnic group	Number of households	Paddy area (ha)	Households with paddy	Households with paddy (%)	Average size of paddy holdings (ha)
Luang Prabang (Phonsay)	Huayman	K	48	2.3	5	10.4	0.45
	Thapho	LL	57	6.3	13	22.8	0.48
Oudomxay (Namo)	Namo Neau	LL	56	22.1	50	89.3	0.44
	Pangdou Tai	K	18	8.8	16	88.9	0.55
Luang Prabang (Pak Ou)	Hatxoua	LL	56	3.6	5	8.9	0.73
	Houayleaung	K	63	12.6	20	31.7	0.63
	Houaythum	K	41	0.2	1	2.4	0.20
	Latthahae	LL	109	16.7	28	25.7	0.60
	Pakchaek	LL	125	30.0	49	39.2	0.61
Average		**LL**	**81**	**18.3**	**29**	**43.5**	**0.57**
Average		**K**	**43**	**6.0**	**10.5**	**33.4**	**0.46**

TABLE 2 Resource allocation in relation to area (ha) of montane paddy owned. (Source: household survey)

Paddy owned	Total available land resources [a] (ha)	Average amount of paddy (ha)	Average amount of upland area [a] (ha)	Percent upland area used for upland rice
None	1.39	0	1.39	69%
> 0 and < 1 ha	1.44	0.46	0.98	68%
≥ 1 ha	2.41	1.55	0.86	38%

[a] Does not include fallow fields

Khamu ethnic groups. These are 2 of the 3 most dominant ethnic groups in these provinces—the other being Hmong—and they provide a contrast in terms of experience with montane paddy production. The Lao Leu have historically settled in the river valleys and practiced montane paddy production. However, they also grow upland rice in shifting cultivation systems (Roder 2001). In contrast, the Khamu historically grew upland rice but more recently have also grown montane paddy rice. Second, the primary livelihood in the selected villages had to be upland rice cultivation; and finally, no large irrigation schemes had been developed for paddy production.

Village level survey

Village level data were collected at the initial village meeting, which was attended by 12 to 15 household heads. Participants included the village head, men and women, village elders, farmers owning montane paddy land, and farmers owning only upland fields. The purpose of the meeting was to gather general information on economic, social, and environmental conditions in the village. Various tools were used to elicit information from farmers. A Time Trend Analysis provided trends in rice yields, fallow periods, weeding frequency, and montane paddy area. A Wealth Ranking was conducted to provide information on how paddy ownership affected household economic well-being and food security. Seasonal Calendars were used in focus group discussions to identify when, where, and how labor was spent on various household activities throughout the year.

Household survey

Following this meeting, a household livelihood analysis was conducted using a semi-structured survey. In each village approximately 10 households were interviewed (total of 93 households). Selection of households was done by the village head, but the criteria were that at least 2 households had montane paddy fields, at least 2 had upland rice fields, and all wealth categories (poor, average, and well-off) were represented. The survey focused on food security, upland and montane paddy rice production, cash crop production, tree crops, livestock, non-timber forest products (NTFPs), and off-farm activities. For each activity the economic inputs and outputs were determined.

For analysis, households were divided into 3 groups based on how much paddy area they owned: 1) those who had none (n=54); 2) those who owned less than 1 ha (n=29); and 3) those who owned more than 1 ha (n=10).

Case study analysis of montane paddy farmers

Case studies were done with montane paddy owners in each village to find out more about paddy development and production. To determine the cost of paddy production (labor and material costs to make terraces, canals, and dams) surveys were conducted with 11 farmers who had developed paddy within the last 2 years to ensure clarity.

Results and discussion

Village characteristics, land resources, and differences between ethnic groups

Pakchaek and Namo Neau were the 2 most established villages, both having been established for over 100 years. All of the other villages were more recent, being established between 1958 (Latthahae) and 1982 (Houaythum). Most villages were established in the mid to late 1970s following the war.

The number of households in each village ranged from 18 to 125 (Table 1). The total montane paddy area per village ranged from 0.2 to 30 ha. The 2 oldest villages were Lao Leu villages and had the most montane paddy area. The Lao Leu historically settled in these flat valley areas and grew both paddy and upland rice. The percentage of households owning montane paddy rice fields averaged 35%, and ranged from 2% (Houaythum) to 89% (Namo Neau and Pangdou Tai). The average paddy area, for those farmers with paddy, ranged from 0.2 ha in Houaythum to 0.73 ha in Hatxoua. With the exception of one farmer, all households surveyed had upland fields.

Total land resources (not including fallow upland areas) were similar for households with little or no paddy area (Table 2). Households with more than 1 ha of paddy had less upland area than other households, but their total land resource of 2.4 ha was, on average, 1 ha more than for the other categories. In general, as the amount of paddy area decreased, the area of upland increased. This may be due to the land allocation policy

in which farmers with paddy area were allocated less upland area.

The average upland area for both ethnic groups was similar (data not shown), supporting findings by Roder (2001). The main difference between ethnic groups was related to the montane paddy. The Lao Leu had a higher percentage of households with paddy (44% vs 33%) and more paddy area (0.57 vs 0.46 ha) than the Khamu. These differences can largely be explained by the fact that the Lao Leu have historically been paddy rice farmers. When they moved into northern Laos they populated the areas with high potential for paddy development. Alternatively, the Khamu have been upland rice farmers and have recently engaged in montane paddy production.

Upland rice

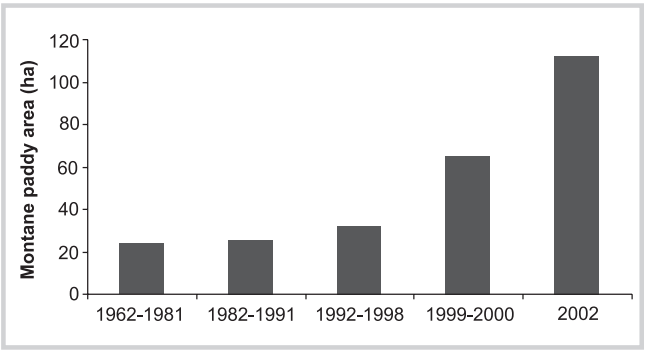
Farmers in all villages reported that upland rice yields declined from the 3 to 4 t/ha range before 1990 to less than 1.5 t/ha by 2002 (data not shown), supporting other reports linking yield declines to land allocation (ADB 2001). The reported rice yields of 3 to 4 t/ha, while seemingly high, have been reported elsewhere in northern Laos following long fallows (Roder et al 1997; Saito et al 2006). Land allocation effectively reduced the fallow periods in shifting cultivation systems to only 2 or 3 years. Fallows in the 1960s and 1970s averaged 9 years in these villages and by 2002 only 3 years (data not shown).

Research conducted in Laos has shown that such short fallows lead to poor soil quality (Roder et al 1995) and declining yields (Saito et al 2006). In addition, returns on labor have declined dramatically over the last half century as farmers reported that more labor was spent weeding and the number of times they had to weed increased from 2 in the 1960s and 1970s to 4 times in 2002 (data not shown). Based on a survey of a number of villages in northern Laos, Roder (2001) reported that weeding accounts for about 50% of the total labor in upland rice production and amounts to about 150 person days/ha/yr.

Expansion of the montane paddy area

The average area of montane paddy increased marginally between 1962 and 1998 in the study villages; however, from 1998 to 2002, the total area increased from an average of 3.5 ha/village to over 12 ha/village (Figure 2). While the growth rate was not uniform among villages, paddy area in all villages increased after 1992, mirroring trends in other parts of northern Laos (Thongmanivong and Fujita 2006) and northern Laos as a whole. In 1991, the total paddy area in the northern region was 47,000 ha; by 2002 it had increased to nearly 81,000 ha—an increase of almost 70% (MAF 2003).

FIGURE 2 Rice paddy area between 1962 and 2002 in the 9 survey villages. (Source: village level survey)



Why farmers develop montane paddy area

The main policy initiative that seems to have encouraged the expansion of the montane paddy area in northern Laos is land allocation. While the objective of land allocation is to protect forests and stop shifting cultivation, the immediate effect has been to shorten fallows to only 2 or 3 years. Such short fallows are unsustainable (Saito et al 2006) and declining upland rice yields have forced farmers to seek alternative production systems, including the expansion of paddy area. Indeed, when asked, 21% of the farmers said they developed montane paddy area in response to the land allocation policy. Also, the rapid expansion of the paddy area in the late 1990s (after land allocation) supports this consensus (Figure 2).

The main reason (51% of respondents) farmers said they developed montane paddy area was because paddy rice production requires less labor than upland rice cultivation and it produces higher yields. Roder (2001) reported that the labor requirement for upland rice cultivation in northern Laos averages about 300 person days/yr compared to about 120 person days/yr for montane paddy rice. Average upland rice yields range between 1.0 and 2.0 t/ha (MAF 2003), depending on length of fallow, rainfall, and weeds (Saito et al 2006). Montane paddy rice yields are generally between 3 and 4 t/ha (Linquist et al 1998); in areas with access to dry-season water there is the potential for double cropping. Also, paddy yields are more stable than upland rice yields because drought is less of a problem.

The government has other initiatives to promote the expansion of rice paddy area in the north. First, there is an exemption (12,000 kip/ha/year, or about US$ 1.20 in 2004) from the payment of land tax for the first 3 years after construction of paddy terraces. Second, the Agricultural Promotion Bank provides credit to farmers for developing paddy land. These incentives have had little impact on influencing farmer decisions to expand paddy area, and none of the farmers in this study mentioned these as affecting their decisions.

Farmers reported in the survey that the main constraints to developing montane paddies are lack of suit-

TABLE 3 Number of years of rice shortage as affected by land ownership. Results are based on household surveys in response to a question asking how many years a household had experienced rice shortages over the past decade. (Source: household survey)

Years of rice shortage	Number of respondents	Average rice area (ha)	
		Montane paddy	Upland
0	37	0.54	0.89
1–4	44	0.18	0.74
5–10	12	0.11	0.75

TABLE 4 Effects of a shift from upland rice to paddy rice cultivation on livelihood activities. Responses are from 37 paddy farmers (new and long-standing owners). (Source: household survey)

Effects	Percentage of respondents
More cash crops are grown	24
Improved food security	19
Increased livestock production and fish farming	19
Stopped upland rice cultivation	16
More time for trading	11
Expansion of paper mulberry plantation	8
More time for working as wage laborer	3

able land, steepness of slope, poor soils, and a lack of water. Interestingly, financial or labor resources were not mentioned.

Food security and livelihoods of paddy and upland rice farmers

The demand for rice may be met from upland and/or paddy rice fields. However, it was the amount of paddy owned (not upland fields) that directly affected household food security (Table 3). In the past 10 years, households with an average paddy rice area of 0.54 ha experienced no rice shortages, while those with an average paddy rice area of 0.18 ha experienced between 1 and 4 years of rice shortages, and households with an average of 0.11 ha of paddy area experienced rice shortages in 5 to 10 of these years. These results are similar to those reported for northern Vietnam (Pandey and Minh 1998), where farmers with an average paddy rice area of 309 m^2 per capita experienced 0–1 years of food shortage in the previous 10-year period; however, where the average per-capita holding was 154 m^2 or less, rice shortages occurred almost every year.

Farmers reported that if they had montane paddy fields they were also able to grow more cash crops on their upland fields (Table 4). Households that had 1 ha or more of paddy used less than 40% of their upland holdings for rice production (Table 2), with the rest being used for cash crops (Figure 3). Households with little or no paddy area grew upland rice on almost 70% of their upland fields. There are several possible reasons why farmers who own paddy still cultivate upland rice. The main reason is to meet their household consumption needs—almost certainly the case for households with small paddy area. Second, upland rice is harvested about 1 month earlier than paddy rice. Therefore, the cultivation of upland rice provides a supply of rice at a time when household rice stocks have usually been depleted, allowing farmers to allocate labor during the period of the rice harvest. Third, upland rice is generally considered to be of higher quality than paddy rice, with a better taste and, when sold, retailing at a higher market price than paddy rice. Finally, upland rice is a good cash crop as prices are stable, there is a good market, and farmers are familiar with the crop. However, as upland rice yields decline and labor inputs increase, farmers are likely to seek other alternatives.

Farmers also reported that a shift to paddy production resulted in increased livestock production and fish farming (Table 4). One of the most striking differences among the 3 montane paddy ownership categories was that paddy farmers had, on average, more small and large livestock than households without paddy (Figure 4). The number of livestock per household also increased with larger paddy holdings. In addition, livestock was the most important source of household cash income for all groups, but income from livestock was more than triple for farmers with a large paddy area (Figure 5).

Cost–benefit analysis of paddy development

Paddy development requires terracing fields. On flat valley bottoms relatively little work is required; however, as the slope increases, more soil has to be moved to

FIGURE 3 Upland area used for upland rice and cash crops based on amount of montane paddy a household owns (small paddy area: <1 ha, large paddy area: ≥1 ha). (Source: household survey)

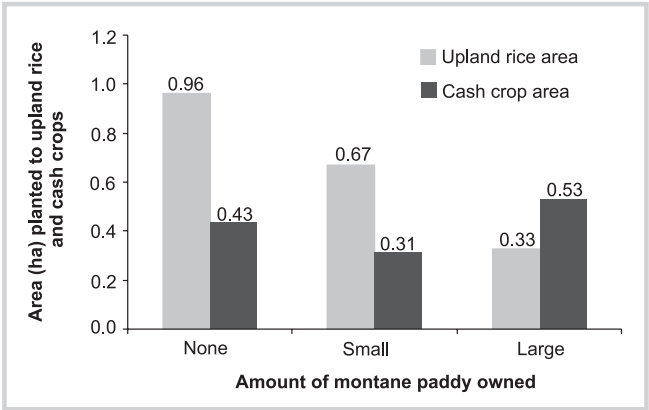


FIGURE 4 Average number of livestock being raised by farmers with differing amounts of montane paddy area (small paddy area: <1 ha, large paddy area: ≥1 ha). (Source: household survey)

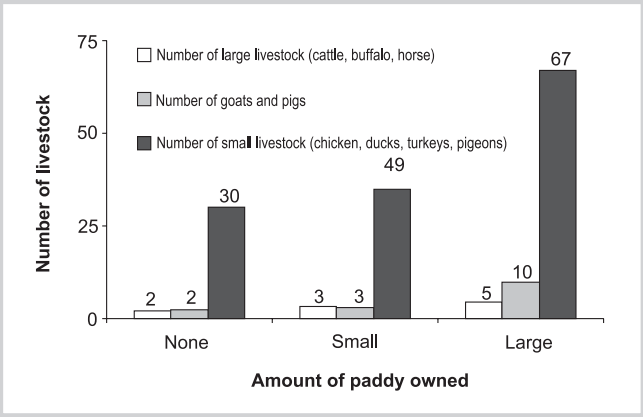
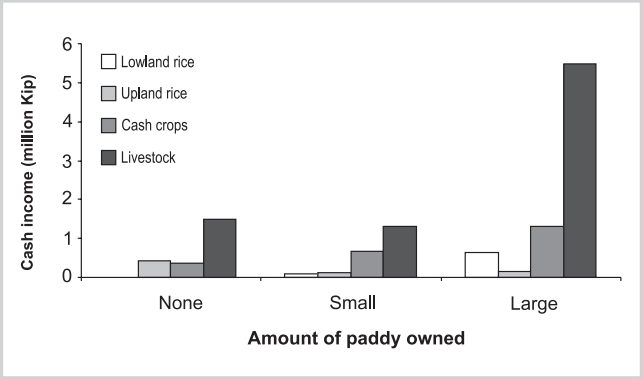


FIGURE 5 Average cash income by source, shown by the cultivated paddy rice area. This calculation only includes sold products. Small paddy area: <1 ha, large paddy area: ≥1 ha. US$ 1 = 10,560 Kip. (Source: household survey)



make flat terraced paddies. In addition to developing the terraces, canals and weirs need to be constructed to carry water to the paddies. In some cases, canals may be several kilometers long. Weirs often consist of wooden logs damming a stream. Although these irrigation systems may be simple and use local materials and labor, there is an opportunity cost associated with their development. This cost is incurred in the initial years when the terraces are constructed. Subsequently, there is usually an annual cost associated with the stabilization and maintenance of the system.

For an economic assessment of paddy development, it is necessary to account for the incremental costs and benefits realized over several years. Costs of paddy development are incurred in the first few years, while the benefits accrue in the future. As the immediate benefit is valued more highly than the same benefit at some time in the future, the later benefits and costs need to be suitably discounted to make them comparable.

The major benefits from the conversion of sloping upland fields into terraced paddy land are the savings in labor input for rice production, together with the improved yield and the increased frequency of cropping over time. The savings in labor associated with the move to increased paddy rice cultivation may in turn be utilized for income-generating activities or for supporting other livelihood activities.

A thorough assessment of the economic value of paddy development requires accounting for all changes in the farming systems and the use of labor for non-farm activities induced by the availability of paddies. Such an assessment is beyond the scope of the present article. Instead, a partial analysis was conducted by considering only the major changes in the farming system likely to be observed. The parameters for the analysis are in Table 5.

Development of terraces involves considerable movement and relocation of soil. As a result, it takes several years for rice yields to stabilize on a newly developed terrace. In the economic analysis, the rice yield was assumed to increase linearly from 1.5 t/ha in the 1st year to 3.4 t/ha in the 3rd year. Montane paddy rice yields range from 3 to 4 t/ha (Linquist et al 1998).

The estimated net present value (NPV) measures the net gain in present value from switching production of household rice from uplands to paddy conditions by constructing terraces. Over the 25 years considered, farmers had the potential to earn a total of US$690/ha after deducting all costs associated with terrace development. The internal rate of return (IRR) indicates that the investment would yield an annual return of around 51%. By most standards, an annual rate of return of 51% is considered good.

A more intuitive interpretation of profitability is provided by the estimated break-even period. It takes approximately 4 years for farmers to recoup the cost of investment through higher rice yields and gains from savings in labor input.

The results are sensitive to the opportunity cost of the labor released as a result of terrace construction. The profitability of terrace construction increases rapidly with the increase in the opportunity cost of labor released. Thus farmers who have a high opportunity cost of labor are likely to find rice production in the paddies a more viable economic proposition than those whose opportunity cost of labor is low. The cost of developing a terrace is the major investment cost. The results of terrace construction can therefore be expected to be sensitive to this parameter. If the cost is half the amount assumed in the exercise (only $150/ha), the IRR increases to 98%.

The profitability of terrace construction is also determined by the number of years needed for the full development of the productive capacity of terraces after the initial soil disturbance. The faster the productive capacity of the paddy fields is stabilized, the shorter the break-even period will be. Thus, farmers are likely to

TABLE 5 Values of parameters used for the base-run cost–benefit analysis.

Parameters	Values used in the base run
Discount rate (%)	10
Yield of upland rice (t/ha)	1.7[a]
Yield of paddy rice (t/ha)	3.4[a]
Cash cost of production of upland rice ($/ha)	10[b]
Cash cost of production of paddy rice ($/ha)	20[b]
Farm-gate price of rice ($/t)	70[b]
Cost of constructing terraces, weir, and irrigation canals ($/ha)	300[c]
Frequency of rice cultivation in paddies	Once per year
Frequency of rice cultivation in uplands	Once every third year, with fallow in between
Planning horizon (years)	25
Loss of rice area due to terrace construction (%)	10
Number of years needed for the rice yield in paddies to reach the assumed yield	3[c]
Labor savings in rice production (person days) per household	280[d]

[a] Source of data: MAF (2003). Yield data are for northern region.

[b] Source of data: household survey.

[c] From case study analysis of paddy farmers.

[d] Assuming an average household size of 6 members and per capita rice requirement of 350 kg per year, the total production needed to meet the household requirement is 2.1 t. Given the assumed rice yields, the upland and paddy rice area required to produce this amount are 1.2 ha and 0.6 ha. The corresponding savings in labor, using labor use per ha from Roder (2001), is thus approximately 280 person days (calculated as [1.2 × 294] – [0.6 × 122]).

find construction of terraces more attractive on the gentler slopes that require less soil disturbance.

Effect of increasing paddy area on upland rice area

Suitable area for paddy development is limited in the highlands; therefore, paddy development cannot be viewed as the only alternative to upland rice cultivation, but rather as one option. It is possible to estimate the potential reduction in upland rice area that may accompany a move to greater montane paddy production. Assuming that upland rice yields average 1.5 t/ha and that there is a 3-year cropping cycle (1 year of rice and 2 years of fallow), the production potential of upland rice fields is 0.5 t/ha/year. Montane paddy rice yields average 3.5 t/ha/year (7.0 t/ha/year if irrigation is available for double cropping). Therefore, for every 1 ha of paddy developed, the upland rice area could be reduced by 7 ha if rice is grown only in the wet season, or by 14 ha if dry-season rice production is also possible. Using these same assumptions, if rice yields from existing paddy fields can be increased (ie through improved varieties or management practices), for every 1 t/ha/year increase in productivity, the upland rice area could be reduced by 2 ha.

Conclusions

The development of new montane paddy area and/or improvement in the productivity of existing paddy area offers opportunities to improve food security in mountainous areas of Laos. There has already been an expansion of paddy area in northern Laos in response to land allocation policies. Such a change can have benefits in terms of food security, livestock management, off-farm activities, and income. While paddy development is not a panacea for the upland problems facing many Lao farmers, it is one option. Montane paddy development is limited by the amount of suitable area, but the rapid expansion of paddy area since 1998 suggests that areas are still available for development.

There is a question whether households with paddy fields are better off because of the paddy, or whether households who were already better off were able to invest in paddy development. While it is not possible to answer this question fully on the basis of our research, we suggest that both are the case. Clearly, there is an investment cost that may prevent poor or small households with little labor capacity from developing paddy. However, the data also suggest that once households have invested in paddy, more time is available to pursue other economic activities. Due to the cost of investment, paddy development may favor the well-off. In order to maintain equity at the community level, government or development agencies could develop incentives or programs (ie credit, loans, food for work, etc) to assist poorer households.

From a physical standpoint, in order to develop new paddy area it is necessary to take into account water availability, water requirements, topography, opportunities for double cropping, and economic and socioeconomic considerations (ie community water rights and needs). The “obvious” areas for paddy development, such as valley bottoms, have already been developed. As one moves from flat valley bottoms to hillsides, the cost of developing terraces increases, and identifying suitable areas for terraces is more challenging. During the survey period, the authors witnessed numerous instances where farmers had invested in developing paddy land but later

found that the land was unsuitable—usually because there was no adequate water source. Initially, new paddy lands require more water because the plow pan (which prevents rapid water percolation through the soil) takes a few years to develop. Additional research and training is required to allow farmers to identify suitable areas for paddy development.

The environmental impacts of a shift toward more paddy area require further research. While increasing paddy area provides a basis for farmers to reduce rice production in associated upland areas and adopt more sustainable agricultural practices in this area, there is no guarantee that farmers will do this. Instead, there may be a shift toward more permanent cash crop production; this has been shown to reduce biodiversity relative to shifting cultivation (Jianchu et al 1999). In addition, the impact of paddy development on natural wetlands and riparian areas needs further investigation.

ACKNOWLEDGMENTS

We would like to acknowledge the Lao Ministry of Agriculture and the Swiss Agency for Development and Cooperation for supporting this research. We would also like to thank the staff of the Northern Agriculture and Forestry Research Center for their help in conducting the surveys.

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