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Farmer Education and Rice Production in Lao PDR

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Introduction

In the past few decades, much research has been devoted to the macroeconomic, industrial and institutional aspects of the transition to a market-oriented economy in former socialist countries. The role of agriculture in transition has occupied relatively little space on the research work despite the great size of the agricultural sector in many of these countries. Lao PDR is also a country overwhelmingly dependent on agriculture. The agricultural sector contributes some 50 per cent of GDP and employs over 80 per cent of the total labor force. Subsistence farming is still widely characterized by low inputs and low yields, with the result that farming incomes are very low. The reform policy in the agricultural sector will be decisive not only for the success of the transition process but also the long term development of the country.

For Lao PDR, the large role agriculture plays and the analysis of this crucial sector can hardly be overlooked. However, the analysis of agricultural productivity in Lao PDR is, to date, very limited. To our knowledge, Bourdet (1995) is the only formal empirical study existing[1]. Thus, the main purpose of this paper is to update the research work on the determinants of agricultural performance using pure rice production (non-monetary). The applied methodology is intensively used until the 1980s. While recent studies focus on the effects of education on household income according to farm and non-farm income, this analysis is deemed to fit much more with the unique characteristics of the Lao farming systems.

The original contribution of this paper is firstly to explore the association between farmer education and farm efficiency in Lao PDR. The Lao farming provides a very interesting case study of measuring the direct effects of education on farm efficiency. It is argued that farmers with higher income tend to have higher education attainment, and vice versus. This endogeinity problem is very small due to various

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backgrounds such as predominantly subsistent and family-based farming, equitable land distribution, and low level of school supplies. Using a large national household survey conducted in 1997/98 (LECS 2) and the first results of the Lao Agricultural Census 1998/99 (LAC) from Lao PDR, this research particularly attempts to analyze the marked differences between the upland and lowland farming system of the country that call for different approaches to agricultural reform.

After a brief review of the literature on farmer education and farm efficiency in section 1, the key features of agricultural sector in Lao PDR are described in Section 2. Section 3.1 presents the theoretical framework and empirical models, and Section 3.2 outlines data description. Section 4 shows the analysis of estimation results, and Section 5 provides some policy conclusions.

1. Farmer Education and Farm Efficiency

The majority of human capital literature for developing countries focuses on wage earnings, in spite of the fact that the largest share of the labor force is engaged in self-employed activities. A rate of returns is a key factor in determining the demand for education, but what are the reasons for these returns to education, especially for farm households? Bowman (1976) has argued that education and information relevant to the small farmer might usefully be categorized as " formation of competences " and " transmission of information ". Basic competences — literacy, numeracy, and general cognitive skills — are best formed through schools or similar institutions. Information — on prices, new seeds or techniques, irrigation methods, and so forth — can be transmitted through a variety of institutional or non-institutional frameworks. Whereas the goals of information transfer services can be stated in narrowly economic terms, the development of competence can be expected to have not only economic benefits in agriculture, but also in the improvement of other aspects of household life.

Concepts of education and farm efficiency through worker effect, allocative effect, and choice of production technique are well-defined in Welch (1970) and Schultz (1975). Another concept of productivity, market efficiency, is defined as a farmer's ability to obtain the highest net sale price for his outputs and the lowest net purchase price for his inputs. Education enhances a farmer's ability to know his alternatives, to know when and where to buy and sell. A better educated farmer is more likely to

know what prices are likely to prevail in equilibrium, and can therefore become a better bargainer. He or she may also have a finer discrimination of differences in quality and may be able to judge quality more accurately.

On the empirical work, a number of studies [for example, Huffman (1974), Fane (1975), Wu (1977), Lockheed et al. (1980), Jamison and Moock (1984), Rosenzweig (1995), Singh and Santiago (1997), and Yang (1998)] have analyzed the effects of education on farm efficiency. The large majority of the literature uses either the education level of one individual in the household or the average level of education in the household. Jamison and Lau (1982) surveyed the literature worldwide on education and small farm production in countries of Asia, Africa, and Latin America and produced 37 data sets. Of these studies, 20 used the education level of the household head or the farm operator, and 14 use the average level of education of the household. They pointed out the positive correlation between education attainment and farm efficiency in 31 out of 37 studies. The effects of education were much more likely to be positive in modern agricultural environments than in traditional ones. Similarly, other studies have also usually found the positive effect of education on farm efficiency, but its effect is often small.

Furthermore, Lin (1991) examined whether the education level of the head of household and the average level of household education affect adoption of new farm technologies in China. Foster and Rosenzweig (1996) and Behrman et al. (1999) showed that anyone within a household having primary education is an important predictor of adopting new farming technology and profitability during the time of the "Green Revolution" in India. However, recent studies on the effects of education on farming pay more attention to the motivation for investing in human capital. Several studies [for example, Huffman (1980), Yang (1997), Fafchamps and Quisumbing (1999), Lanjouw (1999), Yang and An (2002), and Kurosaki and Khan (2004)] found that farmers respond to higher returns to education in the non-farm sector by reallocating labor away from agriculture.

2. Key Features of the Agricultural Sector in Lao PDR

General characteristics There were 798,000 households in Lao PDR in 1998. Of these, 668,000 or over 80 per cent were agricultural holdings. Rice is the single most

important crop, accounting for over 40 per cent of agricultural output. The Lao agriculture is dominated by three main farming systems: dry land rice cultivation, employing shifting cultivation techniques in the northern and eastern mountain regions; the cultivation of horticulture crops in the highland areas of the south or together the so called " upland farming "; and paddy rice cultivation along the Mekong River or the so called " lowland farming " (see Figure 1).

About 60 per cent of rice growers are in lowland cultivation. Some 10 per cent of them are in both lowland and upland cultivation. Rotational shifting cultivation is the most common agricultural practice in the whole country. Pioneering slash and burn practice is more frequent in the North. Overall, the crop sub-sector is characterized by low use of improved varieties of rice, fertilizers or pesticides; irrigation and double cropping are also quite limited; the extension services remain inadequate due to budget and technical limitations. Relative to the upland, the lowland farming makes more use of agricultural such as inputs improved seeds and fertilizer.

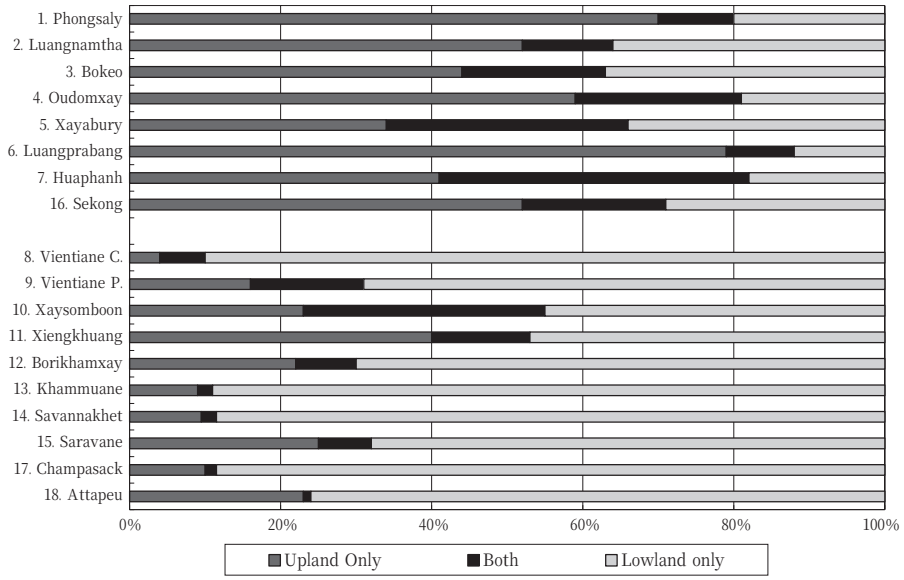

Figure 1: Rice Cropping System[2]
(Computed from Lao Agricultural Census, 1998/99)

In Lao PDR, Farmers often have several activities in producing rice, vegetables/fruits, and livestock. Most farmers produce glutinous rice rather than ordinary rice. Of particular note, the dependency on rice is generally lower in the south. Measured from the income side, however, agriculture is not as dominant as it appears. This low share is due to the low level of access to market. The fact is that less than 13 per cent of rice production was for market despite its dominance in the total agricultural outputs (NSC, 1999). Livestock and vegetables/fruits are the most important income generation sources. Meat (including wild animals) has a large market share, whereas fish is mostly for own final consumption.

Long term trend in rice production The annual growth rate of the Lao economy has accelerated with the average annual growth rate of 6-7 per cent, since the introduction of a market-oriented policy in the late 1980s. On the other hand, agricultural growth has slowed down in recent years (about three per cent over the period of 2001-2005). Nevertheless, the total area of rice planted and the total output have been increasing steadily over the time (see Table 1). Wet season lowland rice is more predominant than the upland rice, especially the provinces of Savannakhet and Champasack. Few rice growers plant a dry season crop. Although dry season rice plants have increased sharply in recent years following the heavy investment in irrigation facilities, the area of dry season rice is still only 15 per cent of the area of wet season in 2004. Dry season rice and improved varieties are most common in Vientiane Capital and Savannakhet. The dry season plots cannot simply be added to the wet season plots to become a total as some plots are used in both seasons. On the other hand, the harvested area of upland rice is decreasing substantially resulted by the government development policy of " focal sites " whereby upland villages would be resettled in lowland " focal " areas. Measuring farm yield, on the other hand, the difference between wet season lowland and upland farming is significantly large. The yield of wet season rice is double or more than that of the yield of upland rice. Nevertheless, the productivity both in upland and lowland farming is increasing gradually over the time. As expected, the yield of irrigated rice is the highest.

Table 1: Rice Production in Lao PDR

	Lowland Season Rice			Irrigated Rice			Upland Rice		
	1990	1997	2004	1990	1997	2004	1990	1997	2004
Total Area (1,000Ha)	392	421	575	11	27	76	260	151	118
Northern	53	70	91	1	3	8	188	112	94
Central-Southern	339	351	484	10	24	68	72	39	24
Total Output (1,000Tons)	1,089	1,304	1,976	39	114	342	381	243	211
Northern	154	239	358	4	10	33	278	181	168
Central-Southern	935	1,065	1,618	35	104	309	103	62	43
Productivity (Ton/ha)	2.77	3.10	3.43	3.43	4.26	4.45	1.46	1.61	1.79
Northern	2.88	3.44	3.93	2.59	3.55	3.99	1.48	1.61	1.80
Central-Southern	2.76	3.03	3.34	3.56	4.34	4.50	1.42	1.60	1.77

Source: Computed from National Statistics Centre, Statistics Book 1975-2005.
Note: Northern Rice production, here, includes seven provinces of the north and Sekong province of the south and Central-Southern Rice production includes the remaining provinces.

Land and productive assets The distribution of agricultural land in Lao PDR is reasonably equitable. There is not much difference between provinces. The LAC showed that almost farmers own land with the relatively small average land size of 1.62 ha. For the country as a whole, 36 per cent of farmers have less than 1 ha of land; 36 per cent have 1 to 2 ha of land; and 27 per cent have 2 ha or more land. On the other hand, the presence of productive agricultural assets is rather scarce. Machinery and fertilizers are widely used only in three major provinces of Vientiane Capital, Savannakhet and Champasack. LECS 2 showed that only seven per cent of farm households own tractors, whereas over 70 per cent of farm households own buffaloes. In general, livestock are an important source of cash income for farmers in other economies. However, owning buffaloes is probably an important factor on increasing productivity in Lao farming, since they provide labor for farming (ploughing, cart, etc.). Therefore, testing the effect of inputting buffaloes on farm efficiency is an interesting point in this study.

Farm labor and off-farm work Most farm labor is provided by household members. Only one-fourth of farm households hired outside labor in 1998/99, mainly for clearing land which is not an education-intensive job. In the north where shifting cultivation is widespread, most farmers employ laborers on the exchange basis. Payment in cash is more common in the center and the south. Furthermore, farmer households tend to have a small family business as a side job (e.g. retail, handicraft, etc.). Out of the total households, 21 per cent engaged in informal sectors as a family business, mostly without paid employees in 1997/98 (40 per cent in urban areas vs. 17 per cent in rural areas). If no legally registered family businesses are included, the estimates could be

much higher. Operating a family business in parallel to farming may cause various contradicting impacts on farm efficiency. The first one suggests that it would reduce the efficiency by allocating time away from farming to their business. The opposite one implies that it would increase the efficiency by having incentives to produce more for market sale and having management skills gained through operating the family business. In this study, thus, we will test whether farmers exposed to a family business would affect farm efficiency or not.

Flood and other restrictions Farmers are facing a number of restrictions including lack of irrigation, credits, market access, knowledge, and insects and animal disease. The most serious restriction for rice growers is flood disaster, especially in the Center and the South. The recent severe floods that occurred in 1995, 1996 and 2000 resulted in huge damaged rice paddies in the country. It is worth noting that there was also a flood in 1997 but limitedly affected on the data of lowland rice production in this study[3]. The average damaged area was 10 per cent, including 6 provinces of Vientiane Capital, Vientiane, Borikhamxay, Khammouane, Savannakhet and Champasack.

3.1 Theoretical Framework and Empirical Models

In a pioneering work, Schultz (1961) emphasized the role of education in improving farm efficiency and in modernizing agriculture. Schultz (1975) proposed that education improves a household's ability to efficiently adjust production decisions during periods of change. Along similar lines, Welch (1970) suggested that education may have two distinct effects. First, education may enhance a worker's ability to produce more with the given resources, the so-called "worker effect" (productivity effect). Second, education may improve the worker's ability to select the mix of inputs, the so-called "allocative effect". In more recent work, Kremer (1993) modeled heterogeneity in the quality of labor inputs in production functions, and he proposed a weak-link production function in which workers of similar skill are matched together.

The model of how education affects production has implications for the appropriate empirical specification of education in the production process. Yang (1997) proposed that using the maximum value for schooling in the household will serve as a reasonable proxy for the allocative effect, while the average value for schooling will proxy for the worker effect. The allocative effect will likely be captured in managerial

decisions, which are presumed to be made by the best-educated individual in the household. The natural implication of Kremer's O-Ring theory is that the minimum value for schooling in the household is the appropriate measure of household education, as it is the weakest link that will ultimately determine the value of the output. Overall, the large majority of the literature on farmer education and farm efficiency use the education level of one individual in the household (usually household head).

The basic method of analysis in this study follows the model proposed by Yotopoulos (1967), cited in the book of Jamison and Lau (1982) page 19-21. Yotopoulos used a production function for agricultural output as his basic tool to analyze the effect of education on efficiency. Subsequent studies use much the same methodology with variations of either the Cobb-Douglas (or ln — ln) production function or the linear production function to relate output, and to the various inputs. In this study, we examine the quantity of output, since most growers in Lao PDR are subsistence farmers and the value of rice production depends on price structures (which may vary widely both within and among regions) and we lack this detailed information.

The studies we have reviewed typically used data from surveys that contain some or all of the following variables used in this study for each farm. The output production model is specified as of:

$$\ln(Y_i) = \alpha_0 + \alpha_1 \ln(T_i) + \alpha_2 \ln(L_i) + \beta_i Sch_i + \gamma X_i + u_i \qquad (1)$$

$$\ln(Y_i) = \alpha_0 + \alpha_1 \ln(T_i) + \alpha_2 \ln(L_i) + \beta_i Edu_i + \gamma X_i + u_i \qquad (2)$$

Y= total rice output (kilograms); T= area under cultivation (Ha); L= labor input (family labors used); Sch = Heads ' years of schooling / average, maximum, and minimum education of labors used; Edu = Heads ' years of educational level dummies; X= other factors including farm experiences, use of irrigation, buffalo, tractor and market access. In equation (1) and (2), the estimated coefficients α_1, α_2 on the input variables indicate how strongly each input affects the output. The coefficients β give the percentage increase in output in response to a unit change in schooling or educational level.

In the recent literature, Jolliffe (2002) estimated the effects of several alternative measures of household education on household income differentiated into farm and non-farm income. The findings supported for using the maximum and average level of school attainment when estimating household income. In this study, we also test several alternative educations within a household, but we will particularly focus on the education of household head as assumed in a significant portion of the published literature in this field. This way fits better with the farming system in Lao PDR, and it also derives a very clear result for the policy implications.

3.2. Data Description

This study employs the national household survey data, the so-called Lao Expenditure and Consumption Survey in 1997-98 (LECS 2). This survey was conducted by the National Statistics Centre of Lao and Swedish International Development Agency, which covered about 1 per cent of the total population. The data was collected from February 1997 to March 1998, with respect to the 1997 wet season and 1997/98 dry season. After clearing the missing data, we finally use the subsample of 4,678 wet season rice farmers: 2,295 from seven provinces in the North and Sekong provinces in the South for mainly the upland farming, and 2,383 of the remaining provinces for mainly the lowland farming.

Summarizing the data, Table 2 presents the characteristics of the samples including: several schooling years/education levels of the household head, labor, and dummies variables of access to irrigation, holding productive assets, and market access measured by having any agricultural output for sale. On average, the schooling years of household heads were about 3.5 years for the upland and 4.2 years for the lowland. The higher the education level, the larger the gap between the two regions. Over one half of household heads and eight out of ten their spouses had not completed a primary education. Roughly 30 per cent of the heads in the upland and 20 per cent of the heads in the lowland were illiterate. Less than 16 per cent of the heads had schooling over the lower secondary level.

Table 2: Mean of Selected Variables in Lao Farming in 1997/98

Variables	UPLAND Farming		LOWLAND Farming	
	Mean	Std. Dev.	Mean	Std. Dev.
Schooling of Household Head (Years)	3.45	3.15	4.20	3.23
No Education	*0.304*	−	*0.199*	−
Some Primary	*0.318*	−	*0.340*	−
Primary	*0.259*	−	*0.302*	−
Lower-Secondary or higher	*0.119*	−	*0.159*	−
Average Education of Farmers	2.55	2.28	3.49	2.43
Maximum Education of Farmers	4.28	3.17	5.53	3.14
Minimum Education of Farmers	1.15	2.02	1.73	2.42
Family Size (Persons)	6.40	2.47	6.67	2.43
Farm Labor (Persons)	3.42	1.70	3.42	1.69
Head Age	40.8	11.7	43.1	12.3
All Land Irrigated	0.147	−	0.110	−
Some Land Irrigated	0.339	−	0.167	−
None Land Irrigated	0.514	−	0.723	−
Owning Tractor	0.081	−	0.072	−
Owning Buffaloes	0.707	−	0.789	−
Market Access	0.349	−	0.297	−
Doing a Family Business	0.130	−	0.152	−
Observations *N*	2,295		2,383	

Source: Author's calculation based on LECS 2 (1997/98)

The agricultural incomes are not examined in this study due to the insufficient and often unreliable samples. The general characteristics of the total rice output between the upland and the lowland are well described in Section 2. Specifically, for the upland farming, Xayaboury province is always the highest rice producer. Savannakhet, Champasack, the capital and Vientiane provinces are major rice producer in the lowland and the whole country. However, the difference in the productivity among provinces both in the upland and the lowland is relatively small. Since land and labor inputs are quite equally distributed among regions, the improvement of education attainments, the introduction of new seeds and agricultural productive tools are probably the key factors that explain the increase in the total output.

On the other hand, the average age of household heads was about 40 years old, which resulted in comparable farm experience. The average family size was six to seven persons in the both regions. Unfortunately, information related to hired labor and the use of chemical inputs was not reported in LECS 2. The average farmer usually used four buffaloes due to the lack of farming machinery. Some 30 per cent of farmers had market access, and nearly 15 per cent of them operated a family business. Furthermore, the Lao farming remains predominantly subsistence in nature. Less than

15 per cent of farmers both in the upland and the lowland had all land irrigated. 50 per cent or more farmers owned dry land without an irrigation system. Since it is difficult to make comparisons based on the extent of irrigation, this study will use only all land irrigated for the dummy variable of access to irrigation.

4. Estimation Results

4.1. Rice Production Function for Lao PDR

The OLS results of the estimation using schooling and educational level variables classified by the upland and the lowland farming in 1997/98 are given in Table 3. In brief, the model performs well with the most estimated variables being statistically significant at least at the 5 per cent level. Most interpretations will rely on the results of the estimation using schooling due to the larger sample sizes. Interestingly, the results support the view that farmer education is very important in increasing farm efficiency in Lao PDR. This subject will be described in detail in Section 4.2.

The results showed that there are no economies of scale in rice production in Lao PDR since the sum of the coefficients of the land area and the labor force is less than one both for the upland and the lowland. A one per cent increase in unit of land and labor would yield roughly 0.55 per cent and 0.2 per cent more rice output, respectively. The elasticity of land input is fairly low compared to other studies, because of shifting cultivation and soil erosion. The results of no economies of scale in rice production found here are consistent with the finding by Bourdet (1995). On the other hand, an additional year of farm experience, slightly higher in the upland than that of the lowland, showed a marginal impact on output. This suggests that farm experience may not be an important determinant for farm efficiency in Lao PDR.

Having access to irrigation system is a very significant factor to increase rice production in other studies. That irrigation facilities have not had much success in Lao PDR is illustrated by their small impact on agricultural performance in the period studied. Farmers with all land irrigated produce only about 13% to 21% more rice than those without full access to irrigation in all regions (wet season). Perhaps, the usefulness of irrigation may be limited during weather conditions with sufficient rainfall. But the poor performance of irrigation system is that most irrigation schemes are small scale and village-based, predominate by utilizing pump-lift from rivers. Many

Table 3: Results of the Estimated Rice Production Model — Farm Household Heads

Variables	UPLAND Farming		LOWLAND Farming	
log (Land)	0.5258**	0.4677**	0.5559**	0.5976**
	(0.0273)	(0.0405)	(0.0256)	(0.0385)
log (Labor)	0.2080**	0.2211**	0.2180**	0.1265*
	(0.0352)	(0.0495)	(0.0369)	(0.0576)
Years of Schooling	0.0462**	—	0.0385**	—
	(0.0052)		(0.0053)	
Primary level	—	0.3280**	—	0.2208**
		(0.0504)		(0.0613)
Lower Secondary Level	—	0.4695**	—	0.3045**
		(0.0792)		(0.0809)
Farm Experience (Head Age)	0.0338**	0.0225**	0.0245**	0.0180
	(0.0091)	(0.0121)	(0.0091)	(0.0130)
Farm Experience Squared/100	-0.0351**	−0.0266**	−0.0245**	−0.0195
	(0.0101)	(0.0135)	(0.0099)	(0.0141)
All Land Irrigated	0.1746**	0.1311**	0.2121**	0.1506**
	(0.0504)	(0.0706)	(0.0520)	(0.0806)
Owning Tractor	0.0230	−0.0487	0.4260**	0.4077**
	(0.0561)	(0.0912)	(0.0602)	(0.0997)
Owning Buffaloes	0.2183**	0.2102**	0.2113**	0.3687**
	(0.0369)	(0.0518)	(0.0440)	(0.0700)
Market Access	0.3311**	0.3677**	0.3541**	0.3218**
	(0.0324)	(0.0468)	(0.0379)	(0.0615)
Doing a Family Business	0.1322**	0.2245**	0.1453**	0.1863**
	(0.0451)	(0.0676)	(0.0476)	(0.0775)
Constant	5.4931	5.6548	5.4787	5.6593
	(0.1892)	(0.2522)	(0.2023)	(0.2884)
Adjusted R^2	0.304	0.297	0.313	0.323
F-test	101.18**	45.75**	109.58**	44.88**
Observations	2,295	1,166	2,383	1,011

Note: Author□s calculation. Standard errors in parentheses.
*Significant at the 5 per cent, and ** at the 1 per cent level.
White heteroskedastisity consistent covariance is applied for all equations.

of the schemes are poorly designed and/or poorly constructed, and this is exacerbated by inadequate maintenance. This suggests that irrigation facilities have a powerful control only in dry season rice. Using tractor yielded very large effect (over 40%) on rice production for the lowland farming, but it is not statistically significant for the upland farming. The impacts of agricultural productive assets are the dominant factor on increasing rice production in only lowland farming. Thus, policy makers should implement different approaches to the unique characteristics of the farming system.

As the typical characteristics related to buffalo input and side business of Lao farmer households, the estimated results showed that using buffalo gives about 21 per cent more output in all regions. Farmers operating a family business tended to have a positive impact in increasing more output roughly 15 per cent than the pure subsistent farmers in all regions. It suggests that farmers may have the incentives to

produce more for market sale and have higher management skills learned through operating a family business. In addition, the results showed that market access is a key factor. More market-oriented and commercialized farmers produce over 30% more rice production than their counterparts.

4.2. Rates of Return to Education of Farmers

As summarized in Table 4, we tested several alternative education variables on rice production in the upland and the lowland farming in Lao PDR, 1997/98. The results indicate that, all other things equal, farmer education has a strong positive effect on farm efficiency. All the coefficients for schooling years/education levels are statistically significant at the 1 per cent level. Our interest here is focused mainly on the impact of household heads on rice production. It turns out that an additional schooling year would result in about 4.62 per cent and 3.85 per cent more rice output for the upland and the lowland farming, respectively. We also found that the coefficients of returns to schooling generally increase as educational level rise. For the upland, the effect of primary education on farm efficiency was remarkable at 33 per cent and the additional gain from lower secondary was at 47 per cent. Similarly, for the lowland, the impact of primary education (22 per cent) is also high, but the additional return from lower secondary education (30 per cent) is fairly small.

Since the returns to schooling for wage earners are generally reported to be higher than that of farmers, it is more interesting to compare the present estimates with other researches based on farmer education and farm efficiency. In the studies with statistically significant positive results, Jamison and Lau (1982) concluded that the rates of return to schooling range from 0.70 per cent to 6.47 per cent with an average of about 2.87 per cent. Although the results of different studies must be compared

Table 4: Rates of Return to Schoolings of Farmers in Lao PDR, 1997/98

	Education Level of Household Head				Schooling in Household (Years)			
	Primary[4]			Lower	Head	Max	Average	Min
	S=1	S=2	S=3	Secondary				
Upland Farming	32.80	16.40	10.93	4.71	4.62	4.21	5.87	4.98
Lowland Farming	22.08	11.04	7.36	2.79	3.85	5.09	6.92	5.04
All Samples	24.03	12.02	8.00	3.72	3.78	3.99	5.47	4.45

Note: Author's calculation based on the estimation in Table 3 and the likes.
All coefficients are significant at 1 per cent level.

with caution, the results of this study indicate that the estimated rates of return to education are relatively high considering the generally low levels of education attainment of farmers, with the majority having the primary education level or lower. This result does not contradict previous studies. For example, Kurosaki and Khan (2004) suggested that the effects of primary education on crop productivity are remarkable but the additional gain from higher education is very small.

In terms of the returns to educational levels, we found that the rates of return per year were particularly high for farmers with a completion of primary level. For the upland and the lowland household heads, the estimated results showed that per year rates of return to primary education were roughly 33 per cent and 22 per cent, respectively. Even if two or three years of foregone earnings while in primary schooling is used in calculating the profitability of investment in schooling, these rates are still the highest. On the other hand, the rates of return per year to lower secondary education were relatively small positive values of roughly three to five per cent over the study period. Thus, the most profitable investment to education is the primary level. The effects of primary education on rice production were remarkable but the additional gain from higher education is very small.

With respect to other alternative education variables, one problem in estimating the models is that several measures of school attainment are highly correlated. This is primarily the case of households with only one or two adult members, resulting the maximum, average, and minimum level of school attainment will be almost the same value. In order to avoid the level of correlation across the variables, all models are estimated by using only a single alternative educational value. The first paradigm is that education improves the productivity of each labor in carrying out his or her tasks, and this is modeled by using the average values of schooling attainment. Another paradigm is the weak link that only the household's minimum value of schooling matters in the determination of farm efficiency. The results showed that estimates using the average values of schooling are at five per cent for the upland farming and seven per cent for the lowland farming. The corresponding estimates by using the minimum value of schooling are roughly the same at five per cent in both cases.

The final paradigm is that education improves the decisions of how to allocate resources to the various activities, and this is modeled by using the maximum value of

education within a household. Of the paradigms considered in this paper, the allocative effect most closely resembles the head of household model, where the head of household has the highest level of education in two-third of the households. The estimates using the maximum value of schooling are about four per cent for the upland farming and five per cent for the lowland farming. Although estimated rates of return to investment in education vary by the proxies used, all findings here significantly suggest that improvement in education can enhance farm efficiency in Lao PDR.

5. Concluding Remarks

The education levels in Lao PDR are still very low. Over one-half of household heads had less than a primary education in 1997/98. The very poor performance in human capital is that 30 per cent of household heads in the upland and 20 per cent of household heads in the lowland were illiterate. It is reasonable to ask whether education, which is often seen as a key investment area for poverty reduction in other developing countries, can be expected to have the same impact in Lao PDR. The findings from this study showed that the role of farmers ' education is quantitatively important in determining the agricultural performance. The estimated rates of return to schooling for both the upland and the lowland farming are relatively high by international levels. Particularly, the rates of return to primary education are very high.

The principal policy implications of the results presented in this study pertain to the potential social and economic benefits of improving education, particularly in rural areas. Adult literacy campaigns (equals to a completion of primary education level) would generate directly the improvements in well-being in the near future. Indirectly, public investment in education may also be helpful in stabilizing shifting cultivation, diversifying the agricultural sector and maintaining a sustainable use of forest products. Up to now, large amount of public investment has been spending on the expansion of irrigation facilities. However, the findings in this study showed that the effect of access to irrigation is obviously low. Thus, policy makers should focus on promoting and/or subsidizing such as free access, soft and long term loan to the uses of new high-yield seeds, productive assets and chemical inputs, for the marked

differences between the upland and lowland farming system of the country.

Notes

1 This paper is reproduced in the book of Bourdet (2000).
2 Based on the predominant rice cropping system in each province, the upland farming in this study is assumed to include seven provinces in the north (No. 1 to 7) and Sekong province (No. 16) in the south; and the lowland farming to include seven provinces (No. 8 to 14) in the center and three provinces in the south (No. 15, 17 and 18).
3 Asian Disaster Reduction Center, for an example, "Lao PDR country report 1998" provides the overview of disasters occurred in Lao PDR, including floods.
4 Recent studies often assume only one year of foregone earnings from primary school graduates. See Psacharopoulos (1995) for the concepts and methods in estimating rate of returns to education.

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