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Irrigation reforms in rural Laos: a study of farmers’ affordability

Arounyadeth Rasphone, Fumio Osanami, and Takumi Kondo

Abstract

This article examines the affordability of irrigation under irrigation reform schemes in rural Laos through a regression analysis of factors affecting the affordability under a scheme in Savannakhet Province. The ability to afford irrigation is influenced by seasonal conditions; social factors, especially the education level of the household head; market factors, especially the paddy price; and the size of landholding. Government should promote policies to increase the level of education in rural areas, improve the operation of the paddy market, and find ways to improve productivity to offset the declining availability of land.

Introduction

The linking of irrigation development and poverty alleviation has been considered a critical synergy in developing countries. The diffusion of the green revolution from the 1960s gave a great boost to agricultural development in many countries. However, the sustainability of public managed irrigation is critical. The deterioration of irrigation hardware not only affects usability and productivity, but also the farmer’s welfare. Therefore, in the past few decades many governments have put an emphasis on improving the efficiency of irrigation management in order to foster irrigation users’ capability and, in turn, their welfare. Many types of reform, including ownership transfer programs, have been chosen to sustain the operation of irrigation systems. These programs encompass ownership recognition, an irrigation management program,\(^1\) privatization of the irrigation system,\(^2\) a participatory irrigation approach,\(^3\) technical improvement,\(^4\) and water pricing.\(^5\) Many studies have confirmed that these programs improve water use.

efficiency, productivity, and revenues, and help to stabilize family income.

In Lao PDR (hereafter Laos), which enjoys abundant water resources, the introduction of small and medium schemes of pump irrigation along the Mekong River and its branches during the 1990s has resulted in annual average secured production of paddy for consumption of more than two million tons. Although water resources available for agriculture are abundant during the wet season, the dry season is a contrast. Also, heavy rain in the wet season, plus limited funding for maintenance, can prejudice the agricultural water supply. Rapid deterioration of hardware has been a costly burden for both public and communal managers. Owing to insufficient collection of water charges, the problem of keeping water supply effective is deepening. In addition, the utilization of the irrigation system in Laos fell sharply after 2003. The irrigated area of wet and dry seasons dropped from 214,832 ha in 2003 to 100,934 ha in 2005. Therefore, to sustain development and improve rural welfare, the same approach of irrigation reform has been undertaken in Laos.

Rural irrigation in Laos was normally managed by local farmer groups and operated without written rules. Farmers cooperated and normally paid no levy, but social-community works were essential. With new management under irrigation reform, farmers are directly responsible for all incurred expenditure for operation and maintenance, and must pay levies according to their irrigated area. However, while the utilization of communal irrigation has not improved, debts on irrigation service fees (ISF) or water charges have increased significantly in many pump schemes. The debts to the state electricity company have accumulated to more than US$ 40 million since 2000. Although the management of the irrigation system has been transferred to farmers, water charge or ISF rules had been set prior to the transfer at a time when the hardware was well-maintained with project funding. Under pre-set rules for water charges, farmers are vulnerable to market forces and environmental conditions because they lack rice storage facilities and market bargaining power. This paper therefore focuses on the issue of the farmer’s ability to afford the water charges or ISF. Although a recent study has shown that farmer affordability depends on the
types of farming system, the study did not include environmental, social and household factors, or farmer attributes. Therefore, both qualitative and quantitative factors will be included in this study, employing two years of survey data.

The first section introduces the data, analytical methods, and study area. The second section summarizes and discusses the results of the analysis, and the conclusion draws out policy implications.

Data, analytical methods, and study area

Data and measurement variables

Field data from two surveys in 2005 and 2006 are used in conjunction with secondary data. The prices of crops and inputs are farm-gate prices. The labor data are estimated in man-days of eight hours per day per person. The family labor opportunity cost is estimated by the number of working hours per activity per day per laborer. In calculating family labor cost, three child laborers of ages 10–14 are considered equivalent to one adult laborer, and the minimum current prices paid for hired labor are used in the analysis.

Other household and farmer attributes included in the analysis are: education level of the head of household in years (denoted as YEDU), age of the head of household (AGE), ratio of family labor share in a household (NFARM/LAB/HHSIZE), duties in village administration and water user associations (VILL/DUTYDUM and WUAD/DUTYDUM), size of land holding (LANDOWNM2), and type of farming system (PADFARM/DUM). Although, some household heads have never had formal schooling, they normally have undergone an illiteracy eradication program, which was made compulsory after the revolution in 1975. With this program, farmers are expected to be able to read and write, which is considered equal to three years of elementary schooling. Other variables are: revenues from on-farm and off-farm in both seasons, and household capital including ownership of large livestock (cattle and buffaloes) and small tractors. The descriptive statistics of study variables are shown in table 1.
Irrigation reforms in rural Laos

Table 1 Descriptive statistics of variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Std. Dev.</th>
</tr>
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<tr>
<td>AFFISFRATIO</td>
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<td>96.59</td>
<td>-35.07</td>
<td>13.90</td>
</tr>
<tr>
<td>LVSTK1</td>
<td>4.48</td>
<td>32.00</td>
<td>0.00</td>
<td>4.80</td>
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<td>LANDOWNM2</td>
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<td>40,000</td>
<td>0.00</td>
<td>8,141</td>
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<tr>
<td>YEDU</td>
<td>5.05</td>
<td>18.00</td>
<td>0.00</td>
<td>4.06</td>
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<tr>
<td>AGE</td>
<td>46.46</td>
<td>87.00</td>
<td>26.00</td>
<td>11.51</td>
</tr>
<tr>
<td>NFARMLAB/HHSIZE</td>
<td>0.71</td>
<td>1.00</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>TTYPEW</td>
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<td>20,640,000</td>
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<tr>
<td>RDOFFFRM</td>
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<td>1,295,278</td>
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<td>RWOFFFRM</td>
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<td>1.00</td>
<td>0.00</td>
<td>0.29</td>
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<tr>
<td>VILLDUTYDUM</td>
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<td>1.00</td>
<td>0.00</td>
<td>0.41</td>
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<td>1.00</td>
<td>0.00</td>
<td>0.45</td>
</tr>
<tr>
<td>ISFREFDUM</td>
<td>0.60</td>
<td>1.00</td>
<td>0.00</td>
<td>0.49</td>
</tr>
<tr>
<td>CAP2</td>
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</tr>
<tr>
<td>ISSUDUM</td>
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<td>0.49</td>
</tr>
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<td>0.00</td>
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<tr>
<td>WUDUM6</td>
<td>0.12</td>
<td>1.00</td>
<td>0.00</td>
<td>0.32</td>
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</tbody>
</table>

Number of Observations: 129.
Source: Farm surveys, 2005 and 2006.

Analytical methods

In order to understand the factors affecting farmer’s ability to afford the ISF, criteria for measurement have to be determined. The affordable ISF is defined as the net receipt to the farmer after subtracting ISF. Equation 1 describes the affordable ISF. If the farmer is able to pay the ISF, the net receipt is greater than zero; otherwise the farmer does not have the capacity to pay the ISF. By plotting a 45 degree chart of affordable ISF against charged ISF, the difference of affordability in the two survey years can easily be distinguished. However, the graph cannot describe the detail of changes in farmer affordability or the affordable level. In this study, the affordable level of each farm household is defined as the ratio between what the household can afford, and what ISF is actually charged. Estimating this affordable level as a function of the net
receipts from engaging in cultivation in a particular season would not take account of qualitative factors. Therefore, both qualitative and quantitative factors are entered into the analysis to give a full picture of factors that affect the affordability of irrigation for farmers. A simple pooled translog OLS (Ordinary Least Square) regression model with a fixed effect, as shown in equation 2 is employed to describe the relationship of various factors to the affordable level.

For equation 1, the net revenues generated in the dry season have to be determined. The net dry-season revenues generated by using land without irrigation water can be assumed to be zero because such land is normally abandoned after wet-season cultivation. The use of farmland for animal grazing is not included in the model for simplicity. As long as the farmer’s income is not negative after paying the ISF, the farmer is deemed able to afford it. Thus, the irrigation service fee’s affordability function is:

\[
AffISF = \sum_{n=1}^{n} Y_i P_i - \sum_{i=1}^{a} (\sum_{k=1}^{m} W_k X_{ik}) - wa 
\]

\(i= 1, 2, 3, \ldots; n; \) and \(k=1, 2, 3, \ldots; m\)  \( (1) \)

where, \(Y_i = \) output of crop; \(P_i = \) price of crop, at farm gate; \(W_k = \) price of input; \(X_{ik} = \) quantity of input, for producing output; \(w = \) rate of irrigation service fee (ISF); and \(a = \) ISF charged area.

In equation 2, both quantitative and qualitative factors that contribute to farmer affordability are included and as follows:

\[
\ln(\frac{AffISF}{ISF}) = \alpha + \beta \sum_{g=1}^{p} C_{hg} + \delta \sum_{h=1}^{q} \ln HH_{jh} + \gamma \sum_{l=1}^{r} \ln REV_{lj} + \lambda \sum_{x=1}^{s} Dum_{jx} + e 
\]

\(g=1, 2, \ldots; p; h=1, 2, \ldots; q; l=1, 2, \ldots; r; \) and \(x=1, 2, \ldots; s\)

\( (2) \)

where, \(\frac{AffISF}{ISF}\) is the dependent variable that indicates the affordable level of household, while the independent variables include \(C\), household capitals (LVSTK1 and CAP2); \(HH\), household attributes (LANDOWNM2, YEDU, AGE, and NFARMLAB/HHSIZE); \(REV\), revenue variables (TTYPW, RDOFFFRM, RWOFFFRM, and PY1D/ISF); dummies \(Dum\) (YEAR, WUADUTYDUM, VilLDUTYDUM, PADFARMDUM, ISPREFDUM, ISSUDUM, and WUDUM1 to WUDUM6); and \(e\), an error term.
Discussion of the analytical factors and their expected signs

Rural households in both upland and lowland areas believe large livestock holdings (LVSTK1) are their main capital savings because they can be converted into cash to meet emergencies for procurement of marketed goods and, in some cases, to offset household rice deficits. Households with a large holding of livestock are perceived to have sufficient savings to cover emergency situations. However, the more animals a farmer has, the more time is required for feeding and taking care of them, even though Lao farmers normally raise their cattle, buffalos or goats in a free-range system. This results in less time for farming, thus reducing the affordability level. Therefore, the sign of the livestock variable is expected to be negative.

CAP2 is the number of small tractors owned by a household. Households that own a tractor are expected to have higher capacity to afford irrigation because labor and other costs can be reduced. In addition, small tractors in rural areas are used not only for plowing but also for transporting, pumping, trashning, and so on. The economic use of a tractor is estimated to be about twenty years according to farmer expectation.

LANDOWNM2 is the size of the land owned by the farmer in square meters. The larger the land holding, the higher the potential for income generation, either by self-cultivation or by partially renting out. This analysis expects to find a positive correlation between the land holding area and the affordability level.

YEDU, the years of formal education of the household head, is expected to have a positive effect on the affordability level because a farmer with higher education has a better chance of earning revenue both on and off the farm. Elementary schooling extends from year one to five, secondary schooling from year six to eight, and high school from year nine to eleven. There are only a limited number of household heads who have ever attended college or university, and usually they migrated to the study area because of marriage.

AGE of the household head is expected to have a positive effect on the affordability level because older farmers have more experience of cultivation and more opportunity to have improved their productivity and revenue. However, the results require careful interpretation because some farmers may be too old to work
efficiently.

A high ratio of family labor to household size (NFAMLAB/HHSIZE) is expected to increase cash revenues and hence render the ISF more affordable, so a positive sign is expected.

YEAR is a dummy to differentiate and capture the effect of the cultivation conditions in year 2005 and year 2006, where 2006 is set at 1 and 2005 at 0. The expectation about the sign of this variable is left open for discussion.

Bureaucratic power and village administrative duties (WUADUTYDUM and VILLDUTYDUM) are expected to have a positive influence because such households will have better sources of information and greater power to influence the distribution of water.

Expectation about the sign of the total wet season paddy revenue (TTYPW) is open because heavy rain in the wet season, low intensity farming, and the need to provide for household food security ensure that farmers are mainly restricted to rice farming. Instead of using net profit or net receipts from dry season paddy in the analysis, the total wet season paddy revenue is used because this figure is easier to interpret. First, the revenue is an indicator of crop prices. Second, the revenue can indicate the level of productivity. Lastly, all other cost factors can be omitted to simplify the estimation. Instead of hypothesizing the sign of this variable, the study aims to identify in which direction this variable will affect the farmer affordability level.

Expectations about the signs of RDOFFFRM and RWOFFFRM (revenue of dry and wet season’ activities, respectively) are also left open because off-farm activities are different during each season of cultivation, the amount of time spent in these activities varies, and the cash revenue from these activities may be used for many different purposes. This issue is discussed in the results section.

The relative price of paddy price to ISF (PY1D/ISF) is included to examine the relationship between the market and water cost. The sign of this variable is expected to be positive. As paddy is the staple food, any program to improve the yield will generally reduce the price of paddy and discourage the farmer from planting paddy in the future. If the market for paddy improves, or the cost of ISF falls
because of subsidies or greater irrigation efficiency, farmer affordability will be improved.

PADFARM DUM distinguishes between farmers that cultivate only paddy (1) and those that cultivate both paddy and cash crops (0). The expected sign is negative because the market value of paddy is lower than other cash crops, but could be reversed if the paddy price rose.

ISFPREFDUM indicates whether the farmer prefers to pay the full amount of ISF in a lump sum (1) or otherwise (0). The expectation about the sign is open since the farmer could opt for a different method on the actual day of the fee collection. However, understanding the type of payment that the farmer is willing to adopt is essential for developing ISF policy.

ISSUDUM indicates whether there is any issue over the delivery of irrigation such as electricity fluctuation, inequality of head and tail farmers, or high seepage. The sign is expected to be negative since such issues would incur a high work load on maintenance and risk of lower revenue. For simplicity, this analysis does not distinguish among different issues.

Water User Unit dummies (WUDUM1, WUDUM2, WUDUM3, WUDUM4, WUDUM5, and WUDUM6) are used to indicate the impact of the location of the household farmland. Each of these variables indicates a different characteristic such as elevation, head-tail combination, soil type and quality, and time spent on water delivery. The results are discussed below.

**Description of the study area**

The Ban¹³ Vuen-Tonhen irrigation scheme was selected because its characteristics are typical of many found in Laos, namely: water delivery by medium-sized direct-electric pumps; multi-village management structure; use of water flows from a Mekong tributary; high poverty incidence; high flood risk; mid-range command area; and location distant from major cities.

The study area is located in Savannakhet¹⁴ Province, 86 kilometers distant from the provincial capital and 450 kilometers south of Vientiane, the capital city. The population of the command area is more than 7,800 people. The beneficiaries are in three villages.¹⁵ Farmers in this area adopted irrigated agriculture in
1981, following the government’s installation of diesel-driven pumps in 1980, but this method failed, and farmers abandoned the use of irrigation until the reconstruction of the scheme in 1989–90. The study area is located next to Xe Bangfai River, which is one of the largest of the Mekong’s tributaries. In order to prevent flood and fight poverty, the government constructed and operated a multi-purpose irrigation scheme.\textsuperscript{16} The specific objectives of such investment were to increase the cropping intensity, especially during the dry season, and to provide protection against floods in the monsoon season.\textsuperscript{17}

A state irrigation company carried out the survey, design, and construction of a 500 ha command area with minor participation by the farmers. The scheme included a fixed headwork with two axial flow electric pumps delivering a discharge capacity of 500 liters/second. During 1990–2, a local state company managed all administrative activities such as water scheduling, water charges (both estimation and collection), maintenance, and operation. During the initial year, farmers cultivated dry-season paddy, while other crops were cultivated only along the river basin.

By 1993 under the Sustainable Irrigation Agricultural Project (SIRAP\textsuperscript{18}), the pilot program of Irrigation Management Transfer (IMT) had rehabilitated the system and trained the local water user associations (WUA) in the requisite skills of operation and maintenance. The total investment cost for rehabilitation and implementation of the IMT program was about 48 million kip or US$ 66,000. In 1997, the government fully transferred all responsibility for infrastructure (including headwork, canals, and laterals) to the Ban Vuen-Tonhen WUA. The total asset value of this irrigation scheme was estimated at 223 million kip (US$ 300,000) on the date of transfer. The principle of total capital cost recovery was applied to the irrigation service fee (ISF), and farmers agreed to repay the investment cost within twelve years at 20,000 kip (about US$ 25) per hectare. This per hectare amortization amount was increased by an additional 20,000 kip/ha every four years. An additional regulation also permits the WUA to utilize the cost recovery fund for operation, maintenance, and administration.

A fact-finding survey in 2004 and 2005 revealed that the original calculation of the ISF by the survey team used a cost-profit
analysis with the potential paddy price set at 600 kip/kg (around US$ 0.15/Kg) while the actual paddy price during the survey period was about 1,200 kip/kg (or US$ 0.12/Kg). Input prices were also set to rise—by 45 percent per annum for electricity, 40 percent for fertilizer, and 30 percent for gasoline. Farmers are thus expected to be vulnerable to the rising ISF. The maintenance cost, that is expected to increase over the years of operation because of deterioration of the irrigation system, will reduce the farmer’s revenues from cultivating in the dry season, yet this factor was excluded from the original calculation of the project’s economic internal rate of return and net production value. This study area was selected to examine the affordability of irrigation under pressure from input and output markets.

**Estimation results and discussion**

*ISF affordability and affordable level*

The affordability of ISF is estimated by equation 1, as shown in Figure 1. The trends of affordability are significantly different in 2005 and 2006 respectively. The figure shows that the signs of the marginal effect of charged ISF on farmer affordability in year 2005 and 2006 are different, but both curves tend to decline when the ISF rises. Although, the R-squared is not very high, the figure shows that the sample farmers were better able to afford the ISF in 2006 compared to 2005. The figure further indicates that charged ISF was lower in the year 2006 and affordable farmers were mostly located above the 45 degree line.

*Factors determining the affordability of ISF*

Table 2 summarizes the explanation of ISF affordability. The model shows a high degree of fit with R-squared of 0.869, D-Watson statistic of 2.20, and probability F-statistic of 0.0007. The table also shows the difference between years and the differences resulting from land location (WUU). The variables that were significant at the 1 percent level include; constant term; years of education (YEDU); total revenue of wet season paddy (TTYPW); ratio of dry season paddy price to ISF (PY1D/ISF); year dummy (YEAR); and both WUDUM2 and WUDUM5.
The variables significant at the 5 percent level include; size of land owned by farmer (LANDOWNM2); small tractor ownership (CAP2); ratio of family labor in household (NFARMLAB/HHSIZE); irrigation issues (ISSUDUM); and WUDUM3. The revenue from off-farm activity in the wet season (RWOFFFRM), the paddy farming dummy (PADFARMDUM), and WUDUM1 are significant at the 10 percent level. However, the size of large livestock holding (LVSTK1), age of the head of the household (AGE), revenue from off-farm activity in the dry season, the duty dummies (WUADUTYDUM and VILLDUTYDUM), preference on mode of ISF payment (ISFPREFDUM), WUDUM4, and WUDUM6 are not significant, but their signs are interesting for observation.

Discussion of variables significant at the 1 percent level

The study shows that each percent increase in formal education of the household head will improve the farmer’s affordability level by 0.87 percent and that the estimate is statistically significant at
the one percent level. The sign accords with expectations. The technical knowledge that the household head obtains from the formal schooling system, as well as the farmer’s ability to interpret and absorb farming techniques through the ability to read and learn, significantly improve affordability.

Table 2 Estimation results on factors affecting affordability

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>t-statistics</th>
<th>Variables</th>
<th>Coefficients</th>
<th>t-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>16.013</td>
<td>***</td>
<td>WUADUTYDUM</td>
<td>0.559</td>
<td>1.206</td>
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<tr>
<td>LVSTK1</td>
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<td>VILLDUTYDUM</td>
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<td>CAP2</td>
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<td>**</td>
<td>PADFARMEDUM</td>
<td>-0.742</td>
<td>*</td>
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<tr>
<td>LOG(LANDOWNM2)</td>
<td>0.774</td>
<td>**</td>
<td>ISFPREDUFU</td>
<td>-0.175</td>
<td>-0.683</td>
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<tr>
<td>LOG(YEDU)</td>
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<td>ISSUDUM</td>
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<tr>
<td>LOG(AGE)</td>
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<td>LOG(NFARMLAB/HHSIZE)</td>
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<td>WUDUM2</td>
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<tr>
<td>LOG(TTYPW)</td>
<td>-1.369</td>
<td>***</td>
<td>WUDUM3</td>
<td>1.667</td>
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<td>LOG(RDOFFRM)</td>
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<td>WUDUM4</td>
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<td>Sample (adjusted)</td>
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</table>

Note: ***, ** and * indicate statistically significant at 1, 5 and 10 percent levels, respectively.

Each percent increase in the total revenue of wet season paddy (TTYPW) will decrease the farmer’s affordability level by 1.369 percent. As explained above, this variable combines the effects of crop price and productivity. The increase of TTYPW, which may be the result of increase in crop prices, productivity, or both, will result in a subsequent decline of the price of paddy in the dry season due to oversupply of wet season paddy. Policy-makers should develop the rice market to stabilize the price and ensure the supply of paddy.

More importantly, a higher ratio of paddy price to ISF (PY1D/ISF) raises the affordability level for the farmer. A percent increase in the relative paddy price increases the affordable level by 1.22 percent, demonstrating the high impact of market factors on affordability. Thus, rather than subsidizing paddy prices or ISF, policies should improve the distribution of paddy in northern and southern areas which are not suitable for rice production.

The increase of farmer affordability between the two years is significant at the 1 percent level (YEAR). The overall socio-economic situation and the level of production raised the farmer’s affordability level by 1.621 percent. This demonstrates that the
farmer's affordability level is vulnerable to socio-economic factors, and implies that the pre-set rules and conditions of the IMT cannot be applied throughout a long-term plan.

Finally, the estimation results show that the WUDUM2 and WUDUM5 dummies about land location are statistically significant at the 1 percent level with coefficients at 2.536 and 2.956 respectively. To examine the policy implications, more detailed investigation is needed on water flow and soil conditions, the permanent and temporary members of each water unit, and the character of each unit's chief.

**Discussion of variables significant at the 5 percent level**

Households owning a small tractor (CAP2) have affordability of 0.72 units higher than those who do not own one. Each percentage increase in landholding (LANDOWNM2) raised the affordability level by 0.77 percent. However, land is a scarce resource and availability is due to decline, which will threaten farmer affordability in the future unless productivity can be significantly improved.

A percent increase of the household's labor share (NFARMLAB/HHSIZE) raises the affordability level by almost 1 percent. The sign follows expectations as it is common that family labor is the main resource for agricultural production. Table 1 shows that the average household labor share is relatively high at 0.72.

Water distribution problems (ISSUDUM) decrease farmer affordability with a coefficient of 0.944. Although this variable encompasses several different problems, these are not analyzed.

**Discussion of variables significant at the 10 percent level**

While the revenue from paddy in the wet season significantly decreases the farmer affordability level, the revenue from off-farm activity in the wet season (RWOFFFRM) has a contrasting effect. A 1 percent increase raises the farmer affordability level by 0.28 percent. The more money farmers can earn during the wet season, the more extensively they will improve their ability to invest and produce in the dry season, resulting in improved financial capacity.

Diversifying from paddy farming also increases the affordability
level, as shown by PADFARMMDUM with a negative sign. Land located at lower altitudes (shown by WUDUM1) suffers from lower farmer affordability because areas converted for cash cropping are affected by seepage from surrounding paddy areas. Farmers in these areas are largely restricted to traditional paddy cultivation that yields lower revenues than cash crops. However, other location factors, captured by WUDUM2, WUDUM3, and WUDUM5, are positive and significant. This indicates that land improvements that allow farmers to choose crops freely according to market conditions are needed to optimize public irrigation investment projects.

**Discussion of non-significant variables**

In contrast to other capital variables, holding a large number of large livestock (LVSTCK1) is not statistically significant. However, the negative sign indicates that larger livestock holdings require more farmer labor, especially for feeding, although farmers usually raise their stock as free range.

For other human capital factors, such as the age of the household head (AGE), and duty at the WUA and village (WUADUTYDUM and VILLDUTYDUM), the calculated results are not statistically significant, but the sign can reflect the actual situation of the rural community. The positive sign indicates that officials of the WUA or village may gain benefits from their position, but more study should be undertaken regarding the roles of rural institutional power.

The off-farm revenue from the dry season (RDOFFFRM) is not significant. However the negative sign suggests that such revenues are earned by withdrawing labor from farming, thus lowering productivity. However, further investigation is needed.

The farmer’s preference on the mode of payment of the ISF is not significant, but the negative sign is unexpected and deserves further investigation.

**Conclusion**

The study highlights that social characteristics influence the ability of farmers to afford the ISF. In the interest of reforming policies related to the ISF, these social influences should not be
ignored. Most importantly, the study confirms that the overall situation of the cultivation year has the greatest impact on affordability. The change in the ratio of paddy prices to the ISF charge greatly affects affordability. This means that either an increase of paddy prices or reduction in the charged ISF will improve the farmer's affordability. However, using subsidies to encourage farmer participation in dry season irrigated agriculture should not be recommended for the sake of irrigation management reform and the sustainability of the communal irrigation management system.

The education level of the household head has a significant impact on the affordability level. This means that high school or higher education is significant in improving farmers' ability to make use of irrigation resources for higher productivity. The government should place a priority on enhancing education levels in rural areas.

Although paddy farming is partly commercialized, the market mechanism merely ensures farmers achieve good welfare from a single crop farming system. Government has promoted diversification to other cash crops with a higher value, which most probably drives down the price of paddy, creating a severe welfare loss. This study confirms that paddy farming is not an attractive option for farmers to improve their financial capacity. Government should develop the market infrastructure for paddy, especially the distribution network among the regions.

The affordability of irrigation currently depends heavily on the size of landholding, yet land is expected to grow scarcer in the future. Therefore, development policies should focus on productivity enhancement and the diffusion of agricultural mechanization. The use of small multi-purpose tractors not only helps to improve the affordability of irrigation but also enhances the household's well-being by providing cheap transportation and a reduction in labor.

The fragmentation of land holding has a significant impact on irrigation management, especially the collection of the ISF. The study shows that the greater the number of land holding parcels, the higher the probability of farmers paying the fee; however, this is not a linear relationship, but a quadratic one. An increase in land scarcity as a result of a high rate of population growth will
eventually have an adverse impact on ISF collection as land becomes more fragmented through inheritance over time. Irrigation systems must be carefully designed to ensure that water reaches each plot on time and in the quantities required. For this to happen, the ratio of irrigated land to the designated command area should not vary significantly.

Finally, the study has shown that the total wet season revenue from agricultural production significantly reduces the farmer's ability to afford irrigation. This factor should be investigated further to understand the causal relationships between wet and dry season cultivation. In addition, government should pay special attention to preventing and mitigating large-scale natural disasters that severely affect farmer livelihoods, the affordability of irrigation, the general welfare of the nation, and the government.

**Notes**

8. FAO, *Regional Data Exchange System on Food and Agricultural Statistics in Asia*


10 Department of Irrigation (DOI), Interim Report on IMT progress (unofficial version) (Ministry of Agriculture and Forestry, 2007).


13 Ban means village.

14 Savannakhet Province has the largest administrative area and second largest population in Laos.

15 These three villages are: Tonhen, Vuen-Nue, and Vuen-Tai, which were merged from Tonhen, Vuen-Nue, Vuen-Tai, Vuen-Xivilay and Vuenxay in 2005.

16 A multi-purpose irrigation system intentionally uses irrigation canals and dikes to provide protection against river flooding, to supply irrigation water to a command area, and to provide feeder access roads to the villages.

17 The monsoon season begins in June and lasts until October; the remaining months are the dry season.

18 SIRAP is a pilot project funded by the Netherlands Government to model the IMT program in the Mekong subregion, especially in Laos and Thailand.