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A Study of Factors Affecting Farming Household Income

A case study of Samrong Commune, Kompong Cham Province, Cambodia

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By using cross sectional data collected from 51 farming households mostly grown rice for income generation in one commune in Cambodia, this study aims at investigating the factors affecting farming household income with two specific objectives (i) to compare farm size, productivity, production cost, and profitability between low income and high income household; and (ii) to analyze the main factors (farm size, labor and capital) affecting rice output and the relationship between farm size and household income. To address these objectives, this study used comparative analysis, income statement analysis, cost concept/function, production function analysis (Cobb–Douglas Production Function), and simple regression analysis. The results of the study find out the similarities and differences between low income household and high income household. Rice output in the study area was characterized by decreasing return to scale. Rice Marginal Cost crosses Marginal Revenue at approximately 17,482 kg (around 3.5 hectares). If the expected price of rice is 515 Riels/Kg, 17,482 kg would be the profit maximizing level of rice production. An increase all resources (farm size, labor, and capital) by 10 percent will add approximately 9 percent to total rice output. Farm size is the main factor affecting rice output, and labor input ranks as the second factor in producing rice output, while capital input contributes little to produce rice output. There is a linear or positive relationship between farm size and household income. Accordingly, increased farm size could be a good solution to increase household income. Furthermore, more emphasis should be given to secondary source of income to supplement rice income.

INTRODUCTION

Cambodia is one of the lowest–income countries in the world. Its gross domestic product (GDP) per capita is estimated at 357 USD. In terms of social capacity for human development, Cambodia is in the lowest tier of the medium human development category and ranked 130th out of 173 nations, with its human development index estimated at 0.543 (UNDP, 2002). Rural households in Cambodia rely mostly on agriculture as the main source of income for their livelihoods, which is dominated by rice production. About 2.16 million hectares or about 90 percent of the total cropped area of 2.42 million ha is planted to rice. The country's average rice yield was estimated 1.97 tones per hectare (ha) in 2004, the lowest in Southeast Asia (MAFF, 2004). In addition to rice income, small scale livestock raising, vegetable production and non–farming activities serve as supplementary source of farming household income.

In 2004, 91 percent of the country's poor lived in rural areas and is depending mostly on agriculture for livelihood. Agriculture remains the primary occupation for 72 percent of heads of households and contributes 31 percent of Gross Domestic Product (World Bank, 2006). Recognizing the importance of agriculture, this sector has an important role to play in reducing poverty, increasing household income and improving the capacity for human development. Given the fact that rural household income mostly generates from farming activities, increasing household income by focusing on rice cultivation and other income generation activities remains an important issue to all stakeholders. One of many ways to improve household income is to be aware of the characteristics of the rural households and constrains in order to seek the best possible solutions. To this end, this study aims at analyzing the factors affecting household income in Samrong commune, Kompong Cham province, Cambodia.

This study also classifies the farming household into two categories, namely low income household and high income household. This classification intends to compare two groups of household with the aim to point out the similarities and differences. By doing so, it is expected to generate useful information in relation to each group of household that can be used by relevant stakeholders working with the farming households in order to promote income generation activities and improve rural livelihoods in the study area.

RESEARCH OBJECTIVES

The specific objectives of this study are:

* To compare farm size, productivity, production cost, and profitability between low income and high income household; and
* To analyze the main factors (farm size, labor and capital) affecting rice output and the relationship

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between farm size and household income.

METHODOLOGY

Data collection

In order to achieve the objectives of this study, the survey questionnaires were produced based on the study. Primary data was gathered through face to face interviews carried out by the researcher with 51 rural households in the target location. The secondary data was also incorporated into this study to supplement the questionnaires. It involved the collection of both published and unpublished materials that are related to the study. This type of information could be obtained from the government publications, earlier researches, physical and non verbal materials, national census and personal records of the farmers or other people.

Data Analysis

A statistical analysis system, Statpad, and Microsoft Excel were used to analyze the quantitative data. The raw data gathered from the survey was classified and presented in the tables, charts and graphs by using comparative analysis and statistical analysis. These analyses include (i) comparative analysis to find out the similarities and differences between low income household and high income household; (ii) cost function analysis to determine how much rice output should be produced and how large should the farm be to get maximum profit; (iii) Income statement analysis to give an indication of the relative profitability of a farming condition and the degree of flexibility the farm has in meeting expenses and t–test to test hypothesis; (iv) Production function analysis (Cobb–Douglas Production Function) to determine the main factor affecting rice output; (v) Simple regression analysis to show the relationship between total cultivated farm size per year and annual household income and to predict household income from cultivated farm size. To assist the readers to interpret the information in the tables and charts, descriptive analysis was also taken into account.

Definition of key term in the study

* *Low Income Household* is defined as households whose annual household income below average household income of the sample size.
* *High Income Household* is defined as households whose annual household income above average household income of the sample size.

Map of study area

RESULTS AND DISCUSSION

Comparative analysis

Comparison of rice cultivated area

Agricultural land is generally accepted that it is one of the most important assets for farming households. In rural area in Cambodia, it sometimes represents the wealth or status of the households. Households possess large farm land can be viewed as better off farming households. On the other hand, households owned small farm size might be regarded as poor households.

The data on figure 2 shows data on the comparison of rice cultivated area between low income household and high income household in early wet season, late wet season, dry season and total cultivated area during one year period. In early wet season and late wet season, it can be seen that rice cultivated area of high income household was notably bigger than low income household. Anyway, the gap in term of land size between low income household and high income household in wet season was not very much different.

On the other hand, there was a big gap in term of

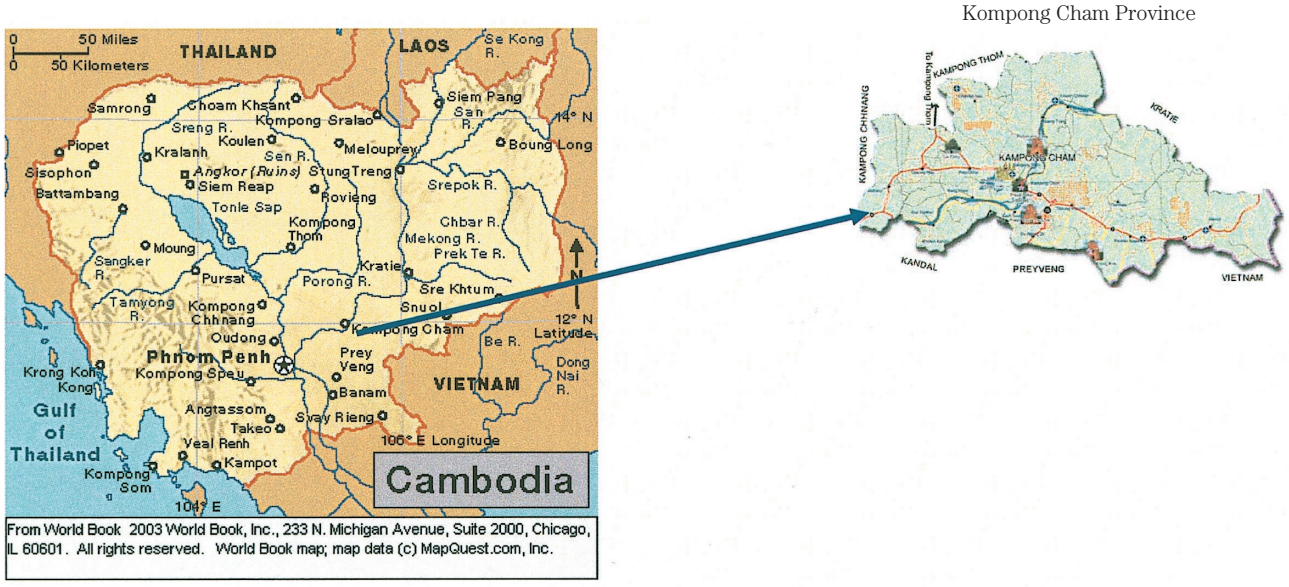

Fig. 1. Map of the Study Area.

Source: United Nations, 1995–1999, Population Map for Windows Produced by UNDESA–UNFPA–VN/IOIT.

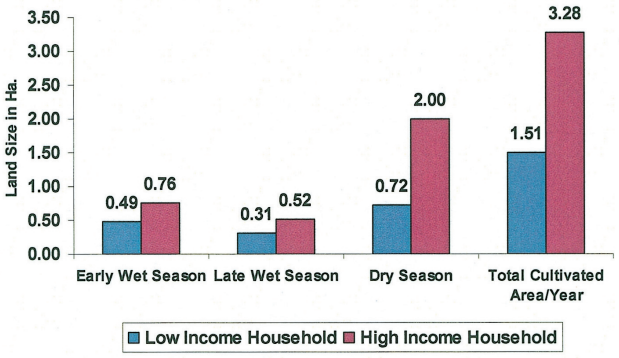

Fig. 2. Comparison of rice cultivated area in early wet season, late wet season, dry season, and total cultivated area per year. Source: Field Survey, 2005

rice growing area between low income household and high income household in dry season. Low income household cultivated rice on 0.72 ha. while high income household grew rice on 2 ha. of agricultural land. This means that high income household could cultivate on large farm size compared with low income household.

In comparing the total cultivated area for the whole year, low income household could grow rice on 1.51 ha. while high income household could cultivate rice on 3.28 ha. per year. This number clearly shows that the total cultivated area of low income household was less than half of cultivated area of high income household. Overall, high income household cultivated rice in larger farm size compared with low income household during the three cropping times, namely early wet season crop, late wet season crop and dry season crop. Therefore, it is safe to say that high income household owns large farm size while low income household possesses small farm size.

Comparison of rice productivity per hectare

The figure 3 contains data on the comparison of rice productivity per hectare between low income household and high income household in early wet season, late wet season, dry season and average rice yield per year. In early wet season rice cultivation, low income household achieved 4.23 t/ha while high income household got 4.58 t/ha. This implies that high household income achieved slightly rice productivity per hectare higher than low income household.

With respect to rice productivity per hectare in late wet season, the same figure also reveals that both households, low income household and high income household, achieved almost the same level of rice yield per hectare. Low income household got 2.08 t/ha, and 2.1 t/ha was attained by high income household. Accordingly, it is comparable in term of rice productivity in this season.

By comparing rice productivity per hectare between low income household and high income household in dry season, unlike early wet season rice cultivation, low income household achieved rice productivity (4.98 t/ha) higher than high income household (4.79 t/ha). This number is slightly different and it is comparable among two groups of household. On the whole year comparison of rice productivity basis, low income household attained 3.76 t/ha while 3.82 t/ha were achieved by high income household. Rice productivity achieved by both households is very high or nearly double compared with the average national rice yield in Cambodia, which is only 1.9 t/ha. From above comparative analysis, it can conclude that both households achieved the same level of rice productivity per hectare.

Comparison of rice production costs per hectare

The figure 4 below provides data on the comparison of average rice production costs per hectare in Riels (Cambodian currency) between low income household and high income household. The term cost of rice production here is classified into variable costs and fixed costs. Variable costs consist of hired costs and input costs. Hired costs are the cost paid out directly by household for hired labor or hired machinery, such as seed bed preparation, seedling, land preparation, transplanting, watering, and transportation. Similarly, input costs are the cost paid out for agricultural inputs, such as seed, organic fertilizer (cow manure), chemical fertilizer, and pesticide. On the contrary, fixed costs are the costs paid for land charge, depreciation of farming tools, and maintenance of farming equipments.

By comparing the variable costs between low income household and high income household, it appears that high income household spent (884,902 Riels per hectare) a little bit higher than low income household

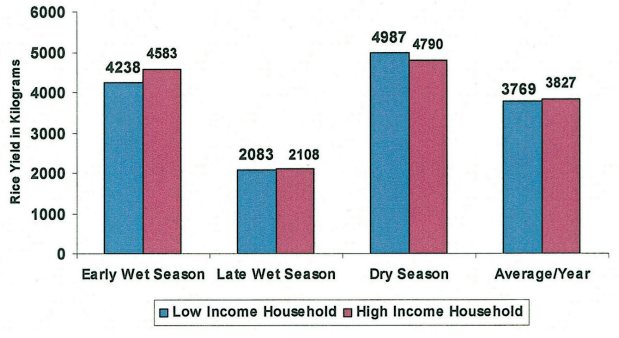

Fig. 3. Comparison of rice productivity per hectare in early wet season, late wet season, dry season and average per year. Source: Field Survey, 2005

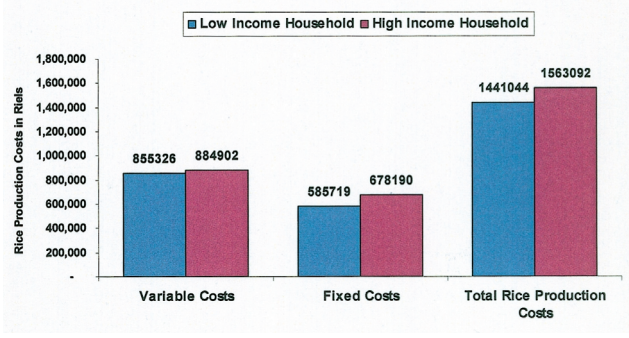

Fig. 4. Comparison of rice production costs per hectare between low income household and high income household. Source: Field Survey, 2005

(855,326 Riels per hectare). This expenditure is almost at the same level of expenses. On the other hand, on the fixed costs side, high income household also spent more than low income household. However, the gap of expenditure was not much different. The reason why high income household paid more fixed costs than low income household was that high income household generally owns more durable assets, such as hand tractor, water pump, other farming assets than low income household. These durable assets are charged into depreciation cost. Accordingly, it leads to the situation where total fixed costs of high income household were higher than total fixed costs of low income household.

Considering the total rice production costs, low income household paid 1,441,044 Riels in the production of rice per hectare, while high income household spent 1,563,092 Riels in the production of rice per hectare. It is clear that high income household invested more than low income household in order to produce one hectare of rice. However, there is no significant difference in term of expenditure.

Cost concepts/function for rice production

With increasing prices for purchase inputs, farming households often express concern for minimizing cost while try to achieve maximum profit for farm business and determine how large should the farm be and how much output should be produced. The two basic questions of "How much output should be produced" and "how large should the farm be to get maximum profit" are always important to farming households. For this reason, it is crucial from a managerial viewpoint that the relationship between the production function, input prices, and the associated cost of production need to be clearly understood. These connections can be found in details in Table 1. This table provides data on farm size, rice output, total variable cost, total fixed cost, total cost, average variable cost, average fixed cost, marginal cost and marginal revenue.

Since Marginal Cost describes how much each additional unit of output costs, a corresponding figure is needed which this describes how much each additional unit output is worth in the market place. The value of output is measured by its price on a per unit base. Marginal Revenue (MR) is calculated by the change in Total Revenue divided by the change in output. As shown in figure 5, rice output price is of 515 Riels/Kg. The graph of Marginal Revenue for a typical farming household in perfectly competitive markets is a horizontal line. This indicates that the market price is not affected by the production of an individual household.

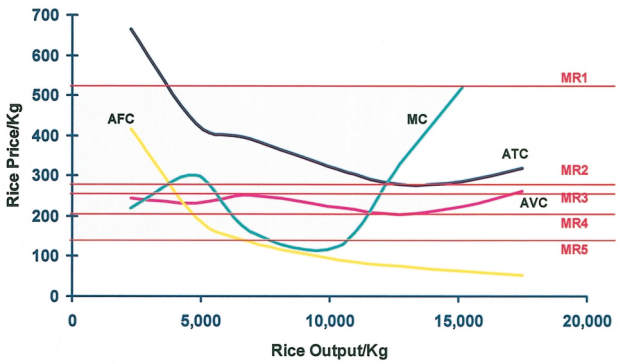

Fig. 5. Average cost curves to determine the profitability of rice production under five possible output prices.

In this context, our decision is to continue increasing production as long as the Marginal Revenue is greater than the Marginal Costs (MC). The optimum point of rice output exists where the additional costs (MC) are just equal to the additional revenue (MR) gained from the last unit produced. This point can be found in figure 5 graphically where the Marginal Revenue curve intersects Marginal Cost. Thus, the decision rule from the output side is that the profit maximizing level of output will occur where Marginal Cost is equal Marginal Revenue.

Taking figure 5 into account, rice Marginal Cost crosses Marginal Revenue at approximately 17,482 kg (around 3.5 hectares). If the expected price of rice is 515 Riels/Kg, *17,482 kg would be the profit maximizing level of rice production*. When the optimal amount of output is calculated, there is no guarantee that this level will produce profits, only which is the best possible level of output given the prices and costs associated with a particular production function. This can be said that by producing at the optimal level of output you may be minimizing losses as opposed to maximizing profits. Further analysis, which is made possible by studying this problem from the output side, could indicate whether this optimal level of output does in fact result in profits or whether it is the best possible loss situation. A third possibility is to shut down if losses are excessive.

Table 1. Data describing the costs associated with various levels of rice production on 3.5 hectares

Farm Size/ha	Rice Output/Kg	MPP	TVC	TFC	TC	ΔTC	AVC	AFC	ATC	MC	MR
0.5	2269	–	557648	947931	1505579	–	246	418	664	–	–
1	4807	2538	1118862	947931	2066793	561213	233	197	430	221	515
1.5	6895	2088	1745135	947931	2693066	626273	253	137	391	300	515
2	10296	3401	2292821	947931	3240752	547686	223	92	315	161	515
2.5	12701	2404	2591586	947931	3539517	298764	204	75	279	124	515
3	15150	2449	3397233	947931	4345164	805648	224	63	287	329	515
3.5	17482	2332	4610675	947931	5558606	1213442	264	54	318	520	515

Source: Field Survey 2005

In order to gain further understanding into this problem and aid in analyzing profitability, it is necessary to calculate additional cost figures. These figures are the Average Total Cost (ATC), Average Fixed Cost (AFC), and Average Variable Cost (AVC). The detail results of calculation are shown in Table 1. Figure 5 indicates typical Average Cost curves with a Marginal Cost and some Marginal Revenue curves superimposed upon them. By using these relationships one can determine whether a production activity should be continued in the long run, operated only in the short run, or shut down production immediately. In order to decide which situation applies (see Figure 5), the MR's represents different prices for rice output. Examine this one by one, notice that MR_5 (MR_5=150 Riels/Kg) intersect MC at a point below AVC. When this occurs, farming households are not able to cover the variable costs of production. In such a case, farmers in the study area should shut down or stop producing rice. If marginal revenue intersects marginal cost below average variable cost, the more that is produced, the greater the loss. By shutting down, only fixed costs are forfeited.

MR_4 (MR_4=200 Riels/kg) intersects MC at the low point of the AVC curve so that all three curves come together at the same point. In this situation, the farmer is meeting the variable costs of rice production but has nothing to apply to fixed costs. He/She should be indifferent as to whether to produce or not since only variable costs are covered and the loss is equal to fixed cost whether production or shutdown take place.

In the event of MR_3 equal approximately 260 Riels/kg, Marginal cost is intersected above the low point of Average Variable Cost but below the Average Total Cost curve. When this occurs, the farmer is in a situation known as loss minimization. That is, all the variable costs are being covered and some contribution is being made to fixed costs but not all fixed costs are being covered. And some contribution is being made to fixed costs but not all fixed costs are being covered. Hence, the farmer should produce in the short run (for the next production season) and hope that prices improve. However, should the price received be equal to price MR_3, no profit will accrue but losses will be at a minimum. Shutdown in this case would result in a loss of fixed costs (greater than the loss involved with production).

MR_2 (MR_2=285 Riels/kg) intersects Marginal Cost the point where Average Total Cost is at a minimum. In this case, the farmer is meeting all of the total costs of production and, therefore, making a normal profit. If the farmer is meeting the total costs of production, then each of these four factors of production will be receiving its fair return. If the total costs of production are being met, there is a fair return to each of the factors of production including management, that return is profit. When all costs are met, the farmer should continue producing in the long run.

Lastly, notice that MR_1 (MR_1>295 Riels/kg) passes through Marginal Cost at a point above Average Total Cost. This point indicates that the farmer is not only earning revenue to cover all the variable and fixed costs of production but is receiving an amount over and above all costs. This latter is referred to as excess or economic profits. When this situation occurs, it should only be present for a short run period of time. As excess profits are available for any production activity, they cause entry by other farmers and entrepreneurs seeking to capture some of these profits. As more producers enter the industry, more of the product will be produced and all things being equal, a downward pressure on price is likely to occur.

Comparison of rice income, production costs and profitability

The data on the figure 6 shows the comparison of rice income, production costs, and profitability between low income household and high income household per hectare. As can be seen from this figure, low income household slightly received less rice income than high income household. It received 1,918,560 Riels per hectare while high income household generated 1,997,809 Riels per hectare. This amount of money is not much different and can be regarded as the same level of income.

On the production cost side, high income household also paid more money than low income household in order to produce one hectare of rice. It spent 1,563,092 Riels/ha and low income household paid 1,441,044 Riels/ha. High income household's cost of rice production is slightly higher than low income household. With regard to rice profitability per hectare, it can be seen that low income household received more economic return/rice profitability than high income household. It received 477,516 Riels/ha compared with high income household, 434,717 Riels/ha. However, there was no significant difference in term of economic return/rice profitability per hectare among two groups of household.

The same figure also reveals that rice income, rice production costs and rice profitability per hectare were slightly different. However, rice income, rice production costs and rice profitability per hectare can be interpreted as at the same level and comparable between low income household and high income household. This result is also consistent with the result done by other researchers. Low income household, who cultivate on

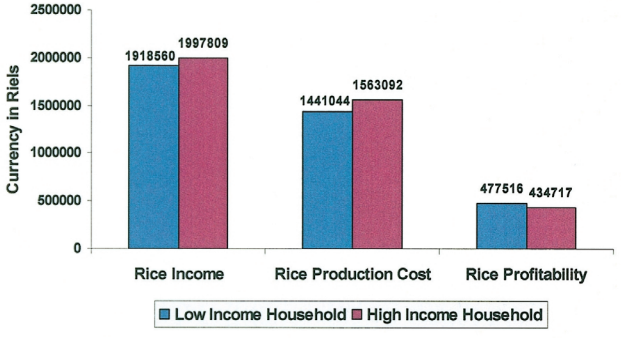

Fig. 6. Comparison of rice income, production costs and profitability per hectare.
Source: Field Survey, 2005

small farm size, seems to be more profitable in growing rice on one hectare basis.

Comparison of households' accessibility to agricultural services

Access to agricultural market, credit, rural infrastructure, and availability of professional services, such as agricultural extension, can have powerful impacts on household income and living standards by raising the productivity and efficiency of agricultural and other employment activities. Unfortunately, an ability of farming households to access such services is still limited.

The data on figure 7 provides the comparison data between low income household and high income household accessibility to agricultural services, such as market, credit, irrigation, and extension worker. As shown in same figure, less than 20 percent of both households could access to agricultural market and there was no different in term of accessibility to agricultural market. This situation presented a serious problem facing low income household and high income household in selling their agricultural products, such as rice, vegetable, and livestock. It would also put households in a disadvantaged position in raising their income by selling agricultural products with a reasonable price.

With regard to agricultural extension workers, who can help farmers in adopting new seed technologies, fertilizer applications, and cultivation practices, there was significant difference in term of accessibility among two groups of households. 92% of high income household claimed they could access to extension workers, while only 59% of low income household could access to this professional service. Interestingly, more than 90% of household could access to irrigation water which makes dry season rice cultivation possible.

In term of accessibility to credit service, 83% of high income household could access to credit, while only 63% of low income household could access to credit. This number shows that credit accessibility of high income household was remarkably higher than low income household. The reason might be high income household normally owns large farm size, which is regarded as asset collateral in borrowing money from rural bank or other financial institutions.

Overall, it is apparent that high income household was in a better position in term of accessibility to agricultural services, especially credit service and extension worker. Since high income household could access to more credit, it is also possible for high income household to borrow money for capital investment in enlarging farm business activities. Furthermore, both households in the study area appear to be in a better position than other rural areas throughout the country in term of accessibility to agricultural services, except accessibility to market.

Comparison of household income from multiple sources

The data on the figure 8 shows the comparison of income between low income household and high income household from rice, livestock, vegetable, non–farming activities and total household income over the period of one year. Clearly, rice income is the primary source of income for both households, and livestock income is the secondary source of income. Livestock income is generated from selling cow, pig, and chicken. However, selling cow is a rare case while selling pig and chicken are commonly practiced by both farming households. In addition to rice and livestock income, low income household and high income household also received additional income from small scale vegetable growing and non–farming activities available to their own community. These two sources of income did not contribute much to the total annual household income.

In comparing rice income between low income household and high income household, it can be seen that rice income is remarkably different among two groups of household. High income household received more than double rice income compared with low income household. Furthermore, there was a big gap in term of livestock income between low income household and high income household. Livestock income of low income household was nearly 5 times lower than high income household. This gap is very high that makes total low income household significantly different.

Besides, high income household also received notably high income from vegetable income and non–faming income. This can be said that high income household generated significantly amount of money higher than low income household from all income

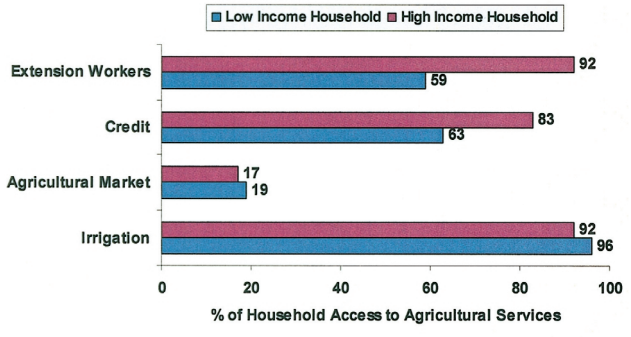

Fig. 7. Comparison of households' accessibility to agricultural services.
Source: Field Survey, 2005

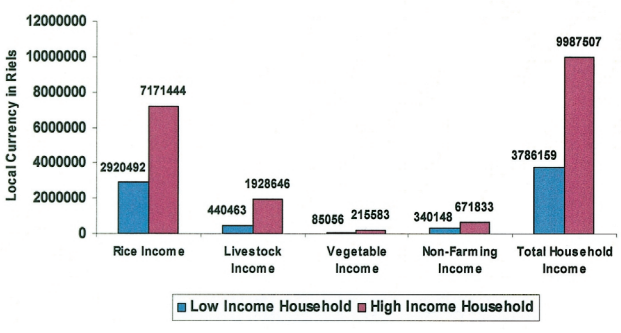

Fig. 8. Comparison of household income from multiple sources and annual household income.
Source: Field Survey, 2005

sources. On the whole year basis, high income household received 9,987,507 Riels/year or 2,496 USD/year. Conversely, low income household generated only 3,786,159 Riels/year or 946 USD/year. This income gap is high, and it results in substantial inequality in income generation from multiple sources.

By comparing low income household and high income household with the national average income, it can be seen that annual income of low income household (946 USD) is lower than the national average income per household, 1,300 USD. On the contrary, annual income of high income household (2,496 USD) was remarkably higher than national average income. This implies that the standard of living of high income household is a little bit high compared with average household in Cambodian rural society.

Comparison of household income statement analysis

Ratios calculated from the income statement give an indication of the relative profitability of a farming condition and the degree of flexibility the farm has in meeting expenses. The *operating ratio* indicates the proportion of the gross income allocated to the paying of operating expenses. Similarly, the fixed ratio indicates the proportion of gross income allocated to meeting fixed expenses. The *gross ratio* indicates the proportion of gross farm income needed to meet total expenses and is the sum of the fixed and operating ratios.

In examining these three ratios, the gross ratio is perhaps the most important one of the three ratios. If the gross ratio is greater than 1, the farm business is not covering the total expenses of operation. Values that are less than 1 indicate that the farm is generating a positive net farm income. The relationship between the fixed ratio and the operating ratio is also important. Farming household with relatively large fixed ratios and small operating ratios generally are more vulnerable to cash flow (also called liquidity) problems than are farms in which the reverse conditions hold true.

In low income household income's situation, it had a gross ratio of 0.68 (Table 2). This means that for every Riels (Cambodian currency) of gross income that the low income household generated, only 0.68 Riels was required to meet the explicit expenses of the operation. The operating ratio and fixed ratio were 0.46 and 0.22 respectively. In high income household income's condition, it had a gross ratio of 0.59 (Table 2). This means that for every Riels (Cambodian currency) of gross income that high income household generated, only 0.59 Riels was needed to meet the explicit expenses of the operation. The operating ratio and fixed ratio were 0.40 and 0.19 respectively.

By comparing low income household and high income household ratios calculated from income statement, it can be seen that the gross ratio of low income household (0.68) and high income household (0.59) is less than 1. This implies that *both farming households were generating a positive net farm income*. However, high income household appears to be in a better financial position than low income household as its gross ratio is smaller than low income household.

To get more understanding regarding to gross ratio of low income household and high income household, t–test analysis is applied. The result of an analysis reveals that the sample averages 0.68 and 0.59 are significantly different ($p<0.05$). Accordingly, there is a significant difference in gross ratio between two households in generating farm income. In other word, it can be said that low income household and high income household received farm income differently.

Factor affecting household income

Since one of the main objectives of this study is to find out the main factor affecting household income, linear regression analysis is used to identify and predict annual household income based upon total cultivated farm size per year. This method is predicting one variable from the other, using an estimated straight line that summarizes the relationship between the variables. By convention, the variable being predicted is denoted Y, and the variable that helps with the prediction is X.

In this Linear Regression, household income is the dependent variable, Y, and total farm size in ha. is the independent variable, X. The main reason to use farm size to predict household income is that more than 70% of household income generated from rice income and rice income is mostly determined by total cultivated farm size. By using linear regression analysis, the results of a, b, the correlation coefficient, and the coefficient of determination are presented in figure 9 below.

Table 2. Comparison of household income statement analysis

Analysis Factor	*How Calculated*	*Low Income Household Calculation*	*High Income Household Calculation*
Income Statement			
1. Operating ratio	$\frac{\text{Total operating expenses}}{\text{Gross farm income}}$	$\frac{1752013}{3786159}=0.46$	$\frac{4022547}{9987507}=0.40$
2. Fixed ratio	$\frac{\text{Total fixed expenses}}{\text{Gross farm income}}$	$\frac{841521}{3786159}=0.22$	$\frac{1907855}{9987507}=0.19$
3. Gross ratio	$\frac{\text{Total expenses}}{\text{Gross farm income}}$	$\frac{2593535}{3786159}=0.68$	$\frac{5930402}{9987507}=0.59$

Source: Field Survey, 2005

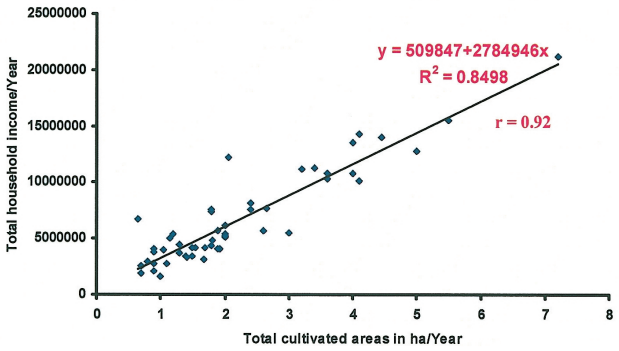

Fig. 9. Relationship between farm size and household income.

As shown in figure 9, this figure supplies information regarding to the relationship between farm size and annual household income. By looking at the scatter plot from figure above, there is a linear relationship between farm size and household income. In other words, it can be said that as the cultivated farm size increased, annual household income also increased in the same direction.

Is increased the farm size a good choice to increase household income? To answer this key question, it is worthwhile referring to figure 9. Note that the correlation coefficient, r, is 0.92. Because the value of r is close to 1.00, this can be concluded that there is a strong positive relationship between total cultivated farm size and annual household income. Therefore, increased farm size is good solution to increase household income. Next, we examine the coefficient of determination, $r^2 = 0.8498$. This value of r^2 implies that 85 percent of the variation in annual household income is explained by total cultivated land size.

Factor affecting rice output

In an attempt to understand the production function and return to scale of rice output, Cobb–Douglas function is applied to identify the main contributor to rice output. As rice output is largely determined by the level of farm size, labor, and capital to achieve a certain amount of rice output, these inputs are regarded as the three–variable in the production of rice output. In addition to these three variables, dummy variable, household category, is also incorporated in the regression model in order to gain more understanding between two groups of household in rice production.

The relationship between output and input variables in Cobb–Douglas production function is nonlinear. However, if we log–transform four variables function, we obtain the following linear equation.

For production, four–variable function can be written as the below:

$$\mathbf{lnY} = \beta_0 + \beta_1 \mathbf{lnX_1} + \beta_2 \mathbf{lnX_2} + \beta_3 \mathbf{lnX_3} + \beta_4 \mathbf{X_4} + \mathbf{u}$$

Where:

* Y = rice output
* X_1 = farm size input ,
* X_2 = labor input,
* X_3 = capital input
* X_4 = Dummy variable: 1 for low income household and 0, Otherwise (High income household)
* $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ are parameters and u is error term

From a purely statistical viewpoint in table 4, the F–test is significant (8.14E–26 level), indicating this model is useful, and the estimated regression line fits the data quite well. The *R Squared* value of 0.929129 indicates that about 93 percent of variation in the (log of) rice output is explained by the log of farm size, labor, and capital. This means about 7% of the variability in rice output is not explained and could be due to other factors such as education, experience, age and credit, etc.

Table 4. Regression statistics for production function

0.929129	R squared
0.19605	Standard error of estimate
51	Number of observations
150.7658	F statistic
8.14E–26	P value

As can be seen coefficient in table 5, the output elasticities of farm size, labor, capital and household are 0.385, 0.382, 0.143 and −0.07 respectively. In other words, in this study, holding other inputs constant, a 1 percent increase in farm size input led on the average to about 0.38 percent increase in the rice output. Similarly, holding other inputs constant, a 1 percent increase in the labor input led on the average to about a 0.38 percent increase in the rice output.

In doing the same way, holding other inputs constant, a 1 percent increase in the capital input led on the average to about a 0.14 percent increase in the rice output. The regression coefficient for household, –0.07, indicates that the expected rice output difference between low income and high income household with the same level of farm size, labor and capital is 0.07% or 7 kg, which rice output of low income household is lower than high income household. The coefficient for household is not significant, and it is not even close.

Table 3. t–Test for gross ratio of low income household and high income household

	Gross Ratio of Low Income	*Gross Ratio of High Income*
Mean	0.68	0.59
Variance	0.053899131	0.018258408
Observations	27	24
Df	49	
t Stat	2.35367617	
P(T<=t) two–tail	0.02264412	

Table 5. Multiple regression results using the log of farm size, labor and capital

	Coeff	StdErr	T	P	Significant?
Constant	4.742766	0.782362	6.062113	2.34E–07	Yes ($p<0.001$)
Farm Size	0.385197	0.105394	3.654835	0.000658	Yes ($p<0.001$)
Labor	0.382239	0.08757	4.364973	7.14E–05	Yes ($p<0.001$)
Capital	0.143179	0.05877	2.436279	0.01877	Yes ($p<0.05$)
Household	–0.07011	0.07813	–0.8973	0.374233	No ($p>0.05$)

The prediction equation is:

Rice Output = 4.742 + 0.385 Farm Size + 0.382 Labor + 0.143 Capital – 0.070 Household

By adding the three output elasticities (Farm size + Labor + Capital), the result is (0.385 + 0.382 + 0.143) = 0.90, which gives the value of the returns to scale parameter. As is evident, rice output in the study area was characterized by *decreasing return to scale*. In other words, it can be said that an increase all resources (farm size, labor, and capital) by 10 percent will add 9 percent to total rice output.

CONCLUSION AND RECOMMENDATION

The similarities and differences between low income household and high income household can be drawn. On the similarities side, both household achieved almost the same level of rice productivity and profitability/economic return per hectare, and the production cost per hectare is also at the same amount of expenditure. Low income household and high income household were generating a positive net farm income and facing a problem in selling agricultural products to the market.

On the differences side, high income household cultivated on large farm size compared with low income household. Large farm size means large quantity of rice yield. Large quantity of rice yield translated directly into high rice income for high income household. High income household generated a great deal of income from livestock raising activity while low income household received little income from this income source. Compared to low income household, high income household had a better access to extension worker and credit service, which can get more capital investment in enlarging farm business. There is a significant difference between two groups of household in generating net farm income.

One more interesting result is found to give answers to the two basic questions of how much output should be produced and how large should the farm be to get maximum profit. Rice Marginal Cost crosses Marginal Revenue at approximately 17,482 kg (around 3.5 hectares). If the expected price of rice is 515 Riels/Kg, *17,482 kg would be the profit maximizing level of rice production*. There is no guarantee that this level will produce profits, only which is the best possible level of output given the prices and costs associated with a particular production function. By producing at the optimal level of output you may be minimizing losses as opposed to maximizing profits.

Rice output in the study area was characterized by *decreasing return to scale*. An increase all resources (farm size, labor, and capital) by 10 percent will add approximately 9 percent to total rice output. Farm size is the main factor affecting rice output, and labor input ranks as the second factor in producing rice output, while capital input contributes little to produce rice output. Also, there is no significant difference between two groups of farming household in producing rice output.

Increasing cultivated farm size would result in substantially increasing rice output. Then, it is likely to translate directly into higher household income. Also, there is a linear or positive relationship between farm size and household income. Accordingly, increased farm size is a good solution to increase household income. Whenever it is possible, householders should pay special attention on livestock raising activity, which could contribute significantly to annual household income and try to improve an access to agricultural market.

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