Research article

A Comparative Study of Economic Efficiency Between Small and Medium Size Rubber Plantation in Thbong Khmom Province

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Abstract The strong fluctuation of price makes investment decision difficult, especially smallholder rubber plantation that depend solely on rubber production to support their livelihood. An investment analysis of the rubber production was needed to complete the study, so a discounted cash flow (DCF) was introduced to account for this study. The findings of the study illustrate that the investment of rubber seemingly economically feasible. However, the result from the Discounted Cash Flow Analysis showed that the time to recover the initial investment on the rubber plantation is getting longer at the current price of rubber. The payback period will be 11.9 years for small size producers. For medium size plantations, the payback period was estimated to be 12.2, 10.5 and 9.8 years in MI, MII and MIII, respectively. The further findings also suggest that small size producers have less choice in term of output produce that they want to put out in the market.

Keywords discounted cash flow analysis, natural rubber, payback period, profitability, productivity, smallholder rubber plantation

INTRODUCTION

Rubber has long been a major commercial crop and export earner for Cambodia and, as a labor-intensive crop, has the potential to contribute to poverty alleviation through rural employment. The gross value added of rubber in 2006 was estimated at USD103.61 million, or about 5 percent of agricultural sector production (MAFF, 2008).

The growing surplus of rubber worldwide, which is steadily decreasing the demand for Cambodian rubber (Hor and Renzenbrink, 2013). According to a representative of Chop Rubber Plantation, a major rubber exporter, the global oversupply of natural rubber reduced their prices significantly from $3,100/ton to $2,100/ton in 2013 (Ross, 2016). Domestic demand for rubber is also very low and studies have revealed that "there is currently very little domestic use in secondary or tertiary industries for Cambodia's natural rubber products" (Ministry of Commerce, 2013).

In 2014, 70% of the total rubber production was contributed by household-owned rubber plantation. According to General Directorate of Rubber, the price of rubber has been decreased by 3/4 compared to a decade ago. However, little attention is given to their profit efficiency and its determinants. Farmers' income who live in the rural areas depends heavily on rubber production. The instability of rubber price, and low productivity due to the lack of technology and information, it affects greatly on their income.

OBJECTIVE

General objective of this study is to analyze economic efficiency of the rubber farmers. The specific objectives are: 1) Identify the socio-economic characteristic of rubber producers, 2) Access to farmer's profitability, 3) Analyze the financial feasibility of rubber producers, and 4) Formulate suggestions and recommendations.

METHODOLOGY

DCF analysis was used as the framework for assessing the returns from the investment of household-owned rubber production, with the usual investment criteria of net present value (NPV), internal rate of return (IRR), and benefit-cost ratio (BCR) (Campbell and Brown, 2003). A positive value of NPV for a given project shows that the project's benefits are greater than its costs. When IRR is equal to or greater than the interest rate, the investment is worthwhile. If the value of BCR is equal to or greater than 1, it is a sign that investment is of worth, but if it is less than 1, the investment project is not profitable. In order to apply DCF, the costs and benefits of rubber production first had to be identified, where the costs include establishment costs (before yielding stage) and maintenance costs (after yielding stage). Then the issue of the discount rate had to be addressed. Therefore, an allowance was made for risk and uncertainty through a sensitivity analysis.

RESULTS AND DISCUSSION

Farm Characteristics of the Small and Medium Size Rubber Producers

Table 1 Farm characteristics of the studied area

Items	S Under 2 (n=20)	MI 2 to 10 (n=18)	MII 10.1 to 20 (n=14)	MIII 20.1 up (n=11)
Average Rubber Owned Area (ha)	1.3	4.4	16.6	41.2
Average Planted Tree (tree / ha)	557	559	566	563
Average Mature Tree (tree / ha)	456	472	511	524
Average Immature/Damaged Tree (% / ha)	17.3	15.7	7.9	7.5
Average Rubber Tree Age (Year)	8	9	12.6	13
Tapping Frequency (days / week)	2	6.6	6.8	7
Output Produces	Coagulum [1)]	Coagulum [1)]	Latex [2)]	Latex [2)]
Labor Type	Family labor	Family labor	Family labor + Seasonal hiring labor	Non-family management [3)] + Fixed hiring labor

Source: Field Survey, 2018

Notes:

1) Coagulum: Coagulated latex. There are two ways to coagulate latex, by additional acid to latex or let it coagulate naturally. Due to high cost of acid S and MI producers in the studied area use the later method to coagulate their latex and sell it as coagulum.

2) Latex: MII and MIII producers sell their produces in the liquid latex form. The price will be determined by the DRC (Dry Rubber Content) % that has in the latex and Dry Rubber Price at the farm gate.

3) Non-family management: No family labor is engaged to manage the plantation. 1 to 2 managers are hired to manage the whole plantation in addition to the working labor (eg: tapping labor).

The farm characteristics is presented in Table1. Rubber producers were categorized into two main types, small (S) and medium (M) scale producers. For further investigation, this study divides medium scale producers into three categories, accordingly. MI refers to medium scale producers that use family labor only to manage the plantation, while M II are producers that manage the plantation themselves and use hired labor occasionally. Lastly, M III are producers that use hired labor only to manage the plantation.

For S producers refer to those who own less than 2 ha and use family labor only. As presented in the Table 1, the average owned area is 1.3 ha, 4.4 ha, 16.6 ha, and 41.2 ha, respectively. There is no transition of land or rental land system found in the studied area. Most of the producers acquired the land from the government, inheritance, and purchased land. The planting density is not so different between the 4 groups of producers, as they planted an average of 550 to 560 per ha. However, the ratio of immature/damaged tree is different across the groups, the producers that has the most immature/damaged tree is S producers that accounted for 17.3% following by MI 15.7%, MII 7.9%, and MIII 7.5%, respectively. This is the crucial point since only the mature area of plantation is calculated and compared and number of tree per ha is statically significant related to the productivity of the plantation itself.

Another distinguish differences that can be spotted in Table 1 is the age of rubber and tapping frequency. Compare to the M producer's groups S producers have smaller plantation area. Since the rubber tree can be tapped every four days, producers with bigger plantation areas tapper can rotate the tree in circle and able to tap every day (Usually 400 trees can be tapped per day per tapper).

Profitability Analysis of Small and Medium Size Rubber Plantation in the Study Area

Total production cost:

The total production cost includes both variable and fixed cost. The variable costs include the expenditure of fertilizers, herbicide control, latex stimulants and labor costs (tapping labor, fertilizing labor, herbicide labor, and latex stimulant labor).

Table 2 Total production cost of rubber production

Items	S Under 2 ha	%	MI 2 to 10 ha	%	MII 10.1 to 20 ha	%	MIII 20.1 ha up	%	t-statistic		
	(n=20)		(n=18)		(n=14)		(n=11)		S vs MI	S vs MII	S vs MIII
Fertilizer	513	11	544	12	642	15	677	15	2.03	**2.03***	**2.07***
Herbicide Control	170	4	178	4	195	4	213	5	2.12	2.06	**2.09****
Latex Stimulation	187	4	193	4	214	5	223	5	2.05	2.08	2.07
Family Labor (2)	3,321	74	3,220	72	929	21	0	0	2.03	**2.04*****	N/A
Hiring Labor (3)	0		0		2,139	48	2,988	68	N/A	N/A	N/A
a. Total Variable Cost	**4,191**	93	**4,135**	93	**4,119**	93	**4,102**	93	2.08	2.03	2.04
b. Total Fixed Cost	**378**	7	**371**	7	**355**	7	**330**	7	2.04	2.03	2.05
c. Total Production Cost (a+b = c)	**4,514**	100	**4,450**	100	**4,425**	100	**4,405**	100	2.04	2.05	2.04

Source: Field Survey, 2018

Notes: N/A = no data

1) The production cost does not include the cost that applied on the immature area of the plantation.

2) Current wages are applied to calculated family labor cost. (25,000 riel/day)

3) There is no hiring labor cost in S and MI producers, only family labor is engaged in the plantation.

4) Establishment cost refers to all the expenses incurred during the first six years till the plantation come to commercial yielding stage. Depreciation straight line method was used to calculate the annual share of establishment cost.

*Significant codes: *** 0.001 **0.01 * 0.05*

Fixed costs consist of establishment costs only, since there are no agricultural taxes in Cambodia and all the interviewed producers owned the land they are farming. Moreover, unlike other countries the interviewed producers only produce and sell raw material (coagulum, and latex), with no machines or heavy machinery involved in the rubber production. Establishment cost includes all the expenses incurred during the first six years till the rubber tree comes to yielding stage. The total cost of establishment comprised land preparation, lining and holding, planting, clone replacement, weeding, pruning/branch induction, fertilizer, and disease control.

To avoid being biased in this study, the total cost per tree has been computed. More than 70% of the total cost goes into labor for S producers. Producers in the studies area applied at least 1 bag (50 kg) of fertilizers (chemical) per ha to the rubber plantation and apply twice per year. One bag of fertilizer can cost up to 120,000 riel/bag (30 USD). The average quantity of fertilizer applied

was roughly 151 kg/ha, the cost of fertilizers wraps up 15% of the total variable costs, annually. Usually, latex stimulant is applied once a month, with roughly about 1 liter/ha costing around 10,000 riel/liter.

Rubber productivity and profitability:

Two types of produce were in the market, coagulum and latex. Coagulum is coagulated latex and consists of two ways to coagulate the latex. It can be developed by introducing additional acid to latex or by simply allowing it coagulate naturally. Due to the high cost of acid, S and MI producers in the studied areas use the latter method to coagulate their latex and sell them as coagulum.

Table 3 Average rubber productivity and profitability

Items	S Under 2 ha	MI 2 to 10 ha	MII 10.1 to 20 ha	MIII 20.1 ha up
	(n=20)	(n=18)	(n=14)	(n=11)
Yield (kg / tree) (a)	4.97	5.41	2.79	2.87
Price (riel / kg) (b)	1,890(1)	1,877(1)	4,307(2)	4,345(2)
A. Revenue (A = a*b)	**9,395**	**10,161**	**12,001**	**12,477**
Total Variable Cost (riel / tree) (c)	4,191	4,135	4,119	4,102
Total Fixed Cost (riel / tree) (d)	378	371	355	330
B. Total Production Cost (B = c+d)	**4,514**	**4,450**	**4,425**	**4,405**
C. Net Farm Income (A+B = C)	**4,881**	**5,711**	**7,576**	**8,072**

Source: Field Survey, 2018

Notes:

1) Coagulum rubber price riel/kg

2) Dry rubber price riel/kg

3) The production cost does not include the cost that applied on the immature area of the plantation.

Table 3 shows the average yield per tree for S and MI coagulum production, the producers' yields equated to 4.97kg and 5.41kg, and the net farm income was computed at an average price of 1,890 riel/kg and 1,877 riel/kg. Net farm income per tree/year came in at a total of 4,881 riels and 5,711 riel for S and MI producers. The average yield per tree was 2.79 kg and 2.87 kg for latex production, with the net farm income standing at 7,576 riel and 8,072 riel.

MII and MIII producers can generate more profit than S and MI producers, as latex is a higher-grade rubber that is used to make elastic bands, teats for babies' bottles, and athletic shoes, while coagulum is a low-grade (quality) rubber that is used for tires (ADI, 2007). Most of the large processors prefer to buy latex rather than coagulum and offer a premium for it. In contrast, smallholders prefer to sell coagulum, as farmers can receive cash in hand (Hing and Thun, 2009), where the smallholders producing the coagulum are selling them to collectors at either the farm gate or at various collection points in the districts' towns. Smallholders are also known to adulterate their latex with all kinds of additives, rendering it unusable for higher grades of rubber (ADI, 2007). Due to this, the factory prefers to make a deal with large-plantations so that they can secure the quality as well as the quantity.

Rubber smallholders have little choice but to sell their collected latex to private companies for processing and export, given that only semi-processed (dry) rubber, not latex, can be exported (Hing and Thun, 2009). Competition among collectors is limited and localized, resulting in price collusions against the farmers (so farmers are quoted the same prices by the collector) (Rubber Sector Profile, 2012).

Discounted Cash Flow Analysis

The financial feasibility analysis for rubber production was carried out by employing important tools such as the Net Present Value, Benefit Cost Ratio, Internal Rate of Return, and Payback Period as seen in Table 4.

The BCR for the rubber plantation presented more than unity in every category, but also implied that rubber cultivation was a profitable venture. The Net Present Value of the stream of

returns from one hectare of rubber plantations worked out to 38,231,362 riel for S producers, 40,820,918 riel for MI, 43,311,209 riel for M II and 46,030,839 riel for MIII at a non-discounted rate. The high positive Net Present Value indicates the soundness of the investment.

The internal rate of returns equated to 21% for S producers, however the ratio was 23%, 32%, and 33% in MI, MII, and MIII respectively. Since the values of the internal rate of returns are considerably higher than the market rate, more than 14.50% would be financially feasible (Shunmugiah, 2000).

Table 4 Benefit cost ratio and internal return rate

	S	M1	M2	M3
IRR	21%	23%	32%	33%
NPV	38,231,362	40,820,918	43,311,209	46,030,839
PB (Year)	11.9	12.2	10.5	9.8
BC	1.8	1.8	1.7	1.8

Source: Field Survey, 2018

The payback period refers to the time required to recover the initial investment in the rubber production. While the payback period worked out to be 11.9 years for S producers, the payback period for medium-size plantations was estimated to be 12.2, 10.5 and 9.8 years for MI, MII, and MIII, respectively. Thus, all the criteria of financial feasibility of the project indicated that investment in rubber production was economically feasible and financially sound in the study areas.

Table 5 Results of DCF analysis for rubber producers

Scenario		5%				8%			
		S	MI	MII	MIII	S	MI	MII	MIII
A	NPV (riel/ha)	-1,244,873	-462,624	-124,128	1,234,496	-1,868,824	-1,015,001	-130,399	-678,883
	B.C ratio	0.97	0.99	1.00	1.03	0.94	0.97	1.00	1.02
	IRR%	3.90%	4.60%	5.30%	7.40%	3.90%	4.60%	5.30%	7.40%
B	NPV (riel/ha)	10,327,710	12,006,326	13,960,084	15,506,547	5,352,964	6,757,139	9,051,105	10,153,484
	B.C ratio	1.26	1.29	1.30	1.33	1.17	1.20	1.24	1.27
	IRR%	13.60%	15.10%	21.00%	22.00%	13.60%	15.10%	21.00%	22.00%
C	NPV (riel/ha)	25,372,068	28,215,962	32,269,560	34,060,215	16,620,349	18,952,529	23,115,069	24,376,616
	B.C ratio	1.64	1.67	1.69	1.74	1.52	1.56	1.61	1.65
	IRR%	23.00%	24.80%	35.80%	36.50%	23.00%	24.80%	35.80%	36.50%

Source: Field Survey, 2018
Notes: A scenario: Rubber price decrease by 30% (of projected price); B scenarios: World Bank projected price; C scenarios: Rubber price increase by 30% (of projected price).

Table 5 shows the DCF applied the sensitivity analysis of small and medium-sized rubber plantations at the discount rate of 5% and 8%. Table 5 is using the wage of 34,000 riel/day to compute.

The results show that for 30% less than the projected price (scenario A), the investment for rubber production is unprofitable in all categories. With the world bank projected price (scenario B), the investment shows positive signs in all categories, indicating that the investment project is viable. At 30% more than the projected price (scenario C), the investment was worthwhile for all discounted rates.

The findings from the sensitivity analysis shows that if the input material costs were to increase by 30% from the current price, the investment in rubber production would no longer be worthwhile, indicating that the expansion of rubber may stop if there is a decline in the price of rubber in the future. In fact, at the wage rate of 34,000 riels/person per day and a discount rate of 5%, the investment in rubber production becomes unprofitable when the price of rubber decreases more than 30% from the current market price. This could perhaps be countered by increasing yields (e.g., through the use of fertilizer) or obtaining a higher farm-gate price by improving the quality of rubber. Nevertheless, the current expansion is clearly vulnerable to a price downturn.

CONCLUSION

The findings suggest that the bigger plantations can generate more income than the smaller plantations due to a difference in output production. Medium-size producers tend to produce latex that are more likely to be in demand by the factory. This type of produce is identified as a high-grade rubber that is commonly used for high-end products. In contrast, small-size producers sell their produce as coagulum used in the tire industry, and they are usually purchased by middlemen. In the current market, the price of latex is twice as profitable than coagulum rubber. However, the small-size producers prefer to sell their produce as coagulum in order to receive cash-in-hand, while the big factories prefer to purchase the latex only from the medium to large-size plantations to secure the quality as well as the quantity.

Further findings also show that despite the continuously decreasing price of rubber, rubber production is still seemingly economically feasible. However, if the price continues to decrease, rubber producers will struggle to recover the initial investment from the rubber plantation as the payback period is getting longer. From the results, it can be concluded that the investment for rubber plantations is getting riskier, and small-size producers are likely to be at the most disadvantaged. Upon weak market channels, rubber producers are not proactively addressing any potential risks, with even the slightest changes to input costs (labor, fertilizer, herbicide, and latex stimulant) having the potential of posing a major threat for rubber producers.

Smallholder rubber plantations usually have no control to dictate the price of their produce, as farm gate prices are usually set by collectors and traders. Therefore, the development of proper fair market channels and support from the government should be established to sustain the rubber producers' livelihoods and to mitigate any potential future risks. Support such as subsidies and quality material inputs should be accessible and available to rubber producers, especially during the establishment period when producers cannot generate any income.

Relevant and timely information on local and international rubber markets and rubber feasibility investment reports should be provided to rubber producers. Moreover, information such as potential markets and required standards should be informed to all rubber producers. Using the latest information and techniques can help rubber producers during the investment making processes and increase their productivity and income, potentially protecting the producer's livelihoods in the long run.

To further address this study, a study on the biophysical components (weather, soil, intercrop system, and clone) should be conducted in order to determine the factors that may affected farmer decision on output produce.

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