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Economic efficiency of rubber production and affecting factors: Case of smallholder rubber production in Quang Binh Province, Vietnam

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Rubber is a perennial crop, so to evaluate economic efficiency of smallholder rubber production, the author uses long-term analysis method with values such as actual present value (NPV), Benefit Cost Ratio (BCR), Internal rate of Return (IRR) and annual value. The factors affecting the productivity of smallholder rubber are assessed through the Cobb-Douglas functional production function analysis method with input factors of communication and non-communication. Data were collected through a survey of 200 smallholder rubber business households in 5 key rubber growing provinces in Quang Binh province. The research results show that Quang Binh province has many favorable conditions for rubber development and the smallholder rubber model has developed strongly, the area has increased rapidly but productivity is low, small in scale, unevenly distributed. In localities, most of them are located in remote areas, investment in resources is limited, production households with low average educational level, not much experience in rubber production and investment capital, limited private. Economic efficiency evaluation shows that with a discount rate of 9%, NPV will reach 80,147 VND / ha; IRR = 18% is larger than the current bank loan interest rate of households and B / C = 1.36> 0, so investment in small rubber business in Quang Binh province is effective. Assessment of factors affecting rubber latex production yield shows that, in addition to the variable density of variables included in the model such as fertilizers, labor, pesticides, rubber garden acreage, age orchards, training, rubber growing areas all have significant impacts on latex yield with 95% confidence.

Key words: Economic efficiency, rubber production, smallholder rubber model, Quang Binh rubber, rubber yield.

INTRODUCTION

The smallholder rubber model is being deployed and strongly developed in Quang Binh in particular and in Vietnam in general. This model is playing an important role in local economic development such as creating

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jobs, increasing stable income for rural workers, contributing to poverty reduction; contribute to increase the volume of rubber products for consumption and export; to restructure the rural economy towards industrialization and modernization. However, this model still faces many difficulties and challenges, especially productivity, output and economic efficiency are not commensurate with the local potential. There have been many studies evaluating the economic efficiency of rubber and rubber smallholder production and business, especially in countries with strong rubber plantation and production. However, the researches on each of the different aspects related to economic efficiency of rubber production and business. There are studies with synthetic evaluation of smallholder rubber but there is a sample size gap; some studies only pay attention to the positive aspects of smallholder rubber business and production but do not represent the average of the smallholder rubber in the study area. In particular, rubber trees are perennial crops, productivity and economic efficiency depend on many factors. For each country and territory has its own characteristics, the organization of rubber production and business and assessment of economic efficiency in rubber production and business are also different, so the research method and the category of research is also different. In particular, there are no studies to evaluate the economic efficiency of smallholder rubber production in Quang Binh province. Therefore, the article aims to study and evaluate the economic efficiency of smallholder rubber production in Quang Binh province through the method of long-term investment analysis with indicators such as actual present value (NPV), Benefit Cost Ratio (BCR), Internal rate of Return (IRR), annualized values and assess the factors affecting the productivity of smallholder rubber through the Cobb-Douglas production function analysis method with traditional and non-traditional input factors.

MATERIALS AND METHODS

Select the study site

The study conducted a survey on rubber growing households in Bo Trach and Le Thuy districts. These are two key rubber-growing districts of Quang Binh province with an area of over 88% of the province's rubber area. In 2 districts, select 5 survey sites: TT Nong Truong Viet Trung, Hoa Trach Commune, Tay Trach Commune, Phu Dinh Commune and Le Ninh Farm Center. These are the localities with smallholder rubber area accounting for over 95% of the rubber area of the 2 districts.

Secondary information

Collect and systemize documents that have been published through books, newspapers, summary reports and results of research projects related to rubber tree production and business in general and Quang Binh province's smallholder rubber in particular. These documents are intended to provide general research information, theoretical basis, practical basis, research site characteristics and research methodology.

Primary information

Directly surveying smallholder rubber production and business households through questionnaires. The questionnaire was elaborated with questions related to rubber production and business situation of smallholder rubber households in terms of acreage, investment, total trees, total number of shaved trees and education level, ... To determine the sample size, the author is based on the number of overall samples and according to the 2019 survey data, Quang Binh province has nearly 5000 smallholder households, so the decision on sample size is done according to Equation 1 the sample size is determined by the following equation:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

With the confidence of 95% and P = 0.5, the sample size with permissible error ± 5%, the study identified the sample to be investigated n = 195 and the author determined the number of households surveyed was 200 households.

The survey is conducted according to a stratified statistical method from year 1 to year 20 according to the rubber tree life cycle and for each year 10 households are selected as representatives, these households are selected according to random method course at each survey site. Thus, based on the number of survey sites selected is 5, the sample structure for each site is 40 households and for each year from year 1 to year 20 according to the life cycle of rubber trees, choose 2 households as represent. Data from the 21st year to the 30th year, the author is based on the research results of the Rubber Research Institute, of experts and practical research to estimate. The reason is only investigated until the 20th year according to the rubber tree life cycle is because the smallholder rubber business in Quang Binh province has only been carried out for 20 years, so since the 21st year there is no practical data to evaluate. Therefore, data from 21 onwards following the rubber tree life cycle, the author used the research results of the Rubber Research Institute to ensure more representativeness and accuracy because it was tested in practice.

Methods

Economic efficiency evaluation of rubber production is usually based on annual economic accounting indicators and long-term investment analysis criteria. On that basis, the research uses research methods.

Method of cost accounting, production results and efficiency

Accounting of production costs

Determining the cost of rubber production in 2 periods, the period of basic construction and the period of business. The study identified a basic construction period of 7 years from the year of planting rubber, including reclamation costs, new planting and interest expenses if any; business period is from the 8th year, the cost includes labor cost, fertilizer cost, cost of production tools, depreciation cost of garden (all expenses for basic construction period) allocated to years of economic periods) and financial expenses.

Accounting results and production efficiency

Conducting the calculation of actual yield of latex harvested for 1 ha of rubber of the surveyed household, the productivity usually

collected from interviews, household interviews and combined with consideration of number statistical data on the productivity of the adjacent year (year) of the statistical office. Summing up and calculating the results and efficiency criteria as follows:

$GO = Q_i * P_i$

In which:
GO: Revenue collected per hectare of rubber tree area (VND 1,000)
Qi: Latex output of one hectare of rubber (kg)
Pi: Price of 1 kg of latex (VND 1,000)
Intermediate cost (IC): is the total amount of regular expenses in money that you spend to buy and rent inputs and services during the production of that total product.
Value-added (VA): The value of products created during that manufacturing period. It is the difference between the value of production and the intermediate cost.
VA = GO – IC
Mixed income (MI): is the remaining added value after deducting expenses: depreciation of fixed assets, taxes and fees (if any).
MI = VA - depreciation of fixed assets - Tax - Bank interest (if any)
Profit:
Profit = MI - expense of family labor - expense of in kind of a household
Evaluate production efficiency through indicators: GO / IC, MI / IC, LN / IC, VA / IC.

Benefit-cost analysis method

The research uses the benefit-cost analysis method in two ways: (1) Analyzing the annual cost benefit for the business period, the data used to perform the based on collected primary information, annual costs including expenses incurred during the year such as costs of supplies, production tools, labor, allocated depreciation of gardens and allocated financial expenses, basic construction expenses are evenly distributed among the years of the business period; (2) cost benefit analysis for the entire production cycle, using NPV, IRR and BCR indicators, benefits and costs arising in different years are realized at discount rates reasonable. The criteria are calculated by the following Equation 2, 3, 4:

$$NPV = \sum_{t=0}^{n} B_t \frac{1}{(1+r)^t} - \sum_{t-o}^{n} C_t \frac{1}{(1+r)^t} \quad (2)$$

In which:
n: Number of life cycles of a rubber tree
t: Year of investment
Bt: Benefits of rubber trees in year t
Ct: Cost of rubber tree year t
r: Discount interest rate (% / year)
If NPV is > 0, the investment in rubber business is effective and profitable. Conversely, if NPV is <0, financially, this investment is ineffective and should not be implemented.

$$IRR = r_1 + (r_2 - r_1) \frac{NPV_1}{|NPV_1| + |NPV_2|} \quad (3)$$

In which:
r_1: Lower discount rate at which NPV1> 0 is closest to 0
r_2: Higher discount rate at which NPV2 <0 is closest to 0.
NPV: Actual present value
The IRR to find (corresponding to NPV = 0) will lie between r_1 and r_2

IRR is the discount rate that makes NPV = 0, with this discount rate, rubber plantation is completely unprofitable because the income is just enough to offset the costs. Conversely, if IRR is greater than the interest rate, then production is efficient. The larger the IRR is, the higher the economic efficiency is.

$$BCR = \sum_{t=0}^{n} B_t \frac{1}{(1+r)^t} / \sum_{t-o}^{n} C_t \frac{1}{(1+r)^t} = PVB/PVC \quad (4)$$

In which:
PVB: Present value of benefits
PVC: The present value of cost
If BCR> 1 the revenues offset the expenses spent, the greater the investment in economic efficiency and BCR, the higher economic efficiency. If BCR is less than 1, the revenues cannot cover expenses, so the investment is not effective.

Method for analyzing the production function of Cobb - Douglas form

Use this method to assess factors affecting rubber production productivity. From practical analysis, identifying the factors affecting rubber production productivity and including Cobb-Douglas production function model has the form:

$Y = A. x_1^{\alpha 1}. x_2^{\alpha 2}. x_3^{\alpha 3}. x_4^{\alpha 4} . x_5^{\alpha 5}. x_6^{\alpha 6}. x_7^{\alpha 7}. e^{\alpha_8 K + \sum_{j=1}^{4} \beta_j D_j}$
Or: $LnY = A + \alpha_1 LnX_1 + \alpha_2 LnX_2 + \alpha_3 LnX_3 + \alpha_4 LnX_4 + \alpha_5 LnX_5 + \alpha_6 LnX_6 +$
$+ \alpha_7 LnX_7 + \alpha_8 K + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 D_4$

In which:
Y: latex yield per hectare of rubber (kg / ha)
X1: NPK fertilizer (kg / ha)
X2: Manure (kg / ha)
X3: Labor (person / ha)
X4: Plant protection drugs (Plant protection) (VND / ha)
X5: Area (ha / household)
X6: Tree density (Number of trees / ha)
X7: Age of orchard (years)
K: Training dummy variable is defined as K = 1 if the head of the household has participated in the training and K = 0 if the head of household has not participated in the training.
Dj: Dummy variable for rubber growing area (j = 1 ÷ 4): D1 = 1, Tay Trach commune; D2 = 1, Hoa Trach commune; D3 = 1, Viet Trung Farm Town Center; D4 = 1, Le Ninh Farm Town Center; D1 = D2 = D3 = D4 = 0, Phu Dinh commune.
A: A constant that shows the impact of other factors on latex yield per hectare of rubber in addition to the inputs in the production function.
αi: Elasticity coefficient, reflecting the influence of input factors Xi and training variable K on latex yield per ha of rubber.
βj: Elasticity coefficient, which reflects the influence of the dummy variable in planting region D on latex yield per ha of rubber.

Scenario analysis method

Based on practical experience, put forward the proposed situations for risk variables (input variables affecting production activities) to consider the change of a result variable to consider the change of economic efficiency criteria for smallholder rubber production when there are changes of many risk factors at the same time.

RESULTS

Assessing the economic efficiency of smallholder rubber production in the surveyed households

The survey data of 200 smallholder rubber producing households in Quang Binh province is processed to determine the following indicators.

GO/IC, MI/IC, LN/IC indicators show that, since the start of exploitation, every 1 VND direct cost invested generated 2.89 VND of production value and 1.39 VND mixed income. Since the second year of exploitation, the value of production and mixed income have increased gradually. This means that each households has invested effectively, saved costs and the investment levels are suitable to each household's capacity. The LN/IC indicator shows the effectiveness of the production significantly, the analysis results of this indicator show that there has been an increase over each year of business period, specifically. Since the 2nd year of exploitation, households, of which the rubber plantation are at this age, for every 1 VND spent generated 1.91 VND of profit, this figure has changed significantly since the 3rd year of exploitation accounted for 2.21 VND and keeping the profit for every 1 VND spent until the 12th year of exploitation, starting the 13th year of exploitation, the profit for every 1 VND tends to decrease, accounted for only 1.84 VND; and decrease sharply in the 27th year of exploitation, which accounted for 0.87 VND. In the 30^{th} year of exploitation, the rubber plantation is no longer profitable.

Long-term indicators NPV, IRR, B/C: Local rubber price in the period of 2008 - 2019 declined and always fluctuated, from the actual survey in 2019, the author chose the price of VND 10,000/kg of latex to calculated because most of the surveyed households sell at this price; and choose the discount rate of 9% which is same as the interest rate of the bank for rubber production and business households in 2019. The NPV, B/C, IRR values calculated are shown in Tables 1, 2 and 3.

According to calculated data with a discount rate of 9%, the NPV is 80,147 VND/ha; IRR = 18% which is higher than the current bank loan interest rate and B/C = 1.36> 0. The results show the ratio of income to expenses during the period of rubber plantation at the current price is 1.36 times, which means that the investment smallholder rubber business in Quang Binh province is effective.

Assess the impact of factors on productivity of smallholder rubber production in Quang Binh province

Based on the research method and survey data, the study uses SPSS 16.0 software to process and analyze. The estimation Cobb - Douglas function and the regression equation are summarized in Table 4(*). The value of F - Statistic = 62,176> F0.05 [k-1, n - k] = 1,805 allows to reject the hypothesis that all individual regression coefficients are equals to 0 and accepts the hypothesis that not all individual regressions are simultaneously equal to 0. The multiple determination coefficient (R^2) of the model is 0.864, means that the independent variables in the model are NPK fertilizer, manure, labor, ... explain 86.4% of the change in rubber latex productivity. On the other hand, we assume that variance inflation factor VIF is in the range of 1 to 5 is less than 10, so there is no multi-collinear phenomena there which means the hypotheses poses in accordance with the model. Thus, the given model is reasonable and suitable with reality at the significance level of α = 1%.

Regression equation (*):

$$Y = 1{,}643.\ X_1^{0{,}134}.X_2^{0{,}409}.\ X_3^{0{,}36}.\ X_4^{0{,}413}.X_5^{0{,}071}.X_6^{(-0{,}253)}.\ .X_7^{0{,}01}.e^{0{,}048.K+0{,}144.D_1+0{,}142.D_2+0{,}181.D_3+0{,}16.D_4}$$

Hay: $LnY = 1{,}643 + 0{,}134.LnX_1 + 0{,}409.LnX_2 + 0{,}36.LnX_3 + 0{,}413.LnX_4 + 0{,}071.LnX_5 + (-0{,}253)LnX_6 + 0{,}01.LnX_7 + 0{,}048K + 0{,}144.D_1 + 0{,}142.D_2 + 0{,}181.D_3 + 0{,}16.D_4$

Table 4 and the regression equation (*) show that the α_i coefficients of manure, pesticides, area, age of rubber plantation and training were all positive with 99% statistical significance; α_i coefficient of NPK fertilizer and labor were positive with the statistical significance of 95%; except for the α_i coefficient of the negative density variable with a statistical significance level of 95%. Thus, in addition to the variable density, the variables included in the model have a positive impact on the productivity of rubber latex production with the significance of α_i <5%, ie the reliability of the explanatory variables above 95%. In terms of each variable, the α_i coefficient of NPK fertilizer equals 0.1134, means that if NPK fertilizer increase 1% when other factors do not change, the yield will increase by 0.113% with significance level α = 0.031 <0.05 means that the reliability is over 95%, so NPK fertilizer has a positive effect on the productivity of rubber latex; the coefficient α_i of manure has a value of 0.409, means that if manure increasse 1% when other factors do not change, the yield will increase by 0.409% with a reliability of over 99%, indicating that manure has a great positive effect on the productivity of rubber latex; The α_i coefficient of pesticides is 0.413, means that if pesticides increase 1% when other factors remain unchanged, the yield will increase 0.413% with the reliability of over 99%. Thus, the influence of NPK fertilizer, manure and pesticides on rubber latex yield is significant, so that households who know how to use fertilizers and pesticides appropriately will increase productivity. The results of this analysis are consistent with the reality of the production of natural rubber in Quang Binh province, many households do not apply NPK fertilizer appropriately, so these households have lower their productivity. On the other hand, many households do not

Table 1. NPV per hectare.

Year	Discount rate (r=9%)	Productivity of latex (kg/ha)	Revenue (1000đ)	Cost	Profit	PV	Accumulated PV
1	0.9174	0	0	16.670	-16.670	-15.293,6	-15.294
2	0.8417	0	0	8.285	-8.285	-6.973,3	-22.267
3	0.7722	0	0	8.145	-8.145	-6.289,4	-28.556
4	0.7084	0	0	8.460	-8.460	-5.993,3	-34.550
5	0.6499	0	0	8.565	-8.565	-5.566,7	-40.116
6	0.5963	0	0	8.970	-8.970	-5.348,5	-45.465
7	0.5470	0	0	9.415	-9.415	-5.150,3	-50.615
8	0.5019	2.700	27.000	28.952	-1.952	-979,8	-51.595
9	0.4604	4.500	45.000	28.314	16.686	7.682,9	-43.912
10	0.4224	6.000	60.000	32.204	27.796	11.741,5	-32.171
11	0.3875	6.400	64.000	32.709	31.291	12.126,4	-20.044
12	0.3555	6.800	68.000	33.240	34.760	12.358,4	-7.686
13	0.3262	6.700	67.000	33.754	33.246	10.844,0	3.158
14	0.2992	6.700	67.000	35.113	31.887	9.542,1	12.701
15	0.2745	6.600	66.000	34.891	31.109	8.540,6	21.241
16	0.2519	6.600	66.000	34.871	31.129	7.840,5	29.082
17	0.2311	6.600	66.000	35.052	30.948	7.151,3	36.233
18	0.2120	6.500	65.000	35.118	29.882	6.334,9	42.568
19	0.1945	6.500	65.000	35.156	29.844	5.804,4	48.372
20	0.1784	6.500	65.000	35.156	29.844	5.325,2	53.697
21	0.1637	6.300	63.000	34.854	28.146	4.607,4	58.305
22	0.1502	6.000	60.000	34.145	25.855	3.882,9	62.188
23	0.1378	5.800	58.000	33.680	24.320	3.350,9	65.539
24	0.1264	5.000	50.000	31.810	18.190	2.299,4	67.838
25	0.1160	4.500	45.000	30.705	14.295	1.657,8	69.496
26	0.1064	4.200	42.000	30.095	11.905	1.266,6	70.762
27	0.0976	3.700	37.000	28.917	8.083	789,0	71.551
28	0.0895	2.900	29.000	26.241	2.759	247,0	71.798
29	0.0822	2.600	26.000	25.598	402	33,0	71.831
30	0.0754	2.500	25.000	24.669	331	25,0	71.856
30	0.0754		110.000		110.000	8.290,8	80.147

Source: Survey data and author's calculation (2019).

know about rubber production techniques, and how to detect and prevent pests, so the use of pesticides to prevent and control is not up to the technical standards with inadequate doses of pests and diseases that lead to low yields. The labor variable with a α_i coefficient of 0.36 means that if labor increase 1% when other factors remain unchanged, productivity will increase by 0.36% with reliability above 95%. This result is consistent with the practice of smallholder rubber production in Quang Binh province because many households do not have sufficient labor to fertilize and exploit properly so these households have lower productivity than those that ensure the number of labor.

Similarly, area variable has a lower impact on the yield of rubber latex, particularly when an increase of 1% of area when other factors do not change, the yield will increase by 0.071% with reliability above 95%. This is inconsistent with the theory as all are calculated per hectare. However, the fact proves that there is a productivity difference between smallholder producers and larger households because smallholder households are often unable to invest in intensive farming, applying scientific and technological advances in planting and harvestings, therefore, increasing 1% of the area increases the productivity of latex production. Similar to the area variable, the age has a α coefficient of 0.01, means that if the age of rubber plantation increase 1% when other factors remain unchanged, the yield will increase by 0.01% with significance level of $\alpha = 0.027 < 0.05$, that means the reliability is over 95%, so it is concluded that increasing the age of rubber plantation also increases productivity. This result is appropriate

Table 2. Benefit - Cost (B/C).

Year	Discount rate r=9%	Revenue	Cost	GTHT (Revenue)	GTHT (Cost)	Accumulated revenue	Accumulated Cost
1	0.9174	0	16.670	0	15.293,58	0.00	15.293,58
2	0.8417	0	8.285	0	6.973,32	0.00	22.266,90
3	0.7722	0	8.145	0	6.289,43	0.00	28.556,33
4	0.7084	0	8.460	0	5.993,28	0.00	34.549,61
5	0.6499	0	8.565	0	5.566,66	0.00	40.116,27
6	0.5963	0	8.970	0	5.348,52	0.00	45.464,79
7	0.5470	0	9.415	0	5.150,33	0.00	50.615,12
8	0.5019	27.000	28.952	13.550,39	14.530,18	13.550,39	65.145,30
9	0.4604	45.000	28.314	20.719,25	13.036,37	34.269,64	78.181,66
10	0.4224	60.000	32.204	25.344,65	13.603,13	59.614,29	91.784,79
11	0.3875	64.000	32.709	24.802,10	12.675,66	84.416,39	104.460,44
12	0.3555	68.000	33.240	24.176,36	11.817,94	108.592,75	116.278,38
13	0.3262	67.000	33.754	21.853,97	11.009,96	130.446,72	127.288,34
14	0.2992	67.000	35.113	20.049,51	10.507,38	150.496,23	137.795,72
15	0.2745	66.000	34.891	18.119,51	9.578,89	168.615,74	147.374,62
16	0.2519	66.000	34.871	16.623,40	8.782,95	185.239,15	156.157,57
17	0.2311	66.000	35.052	15.250,83	8.099,48	200.489,98	164.257,05
18	0.2120	65.000	35.118	13.779,59	7.444,74	214.269,57	171.701,79
19	0.1945	65.000	35.156	12.641,83	6.837,39	226.911,40	178.539,18
20	0.1784	65.000	35.156	11.598,01	6.272,84	238.509,41	184.812,02
21	0.1637	63.000	34.854	10.312,98	5.705,56	248.822,39	190.517,58
22	0.1502	60.000	34.145	9.010,90	5.127,97	257.833,29	195.645,55
23	0.1378	58.000	33.680	7.991,32	4.640,44	265.824,61	200.285,99
24	0.1264	50.000	31.810	6.320,25	4.020,89	272.144,86	204.306,88
25	0.1160	45.000	30.705	5.218,55	3.560,78	277.363,41	207.867,66
26	0.1064	42.000	30.095	4.468,49	3.201,92	281.831,89	211.069,58
27	0.0976	37.000	28.917	3.611,49	2.822,51	285.443,38	213.892,09
28	0.0895	29.000	26.241	2.596,90	2.349,86	288.040,29	216.241,94
29	0.0822	26.000	25.598	2.136,02	2.103,01	290.176,31	218.344,95
30	0.0754	25.000	24.669	1.884,28	1.859,33	292.060,58	220.204,28
30	0.0754	110.000	0	8.290,82	0,00	300.351,41	220.204,28

Source: Survey data and author's calculation (2019).

because rubber is long-term industrial crop, the life cycle lasts about 30 years. In Quang Binh, since the 8th year, rubber trees have been harvested and started to be exploited. This year, the productivity is still low, in the range of 1800 - 2500 kg of fresh latex per ha; by the 9th year, the latex yield is high and reaches about 3,000 - 4800 kg of fresh latex per hectare, from the 10th to the 20th year, the latex yield increases gradually over years ranging from 5,000 to 7000 kg of latex fresh on hectare, but by the 21th year, the rate of productivity growth is moderate, from the 26th year onwards the tree starts to age, productivity starts to decrease. In this model, the author only studies rubber plantation up to the age of 20, so the latex yield of trees increases gradually over the years. Therefore, the results of analyzing the age of rubber plantation on the impact of increasing rubber yield are reasonable and consistent with reality.

Unlike the above variables, the density variable negatively affects the yield of rubber latex. That means when the density increased by 1%, the latex yield decreased by an average of about 0.253% with a reliabily of over 95%. Through research practice, many smallholder rubber households in Quang Binh tend to grow thicker than the recommended density by soil type to prevent trees from dying due to weather and air. However, in fact, many rubber plantation do not face these risks, resulting in high density and households do not perform pruning to ensure the right density so they do not guarantee space for trees to grow, lack nutrients and susceptibility to pests and diseases leads to a lower yield. Therefore, the research results when increasing the density leads to reduce productivity are consistent with the practice.

The training variable with a α coefficient of 0.048 means that under normal production conditions, rubber

Table 3. NPV according to different discount rates.

Discount rate	NPV (1000đ)
0.08	99.723
0.09	80.147
0.10	63.893
0.11	50.347
0.12	39.021
0.13	29.523
0.14	21.537
0.15	14.806
0.16	9.122
0.17	4.315
0.18	243
0.19	-3.209
IRR = 18%	

Source: Survey data and author's calculation (2019).

Table 4. Estimation of Cobb - Douglas production function.

Variables	Impact lavel	t-Stat	P-value	VIF
(LnA) Constant	1.643	1.338	0.184	
X_1 – NPK fertilizer	0.134	2.188	0.031	1.7
X_2 - Manure	0.409	4.454	0.000	2.1
X_3 - Labor	0.360	2.076	0.040	3.2
X_4 - Pesticides	0.413	4.192	0.000	3.0
X_5 - Area	0.071	3.004	0.003	1.1
X_6 - Density	-0.253	-2.234	0.027	1.1
X_7 – Age of rubber plantation	0.010	3.358	0.001	1.8
K - Training	0.048	2.613	0.010	1.1
D_1 – Tay Trach commune	0.144	2.947	0.004	5.4
D_2 - Hoa Trach commune	0.142	3.080	0.003	4.6
D_3 – Viet Trung farm town	0.181	4.192	0.000	4.1
D_4 – Le Ninh farm town	0.160	4.231	0.000	2.9
R^2	0.864			
F	62.176		0.000	

Source: Survey data and author's calculation (2019).

plantation of trained households is higher than that of untrained households with the reliability above 99%. This result is consistent with theory and practice because rubber is a long-term industrial crop requiring planting, tending and exploitation with proper techniques for high productivity, minimizing risks from pests and natural disasters. Therefore, in practice, the trained households often have more production techniques than those who have not been trained, so the productivity of rubber plantations of these households is higher.

Analyzing whether the yield differences between different planting regions or not, the study conducted an analysis of 5 planting areas in two key districts for planting rubber in Quang Binh province, the results show that productivity of Viet Trung Farm Town is higher than other areas and rubber plantation in Phu Dinh commune has the lowest productivity. Under normal production conditions, investing in the same inputs, if an increase of 1% of the inputs, the rubber productivity in Viet Trung Farm Town is higher than that in Phu Dinh commune, Le Ninh Farm Town, Tay Trach and Hoa Trach by 0.181%, 0.021%, 0.037% and 0.039%, respectively with reliability above 99%. Similarly, investing in the same inputs, if increasing 1% of the inputs, the productivity of rubber in Le Ninh farm town is higher than that of Phu Dinh commune, Tay Trach commune and Phu Dinh commune

by 0.16%, 0.016% and 0.018%, respectively, with reliability over 99%. Of the three communes where rubber is planted in Bo Trach district, the rubber plantation in Tay Trach Commune is the most productive. Specifically, investing in the same inputs, if the increase of 1% of the inputs, the rubber productivity in Tay Trach commune is 0.144% higher than in Phu Dinh commune and 0.002% higher than in Hoa Trach commune with reliability over 99%.

In addition to the factors included in the model, latex yield is also influenced by other factors such as weather, varieties, rubber plantation slope and soil type. But these factors are not included in the production function model. Because the households producing and trading rubber trees in Quang Binh province use many different varieties, the accuracy of this variable is not high and the slope of the rubber garden provided by the households is inaccurate and there are regulations on the maximum slope for rubber plantation is not more than 25 degrees.

DISCUSSION

There have been many studies discussing economic efficiency in rubber production, especially in countries with strong rubber plantation and production such as India, Laos, Malaysia, Vietnam, Indonesia, Thailand, and Sri. Lanka. Typically there are a number of research projects such as,A study on the Impact of the Efficiency of Rubber Production on the Welfare of Rubber Farmers in Jambi Province use Cobb-Douglas production function analysis with stochastic fungus production function approach. Results showed that the average rubber farmers in the study area have not been efficient in allocating inputs and not yet prosperous production (Kuswanto et al, 2019). The study examines productivity of rubber in Peninsular Malaysia in a disaggregated form. Data collection 307 observations were used in computing inferential statistics. The results revealed that there is actually a difference in mean TE between the all-age and the matured-age and old-age categories (Aliyu, 2018). The main objective of the study was to figure out, identify and analyse the technical efficiency of rubber smallholders' production in Negeri Sembilan, Malaysia. A parametric Stochastic Frontier Analysis (SFA), with a transcendental logarithmic (Translog) functional form, was used in the study. The inferential statistics showed that, the mean technical efficiency was found to be 0.73 with a standard deviation of 0.089. Thus, this translates that 27% accounted for technical inefficiency (Aliyu et al, 2017). Study evaluates the efficiency level of producing rubber among 95 rubber smallholders in Pahang using the Data Envelopment Analysis (DEA) model, under the assumption of Variable Return to Scale (VRS) and Constant Return to Scale (CRS). The study found the majority of the smallholders were not technically efficient in producing rubber (Ramli and Zulkipli, 2016).

The importance of smallholders in both rubber and oil palm production is the indirect result of the establishment of plantations. Recent historical trends in Malaysia and Indonesia confirm that tied and independent smallholders are perfectly capable to take charge of plantation crop production, even when their yields appear lower than those of estates. This potential could be reinforced through measures such as the provision of training services for the diffusion of best practices along with improved access to finance for intensification and replanting, all of which could have significant impacts on yield improvements (Bissonnette and De Koninck, 2015). Examined the costs and return analysis in rubber latex production in Edo Sate, Nigeria. Multi-stage sampling method was adopted to select 96 smallholder rubber framers for the study. The result of the budgetary analysis indicated that rubber production was profitable in the study area. However, the return on investment of 0.71 indicated a low profit level. The major constraints faced by the farmers were high cost of labour, incidence of pests and diseases, inadequate credit facilities, inadequate extension services among others. It was recommended that extension services should be provide to assist the farmers in tackling the problems associated with pests and diseases as well as training of rubber farmers in the area of management practices in rubber plantation (Ekunwe and Idubor, 2015). Estimated the profitability and the resource use condition of rubber small holders in Nigeria using data collected from 80 randomly selected farmers in Edo, Delta, Ogun and Akwa Ibom state. OLS estimation of the Cobb-Douglas production revealed that farm size, capital and planting material were statistically significant in explaining rubber production. Also, the sum of the elasticities of production (1.079) of the explanatory variables indicates that the rubber farms operate in the inefficient stage. The suggestion are farmers should increase their productivity by integrating their mature rubber plantation with mini-livestocks for increase income and also, agricultural inputs should be made available for agricultural production for increase agricultural output (Mesike and Esekhade, 2015).

Thus, the research on economic efficiency in rubber production and business, the works are mainly discussed in different aspects. Some studies have sample size shortcomings for those who are actually involved in rubber replanting so the results of this study are still inconclusive; Some studies only pay attention to the positive aspects of smallholder rubber business and production but do not represent the average of the smallholder rubber in the study area. There has not been any research on economic efficiency of smallholder rubber business and production model in Quang Binh province. In particular, there are no studies that simultaneously use long-term investment analysis methods with indicators such as NPV, BCR, IRR,

Annualized values and evaluating the factors affecting

the productivity of smallholder rubber through the method. Cobb-Douglas production function analysis to evaluate economic efficiency of smallholder rubber production and business in a locality. Therefore, research and assessment of economic efficiency of smallholder rubber production and business in Quang Binh province ensure newness and creativity; Research has based on the general theoretical basis to form the theoretical basis of the smallholder rubber model and evaluate economic efficiency in rubber production, thereby forming research methods, evaluating economic efficiency. rubber production and business activities and research and evaluation of smallholder rubber models in Quang Binh province. Research results have supplemented and enriched theories about economic efficiency assessment in rubber production and business; is an important reference source for organizations and individuals to research and implement issues related to rubber and rubber production and business; at the same time, they are important practical bases to help smallholder rubber households, local authorities at all levels in Quang Binh have strategies and solutions to improve economic efficiency of rubber, rubber production and business. fill in Quang Binh province.

Conclusions

Assessing the economic efficiency of rubber production plays an important role on investing in rubber production, so there have been many study in this field. However, there has not been any work concurrently performing the method of determining the results, production efficiency and assessing economic efficiency through criteria such as revenue, added value, profit or long-term targets such as NPV, IRR, BCR, at the same time, the Cobb - Douglas production function model was used to evaluate the influence of factors on rubber production productivity.

To achive that goal, the study systematize the theory and practice to evaluate economic efficiency of rubber and smallholder rubber production; identify theoretical basis and research methods to conduct research to evaluate the economic efficiency of smallholder rubber production in Quang Binh province and the influencing factors.

The research results show that Quang Binh province has many favorable conditions for rubber development and the smallholder rubber model has developed strongly, the area has increased rapidly but productivity is low, small in scale, unevenly distributed. In localities, most of them are located in remote areas, investment in resources is limited, production households with low average educational level, not much experience in rubber production and investment capital and limited private. Evaluating economic efficiency through long-term investment analysis method with indicators such as NPV, BCR, IRR, and annualized values shows that the typical rubber model in Quang Binh province has economic efficiency. However, the economic efficiency in the period of 2008 - 2019 has many changes due to the great influence from changes in selling prices and interest rates; smallholder rubber plantations have a great growth in acreage and output, but the yield is not as high as about 0.9 - 1.1 tons of dry latex / ha, lower than other localities with similar conditions as Quang Tri province yield of 1.4 tons of dry latex / ha and Nghe An with a yield of 1.2 tons of dry latex / ha.

Evaluation of factors affecting rubber latex production yield shows that, in addition to density variables, variables included in the model such as fertilizers, labor, pesticides, rubber garden acreage, age of orchards and training all have a significant impact on rubber yield with 95% confidence. In addition, research results also identify different growing areas for different productivity and economic efficiency. Besides the factors included in the model, the research results also determine that latex yield is influenced by other factors such as weather, varieties, rubber garden slope and soil type. However, these factors are not included in the model because the accuracy is not high because smallholder rubber business households in Quang Binh province use many other varieties, households provide inaccurate slope and have the maximum slope for rubber plantations is no more than 25°.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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