เอกสารหมายเลข 4

Economic Performances of Small Holding Rubber-based Farms in Southern Region Thailand: Case study in Khao Phra, Phijit, and Khlong Phea communities Songkhla Province

Parinya Cherdchom[1] Paratta Prommee[2] and Buncha Somboonsuke[3]

ABSTRACT

Rubber small holding farms, presently, were forced to adapt to maintain economic viability under the economic crisis in South East Asia. The results were founded that four systems of rubber based farms, namely, rubber-intercrop farming system, rubber-fruit tree farming system, rubber-livestock farming system and rubber-integrated framing system show better economic performances with greater gross margin, higher net farm income, and better justification as evidenced by investment appraisal than other farm types, especially in cases of the sub-systems including rubber-pineapple farming system (R_{21}) Rubber–durian-mangosteen farming system (R_{43}), rubber–durian-mangosteen-rambutan farming system (R_{44}), rubber-chicken farming system (R_{53}), and Rubber–durian-fishery farming system (R_{61}). These system are, therefore, appropriate for promoting extension service in the rubber growing area in Thailand.

Key words: farming system economics, rubber-based farm, rubber small holder, economic performance, and economic development.

INTRODUCTION

Rubber is a economic crop in southern, Thailand, which has helped sustainability the development of quality of life and the increase in family income of rubber small holder in Thailand (RRIT, 1999). In during economic crisis of 1997, Thai rubber small holders were forced to adjust their farming strategies to maintain viability and remain sustainable. These adjustments were including economic adjustment, and social adjustment toward increasing their farm productivity and efficiency. However, small holding rubber-based farming system, presently, has forced with many challenges with have impacted the productivity and efficiency such as deficient direction of economic evaluate situation and deficient understanding of causal agents of their expenses and incomes. The purpose of this paper was to describe the approach of the economic analysis of small holding rubber-based farming system for finding what systems are excelled economic performance.

The Objectives of this paper
1. Evaluate the economic performance of small holding rubber-based farming system by means the calculation of net farm income and relative measurement, farm efficiency measurement, farm capacity and productivity, and investment appraisal.

---

[1] Department of Agricultural and Resource Economics, Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songkhla 90112, Thailand.

[2] Department of Agricultural and Resource Economics, Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songkhla 90112, Thailand.

[3] Department of Agricultural Development, Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songkhla 90112, Thailand.

2. Recommendation the appropriate alternative rubber-based systems which show excelled economic performance for extension.

LITERATURE REVIEW

1. Rubber farming system

Rubber farming system is one of cropping systems. In rubber farming system, there are comprises two factors, namely, endogenous factors and exogenous factor (Ruthenberg, 1980:Spedding, 1998) Endogenous factors are bio-physical components that direct impact on smallholding farms' plan and implementation strategies such as rubber yielding breed, smallholder' decision making process and empowerment (skill, knowledge and attitude) soil and soil fertility farms' management practices, input factor (farms' capital for investment, labor, fertilizer), including farms' production and yield. While the exogenous factors are comprises the some physical and economic factors that indirect impact on smallholding farms' plan and implementation strategies and largely out of control such as climate, temperature, the quantity of rain, natural resources socio-economic factor such as marketing and processing system marketing plan and policy including the service. The changing of two factors is impact on smallholding farms' adjustment under the current farms' situation. (Figure 1)

2. Rubber small holding system

The rubber small holding system is usually interplant with fruit, coconuts and annual crop (as mixed cropping). The trees do not always form continuous stands but may be in clumps separated by other vegetation. Beyond the environs of the small holders' house. The mixed stand of rubber and other crop (mixed crop) usually give away to a pure stand of rubber in the midst of tall undergrowth. Rubber small holding farm in Thailand average between 0.3 ha and 8.0 ha, Malaysia average between 1 ha and 3 ha, Indonesia average between 1 ha to 4 ha, India average between 1 ha to 20 ha that similar to Sri Lanka average farm size. In contrast with estate planting (300 tree per hectare), final-stand planting on small holdings is usually very dense, with 500-900 trees per hectare, disregarding higher labor input. while estates try to economize on labor by aiming at high yield per tree. Rubber tapping is not necessary a regular task and this make rubber such as attractive crop for small holders. since, during the peak rice-planting and rice-harvesting seasons little labor need be devoted to rubber. Small holders prefer to tap when time permits or when cash is needed, although irregular tapping may lower average returns. In some cases, small holders tap only during periods when schools are closed-weekends and vacation. Another advantage of rubber for small holders lies in the possible employment of farm family labor at low costs. Small holders use unselected seeding. Usually, they do not receive maximum yields because of poor cleaning, Lack of managing, irregular tapping, over tapping when cash is needed and often wasteful tapping techniques. They are, however, low-cost products, and so are competitive with estates and return per hour of work compare favorably with arable crops. Whereas estates are severely by falling prices, small holders may cultivate other crops more intensively or keep up animal such as sheep, cow and poultry and in the meantime trees may rest for rejuvenation, to produce larger yields when rubber prices rise (Ruthenberg,1980:Barlow,1978)
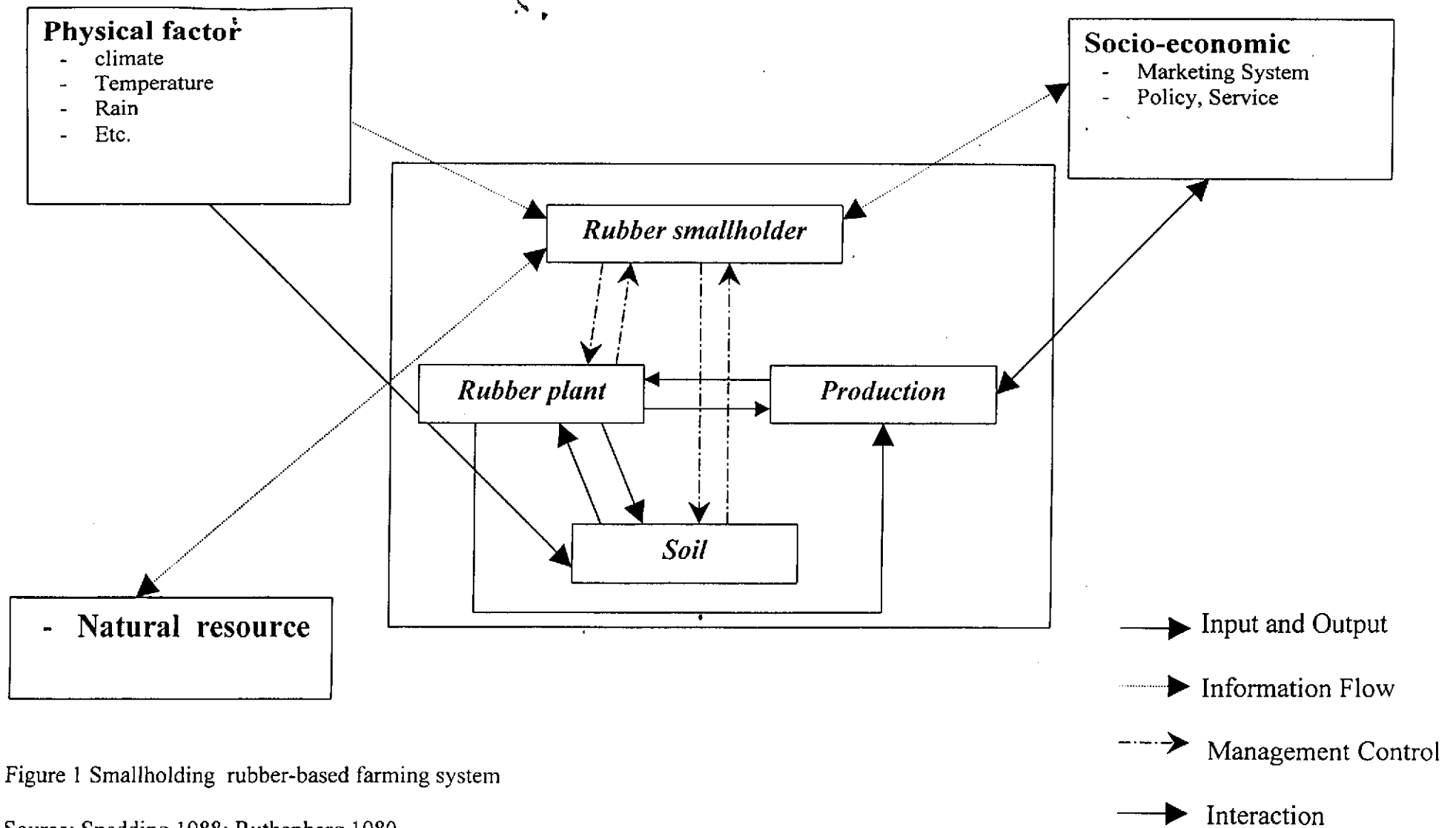
Figure 1 Smallholding rubber-based farming system

Source: Spedding,1988: Ruthenberg,1980

3. Typology of small holding rubber based farming system in Thailand

The rubber holding in Thailand can be classified into three different sizes namely; small middle and large size, small size farm with the area between 0.32-8.0 hectares comprised of 1,012,000 farms or 93.0% of total rubber holdings in country in 1999 with an average farm size of 2.08 hectares. The middle size farm with the area between 8.01-40.0 hectares comprised of 73,000 farms or 6.7% of total rubber holdings in country and the average of farm size were 9.6 hectares, while the large size farm comprised of 3,000 farms or 0.3% of total rubber holdings with an average farm size of 63.2 hectares. (RRIT,1999)

In addition, there are various criteria of classification the typology of small holding rubber based Farming system such as

Thungwa (1998) classified three types of small holding rubber based farming system based on the number of associated crop with rubber following; (1) Rubber plantation with associated one cash-production crop. (2) Rubber plantation with two other cash-production crops, and (3) Rubber plantation with tree or more other cash-production crops grown in various patterns between the truck and/or row of rubber trees.

Kjonchaikun (1995) classified small holding rubber based farming system based on type of crop that are usefulled in supplementing the household income; (1) Rubber-intercropping system, (2) Rubber-covercrop system, (3) Rubber-orchid system. and(4) Rubber-multicrop.system.

Nissapa and et.al (1994) classified the types of small holding rubber based farming system in southern Thailand; (1) The jungle rubber community, (2) Tradition jungle rubber (3) Economic rubber system, and (4) Rubber monocultured system.

Somboonsuke and Shivakoti (2001) classification the six current main types of small holding rubber-based farming systems (R) in Southern Thailand based on the criteria of individual farm's agricultural production activity, socio-economic structure and agroecozone ; (1) Small holding rubber-monoculture farming system (R_1), (2) Small holding rubber-intercrop farming system (R_2), (3) Small holding rubber-rice farming system (R_3), (4) Small holding rubber-fruit tree farming system (R_4), (5) Small holding rubber-livestock farming system (R_5), and (6) Small holding rubber-integrated farming system (or rubber-integrated activity farming system)(R_6)

METHODOLOGY

The Study area was Songkhla province that was divided the area into three agroecozones based on the criteria of topography, biodiversity, and socio-economic characteristics. Three communities were selected by purposive sampling method; Khao phra , Phijit, and Khlong Phea communities, receptively. The economic analysis of the representative small holding rubber-based farming systems were as net farm income and relative measurement, farm efficiency measurement, the measurement of farm financial capacity and productivity and investment appraisal, respectively.(Johl and Kapur,1992) Simple random sampling technique was small holding farms to select 177 farms for net farm income and relative measurement and 379 farms for measurements of farm efficiency measurement and investment appraisal that coverage 25 farming system cases from six main type of small holding rubber-based farming system for economic analysis: net farm income and relative measurement. Selection the systems that are show the excelled economic performance to analyze farm efficiency measurement, measurement of farm financial capacity and productivity and investment appraisal from collection data in 379 farms.

1. The concept of economic analysis

The economic performances of the small holding rubber-based farming systems were identified through calculation of net farm income and relative measurement such as gross margin analysis, return to family labor, return to fixed cost, and return to variable cost. and investment appraisal. The result of these have been the basis for evaluating the economic status of small holding rubber-based farming system. (Johl and Kapur.1992)(Figure 2).
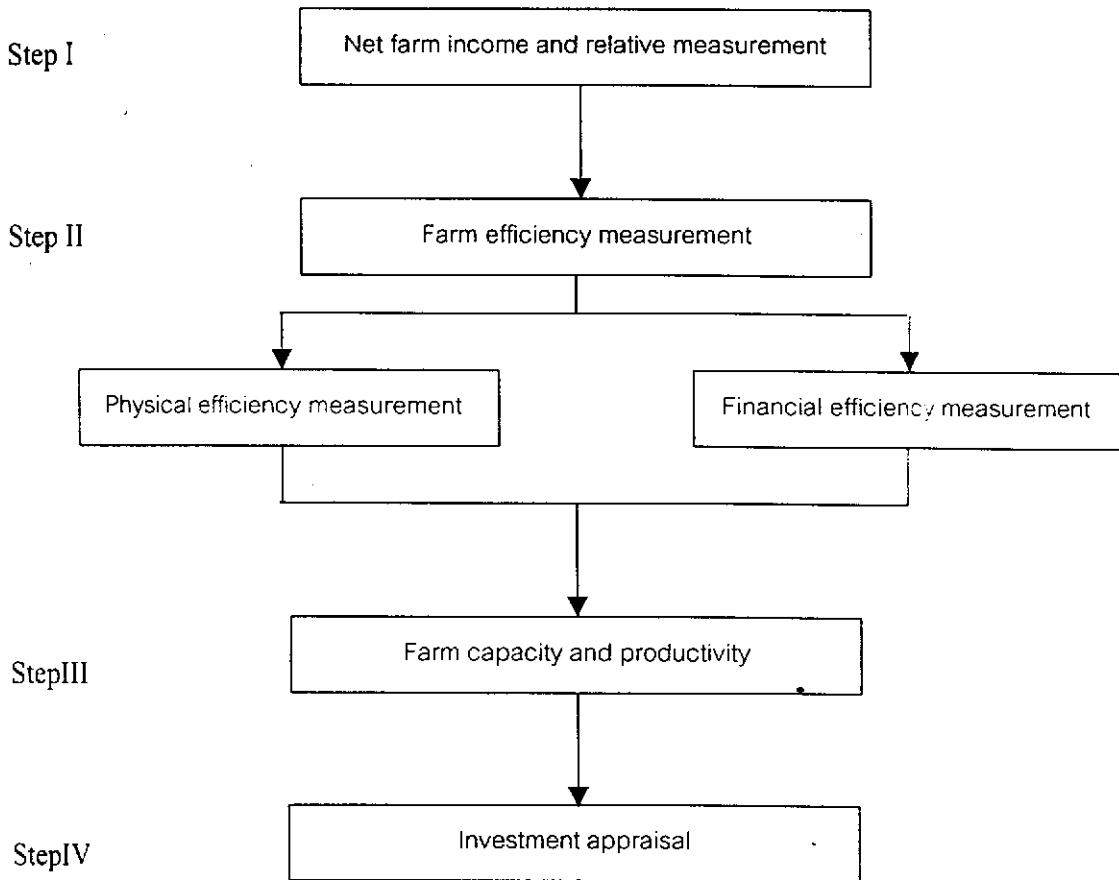

Figure2 Conceptual framework of rubber-based farming system
Source: Johl, S. S. and Kapur. T.R.. 1992.

1.1   Net farm income and relative measurement

Net farm income has been used in the context of "measure of rubber small holding farm performance". It is calculated as the total gross output per farm by computing the value of all farm products and deducting the total variable costs. By using net farm income (NI), one can derive further relative measures of economic performances such as productivity, which are then used to compare factors such as family labor input or total cash cost. etc. Several relative measurements of economic performances of small holding rubber-based farms were used which included gross margin (GM), return to family labor (NFL), return to fixed cost (RFC) and return to variable cost (RVC).

gross margin (GM) = total gross output − total variable cost

$$\text{return to family labor (RFL)} = \frac{\text{gross output} - \text{variable cost expect labor}}{\text{amount of labor}}$$

$$\text{return to fixed cost (RFC)} = \frac{\text{gross output}}{\text{total fixed cost}}$$

$$\text{return to variable cost (RVC)} = \frac{\text{gross output}}{\text{total variable cost}}$$

1.2 Farm efficiency measurement

Farm efficiency measurement is important for small holding farm business management and the small holder decision making process relate to the manner in which available farm resources are allocated vis-a-vis the objectives of the small holder. Farm efficiency is divided into two measures, the physical efficiency measurement and the financial efficiency measurement, for comparison among the small holding systems, and this study has used both aggregate and ratio measures for analyzing farm efficiency.

Measure of physical efficiency

$$\text{production efficiency (PE)} = \frac{\text{production per hectare of farm} \times 100}{\text{average production per hectare of farm in community}}$$

$$\text{crop yield index (CY)} = \frac{\text{yield of crop in farm} \times 100}{\text{average yield of all farm in community}}$$

$$\text{cropping intensity (CI)} = \frac{\text{area croped} \times 100}{\text{total cultivated area}}$$

$$\text{total labor per area (LPA)} = \frac{\text{total man - equivalent}}{\text{total cultivated area}}$$

$$\text{crop area per man (C.A.P.M)} = \frac{\text{total area in crops}}{\text{man - equivalent}}$$

$$\text{productive man-work unit per man-equivalent (P.M.W.U)} = \frac{\text{total P.M.W.U}}{\text{man - equivalent}}$$

Measure of financial efficiency

$$\text{Gross output per gross input} = \frac{\text{total gross output}}{\text{total gross input}}$$

$$\text{Fertilizer cost per cultivated area} = \frac{\text{total fertilizer}}{\text{total cultivated area of farm}}$$

$$\text{M.P and E investment per crop area} = \frac{\text{total machinery investment}}{\text{total cultivated area}}$$

Cost Ratio:

$$\text{- operation cost ratio} = \frac{\text{total operation cost}}{\text{total profit}}$$

$$\text{- fixed cost ratio} = \frac{\text{total fixed cost per year}}{\text{gross profit}}$$

$$\text{- gross cost ratio} = \frac{\text{total expense}}{\text{gross profit}}$$

$$\text{- cost per area} = \frac{\text{total expenses}}{\text{unit of area}}$$

Income Ratio:

$$- \text{Net income per area} = \frac{\text{total net income}}{\text{total area}}$$

$$- \text{Net farm income per farm labor} = \frac{\text{total net income}}{\text{man - eqivalent}}$$

1.3 The measurement of farm financial capacity and productivity

Further measures of productivity such as rate of return to capital and farm equity capital are employed to analyze farm efficiency.

measure of farm productivity

$$\text{rate of return to capital (RRC)} = \frac{\text{(net farm earning - value of family labor)}}{\text{total farm capital}} \times 100$$

$$\text{rate of return to farm equity capital (RRFEC)} = \frac{\text{(net farm earning - value of family labor)}}{\text{total farm equity}} \times 100$$

measure of financial capacity

self financing capacity and debt servicing capacity

method:

+ net farm income

- depreciation

- family expenses

= self financial capacity

- repayment of interest

= debt servicing capacity

1.4 Investment appraisal analysis

For the investment appraisal, benefit and cost analysis including net present value, internal rate of return are used for assessing the economic characteristics of proposed farm projects.

$$\text{benefit and cost analysis (B/C)} = \frac{\dfrac{b1}{(1+i)^1} + \dfrac{b2}{(1+i)^2} + ... + \dfrac{bn}{(1+i)^n}}{\dfrac{c1}{(1+i)^1} + \dfrac{c2}{(1+i)^2} + ... + \dfrac{cn}{(1+i)^n}}$$

$$\text{net Present value (NPV)} = \left| \frac{b1}{(1+i)^1} + \frac{b2}{(1+i)^2} + ... + \frac{bn}{(1+i)^n} \right| - \left| \frac{c1}{(1+i)^1} + \frac{c2}{(1+i)^2} + ... + \frac{cn}{(1+i)^n} \right|$$

internal rate of return (IRR)

$$0 = \text{inv} + \frac{b1}{(1+i)^1} + \frac{b2}{(1+i)^2} + ... + \frac{bn}{(1+i)^n}$$

Where $\dfrac{1}{(1+i)^n}$ = the discount factor that is the process of finding the present worth of a future income is called discounting

b = annual benefit

c = annual cost

n = number of year
i = Rate of interest
inv = investment project

RESULTS AND DISCUSSIONS

1. Net farm income (NFI) and relative measurement

Table 1 shows that the rubber cultivation as monocultured cultivation has the lowest benefit while the rubber cultivation associated with other activities has more benefit. This was confirmed in R_2, R_4, R_5, and R_6 systems. The results found in R_{21} system (Rubber-pineapple farming system) show the excellent economic performance as Net Farm Income (NFI), Gross Margin (GM), Return to Family Labor (RFL), Return to Fixed Cost (RFC) and Return to Variable Cost (RVC).For NFI, it was found that R_{64} system (Rubber-Durian-Fishery farming system) has the highest economic performance with 114,829.26 baht/year. But, it uses more farm's resources and high cost of input factor. This result shows higher total cost of 169,872.00 baht/ha/year.The second rank was R_{63} system (Rubber–rice-durain farming system) with the value of 91,571.64 baht/ha/year. The third rank was R_{21} system (Rubber–pineapple farming system) with the value of 79,752.62 baht/ha/year Small holders in this system are more business-oriented than other R_2 systems. The pineapple market system is efficient and production is normally sent to industry system. However, small holders use high cost of input factor that confirmed the total cost with 37,503.58 baht/ha/year. The R_4 systems (Rubber-fruit tree farming system) also have the excellent NFI. It was found that R_{412} (Rubber-Durian system), R_{413} (Rubber-Mangosteen farming System), R_{421} (Rubber-Durian-Mangosteen System), and R_{432} (Rubber-Durian-Mangosteen-Rambutan farming System) have the excellent NFI with 35,093.97, 22,597.46, 64,601.20 and 61,683.14 baht/ha year, respectively. However, this system uses high investment. In R_5 systems (Rubber-livestock farming system), it was found 3 sub-systems have similarly high NFI, but lower than R_4 systems because R_5 systems normally use higher cost of production and more management skill than R_4 systems. In Gross Margin Analysis, the highest gross margin value was found in R_{64} system (Rubber-Durian-Fishery farming System) with the value of 132,908.11. Also, the results show that nine systems (R_{63}, R_{21}, R_{421}, R_{432}, R_{424}, R_{422}, R_{412}, R_{423}, and R_{413}) also have the high gross margin value when compared among within systems. In RFL, it implies the labor's ability in production system, and the unit of labor used in farm's operation that small holders can get unit of output. Table 1 shows that R_4 systems show high value of RFL, which means the ability of labor in this systems is higher than those in other system. Especially, R_{412} (Rubber-Durian system) has the highest NFL of 10.40 units. It means that with 1 unit of labor used in farm's operation, small holders can get 10.40 units of output. R_2 systems and R_6 systems have lower value. RFC and RVC show the ability to return cost of production as relationship between the unit of investment cost (fixed cost and variable cost) and the unit of profit or output that small holders can get. The results show that R_2, R_3, and R_5 systems have high value of RFC because small holders in these systems have used a little equipment and building in operation, confirmed by the value of RVC that was quite low due to use of the high variable cost of production.

Table 1 Net farm Income and relative measurements of small holding rubber - based farming systems.

Measurement	R_1 (n=22)	R_2 (n = 33)				R_3 (n=23)		R_4 (n=34)				
								R_{41}				
		R_{21}	R_{22}	R_{23}	R_{24}	R_{31}	R_{32}	R_{411}	R_{412}	R_{413}	R_{414}	R_{415}
1. Total cost (baht/ha/yr)	26,513.74	37,503.58	29,384.00	24,428.00	33,231.48	21,190.07	38,464.15	51,801.89	51,117.79	53,009.21	50,441.13	50,240.51
2. Total variable cost (baht/ha/yr)	20,064.27	30,076.91	25,957.33	20,147.33	29,211.04	20,176.39	35,409.93	43,053.46	42,383.85	43,773.6	41,964.63	41,801.61
2.1 Cash	15,188.65	22,768.22	19,649.70	15,251.53	22,112.76	15,273.53	26,805.32	32,591.47	32,084.57	33,136.62	31,767.22	31,643.82
2.2 Non - cash	48,75.61	7,308.68	6,307.63	4,895.80	7,098.28	4,902.86	8,604.61	10,461.99	10,299.27	10,636.98	10,197.40	10,157.79
3. Total fixed cost (baht/ha/yr)	6,449.47	7,426.67	3,426.67	4,280.67	4,020.44	1,013.68	3,054.22	8,748.43	8,733.94	9,235.61	8,476.50	8,438.90
4. Total gross output (baht/ha/yr)	41,300.51	117,256.2	34,000.00	26,057.66	36,000.00	23,973.21	40,141.44	62,106.37	86,211.76	75,606.67	66,606.67	67,749.23
5. Net farm Income (baht/ha/yr)	14,786.77	79,752.62	4,616.00	1,629.66	2,768.52	2,783.14	1,677.29	10,304.48	35,093.97	22,597.46	16,165.54	17,508.72
6. Gross margin (GM) (baht/ha/yr)	21,236.24	87,179.34	8,042.67	5,910.33	6,788.96	3,796.82	4,731.51	19,052.91	43,827.91	31,833.07	24,642.04	25,947.62
7. Return to family labor (RFL)	8.94	7.52	1.68	1.22	1.34	1.87	2.92	8.10	10.40	9.20	9.00	9.12
8. Return to fixed cost (RFC)	6.40	15.79	9.92	6.09	8.95	23.65	13.14	7.10	9.87	8.19	7.86	8.03
9. Return to variable cost (RVC)	2.06	3.90	1.31	1.29	1.23	1.19	1.13	1.44	2.03	1.73	1.59	1.62

Source : Field survey,2000

Remark : The cost of production in calculated in terms of baht per hectare per year. and uses the average price for ten years of cultivation (1990-1999) from RRIT,1999

R : Smallholding rubber-based farming system with R_1 : Rubber-monocultured farming system, R_2 : Rubber-intercrop farming system
With R_{21}: Rubber-pineapple farming system, R_{22} : Rubber-sweet corn farming system, R_{23} : Rubber-rice farming system and R_{24} : Rubber-banana farming system
R_3 : Rubber-rice farming system with R_{31} : Rubber-rice in the same plot of rubber farming system (pattern I) and R_{32} : Rubber-rice in different plot of rubber (Pattern II)
R_4 : Rubber-fruit tree farming system with R_{41} : Rubber with one associated fruit tree ; R_{411} : Rubber-rambutant farming system, R_{412} : Rubber-durian farming system,
R_{413} : Rubber-mongosteen farming system, R_{414} : Rubber-longkong farming system and R_{415} : Rubber-pistole farming system

Table 1(continued): Net farm income and relative measurements of small holding rubber-based farming systems.

| Measurement | R4 (n=34) | | | | | | R5 (n=33) | | | R6 (n=32) | | | |
| | R42 | | | | R43 | | | | | | | | |
	R421	R422	R423	R424	R431	R432	R51	R52	R53	R61	R62	R63	R64
1. Total cost (baht/ha/yr)	57,610.56	56,403.23	55,042.47	56,933.89	62,136.89	60,327.92	112,406.53	95,186.53	86,736.53	154,750.90	189,501.37	48,486.12	169,872.00
2. Total variable cost (baht/ha/yr)	47,722.78	4,7002.63	45,913.80	47,303.55	52,341.36	50,532.58	101,383.20	77,433.20	60683.20	130,720.05	176,360.60	32,898.45	151,793.15
2.1 Cash	36,126.14	35,580.99	34,756.75	35,808.79	39,622.41	38,253.16	76,747.08	58,616.93	45937.18	98,955.08	133,504.97	24,904.13	114,907.41
2.2 Non - cash	11,596.64	1,1421.64	11,157.05	11,494.76	12,718.95	12,279.42	24,636.12	18,816.27	14746.02	31,764.97	42,855.63	7,994.32	36,885.74
3. Total fixed cost (baht/ha/yr)	9,887.78	9,400.60	9,128.63	9,630.04	9,795.53	9,795.34	11,023.33	17,753.33	26,053.33	24,030.85	13,140.77	15,587.67	18,078.85
4. Total gross output (baht/ha/yr)	122,211.76	95,011.76	77,746.57	101,945.29	78,670.21	122,011.76	132,286.39	109,286.29	107,286.39	171,786.36	204,830.98	140,057.76	284,701.26
5. Net farm income (baht/ha/yr)	64,601.20	38,608.53	22,704.10	45,011.40	16,533.32	61,683.84	19,879.86	14,099.76	20,549.86	17,035.46	15,329.61	91,571.64	114,829.26
6. Gross margin (GM) (baht/ha/yr)	74,488.98	48,009.13	31,832.77	54,641.74	26,328.85	71,479.18	30,903.19	31,853.09	46,603.19	41,066.31	28,470.38	107,159.31	132,908.11
7. Return to family labor (RFL)	9.00	8.95	9.42	9.28	8.60	8.22	2.68	3.39	4.89	2.54	2.2	2.72	5.37
8. Return to fixed cost (RFC)	12.36	10.11	8.52	10.59	8.03	12.46	12.00	6.16	4.12	7.15	15.59	8.99	15.75
9. Return to variable cost (RVC)	2.56	2.02	1.69	2.16	1.50	2.41	1.30	1.41	1.77	1.31	1.16	4.26	1.88

Source : Field survey,2000

Remark : The cost of production in calculated in terms of baht per hectare per year, and uses the average price for ten years of cultivation (1990-1999) from RRIT.1999

R : Smallholding rubber-based farming system with R_{42} : Rubber with one associated fruit tree ; R_{421} : Rubber-durian-mangosteen farming system,

R_{422} : Rubber-durian-rambutan farming, R_{423} : Rubber-durian-longkong farming system and R_{424} : Rubber-mangosteen-longkong farming system

R_{43} : Rubber with more than two associated types of fruit tree: R_{431} : Rubber durian longkong rambutan framing system,

R_{432} : Rubber-durian-mangosteen-rambutan farming system, R_5 : Rubber-livestock farming system with R_{51} : Rubber-cattle farming system, R_{52} : Rubber-goat farming system

and R_{53} : Rubber-chicken farming system, R_6 : Rubber-Integrates farming system ; with R_{61} : Rubber-friuttree-livestock (goat+chicken) farming system (Pattern I)

R_{62} : Rubber-rice-livestock (cattle) Farming system (Pattern II), R_{63} : Rubber-rice-friuttree (durian) farming system (Pattern III)

R_{64} : Rubber-fruittree-fishery farming system (Pattern IV)

2. The Farm efficiency measurement

The results in Table1 show that there were founded the 11 representative systems show the excelled net farm income and relative measurement so, these systems were selected and identified farm efficiency measurement in terms of Physical Efficiency Measurement and Financial Efficiency Measurement(Table 2).

2.1 Physical efficiency measurement

It was found R_{52} systems (Rubber-livestock farming system), and R_{413} systems (Rubber-Fruit tree farming system) show the high percentage of production efficiency (PE) that correlate with crop year index (CY1). It indicated that land use of R_4 systems was the most efficient when compared with other systems. The result, also, shows the correlation with labor efficiency measurement. It was found R_4 systems, especially R_{412} and R_{413} show the high total labor md./ha/year with the value of 193 and 178 md./ha/year respectively. Also it was found R_5 systems and R_6 system especially, in R_{51} and R_{64} have 198 and 173 md./ha/year, respectively. In comparison of productivity of manpower (Full-time worker), it was found that R_{21} system (Rubber-pineapple system), R_{432} system (Rubber-durian-mangosteen-rambutan system) and R_{64} system (Rubber-durian-fishery system) show high values with 54.44, 71.22 and 60.88 kg/md., respectively. The summary shows that though the systems have high land use efficiency, their labor efficiency is quite low. This is because these systems require more labor, that leads to high cost of production.

2.2 Financial efficiency measurement

In aggregate measurement, the results show that R_4-systems (R_{41}, R_{42}, R_{43}, and R_{44} systems) have the excellent economic performance in NFI, total operation cost, and total variable cost. However, these systems also have high total cost of production. R_1 system and R_3 system show quite low economic performance. This is because the monoculture crop cultivation, normally, does not require complicate management and more input factor and equipment.In ratio measurement, there are 5 financial measurements for the farm's efficiency to set plan and implementation strategy and decision making process. The measurements are as follow: (1) Gross output per gross input that measures the ability to investment, (2) Fertilizer cost per cultivated area that measures the use of fertilizer per farm's size, (3) Machinery cost per area that measures the total cost of machinery in operation per farm's size, (4) Cost ratio, and (5) Income ratio that measures the financial capacity of farms in production system.

In gross output per gross input, it was found all systems showing profitable operation. Especially in R_4, R_5, and R_6 systems, they show high values, which means that with one unit of cost of input, small holders can get one unit of output. It indicated that the higher value of ratio, the more profitable operation. For the fertilizer per area, it was found R_5 systems show the high value. Especially, R_{51} systems (Rubber-cattle system) have the highest value of 20,495.70 kg/ha. In the machinery cost per area, it was found R_4, R_5, and R_6 systems show high ratio of machinery cost per area, which indicated that these systems normally have more use of farm's energy than other systems.

In cost ratio, the purpose is to indicate strong or week points in the organization or operation of farm's business. There are 4 cost ratios that were measured as following: (1) *Operation cost ratio* measuring that every unit of farm's outcome, small holders have to pay one unit of operation cost. However, it may also increase or decrease because income may be increased or decreased due to product price changes; (2) *Fixed cost ratio* measuring that every single unit of farm's outcome, small holders have to pay one unit of fixed cost in production system; (3) *Gross cost ratio* measuring that every unit of outcome, small holders have to pay

one unit cost of expenses; and (4) *Cost per area* measuring the with one unit of actual cultivated area, small holders have to pay one unit of total farm expense.

The result shows that R_{21} systems (Rubber-pineapple system) and R_{432} system (Rubber-Durian-Mangoteen-Rambutan system) have low value of operation cost ratio with 0.25 and 0.20, respectively. This means one unit of farm's outcome, small holders have to pay 0.25 and 0.20 units of operation cost, which show the efficiency of using operation cost. While R_{53} system (Rubber-goat system) and R_{64} (Rubber-Durian-fishery system) have high value of operation cost ratio with value of 0.72 and 0.67. It indicated that R_{53} and R_{64} are less efficient in using operation cost than R_{21} and R_{432} system. This result is similar to result of gross cost ratio. It was found that R_{21} and R_{432} show low value of gross cost ratios with 0.30 and 0.21, which reveals the most efficient use of farm's expense per one unit of farm's output.

For cost per area, it was found that R_4, R_5 and R_6 systems show high value of cost per area, indicating that these systems pay high cost of expense per one unit of cultivated area, while R_1, R_2, and R_3 systems show low value of cost per area.

For income ratio, there are two measures: *Net Farm Income per area* that shows the farm's efficiency to get net benefit per one cultivated area, *and Net Farm Income per farm's labor* that shows the labor's efficiency to get benefit in operation per man equivalent. The result shows that R_4, R_5 and R_6 systems show high value of net farm income per area while R_1, R_2, and R_3 systems show low value of net farm income per area. This result was similar to net farm income per man equivalent.

From above results of farm efficiency measurement, it indicated that R_2 systems (Rubber-pineapple farming system), R_4 systems (Rubber-fruit tree farming system), R_5 systems (Rubber-livestock farming system) and R_6 systems (Rubber-Durian-Fishery farming system) show the excellent farm efficiency measurement that they should be offered to small holders.

Table2 Farm Efficiency Measurements of Small holding rubber-based farming systems.

Measurement	Small holding rubber-based farming systems										
	R_1	R_{21}	R_{32}	R_{412}	R_{413}	R_{421}	R_{432}	R_{51}	R_{52}	R_{53}	R_{64}
	(n=33)	(n=44)	(n=44)	(n=32)	(n=36)	(n=22)	(n=28)	(n=42)	(n=34)	(n=27)	(n=37)
1.Physical eefficiency measurement											
1.1 Aggregate measure											
1.1.1 Total area(ha) (Household area)	3.76	4.00	6.12	4.48	4.98	5.78	6.58	6.00	3.15	3.00	7.13
1.1.2 Total agricultural area(ha)	2.57	3.16	3.8	2.75	2.25	2.36	2.08	2.63	3.58	3.11	3.12
1.1.3 Total production(kg/year)	278,6.97	7,403.63	4695.07	663,8.53	441,6.92	5,790.82	12,036.60	8,683.31	8,770.74	5,008.89	10,532.43
1.2 Ratio measurement											
1.2.1 Land use efficiency											
1.2.1.1 Production efficiency(PE.)(%)	115	113.7	91.0	136.5	145.4	133.4	123.4	150.0	156.5	121.5	121.5
1.2.1.2 Crop year index (CYI)(%)	114	110.5	84.0	140.1	144.5	139.2	107.6	-	-	112.2	112.2
1.2.1.3 Cropping intensity (CI)(%)	93.1	72.5	101.0	98.1	97.3	81.5	72.2	-	-	92.3	92.8
1.2.2 Labor efficiency measurement											
1.2.2.1 Total labor(md/ha/yr)	148	136	165	193	178	171	169	198	175	175	173
1.2.2.2 Crop area per man equivalence(ha/md)	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
1.2.2.3 Productive manwork Unit(kg/md)	18.83	54.44	28.45	34.40	24.81	33.86	71.22	43.86	50.12	28.62	60.88
2. Financial efficiency measurement (baht/yr)											
2.1 Aggregate measure											
2.1.1 Total capital management (baht/yr)	6,449.47	3,426.67	3,162.67	3,652.67	3,153.85	5,011.25	4,454.76	8,350.64	7,770.00	8,045.11	9,280.85
2.1.2 Gross expense (baht/yr)	10,329.15	7,554.55	1,049.09	15,174.38	7,689.86	6,760.68	88,75.5	10,743.45	9,373.59	8,193.93	13,655.73
2.1.3 Gross income (baht/yr)	48,827.71	62,930.85	61,476.63	137,145.13	92,251.58	122,223.35	254,049.25	182,349.51	187,255.29	106,939.80	244,464.76
2.1.4 Net farm income (bath/yr)	6,629.47	15,991.05	1,055.22	8,733.94	9,235.61	9,907.78	9,795.33	26,073.33	11,023.33	17,753.33	38,078.85
2.1.5 Total operation cost(baht/yr)	22,133.97	31,427.27	25,011.48	86,027.34	39,242.37	64,612.79	19,1912.36	95,592.98	74,848.76	11,753.27	54,592.76
2.1.6 Total fixed cost (baht/yr)	20,064.27	15,512.53	35,409.93	42,383.85	43,773.6	47,702.78	52,341.56	60,683.2	101,383.20	77,433.20	151,793.15
2.2 Ratio measures											
2.2.1 Gross output per Gross input	0.21	0.12	0.02	0.11	0.08	0.06	0.03	0.06	0.05	0.08	0.06
2.2.2 Fertilizer per Area (kg/ha)	4,597.27	5,688.40	9,200.60	3,659.90	3,716.50	5,825.30	6,606.60	20,495.70	18,745.10	19,945.70	4,207.92
2.2.3 Machinery cost per Area (baht/ha)	1,961.70	357.70	642.50	1428.50	1,285.10	1,539.50	2,008.30	5,000.50	2,150.00	4,000.00	1,963.53
2.2.4 Cost ratio											
2.2.4.1 Operating cost ratio	0.41	0.25	0.57	0.31	0.47	0.39	0.20	0.33	0.54	0.72	0.67
2.2.4.2 Fixed cost ratio	0.13	0.05	0.05	0.03	0.03	0.04	0.01	0.04	0.04	0.07	0.04
2.2.4.3 Gross cost ratio	0.54	0.3	0.62	0.34	0.5	0.43	0.21	0.37	0.58	0.79	0.61
2.2.4.4 Cost per area	10,316.63	9,969.49	9,596.09	18,588.28	23,559.65	24,411.34	29,873.5	32,987.27	31,404.06	30,606.60	54,446.15
2.2.5 Income ratio											
2.2.5.1 Net farm income per area (baht/ha)	2,579.560	5,060.45886	277.6894737	3,175.97818	4,104.71556	4,198.21186	4,709.29327	9,913.81369	3,079.14246	5,708.46624	12,204.7596
2.2.5.2 Net farm income per farm labor (baht/md)	150.77	231.08	151.58	445.74	220.46	377.85	1,135.58	482.79	406.78	67.16	315.56

Source : Field Survey, 2000 From 379 Small holding forms in three Communities of Songkhla Province

3. Measurement of farm financial capacity and productivity

Table 3 shows the result of farm's financial capacity and productivity, In farm financial capacity, it was found that R_{64}, R_{21}, R_{413} and R_{432} have the high Self-financial Capacity. It indicated that these systems have high financial potential and ability to take up new investment. Especially, R_{64} systems (Rubber-durian-fishery farming system) has the highest value of 90,440.06 baht/ha/year and a high value appeared in R_{413} (Rubber-durian-mangosteen Farming system), R_{432} (Rubber-durian-mangosteen-rambutan farming system), and R_{21} (Rubber-pineapple system) with 86,931.90, 79,665.80 and 79,750.63 baht/ha/year, respectively. For debt service capacity, the positive correlation was found with the self-financial capacity. The more self-financial capacity a system has, the more debt service capacity it has also. The result shows that R_{64}, R_{421}, R_{432} and R_{21} have the highest debt service capacity. It indicated that these systems have ability to pay interest and to cover loan payment in given period.

For farm productivity, it was found R_{64}, R_{412}, R_{413}, R_{421} and R_{432} have high Rate of Return Capital (RRC) and Rate of Return to Farm Equity Capital (RRFEC). Especially, R_{64} and R_{412} show the highest value of RRC with the similar value of 186%. It indicated that small holders invest one unit of farm capital, they get more than one unit of net farm earning. R_3 and R_1 show low value of RRC. R_{64}, and R_{413} show the high RRFEC with 179% and 174%, respectively. The results of RRC and RREFC show that R_{64} and R_{413} showing the excellent RRC and RREFC performance.

4. Project analysis of rubber-based farming system

In calculation of investment appraisal of 11 excellent small holding rubber-based farming systems as shown in Table 4, it was found that rubber monoculture cultivation shows the lowest values of NPV, BCR, and IRR when compared to other rubber integrated systems. It indicated that the rubber with associated activity provides more income than rubber monoculture system. However, although these rubber-integrated systems have got high benefit, their cost of production is high. For example, in R_{21} system (Rubber-pineapple farming system) gets high benefit with the value of 920,500.68 baht/ha/year, but the cost of production is 310,825.82 bath/ha/year. Also, the similar result was found in other rubber-integrated systems such as R_4, R_5, and R_6 (Table 4). This result is considered useful for small holders to make decision in selecting their appropriate production systems based on the potential of area with the highest benefit. Table 4 also illustrates that all systems show justification in investment appraisal, confirmed with NPV value more than zero, BCR value more than one, and IRR value more than the opportunity cost (Debt interest rate 5%). This means the rubber-integrated system needs more investment than rubber monoculture system such as R_{61} systems (rubber-durian-fishery farming system) which shows high values of NPV, BCR, and IRR of 847,158.27 baht/ha/year, 1.64, and 31%, respectively. Similarly, R_{21} and R_{51} show high investment appraisals. Thus, rubber-integrated system should be contributed and extended to small holders and they should be involved in planning of sufficiency economics to improve small holders' standard of living under the current economic crisis.

Table 3 The measurements of farm financial capacity and productivity of small holding rubber-based farming systems.

Measurement	Small holding rubber-based farming system (R)										
	R_1	R_{21}	R_{32}	R_{412}	R_{413}	R_{421}	R_{432}	R_{51}	R_{52}	R_{53}	R_{64}
	(n=33)	(n=44)	(n=44)	(n=32)	(n=36)	(n=22)	(n=28)	(n=42)	(n=34)	(n=27)	(n=37)
1. Measurement of financial capacity											
1.1 Self-financial capacity	15,166.81	79,750.63	9,665.67	57,886.30	46,115.31	86,931.90	79,665.80	16,465.45	11,743.43	11,570.70	90,440.06
1.2 Debt service capacity	13,916.81	74,950.60	8,165.70	54,800.31	43,112.40	82,431.49	73,965.45	11,965.02	9,420.44	8,574.65	79,440.46
2. Measurement of farm productivity											
2.1 Rate of return capital (RRC)(%)	119.83	133.10	110.31	186.35	183.10	160.30	171.47	121.43	123.16	104.97	186.28
2.2 Rate of return to farm equity capital(RRFEC)(%)	129.81	159.22	116.50	155.43	174.6	128.69	167.21	139.28	153.95	149.96	179.42

Source: Field Survey, 2000 From 379 Small holding farms in three communities of Songkhla Province

Table 4 The comparison projected analysis between rubber-based farming systems.

Item	R_1	R_{21}	R_{32}	R_{412}	R_{413}	R_{421}	R_{432}	R_{51}	R_{52}	R_{53}	R_{64}
Total present worth cost (C)	177,320.94	310,825.82	299,080.50	346,214.50	298,616.20	455,162.87	563,495.19	945,303.85	351,590.58	283,677.64	1,331,226.28
Total present worth benefit (B)	350,477.35	929,500.68	459,958.56	657,008.71	724,455.72	1,002,538.71	1,061,363.05	1,763,659.76	796,491.76	20,119.12	2,178,384.55
BCR at df 5%	1.98	2.99	1.54	1.90	2.43	2.20	1.88	1.87	2.27	2.54	1.64
NPV at df 5%	173,156.41	618,674.86	160,878.06	310,794.21	425,839.52	547,375.84	497,867.86	818,355.91	444,901.18	436,441.40	847,158.27
IRR	12.92%	34%	14%	16%	23%	24%	19%	30%	23%	23%	31%
The justification	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

Source: Field Survey, 2000 From 379 Small holding farms in three communities of Songkhla Province

CONCLUSION AND RECOMENDATION

Eleven representative systems show high net farm income (NI) and relative measurement including in rubber-monocultured farming system, (R_1) Rubber-intercrop farming, system (R_{21}), Rubber-rice farming system (R_{31}), Rubber-durian farming system (R_{412}), Rubber-mongosteen farming system (R_{413}), Rubber-durian-mangosteen farming system (R_{421}), Rubber-durian-mangosteen-rambutan farming system (R_{432}), Rubber-cattle farming system (R_{51}), Rubber-goat farming system (R_{52}), Rubber-chicken farming system (R_{53}) and rubber-fruittree-fishery farming system (R_{64}), respectively. For farm efficiency measurement; there was founded that three system types including in Rubber-intercroped system (R_2), rubber-fruittree system (R_4), and rubber-integrated system (R_6) show the excellent farm efficiency measurement that they should be offer to smallholders. In calculation farm's financial capacity and productivity, five systems of R_{64}, R_{21}, R_{421}, R_{432} and R_{21} show high self-financial capacity, and also four systems of R_{64}, R_{421}, R_{432} and R_{21} show high dept service. It indicated that these systems have ability to pay interest and to cover loan payment in given period

For farm productivity, two systems of R_{64} and R_{421}, show the excellent RRC and RREFC performance. And also, there was found that all representative systems show signification of investment appraisal, these systems should be contributed and extended to smallhoders and they should be involve in planing of sufficiency economics to improve small holders' standard of living under the current economic crisis.

LITERATURE CITED

Ruthenberg, H. 1980. *Farming System in the Tropics.* Clorenlon Press, Oxford, New yourk USA : 2-8.

Barlow, S.C., and R. Dereinda; 1989. *Alternative Approaches to Small Holder Rubber Development.* CPIS, August 1989.

Rubber Research Institute of Thailand (RRIT). 1999. *The Annual Report of Rubber Research Institute of Thailand 1988.* Ministry of Agriculture and Cooperative, Bangkok, Thailand : 57 p

Thungwa, S. 1995. *Sustainability of Para Rubber-based Agarian System in Ampher Khao Chaison, Chang wat Pattalung.* Faculty of Natural Resources, Prince of Songkla University, Hatyai Thailand : 199 p

Nissapa, A., S. Thungwa, and V. Imlohim, 1994. *Bio-diversity in rubber plantation in Southern region Thailand.* Faculty of Natural Resource, Prince of Songkla University. Hatyai Thailand : 16 p

Somboonsuke, B. and P. Shivakoti. 2001. *Agricultural Suatainability through Empowerment of Rubber Small Holders in Thailand.* Asia-Pacific Journal of Rural Development Vol. XI, July 2001 No. 1 : 65-89.

Kjonchaikun, P. 1995. *The Supplement Income of Small Holder in Thailand.* Surathani Rubber Research Center Vol.2 No. 2 April, 1995.

Johl, S. S. and T.R. Kapur., 1992. *Fundamentals of Farm Business Management.* Kalyani Publishers, New Delhi, India.