Kasetsart J. (Soc. Sci) 22 : 61 - 74 (2001) ว. เกษตรศาสตร์ (สังคม) ปีที่ 22 : 61 - 74 (2544)

# Recent Evolution of Rubber-Based Farming Systems in Southern Thailand

**Buncha Somboonsuke**

## ABSTRACT

Following the economic crisis of 1997 in Thailand, rubber-based smallhold farms were forced to take various steps to remain economically viable. These steps were taken with the objective of increasing the farm's productivity and farm income, and as a result six types of rubber-based farming systems evolved, which are now found throughout the rubber growing areas of Thailand. These changes involved many aspects of the bio-physical and socio-economic attributes of the farms, and the farmers who wished to adapt also faced a number of constraints which affected the ability of smallholders to adopt the new technology. Adaptations included consolidation of farms by enlarging the size, improving the equipment and machinery used, strengthening local farmer's groups, using high-yield varieties, changing to modern methods of disease and pest control, and adapting the rubber products to meet current market demand. These changes are studied in relation to the smallholders' decision making process leading to farm transformations. Rubber-fruit and rubber-integrated farms excelled in economic performance due to greater farm income than other farm types. However, smallholders face many constraints in trying to maintain a profitable farming operation, including fluctuating prices, low capital for investment, disease and pests, insufficient water and poor water management systems. To encourage and help farmers change, farm modernization implementation strategies are suggested, including providing improved credit systems, modern tapping methods, provision of soil and leaf analysis, provision of infrastructure and financial incentives, provision of information on high-yield varieties, and new water resources infrastructure development. To help increase farm income directly, it is suggested to implement government programs which focus on the needs of smallholders, encourage agents of technology transfer to be more supportive of smallholders, improve rubber-processing technology, encourage the establishment of value-added businesses in local communities and optimize land use.

**Key words:** rubber, farming system, small holding rubber-based farm, farm's evolution

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

# INTRODUCTION

Rubber is the world economic crop which has helped substantially in the development of quality of life and increase family income in many parts of the world (RRIT, 1999). In Asia, especially in the Southeast Asia region, over the last four decades global trends in rubber cultivation continue to be dominated by three major producing countries, Thailand, Malaysia and Indonesia (IRSG,1999). In 1999, more than 70% of the world's total rubber production (or 4.74 million tones) came from Southeast Asian rubber producing countries. In Thailand, Malaysia and Indonesia 72%, 74%, and 76% of total rubber production come from small holding sector using various cultivation patterns (Burger and Smith,1999). Following the economic crisis of 1997 in Southeast Asia, small holding rubber-based farming systems were forced to adapt in trying to maintain economic viability (TRS, 1999). In Thailand alone there are 800,000 rubber growing farms out of which 744,000 are small holding farms (RRIT,1999). Since 1995, Thailand has become the world's largest rubber producing country. The production continued to increase from 1.80 million tons in 1995, to 2.16 million tons in 1999, with an annual increase of four to seven percent per year. Effect of economic crisis has been reflected by change in production from Ribbed Smoked Sheet (RSS) to Rubber Block for meeting market requirement (Tirasarnvong, 1999). However, smallhoding farms in Thailand have faced many constraints which have reduced productivity and income due to uneconomic size, price fluctuation, technology transfer, capital inefficiency, shortage of labor, lack of access to credit facility, inefficient market system and inefficient smallholders' group in local of area (Penot, 1999). Thus, there is a need for small holding farms to adjust their implementation strategy for increasing production efficiency.

The summary above indicates that rubber smallholder in Thailand, acting on their own are apparently unable to improve their income and productivity toward improving their quality of life. From the economic crisis of 1997 to present, smallholders have to spend more income to meet the increasing cost of living. Understanding what smallholders have done to try to adjust to this new condition is a necessary and important step in trying to suggest policies that will help improve their situation and quality of life.

**Objective of the study**

This research was undertaken to

(1) Find what adjustment the smallholders have made to try to adapt

(2) Examine the current major rubber-production systems and

(3) Try to determine possible constraints in the farmers' adoption of better growing methods and suggest possible solution to achieve these.

# RESEARCH METHODOLOGY

The study area is Songkhla province in southern Thailand where there are a total of 136,375 rubber smallholders. The smallholders are those farmers who have under 8 hectares of rubber, in both

upland and lowland areas (DOAE, 1999). Songkhla is the most important province for industrial rubber development in southern Thailand due to the large number of small holders' large rubber planting area and the greatest number of approved rubber projects with the investment fund of 3,875 million baht in 1999 (BOI, 2000: RRIT 1999). All types of rubber-based farming systems in varied topography are found in the province, making it an ideal representative study area. The study area has been classified into three Agroecozones based on three criteria as suggested by Trebuit *et al.*, and Conway: (1) topographic characteristics (primarily land slope); (2) land use and biodiversity, and (3) socio-economic characteristics (farm size) (Trebuil *et al.*, 1983; Conway, 1985). Three representative communities of Agroecozones (Khao Phra Community, Ratthaphum district (Agroecozone I), Phijit Community, Namom district (Agroecozone II), and Khlong Phea Community, Cha Na district (Agroecozone III) were selected using a purposive sampling method on the following criteria: (1) all communities are included a target area of the provincial rubber development plan. According to the Rubber Development Strategic Plan of 1999-2003; (2) These communities have at least several rubber-based farm types; (3) each community has a large number of small holding farms and more than 70% of all farmers in the community which involved in rubber production; (4) there is variation in topography for comparison of farms among Agroecozones; and (5) smallholders have faced the constraints in production system (DOAE, 1999).

Twenty-six representative farms from three communities were selected. The evolution of rubber small holder's adjustment traces the history of the smallholders and their adaptation over time to changing conditions, looking at such factors as bio-physical changes, socio-economic changes, and changing government policies. Secondary data and Participatory Rural Appraisal (PRA) techniques were also used. The examination of the smallholder's agricultural production system compared the farm types, again using both secondary data and PRA with a semi-structured interview form. Identification of constraints and possible solutions to the constraints the farmers faced in their production, their causes, and potential solutions to these constraints were performed using the Problem Tree Analysis Technique based on a focus group interview and secondary data collection method.

## RESULTS AND DISCUSSION

### 1. Main types of small holding rubber-based farms

We identified six types of small holding rubber-based farming systems (R) in, Songkhla province, based on the criteria of individual farm's agricultural production activity, socio-economic structure and agroecozone, respectively..

#### 1.1 Type $R_1$: small holding rubber-monoculture farming system

Rubber production is the major occupation of the farmers in study area representing 21.3% of the total of 807 farm households studied. It is indicated that Rubber Replanting is still an emphasized activity of the government. These crops usually use high technology. High yielding varieties of rubber grown

used RRIM600, BPM24 and Songkhla 36 (Nissapa *et al.*, 1994). There is low efficiency due to the diversity in management. The constraints on low efficiency include lack of labor especially during tapping period, high cost of production and off-farm employment opportunities. However, most of the smallholders in this type are still interested to maintaining their rubber holding because rubber occupation has been a tradition for a long time as a cultural crop of the southern region of Thailand. (Ivanoff and Roux, 1989)

**1.2 Type ($R_2$): small holding rubber-intercrop farming system**

The majority of the farmers in this farm type include those who have participated in the Office of Rubber Replanting Aid Fund's (ORRAF) replanting program. The support is provided during the initial unproductive period (0-36 months). Approximately 26.36% (1,007 farms) fall into this category. Normally, crops intercropped are pineapple, rice, corn, vegetables, and other annual crops (Laosuwan, 1987; Bulanathum, 1999). The decision to intercrop depends on a number of factors such as soil and terrain condition, marketing and labor availability. When rubber plant becomes more than 36 months old smallholders change farm's cultivation pattern to other types of rubber-based farming for sustaining family income (Thungwa, 1995).

**1.3 Type $R_3$: small holding rubber-rice farming system**

These comprise approximately 33.69% (1,287 farms) of the total small holding farms. Normally, there are two patterns: (1) rice is grown between immature rubber rows, as intercroping; and,(2) rice is grown in a different sector within the rubber plantation. Normally smallholder's experience in rice practice is derived from their ancestor using both high-yield and indigenous rice strains. The rice production is used for family consumption only. In the future, this type may decline due to many constraints such as shortage of family labor, high cost of input factor and uncertain price (DOAE, 1998).

**1.4 Type $R_4$: small holding rubber-fruit tree farming system**

Intercropped fruits are economically valuable fruits of southern Thailand which include durian, rambutan, longkong, champada, etc. Normally, the fruit trees are mixed. These represent 11.09% (424 farms) of the total rubber growers and can be classified in two patterns of plantations: (1) Fruit trees are cultivated in the same plot of rubber, that is, grown between rubber rows called rubber multi crop (Nissapa *et al.*, 1994). The objective is to get fruit production at the same time as rubber production, however, farmers tend to postpone the rubber collection if the price of fruit is higher than rubber; and (2) Fruit trees are grown in a different section of the rubber plantation. These farmers are normally more experienced and skilled in fruit tree cultivation than those in the previous pattern, and this pattern is more like a normal business. This type requires higher capital investment and family labor. The constraints of this type include the shortage of water and its management and deficiency of capital investment. However, this type has yielded the highest economic performance due to greater farm income than other farm types.

**1.5 Type $R_5$: small holding rubber-livestock farming system**

Very small proportion of approximately 2% (75 farms) of the total rubber farmers practice this type. Livestock is normally reared within both immature and mature rubber areas. Types of livestock include cows, poultry, swine, goat and sheep. The main constraints are the high cost of production and a deficiency of farm labor and feed. In immature rubber, the rubber plant normally has to be above 2 meters hight and at least 18 months old for livestock raising. Usually, the average number of livestock rearing in rubber area, range between 6-8 bodies per hectare. Smallholders in this type have experience in livestock raising practice for a long time. However, livestock under rubber is only supplemental occupation in enhancing family income (RRIT, 1999).

**1.6 Type $R_6$: small holding rubber-integrated farming system (or rubber-integrated activity farming system)**

There are approximately 5.77%, or 220 farms in this type of rubber farming system. There are four patterns: Rubber-Fruit Tree-Livestock, Rubber-Rice-Livestock, Rubber-Rice-Fruit Tree and Rubber-Fruit Tree-Fish. The main constraints facing this type are the shortage of family labor, fluctuating prices, deficiency of capital for investment and lack of management skills. However, this is one of the better alternatives for increasing family income due to its excelled economic performance.

**2. The evolution of small holding rubber-based farm bio-physical and socio- economic factors**

During the last four decades (1960-1999), the biophysical and socio-economic components of rubber small holdings have evolved into five periods as follow:

**2.1 Before 1960: The Conventional Rubber Production System**

During 1900-1959, the rubber small holdings were characteristically normal, conventional farms sometimes-called rubber forestry or rubber community forestry. Smallholders derived skill and knowledge from their ancestors, and the main purpose from the farmer's point of view was a simple livelihood, based on indigenous technology and family labor. There were no chemical fertilizers or herbicides. An indigenous rubber strain was dominant from 1899-1934 in which there was a change to a high yielding strain such as Tjir and PB86. The monoculture rubber plantation (R1) are derived from this traditional style. Normally, rubber farms obtained water from natural sources such as rain and canals. The rubber was low quality and more than 90% of total rubber production was Unsmoked Sheets (USS). The marketing system was in form of a barter system and smallholders normally sold their rubber products individually at a local market.

**2.2 The green revolution of the 1960s: initial modernized rubber production system**

The Office of Rubber Replanting Aid Fund (ORRAF) and the Rubber Organization were established in 1960 to promote modern rubber production technology. The ORRAF's replanting program introduced modernized rubber production technology to smallholders and also trained them to adjust their implementation strategies by such means as (1) Use of high yield rubber strains such as RRIM

623, TJIR1, PB5/51 and PR107, PRIM600 and GT1; (2) Adoption of high technology from ORRAF such as farm management systems and improved tapping methods; (3) Introduction of chemical fertilizer and weed control systems, based on ORRAF recommendations; (4) Introduction of water management systems such as ponds; and (5) Persuading smallholders to look for alternate occupations such as moving off the farm and doing labor jobs when rubber was not being harvested. In 1965, the Rubber Research Center of Hat Yai (RRC) was established to serve southern Thailand. The role of RRC Hat Yai was rubber research and development at both the national and international levels. In the late 1960s, smallholders were encouraged to find more off-farm work and enlarge their farm size with more land. Without marketing system or farmers' organizations, there was high competition at this time.

**2.3 The 1970's: modernized rubber production systems**

Small holders were initially interested in group systems to improve their marketing abilities, and participated in several local farmers' groups for socio-economic and production activities. The Department of Agricultural Extension (DOAE) also supported this activity of the farmer's groups. Smallholders were helped with initial adjustments such as increasing their farm's biodiversity, hiring labor, participation in training courses about rubber production technology, and farm management as agribusiness. Smallholders enlarged their farm size by purchased land. During this time more than 90% of total rubber production still Unsmoked Sheets at the grade four level, and most rubber were still sold at either the local market or through the local farmers' group. Smallholders began to use equipment and machinery such as water pumps, because of the shortage of water resources. Normally, smallholders grew fruit trees in a form of mixed crop cultivation in both the same and different plots of their rubber plantations. Smallholders began to use chemicals for fertilizing their land based on ORRAF's recommendations of N: P: K: at a ratio of 15-15-15 and also began to use chemicals such as Gyphozate and Spark for weed control.

**2.4 The 1980's: alternative rubber production systems**

Small holders began to widely change their activities, participating in such things as rubber farmers' groups, such as the Rubber Sheet Making Group or the Rubber Latex Group. Rubber production also began to change from Unsmoked Sheet to Rubber Latex, although more than 80% of total rubber production was still in Unsmoked Sheet production. More and more family labor was moving out of the farm, creating a shortage of labor for rubber production. Smallholders were getting more agricultural information from both private and government sectors, especially concerning new patterns of rubber-based farming systems such as Rubber-Fruit Tree Farming (R4), Rubber-Livestock Farming (R5) and Rubber-Integrated Farming (R6). However, the main occupation was still rubber production. During this time there was also increased infrastructure put in place to support the rubber production, such as improved roads, communications, and water management systems.

**2.5 The1990's: industrial rubber system**

The industrial rubber system was an important addition to the rubber production systems and also had a large effect on the smallholders as they changed their rubber productions from Unsmoked Sheet (USS) to Rubber Block to meet industrial requirements, and also during this time many family members found off-farm work, creating a serious labor shortage, especially for tapping and sheet making. At this time, the price of rubber was fluctuating widely and the cost of production was high, leading the smallholders to look for other crops to grow with the rubber such as fruit trees, livestock, vegetables, etc. With the advent of the economic crisis in 1997, the opportunity to change from rubber to other crops became greater, and during this time several of the alternative rubber-intercropping systems began to be widely used especially the Rubber-Fruit Tree Farm (R4), Rubber-Livestock Farm (R5), and Rubber-Integrated Farm (R6). In the local rubber market system, smallholders had potential to bargain their prices, because the majority of smallholders sold their rubber to farmers groups, and there was high competition.

**3. Small holders' decision making process leading to farm transformations**

The socio-economics and bio-physical factors affecting the changes to the agricultural production systems are shown in Figure 1; (1) Small holding rubber-monoculture farms (R1) will be able to change to small holding rubber-fruit tree farms given sufficient water resources, farm size and available labor, and to small holding rubber-integrated farms if conditions such as product price, farm size, and available labor are met. (2) Small holding rubber-intercrop farm (R2) will be able to change to small holding rubber-fruit tree farms (R4) and small holding rubber-livestock farms (R5) if conditions of product price and available labor are met, and to small holding rubber-integrated farms (R6) if product price, farm size and available labor are satisfied. In addition, it can change to a small holding rubber monoculture farm (R1) under limitations of farm labor, water resources, product price, government plan and policy and technological knowledge. (3) Small holding rubber-rice farm (R3) will be able to change to small holding rubber-fruit tree farms (R4) if the soil is fertile; to small holding rubber-integrated farm (R6) under suitable conditions of product price, farm size and topography; and to small holding rubber-monoculture farms (R1) if water resources are adequate. (4) Small holding rubber-fruit tree farms (R4) will be able to change to small holding rubber-monoculture farms (R1) if water resources are limited, or farm equipment, farm labor, product price and unconvenient communication for production transportation. (5) Small holding rubber-livestock farms (R5) will be able to be changed to small holding rubber-fruit tree farms (R4) or to small holding rubber-integrated farms (R6) under certain conditions, i.e. good marketing system, product price, capital for investment, extension policy, suitable varieties, climate, water resources and small holders' experience and motivation; and also they can change to small holding rubber monoculture farm (R1) under limited conditions of feed and fertilizer in the community, farm labor, capital for investment. (6) Small holding rubber-integrated farms (R6) will be

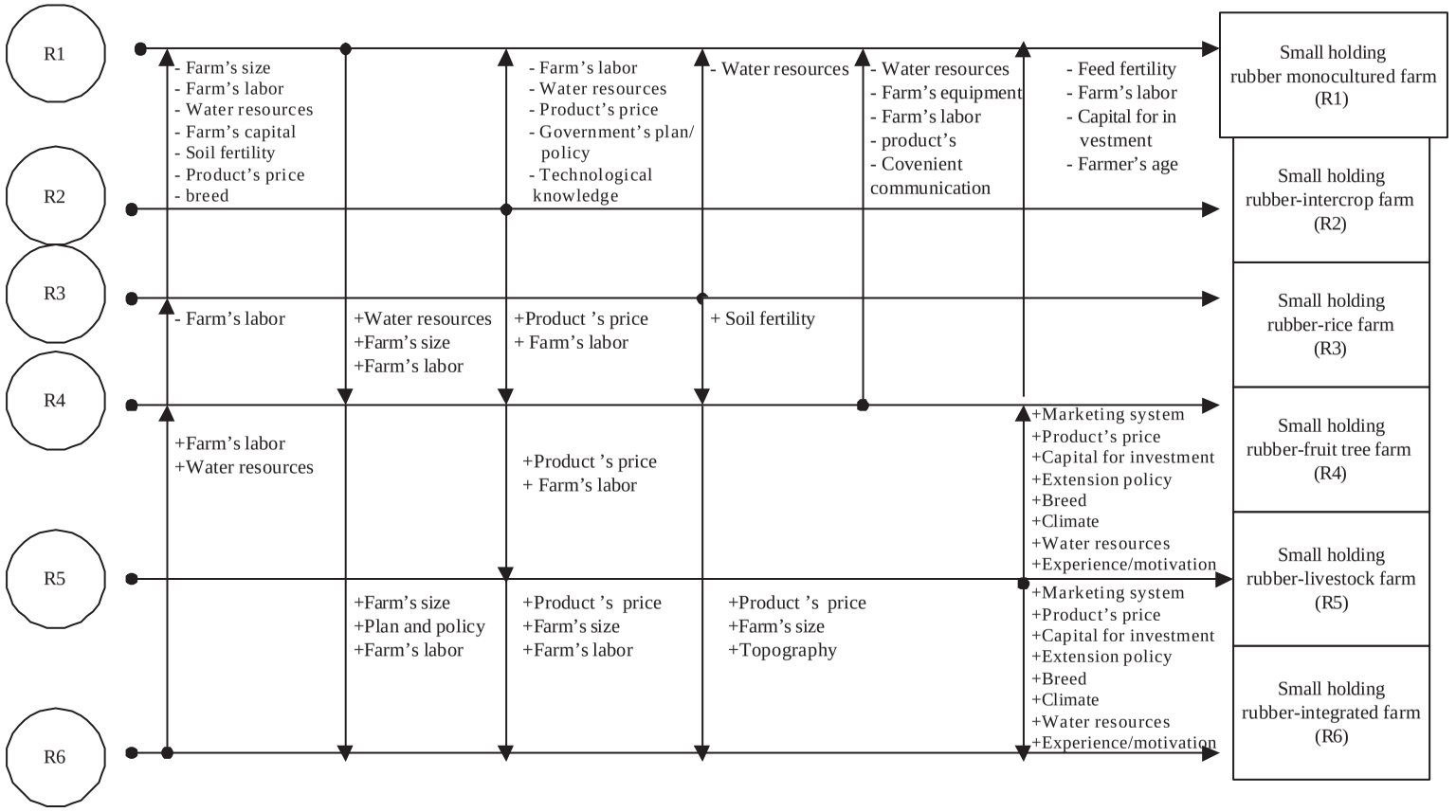


**Figure 1** Small holders' decision making process.

Sources: In-dept interview of RRA method and Secondary data. Remark: -: unsuitable condition and + suitable condition

able to change to small holding rubber-fruit tree farms (R4) under suitable conditions of farm labor and water resources; and to small holding rubber-rice farms (R3) under suitable conditions of farm labor. Also, it can change to smallholding rubber-monoculture farm (R1) under limited conditions of farm's size, farm's labor, water resources, farm capital, soil fertility, product price and variety.

Summary results indicated that trend and development at small holding rubber-fruit tree farming system and small holding rubber-Integrated farming system will be relatively well-known and extensively disused in recent year due to high opportunity in change from other small holding types to these types, when suitable conditions, meanwhile, under unsuitable conditions, all small holding types will be able to change to small holding rubber-monocultured farming system.Then, it can be said that Rubber is the traditional farming choice of many southern Thai farmers, and adapting to new conditions is accepted as necessary from time to time, as the above explanation shows.

**4. Agricultural production system : adjustment at farm household level**

With these evolution-taking place over the years, various components of agricultural production systems were adjusted to fit in the changing context. In this section, we describe the current ongoing agricultural production system practiced by rubber-based farm households:

**4.1 Physical component**

The average size of small holding rubber-based farms ranges normally between 3.00-7.00 hectares in comparison to Malaysia and Indonesia being an average of four or less and two hectares respectively. These farms have mainly used natural water resources such as rain water or pond, but has no irrigation system in place (Oakeley, 1997; Budiman, 1986). These farms are normally located in unfolded plains or upland areas. In the future, many smallholders are likely to enlarge their farm size as such and become small holding rubber-fruit tree farm or rubber-integrated farm as depicted by the on-going trend.

**4.2 Biological component**

Most farms use high yield rubber varieties such as RRIM600, and also grow high yield fruit tree and intercrop varieties. However, for rice and livestock indigenous varieties and breeds are preferred because they have been adjusted over generations for a specific area. Fertilizers for rubber and fruit trees normally applied at N: P: K ratio of 15-15-15, and for rice it is 16-20-0. Frequency of fertilization is usually twice per year for rubber, 3-4 times per year for rice and 3-4 times per year for fruit trees. For livestock, feed is usually local grass from the farmer's field or the local community. The uses of chemical for disease and pest control and weed control are becoming common. For weed control, Glyphosate is by far the most widely used herbicide in the small holding farms as substitute for labor due to high cost of labor (ORRAF, 1999). The Rubber Replanting Aid Fund of ORRAF distributed over a million lit of Glyphosate to small holding farms who participated in their ORRAF's Planting Program (Liangsutthisagon, 1995). All farms use equipment and machinery but is more common in small holding rubber-fruit tree farming system and Small holding rubber-integrated

farming system. Farm production is highest in the small holding rubber-fruit tree system.

**4.3 Social component**

The average number of people on a farm is 4.31, and average farmer has completed only Primary School. It is, also indicated that the majority of smallholders have little access to credit facilities, low level of technology adoption, and lack of up-to-date and rubber price information (Promdej, 1987). Average hours of work that farmers spend farming activities are 7.3 hours per day, and most of the farmers are Buddhist (by religion). General objective of the household is to improve farm productivity and quality of life.

**4.4 Economic component**

The average number of economically active farm labor in a family is 2.13 persons and actual cultivated area is 1.92 hectares per family. This is indicated that the family labor is less than the required which has effect on hiring out off farm labor, especially, during tapping labor in tapping period for type 3 farm(Thungwa, 1996). The income of small holding rubber-fruit tree farms (R4) and small holding rubber-integrated farms (R6) were reported higher than that of other types of systems. The highest farm income was obtained by the small holding rubber-fruit tree farming system (R4) (Table1). It is anticipated that in the future, small holding rubber-fruit tree farming systems (R4) and small holding rubber-integrated farming systems (R6) will be important alternatives for smallholders and, thus support should be extended to smallholders who wish to change to these methods. However, these types have faced more constraints than the other types of systems and have incurred high cost of production than other types of systems.

**5. Constraints on small holders' options and possible solutions**

Low product price is the most serious constraint of all types of farmers. In addition,

**Table 1** Economic performances of small holding rubber-based farming systems.

| Item | $R_1$ | R2 | R3 | R4 | R5 | R6 |
|---|---|---|---|---|---|---|
| 1. Total Farm's Labor (person) | 3.5 | 2.0 | 3.5 | 2.0 | 3.0 | 4.4 |
| 2. Total Farm's Agricultural labor (person) | 2.5 | 2.0 | 2.5 | 1.9 | 3.0 | 3.3 |
| 3. Total Farm Income (baht/ha/year) | 16,607 | 25,000 | 12,479.9 | 19,773.4 | 17,593.8 | 26,127.6 |
| 4. Total Farm Expenditure (baht/ha/year) | 16,296.7 | 22,300 | 10,897.4 | 14,959.7 | 16,000 | 18,804.5 |
| 5. Net farm Income (baht/ha/year) | 310.3 | 2,700 | 1,582.5 | 4,813.7 | 1,593.8 | 7,323.1 |

Source: PRA method with Semi-structured interview

deficient production knowledge, disease and pests, insufficient capital for farm investment, and the poor market system are also important constraints on all types of farms and farmers (Table 2). Like other primary commodities, rubber price fluctuation at great deal depends on both supply and demand factors in the market and external event, During last twenty years, the rubber price have fluctuated, and affected Small holding farms in Thailand. For example in 1995, world's rubber production was excess of consumption and rubber price dropped. This had bad effects on smallholder and this is major reason for small farms to leave their farms to search for off-farm employment (Juman, 1987; Somboonsuke and Rattanachai, 1997). Inevitably, this led to under utilization of land and productivity further declined in Thailand including Malaysia, and Indonesia. Due to deficient production knowledge of smallholders in Thailand the problem is further substantiated by low level of education, lack of accessibility to credit facilities and low adoption of new agricultural practice and innovations. The market constraints which include the low type and grade (normally 80% of USS grade 3and 4) also reflect the inefficiency, complexity and constraints of industry (Somboonsuke and Rattanachai, 1997). Then, smallholders get unfair price in local market and also, marketing becomes difficult and complicated for these smallholders to comprehend and moreover individual smallholders are unable to cope with it (Thipayakul and Promdej, 1987). The market structure and rubber prices are complementary to each the other in determining the final price paid to smallholders, who are the original producers of raw material. The price paid to the producer in local market is residue of the FOB price, after deductions for export and other taxes and marketing margins. The constraint of insufficient capital for investment, high cost of production and input such as fertilizer, seed and chemical for weed control and also low farmgate price are causes of

**Table 2** The constraints of small holding rubber-based farming systems.

| Constraint | Percentage |
|---|---|
| 1. Low production price and quality | 25.4 |
| 2. Deficient capital for farm investment | 13.8 |
| 3. Disease and Pest | 11.2 |
| 4. Deficient input factors and High cost of input | 10.9 |
| 5. Inefficient local marketing system | 10.2 |
| 6. Deficient knowledge of agricultural knowledge | 6.8 |
| 7. The shortage of water resources | 6.8 |
| 8. Low soil fertility | 6.1 |
| 9. The shortage of family labor | 5.1 |
| 10. Inefficient local extension system | 3.7 |

Sources: PRA, Secondary Data and Problem Tree Analysis

insufficient capital for investment. One possible solution to overcome these problems is that the government should have clear plans and policies, such as local price insurance system making available of local capital for farm investment, strengthening the local market system, supporting and transferring new technology, and support of local farmers' groups in bargaining for better prices. Without such government assistance, the problems of the smallholders become much more difficult to solve.

## CONCLUSION AND RECOMENDATION

Following the economic crisis of 1997, smallholders along with many other sectors of the economy have had to adjust their attitudes towards their traditional ways of farming and doing business, to become more efficient. The six types of rubber small holdings described in this article are all important for rubber development in Thailand, but many of them should be considered changing to the more profitable rubber-intercropping and rubber-fruit systems as described where they have that opportunity and are not hindered by the constraints on change (as esib). Various suggestions are offered to overcome these constraints in certain cases, and public policy options are also suggested in helping farmers to make the change. What is certain is that rubber will remain an important commodity in the world, and Thailand is an important world supplier of this commodity, so with a positive attitude and willingness to work to adapt, the rubber industry can remain an economic strength of southern Thailand.

## LITERATURE CITED

Arifin, S., M.J. Rasyid, G.Wibawa, A.D. Gozali, and Delabarre.1987. Land management towards Improvementof rubber smallholders in Indonesia, pp. 85-100. *In Proc. 6th The Progress and Development of RubberSmallholders Seminar*, Palembang, Indonesia.

Arshad, N.L and T.Ismal.1987. "Maximising land use in rubber small holdings", pp. 67-74. *In Proc. 6thThe Progress and Development of Rubber Smallholders Seminar*, Palembang, Indonesia.

Board of Investment (BOI).2000. "Investment in Southern Thailand in 1999". *Rubber International Magazine. Vol.2 No. 16 (April 2000)*

Budiman, AFS.1986. "Indonesia country report", pp 5-10. *In Proc.6th The Progress and development of Rubber Smallholders Seminar*, Palembang, Indonesia.

Bulanathum, V.1999. "Cover crop, Intercrop and multicrop for small holding rubber development in Thailand", pp 1-30. *In Proc. 1st Seminar Rubber Development 1999.* RRIT, Songkhla, Thailand.

Burger, K and H.P. Smith.1999. "How will the current change global NR demand and supply of natural rubber pattern", pp. 19-55. *In Proc. International Rubber Marketing Conference 1999*, Hat yai, Thailand.

Conway, G.R.1985. *Agroecosystem Analysis. Agricultural Administration* 20p.

Department of Agricultural Extension (DOAE). 1998. *Agricultural Statistics of Songkhla Province*

*1998*. Songkhla Agricultural Extension Office, Songkhla, Thailand. 120p.

Department of Agricultural Extension (DOAE).1999. *Trend to Agricultural Development in Songkhla Province 1999*. Songkhla Agricultural Extension Office, Songkhla. 99p.

International Rubber Study Group (IRSG). 1999. "Highlight topic: changes in the natural rubber sector-part I". *International Rubber digest*: pp. 48-52.

Ivanoff, J and P.L. Roux. 1989. *Ethnology: A global Approach in Farming System*. CcDRASEMI-EHESS/ECASE UPR 298-CNRS.Paris, France: 30p.

Juman, M.1987. "Increasing productivity of rubber small holding through plantation technology: FECCRA's experience", pp. 43-57 *In Proc.6th The Progress and Development of Rubber Samallholders Seminar*, Palembang, Indonesia.

Laosuwan, P.1987. *A study on intercropping with young rubber*. Faculty of Natural Resource, Prince of Songkla University, Hat Yai, Thailand. pp1-45.

Liangsutthisagon, S.1995. *The Management on the Imperata in Rubber Smallholder Plantation in Thailand*. Mimeo. Office of Rubber Replanting Aid Fund, Bangkok, Thailand. 26p.

Nissapa, A., Thungwa, S., and Imlohim,Y.1994. Biodiversity in *Rubber Plantation in Southern Region Thailand*. Faculty of Natural Resource, Prince of Songkla University, Hat Yai, Thailand. 16p.

Oakeley, H.B., C. Conroy, A. Faiz, A. Gunawan, A. Gouyon, S. Liasutthisagon, and H.D. Nguyen. 1997. "Imperata management strategies used in smallholder rubber-based farming system", pp. 83-104. *In Proc. International center for Research in Agroforestry*, Kluwer Academic Pub, Netherland.

Office of Rubber Replanting Aid Fund (ORRAF). 1999. *The Procedure of ORRAF's Rubber Replanting Program*, Songkhla Province, Thailand. 12p.

Penot, E.1999. "Jungle rubber improvement in Indonesia, CIRAD-CP/ICRAF Annual Seminar, Nairobi, Nigeria. P8-27 Promdej, S.1987. Thailand country report", pp. 31-42. *In Proc.6th The Progress of Development of Rubber Smallholdrs Seminar*, Palembang, Indonesia.

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

Rubber Research Institute of Thailand (RRIT). 1999. *Thailand rubber statistics. Vol. 28 (1999) No 1-2,* Rubber Research Institute Department of Agriculture, Bangkok, Thailand: 29p.

Somboonsuke, B and Rattanachai, A.1997. "Analysis of the labor Situation in rubber tapping and sheet making in Southern Thailand", *Kasetsart J. (Soc. Sci)* 18 : 25-38.

Somboonsuke, B. and A. Rattanachai 1997. "Factors affecting the achievement of para rubber groups' operation in southern Thailand", *Kasetsart J. (Soc. Sci)* 18 : 113-132.

Suthisong, S.2000. "Tren to production development of Thai block rubber: current situation production". *Rubber International Magazine*. Vol.2 No.16

(April 2000) : 8p.

Thai Rubber Association (TRA). 1999. "NR Production and consumption in the next decade", pp. 81-109. *In Proc. International Rubber Marketing Conference 1999.* Hat Yai, Thailand.

Thungwa. S. 1995. *Sustainability of Para Rubber-Based Agrarian System in Amphor Khao Chaison, Changwat Patthalung.* Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Thailand. 199p.

Thunwa, S.1996. A diagnosis of agrarian system in King Amphoe Kasae-sin Changwat Songkhla, pp. 426-437. *In Proc. The 34th Kasetsart University Annual Conference*, Bangkok, Thailand.

Tirasarnvong, P.1999. "Structural change of he Thai rubber industry after the Asian crisis (RSS vs STR vs LATEX)", pp. 11-15. *In Proc. International Rubber Marketing conference 1999*, HatYai, Thailand.

Thipayakul, N. and S. Promdej 1987. "Farmgate price of smallholders, rubber in Thailand", pp. 141-152. *In Proc.6th The Progress and Development of Rubber smallholders Seminar*, Palembang, Indonesia.

Trebuil, G., S. Thungwa, I. Patamadit-trebuil, 1983. "The present system and recent change in land use in Sathing Phra District Southern Thailand". *Farming System Project of Faculty of Natural Resources*, Prince of Songkla University. Pub. No. 2:101p.