International Journal of Agricultural Technology 2021Vol. 17(3):1147-1160
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

The connection between rubber production and livelihood under rubber farming system along with oil palm growing in the southeast coast of Thailand

Somboonsuke, B.[1], Boonkongma, M.[1], Kongmanee, C.[2*], Thatthong, K.[3] and Prapatigul, P.[4]

[1]Department of Agricultural Innovation and Management Division, Faculty of Natural Resources, Prince of Songkla University, Hat Yai Campus, 90112 Thailand; [2]Department of Agricultural Economics, Faculty of Economics, Prince of Songkla University, Hat Yai Campus, 90112, Thailand; [3]Nakhon Si Thammarat Rajabhat University, Nakhon Si Thammarat, 80280, Thailand; [4]Department of Agricultural Economy and Development, Faculty of Agriculture, Chiang Mai University, 50200, Thailand.

Somboonsuke, B., Boonkongma, M., Kongmanee, C., Thatthong, K. and Prapatigul, P. (2021). The connection between rubber production and livelihood under rubber farming system along with oil palm growing in the southeast coast of Thailand. International Journal of Agricultural Technology 17(3):1147-1160.

Abstract The results showed that the farmers still relied on the old production technology for rubber and oil palm. The financial cost of production was quite highly compared with the quality of livelihood. The study found that farmers still lacked adaptation skills for self-development and easily vulnerable to change the condition sof unstable weather and price fluctuation. The purpose of linking their socioeconomic status, the society, rubber production with sustainable livelihood of smallholding rubber farming, oil palm growing under rubber production system, and other agricultural activities indicated that economic factors such as price of production, cost of production, income level, and poor saving culture had considerable effect on the finances of the households. Social factors, such as lack of information, poor educational level and other experiences were combined with social capital and adaptation of rubber farmers for changing times. To reduce the limitations on their livelihood and production outputs, the farmers needed to learn the proper techniques for production that would improve the efficiency of the production process and lead to harnessing resources effectively. These would positively impact their natural capability to earn their livelihood. The format of linkage between production and livelihood was composed of 4 related sub-systems. These were the production system, support system, strategic system, and livelihood achievement system.

Keywords: Smallholder livelihood, Rubber farming system, Oil palm farming system

Introduction

Para Rubber is an economic crop in the south of Thailand. In 2016, there were rubber plantations up to 2.33 million hectares, equivalent to 63% of the

* **Corresponding Author**: Kongmanee, C., **Email**: chaiya.k@psu.ac.th

total agricultural land in the southern region. The major growing rubber areas were Surat Thani province (0.46 million hectares), Songkhla province (0.33 million hectares), Nakhon Si Thammarat province (0.29 million hectares), and Trang province (0.24 million hectares). These growing areas produced 3.33 million tons of rubber products a year, equivalent to 71% of the national total (Office of the National Economic and Social Development board, 2016). Due to the global fall in rubber prices, the livelihoods of rubber farmers, which depend so much on the rubber plantations, had been adversely affected. Although people in the south earn had been earning incomes for their households from the rubber plantations, the study found that these households' livelihoods were still vulnerable and weak as result of their level of poverty (Office of the National Economic and Social Development Board, 2016). This also has impacted their farm structure, farming system, production management, and choice of technology which has not been productive enough or the right tools necessary for a profitable farming experience and improved livelihood.

Prachuap Khiri Khan, Chumphon, and Surat Thani are the three provinces engaged in rubber plantations as the major occupation of farmers. Rubber plantation jobs are significant for the economy, society, and the quality of life of farmers. Following the recent fall in rubber prices at the global market, the livelihoods of these farmers had been affected adversely, with household incomes in the three provinces declining. These smallholding rubber farmer households, however, also engage in various other jobs along with rubber plantation farming, because the three provinces are close to the coast of the Thai gulf. Prachuap Khiri Khan, for instance, had 26,066.9 hectares of rubber growing areas in 2016 which yielded an average production/rai of 172 kg/year. Chumphon's rubber growing areas in 2016 covered 91,693.1 hectares, yielding an average production/rai of 248 kg/year. Surat Thani in the same year 2016 had rubber growing areas of 456,804.4 hectares which yielded an average production/rai of 259 kg/year (Office of Agricultural Economics, 2016). In 2015 there were almost one million poor people in the south of Thailand, equivalent to 9.9% of the population in the region (Office of the National Economic and Social Development Board, 2016).

From the aforementioned data, the study indicated that livelihood in extreme poverty condition was still the major problem of the south. One reason for this level of poverty is a farming culture and agricultural system of livelihood that mostly depends so much on rubber products. In addition, there

are the limitations of topography, public health, social amenities, local culture, ineffective government policies and services. The data further revealed that these poor households had the culture of working in rubber plantations as their major occupation or supporting means of livelihood. These had affected the rubber farmers in the south in terms of their low quality of life (Agricultural Extension Office, 2015).

The authors were interested in examining the model of rubber production for livelihood used by the rubber farmers, along with their supplementary oil palm growing in the southeast coast of Thailand. The study aimed to examine their livelihood system, vulnerability, and factors that influenced their vulnerability and lowered their livelihood. The aim was also to synthesize a model of production management for the improved livelihood of rubber farmers under the existing rubber farming system, along with supplementary oil palm growing in the study areas. The data received would be relevant in the improvement of the farming system and production practices of rubber farmers for sustainable growth. So, the objectives of this study were: 1) to examine the rubber production practices of the current rubber farming system combined with oil palm growing, 2) to examine the livelihood of farmers according to the sustainable livelihood framework of the current rubber farming system combined with oil palm growing, and 3) to synthesize a model of connection between rubber production and the livelihood of rubber farmers under a rubber farming system combined with oil palm growing.

Materials and methods

The study areas are the rubber plantations in Prachuap Khiri Khan province, Chumphon province, and Surat Thani province (Figure 1). The reason for selecting these areas for this study was because rubber farmers grow a lot of rubber trees in the diversified rubber typographies, such as plain area, lowland along the coast, folding or undulating area, and highland or mountainous area (Agricultural Extension Office, 2015).

The sample group selected was made up of 399 farming households in the three provinces. The instrument used for this study was a structured interview. For the data analysis, descriptive statistics such as mean and percentage were used to generate data distribution for analysis, production and livelihood in terms of the Sustainable Livelihood Framework (SLF) of rubber farming systems along with oil palm growing (DFID, 2001). Referential statistics, such

as the multiple linear regression analysis was also calculated for analyzing influencing factors among livelihoods components. Then the descriptive model connecting economy, society, and production with the livelihood of rubber farmer households under rubber farming system, along with oil palm growing, was synthesized.

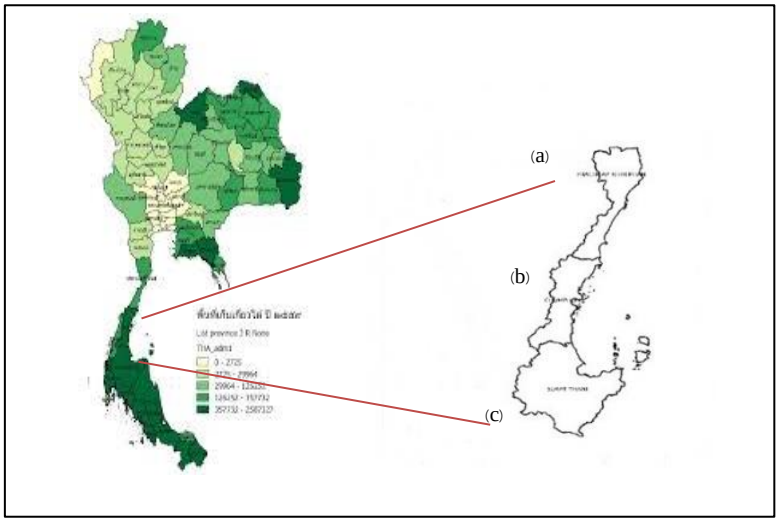

Figure 1. The studied areas are rubber plantations in (a)Prachuap Khiri Khan province, (b)Chumphon province and (c)Surat Thani province
Source: ROAT, 2018

Results

Recent rubber production of rubber farming system, along with oil palm growing

The study found that the farmers had been working on the rubber plantations for an average of 23.6 years; and had rubber lands holding an average of 2.1 hectares /household. RRIT600 rubber breed was grown in 82.6% of the plantations, with the recent age of rubber trees at an average of 16.6 years, and the growing space of 3x7 meters in 95.2% of the area. The number of rubber trees grown were 476.3 trees/hectare. About 77.2% of the farmers received financial aid from RAOT. Most of the farmers applied 100.0% of chemical fertilizers at a frequency of 1.6 times/year with an average amount of

627.8 kg/time/year. The average price of the fertilizers was 852.0 baht/sack. For the application of organic fertilizer, the study found that 26.5% of the farmers applied organic fertilizer at a frequency of 1.2 time/year with an average amount of 607.3 kg/time. The average price of organic fertilizer was 410.5 baht/sack. About 67.2% of the farmers eliminated disease and pests by chemical control. The farmers did weed control by the mechanical method in 90.9% of the cases, and by chemicals for 47.92% at the frequency of 1.7 times/year, with an average expense of 1,434.8 baht/time. In regard to the tapping systems used, the study found that 58.3% of the farmers used 1/3S 4d/5, while 21.6% used 1/3S 5d/6, and 11.1% used 1/3S 2d/3. For the type of rubber tapping labour, 70.7% were those from households, and 29.3% were hired tapping workers with an average of rubber tapping labour of 2.1 people. The farmers in 57.4% of those studied had a benefit ratio with the hired tapping labour at 50:5. The most rubber products that farmers sold were latex (72.0%), cup lump (17.3%0, and raw rubber sheet (10.6%). For 56.3% of the farmers, their rubber products were sold to local buyers; 26.0% sold to the latex group, while 17.7% sold to the cooperatives. The sample group sold rubber products at an average price of 34.5 baht/kg. The farmers worked for an average of 141.0 days/year; with 22.7% of them having the plan to reduce production in the next 5 years, whereas 72.6% had no plan to change production in the next 5 years. All the incomes accruing to the farmers from the agricultural sector was being spent on improving their livelihood, which, rated at the highest level, was equivalent to 40.88%.

Livelihood of smallholding rubber farming system along with oil palm growing

The analysis of the broad spectrum of livelihood of smallholding rubber farmers along with oil palm growing in the 3 provinces followed the Sustainable Livelihood Framework guidelines as the follows: (1)Weakness and fragility component: The study found that the major factors affecting rubber farmers' livelihood were tendency for price changes of agricultural products and wage (81.1%), barriers and limitations such as labour shortage (54.1%), unfair marketing (71.7%), unpredictable weather (85.46%), soil deterioration (87.3%), and decreased farming water (76.4%). It was observed that the problems of decreased farming water, soil deterioration, and season uncertainty were real barriers to agricultural work, added to the low prices of rubber and oil

palm products which caused the farmers to make changes in career path, moving from the agricultural sector to jobs outside agriculture or supplementing with other activities to augment their income. (2) An asset for livelihood component: The study found that human capital was at an average of 81.3 (highest level), the natural capital at an average of 79.1 (high level), the financial capital at an average of 72.2 (high level), physical capital at an average of 61.2 (medium level), while the social capital was at an average of 76.46 (high level). By analysing the total index of the human capital, the study found that the mono-rubber-tree farming system had an average of 74.1 (high level). (3) Structure change and process component: The study found that rubber 55.7% of the farmer households under this recent system had participated in farming activities and received financial aid from the relevant government departments or government agency. About 49.8% of these rubber farmer households received aid or participated in activities organised by RAOT. The study also indicated that 54.8% of the farmers belonged to the cooperatives. By participating in activities and receiving aid from such institutions, 28.54% of the farmer groups had better livelihoods, received knowledge and information, and also developed skills which they applied to their careers. (4) Livelihood strategic component: The study found that 61.2% of the farmers had adjusted their production pattern to match the demands of the market; 41.4% of them changed the number of tapping days; 44.9 % switched to the rubber breed that gave higher yield; 57.8% looked for a method of cost reduction; and 44.2% diversified their income from rubber plantations by raising animals and growing intercrops as well. (5) Livelihood success component: The study found that the farmer households had the total improved livelihood success at an average of 73.0% (high level), while their level of social relationship was rated at 88.8%. The study indicated their ample financial sufficiency conditions at 76.6%, food security and facilities at 81.2%, asset ownership or holding at 49.5%, and sanitation at 77.5%. Synthesizing these data based on the guidelines of the Sustainable Livelihood Framework (SLF) of mono-rubber-tree farmer households to see the connection between the production system and livelihood, this study showed the following framework (Figure 2).

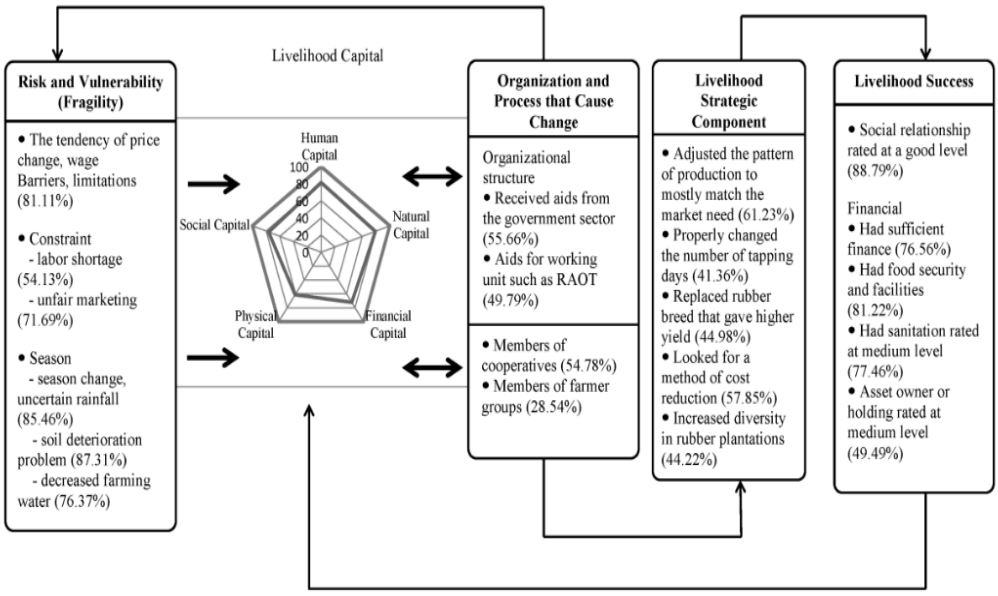

Figure 2. The SLF of smallholding rubber farming system along with oil palm growing
Source: adaptation SLF framework from DFID, 2001

Influencing factors among livelihoods components under rubber farming system along with oil palm growing

The influencing factors among components of livelihoods under rubber farming system along with oil palm growing is based on the relationship within the various livelihood components of the Sustainable Livelihood Framework (SLF), which are shown in six models as follows: (1) The asset component or capital factor had an influence on the vulnerability and fragility component (model 1). (2) The asset component or capital factor that had an influence on livelihood achievement (model 2). (3) The factors of structure and process that had an influence on vulnerability and fragility component (model 3). (4) The factors of strategic livelihood component that had an influence on livelihood achievement (model 4). (5) The factors of livelihood achievement component that have an influence on vulnerability and fragility (model 5). (6) The factors of vulnerability component, asset component, structure and organization

component, and strategic livelihood component that had an influence on livelihood achievement (model 6).

Model 1 showed that factors of asset component or capital had influenced rubber farming system along with oil palm growing (Table 1). It presented the vulnerability and fragility component at 6.40% with statistical significance at 0.05 (Sig 0.165). The standard equation ofv the influence of asset variable found that the natural capital had influenced on the prediction of vulnerability and fragility more than other assets (β =0.325ZA3). Model 2 showed that factors of asset component or capital had influenced on livelihood achievement from rubber farming system along with oil palm growing up to 9.60% with no statistical significance at 0.05 (Sig 0.088). The standard equation for influence of asset variable found that the social capital had influenced on the prediction of livelihood achievement more than other assets (β =0.304Z A5). Model 3 showed that factors of structure and process component had influenced on vulnerability and fragility of rubber farming along with oil palm growing component in 17.90% of the farmers, with statistical significance at 0.05 (Sig 0.014). The standard equation analysis for influencing the structure and process variable revealed that government agents that came with support or created training activities had affected on the prediction of livelihood more than other assets (β =0.387Z T1). Model 4 indicated that factors of livelihood strategic component on rubber farming system along with oil palm growing had affected on livelihood achievement for the farmers at 23.50% with statistical significance at 0.05 (Sig 0.036). The standard equation for the influence of strategic variable resulted to receive and support from government agencies had influence on the adjustment of predicted livelihood achievement more than other strategies (β =0.413Z ST12). Model 5 showed that factors of livelihood achievement component on rubber farming system along with oil palm growing had influenced on vulnerability and fragility for farmers at 1.90% with no statistical significance at 0.05 (Sig 0.058). The influence of achievement variable found that achievement of asset proprietorship had affected the prediction of vulnerability and fragility more than other (β =0.346Z LA3).

Model 6 indicated that the factors of vulnerability component, asset component, structure and, organization component, rubber farming system along with oil palm growing and strategic livelihood had influenced on livelihood achievement of 11.50% of the farmers with no statistical significance at 0.05 (Sig 0.112). The component variables found that vulnerability and

fragility had influenced on the prediction of livelihood achievement more than other (β =0.358Z V).

Table 1. Recent production of rubber farming system along with oil palm growing

Production technology	Unit	Results
1.Farm experience	years	Average (23.6)
2.lands holding	rai/household	For rubber an Average (13.3), oil palm an average (25.2)
3.Rubber and oil palm varieties	percentage	For rubber: RRIM600 (82.7), For oil palm: Surat Thani 2 (100.00)
4.The recent age of rubber and oil palm trees	years	For rubber an average (16.6), for oil palm an average (5.8)
5.The agricultural growing space	percentage	Rubber plantation (100.00), oil palm plantation (56.0), and Fruit tree farm (23.8)
6 A number of trees	Trees/rai	rubber (83.4), oil palm (21.8)
7.Source of financial aids	percentage	from RAOT (77.2), 0ther sources (22.8)
8.Fertilizer used	percentage	Chemical fertilizer (100.0) both rubber and oil palm, organic fertilizer (26.5) only rubber
9.Disease control method	percentage	Chemical control (67.2) for rubber, (44.4) for oil palm
10. Weed control method	percentage	Mechanical method (90.9), Chemical control (47.9) for rubber, Mechanical method (78.4), Chemical control (21.7) for oil palm
11.The recent tapping systems used	percentage	1/3S 4d/5(58.3), 1/3S 5d/6(21.6), and 1/3S 2d/3(11.1) for rubber
12. production quantity	kg/ rai/year	Rubber production (272.6). oil palm production (18,878.0)
13.Rubber product form	percentage	Latex (72.0), cup lump (17.3), and raw rubber sheet (10.6)
14. Rubber price	baht/kg	Average (34.5)

Table 2. Influencing factors among livelihoods components under rubber farming system along with oil palm growing in study areas of Surat Thani province, Prachuap Khiri Khan province, and Chumphon province

Model	Model	Equation function	Standardized Equation Function	Std. Error of the Estimate	significant	Adjust R^2
1	The factors of asset component or capital that have an influence on vulnerability and fragility component	$Y=0.618+0.575^{A1}+0.345^{A2}-0.415^{A3}-0.212^{A4}+0.240^{A5}$	$Z=0.261Z^{A1}+0.103Z^{A2}-0.325ZA3^{A3}-0.095Z^{A4}+0.070Z^{A5}$	1.085	0.165	0.064
2	The factors of asset component or capital that have an influence on livelihood achievement	$Y=1.24+0.238^{A1}+0.243^{A2}-0.134^{A3}+0.130^{A4}+0.258^{A5}$	$Z=0.130Z^{A1}+0.163Z^{A2}-0.098\ Z^{A3}-0.118Z^{A4}+0.304Z^{A5}$	0.815	0.088	0.096
3	The factors of structure and process component that have an influence on vulnerability and fragility component	$Y=0.120+0.564^{T1}+0.480^{T2}$	$Z=0.387Z^{T1}+0.376Z^{T2}$	0.920	0.014	0.179
4	The factors of livelihood strategic component that have an influence on livelihood achievement component	$Y= 3.628+0.302^{ST1}-0.346^{ST2}+0.021^{ST3}-0.038^{ST4}+0.022^{ST5}+0.005^{ST6}+0.612^{ST7}-0.141^{ST8}+0.092^{ST9}+0.033^{ST10}-0.207^{ST11}+0.154^{ST12}$	$Z=0.224Z^{ST1}-0.402Z^{ST2}+0.018Z^{ST3}-0.118Z^{ST4}+0.024Z^{ST5}+0.019Z^{ST6}+0.262^{ST7}-0.239Z^{ST8}+0.189Z^{ST9}+0.194Z^{ST10}-0.258Z^{ST11}+0.413Z^{ST12}$	0.843	0.036	0.235
5	The factors of livelihood achievement component that have an influence on vulnerability and fragility component	$Y= 0.525+0.389^{LA1}+0.291^{LA2}-0.362^{LA3}-0.264^{LA4}+0.374^{LA5}$	$Z=0.240Z^{LA1}+0.084Z^{LA2}-0.346Z^{LA3}-0.150Z^{LA4}+0.196Z^{LA5}$	1.230	0.058	0.019
6	The factors of vulnerability component, asset component, structure and organization component, and livelihood strategic component that have an influence on livelihood achievement component	$Y= 1.449+0.287^{A1}+0.244^{A2}-0.322^{A3}+0.105^{A4}+0.317^{A5}-0.274^{V}+0.218^{T}+0.188^{ST}$	$Z=0.187Z^{A1}+0.190Z^{A2}-0.238Z^{A3}+0.098Z^{A4}+0.275Z^{A5}-0.358Z^{V}+0.141Z^{T}+0.170Z^{ST}$	0.794	0.112	0.115

Remark:The symbol of livelihoods component variables are following;(1)Weakness and fragility component; season uncertainty(V1) and tendency of price change of agricultural products and wage(V2),(2) An asset for livelihood component: human capital(A1), financial capital(A2), natural capital(A3), physical capital(A4), and social capital(A5), (3) Structure change and process component; The participated activities and received aids from the government sectors(T1), Impact and benefit from government sector(T2)Local working unit and Institution(T3),and Impact and benefit from Local Government unit and Institution(T4), (4) Livelihood strategic component; Production technology(ST1), Production efficiency improvement(ST2), Decreasing cost of production(ST3),production size enlargement(ST4), The improvement of biodiversity(ST5), household labour for production(ST6), non-agricultural labour utilization(ST7), Farm financial management(ST8), Food consumption(ST9),The farm‘s marketing adjustment(ST10), the farm‘s social adjustment(ST11),and Participation level(ST12), (5) Livelihood success component; the sufficiency conditions of ample finance(LA1), Food security and facilities(LA2), Asset owner or holding(LA3), the sufficient Production resource(LA4), the level of social relationship(LA5),and Sanitation(LA6)

The connection between socio-economic factors and rubber production with sustainable livelihood

The connection between socio-economic factors and rubber production with sustainable livelihood under smallholding rubber farming system along with oil palm growing resulted as follows: (1) Economic circumstance and livelihood, The data relevant to economic factors such as income and expenditure, the conditions of households savings habit and owed debts were affected by the fluctuation of rubber prices and unfair marketing, and increased the risk of the production process affecting the financial capital level of households as well as the fragility of the production process. The farmers had adjusted themselves to meet their economic needs. For example, farmers had supplementary activities to support their household incomes in order to efficiently manage the financial resource of households. (2) Social circumstance and livelihood, the data reflected that social background such as knowledge, educational level, experience, being a group member, and relevant production process policy was partly involved in the decision making process. Furthermore, the participation process relevant with the production process and the marketing process affected the risk management process with related to human and social capital. Then, farmers had selected strategies for the adjustment by creating a concept and building innovation to increase values for more household incomes and strengthened livelihood. These had led to livelihood results to achieve food security, more facilities, and community interaction. In brief, there would be increased in the potential of human capital and social capital in the production process. (3) Rubber production and livelihood: Data were reflected by using appropriate technology in the production process that affected the efficiency of production. The production process had proper physical and biological factors. These factors brought about the selection of the production process that conformed to the area's weather condition. Such factors had related to the process of risk management which targeted the quantity and quality of rubber production. However, physical and biological factors also had interacted with the fragility of natural capital in the weakness component of livelihood which directly affected the livelihood of farmers in successful production output, food security, and good sanitation.

Discussion

The rubber production system and the livelihood of rubber farmer households under rubber farming system along with oil palm growing in Prachuap Khiri Khan province, Chumphon province, and Surat Thani province of Thailand was discussed. The socio-economic implications of rubber production under the smallholding rubber farming system was emphasized to find the ways of livelihood outcome development to receive by the farmers for their future security. Then, farmers would be able to live in changed situation of economic growth in their smallholding rubber plantations by growing rubber trees along with doing other alternative activities for more income when the seasons change. The improved livelihood depended on the peculiar circumstance of each household. The different household circumstances would require different adjustment to achieve different results as reported by Intraskul and Somboonsuke (2016). Nevertheless, there would compromise between the pre-proposed targets during the changing process of livelihood strategies and meeting those targets. However, there is another aspect that mainly depends on the circumstance of the resource profile of the households where additional factors such as human resource, physical resource, financial resource, social resource, and natural resource affect the households to find th eother ways of strategic adjustment for better livelihood outcomes. The hard times of life in the community and the conditions of other available resources would let farmer households to appropriate and utilize those resources to further affect their livelihoods as stated by Somboonsuke *et al*. (2019).

The study found that most of the household heads were male, rubber plantations were the major occupation, the farmers were highly experienced, and most of the workers were parent generations or elderly laborers. For the success of the social relationship, the family household relationship was rated at a good level. Sometimes, working in the rubber plantations encountered challenges caused by weather conditions and natural disasters which directly affected rubber production because rubber yields could not be harvested which affected the farmers' livelihood which also stated by Somboonsuke *et. al* (2019). This conforms to the study by Masae *et al.* (2007) who found that agricultural farming was not an outstanding career in rural societies. There had been changed in production pattern from the subsistence to the commercial modes for the whole outlook in rural areas. This change was rather directed to consumerism which tied up more income in term of cash. The households in

rural areas did not rely the full-time agricultural work. Those households slowly adjusted from the practice where every family members in a household used to help each other to work full-time and several other activities at the same time. For this adjustment in livelihood patterns, the households in the rural areas with different circumstances had different adjustments which depended on the various resource profiles by their group economic circumstances. The poor households had more compromised to make the average circumstance, and rather rich among them. The resources necessary for these adjustments in the rural community was mainly material resources. For example, land is the major foundation to build up the economic wellbeing in rural societies that increased capital.

Capital is very important in the society of this new era. However, social resource and cultural resource still play important parts in building relationship and connection with other resources. For the human resource, particular household labour plays a major role of the factors to elevate the production levels that yield ample livelihood results. Developing human resource by providing a proper level of education is necessary for the future of members of the rural community for their livelihood adjustment in terms of sustainable socio-economic improvement in changing times. For environment resources which means common properties existing in the community or the nearby areas such as water resources, animal grazing areas, and arable forests, the study found that these resources were limited in use at the time of the study. This conforms to the study by Sapram and Chaigarun (2007) who found that there was a relationship among production mode, poverty, and health, for smallholder farmers in production activity. This study mentioned that farmers in the production mode who adjusted from intensive chemical agriculture to sustainable agriculture still remained in economic poverty condition because of the high production cost (even though the cost of chemicals might be low) while the product prices were fluctuated and relied in the market-driven economic system for their livelihood. Also, the food expenses were quite high with a tendency of having high debt condition. Similarly, the economic poverty had an impact on living standard and livelihood of the farmers. Considering the state of well-being of the famers, the study indicated that such conditions tended towards a better livelihood. For example, the physical and social well-beings of the farmers were improving because farmers had low risk to handle chemicals in the production system, and there was more information sharing on safe farming practices between neighbors and networks.

Acknowledgements

This research was supported by Natural Rubber Innovation Research Institute, Prince of Songkla University (Grant No. NAT610286S).

References

Agricultural Extension Office (2015). Evaluation of approach to develop farmers' market. Report, Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Department for International Development (DFID) (2001). Sustainable livelihood guidance sheets. *(*Working paper*)*. 94 Victoria Street, London SW1E 5JL, 48.

Intraskul, S. and Somboonsuke, B. (2016). ASEAN Economic Community: Opportunity and Feasibilities of Thailand's Rubber Industry Investment. Journal of Agricultural Technology, 12:579-589.

Masae, A., Somboonsuke, B. and Sabaiying, M. (2007). Modernization and Livelihood Adaptation in Rural Communities. Conferences. Southern Thailand English Language Teaching/Cultural Change Conference, (pp. 76-77). January 29-30, 2007 at The Hansa JB Hotel, Hat Yai. Songkhla: Faculty of Liberal Art, Prince of Songkla University.

Office of Agricultural Economics (2016). Agricultural production data. Retrieved from: http://www.oae.go.th/production.html.

Office of the National Economic and Social Development Council (2016). The tenth national economic and social development plan (2007-2011). Bangkok, Thailand: Office of the Prime Minister.

ROAT (2018). Thai Natural Rubber Management of whole system strategic plan 2017-2021.Rubber Authority of Thailand, Bangkok,Thailand: 105 pages.

Sapram, N. and Chaigarun, S. (2007). Sustainable Agriculture Processes and Indicators. Nonthaburi, Thailand: Sustainable Agriculture Foundation.

Somboonsuke, B., Yincharoen, A., Kongmanee, C. and Phitthayaphinant, P. (2019). Rubber production system and livelihood of smallholding rubber farming system (SRFS) in southern Thailand: A case study in provinces of Nakhon Si Thammarat, Phatthalung and Trang.' International Journal of Agricultural Technology, 15:645-664.

(Received: 24 July 2020, accepted: 20 April 2021)