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Can Cooperatives Improve the Incomes of Rubber Smallholders in Thailand?: A Case Study in Chumphon Province

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Abstract

Smallholders are the major planters of the Para rubber tree (*Hevea brasiliensis*) in tropical Asia. One challenge they face is having to overcome the disadvantages of rubber processing and marketing; accordingly, organizing smallholders into cooperatives has been a major policy objective. The Thai government established smallholders' cooperatives in the 1990s and granted them smokehouses for processing latex into ribbed smoked sheets (RSSs). More than two decades have passed since then; the cooperatives' market share in the rubber processing/marketing industry has meanwhile declined to only 5% amid an accelerated growth in the private sector. This study aims to assess the impact of processing and marketing activities among Thailand's rubber cooperatives, based on a case study in Chumphon province. It was discovered that the profit per unit area (rai) from rubber production was significantly higher for cooperative members than for non-members, which was primarily due to the higher prices of rubber offered by these cooperatives. This became possible because cooperatives produced higher-quality RSS than the private sector, which had to purchase unsmoked sheets (USSs) from a large number of rubber smallholders. Our regression analysis showed that cooperative membership ensured a higher profit per rai of 1,407 baht. It was also found that member households earned 50% higher total household income than non-members. In rubber production, the members depended more on hired labor, such as tappers, while allocating a major proportion of their family labor to other work opportunities, especially to non-rubber agricultural activities, which are more profitable considering the current low prices of rubber worldwide.

Introduction

Smallholders are currently the major planters of the Para rubber tree (*Hevea brasiliensis*) in tropical Asia [Fox and Castella 2013]; earlier, large-scale plantations had dominated for a certain period after the tree's introduction to Asia from Brazil via Kew Gardens (London) in the late nineteenth century. The labor intensity of rubber production is a major reason why family labor-based smallholders are currently dominant.

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However, the smallholder sector has several disadvantages. First, the Para rubber is a perennial crop and typically requires seven years before harvest, and thus, smallholders with insufficient capital face difficulties. Second, smallholders tend to experience disadvantages in rubber processing and marketing, even if advantageous production occurs [Hayami *et al.* 1990].

Regarding the first point, smallholders have historically counteracted the disadvantages of capital endowments with diversified sources of income, including food crop production. However, an important government initiative has focused on assisting smallholders' rubber replanting activities with funds mobilized from rubber export taxes. For instance, the Thai government established the Office of Rubber Replanting Aid Fund (ORRAF) under the Ministry of Agriculture and Cooperatives in 1960. An export levy (called "cess") was introduced for rubber products, and it was decided that 85% of the tax revenue was to be used for the replanting program [ORRAF 1960]. Replanting accelerated after the 1970s,[1] resulting in the dissemination of high-yield rubber clones. Consequently, the average yield of rubber in Thailand began to increase sharply after the mid-1980s, from 400 kg/ha to 1,600–1,800 kg/ha recently [FAOSTAT 2018].[2]

Relative to the second point, economies of scale exist in rubber processing and marketing. Additionally, it is relatively difficult for smallholders, with their smaller units, to maintain a rubber product quality to meet international requirements. They also often face problems in marketing their product that arise from their weak bargaining power vis-à-vis private traders [Barlow *et al.* 1994; Effendi 1985; Somboonsuke 2001]. Rubber smallholders' cooperatives were organized by the governments in many countries to solve such problems. In most traditional rubber-producing countries, such as Malaysia, Indonesia, Thailand, and India, the idea of the cooperative came into existence from the 1950s to the early 1960s [Karrakarn 1985; Salleh 1985; World Bank 1987; Thomas 2004]. However, as will be mentioned below, the government's actual introduction of rubber cooperatives was largely delayed in the 1990s for almost the same period as in new rubber-producing countries, such as Laos [Vongvisouk and Dwyer 2017].

Rubber is harvested as latex, and the collected latex is processed into unsmoked sheets (USSs) by coagulating latex with formic acid and rolling it into sheets. Moreover, USSs are further processed as ribbed smoked sheets (RSSs) by drying them in a smokehouse for several days, and RSS is the final product for export and/or sales locally, such as to tire factories.[3] The quality of RSS is ranked into

1) Initially, the replanting program experienced slow progress for about a decade. The smallholders were not interested in the program due to a lack of awareness, and an inappropriate information dissemination system.
2) India, Vietnam, and Thailand achieved the highest global yields.
3) The other major type of final rubber product is technically specified rubber (TSR), which is made from low-quality USS and cup lump. The market share of TSR is currently increasing worldwide.

five categories, with RSS 1 as the best. The rubber clone type does not affect quality, as this is basically determined during the first step of processing latex into USS. As USS can be easily processed without much capital or sophisticated technologies, smallholders typically make USS themselves [Maneekul 1985], although with generally low quality and a lack of uniformity due to the different environments and technologies under which USS is processed by numerous smallholders. Even if some smallholders make high-quality USS, the overall quality of the resulting RSS lessens, as USS is collected from many smallholders and mixed as it is further processed into RSS. Hence, smallholders cannot gain higher prices for their product even if their production output is high quality.

Theoretically, if smallholders are organized into cooperatives (or unregistered groups) and the cooperatives purchase latex from member smallholders to collectively process it into USS, they can overcome some disadvantages faced in rubber processing and marketing. However, these cooperatives must compete with the private sector. If they are not sufficiently efficient or are inconvenient for smallholders due to internal management problems or other reasons, smallholders will become reluctant to join these cooperatives. For example, Thai smallholders were reluctant to join cooperatives prior to the 1990s, as profit on rubber sheets was low and there were disagreements over groups' use of processing facilities [Chaiprasit and Lim 1976]. Further, Indian rubber smallholders prior to the 1980s were unwilling to join cooperatives, primarily because these were typically located far from their villages [Thomas 2004].

Although the situation subsequently improved, the cooperative sector's market share in rubber processing and marketing is still very small. Many rubber smallholders in Malaysia now sell directly to government agencies or state companies, such as the Rubber Industry Smallholders Development Authority (RISDA) and the Federal Land Development Authority (FELDA). Cooperatives' market share remains limited even in India (Kerala), where the sector developed after 1986 [Santhakumari and Pillai 2011].

However, many studies have reported that cooperatives have benefited the rubber smallholders. These benefits were primarily derived from decreased processing costs, higher rubber prices, and increased bargaining power vis-à-vis private traders, among others [Fathoni 2009; Leimona *et al.* 2010; Agustina *et al.* 2017 in Indonesia; Vongvisouk and Dwyer 2017 in Laos]. The benefit in India was primarily reported in terms of improved rubber product quality (RSS), resulting in better price gains [Viswanathan 2008; Anjula *et al.* 2012; Varghese 2012; Balakrishnan 2013].

On the other hand, research on rubber cooperatives is scarce in Thailand, and especially those from the cooperative sector versus private sector perspectives. Tunjakho [2010], Preuksa [2013], and Preuksa *et al.* [2013] offer detailed studies on rubber cooperatives, but they mainly focused on coopera-

tives' internal management issues without much attention to their competition with the private sector.

More than two decades have passed since rubber cooperatives were established in Thailand in the 1990s. Initially, the government's primary intention was to assist rubber smallholders who were suffering due to the global drop in rubber prices at the time; while the government granted smokehouses to these cooperatives with a goal of building 1,500 smokehouses, various problems[4] led to only 675 being built.[5] However, the Thai government stopped this smokehouse program after 1996, and it has never revived until today.[6]

The economic environment drastically changed thereafter; specifically, a notable increase in private smokehouses in terms of both number and size can be observed. The total standard capacity in the private sector today is 60–80 tons/day of RSS,[7] while the total capacity in the cooperatives is only less than 10 tons/day, which remains unchanged since the 1990s until today [Cooperative Promotion Department 1995]. The cooperative sector's share of total processed and marketed rubber in Thailand has declined over time, and recently it has been estimated at only 5% [Mankong *et al.* 2013]. Further, cooperatives' smokehouses are outdated and require renovation. Is the rubber processing and marketing industry in Thailand's cooperative sector still socially significant? Naturally, no one denies the importance of cooperatives (or unregistered groups) in the government's efficient dissemination of rubber production technologies. However, questions remain on the cooperatives' placement in the rubber processing and marketing sector. If rubber processing by cooperatives is inefficient, restructuring might be necessary; however, if the cooperatives in this sector have advantages vis-à-vis the private sector, the government has an impetus to continue its supporting policy. Note that the Thai government has supported cooperatives until recently by providing interest-free loans for: 1) renovating smokehouses, and 2) working capital.

This study primarily aims to assess processing and marketing activities' impact among Thailand's rubber cooperatives. We compare cooperative members and non-members in terms of cost, income, and profit per the unit area of rubber in an attempt to understand the rubber cooperatives' roles. For such a purpose, we selected a study site from Pathio district, in south Thailand's Chumphon province, which is one of the country's major rubber-producing provinces.

The rest of this paper is organized as follows: Section 1 presents the study site's basic characteris-

4) The major obstacle was difficulty in finding land for the smokehouses [Intarayota and Buncharoen 2007].
5) Many smokehouses later ceased operations, primarily due to conflicts between the owner of the land (where the smokehouses were built) and other cooperative members.
6) Organizing rubber cooperatives continued after 1996, although the government stopped granting smokehouses.
7) The standard capacity of a smokehouse in the private sector is 20 tons/day, and each firm typically has 3–4 smokehouses.

tics, method of sampling rubber smallholders, and general information on the rubber cooperatives in the study site. Section 2 presents: 1) basic information on the sample rubber smallholder households, including the population and labor force, land tenure, and land use, among others; 2) households' income-earning structure, including the income from rubber, non-rubber agriculture, non-farm activities, and remittance from migrants; and 3) the cost and return structure of rubber production. Finally, an analysis on rubber cooperatives' contribution to the income/profit per unit area of rubber is conducted using a multiple regression analysis. Finally, we summarize the argument and conclude.

1. Study Site and Research Methodology

1.1 *Study Site*

Chumphon province was selected for the study (Fig. 1) as it is a major rubber-producing province with rubber cooperatives that are known to be both active and innovative. Private firms in the province engaged in rubber processing and marketing are also active. In 2017, we visited all six rubber cooperatives in Pathio, the largest rubber-producing district in the province (Table 1).

Table 1 reveals that all the cooperatives were established in the mid-1990s. As of 2018, 523 rubber cooperatives exist in the entire country, with the largest number in the southern region (58%), followed by the northeastern (30%), central/eastern (8%), and northern (4%) regions [Cooperative Auditing Department 2018]. Most of the cooperatives in the south and central/east were established in the 1990s, while those in the north and northeast were set up after the 2000s (Fig. 2).[8] All the cooperatives in Pathio district were granted four smokehouses with a capacity of two tons/day

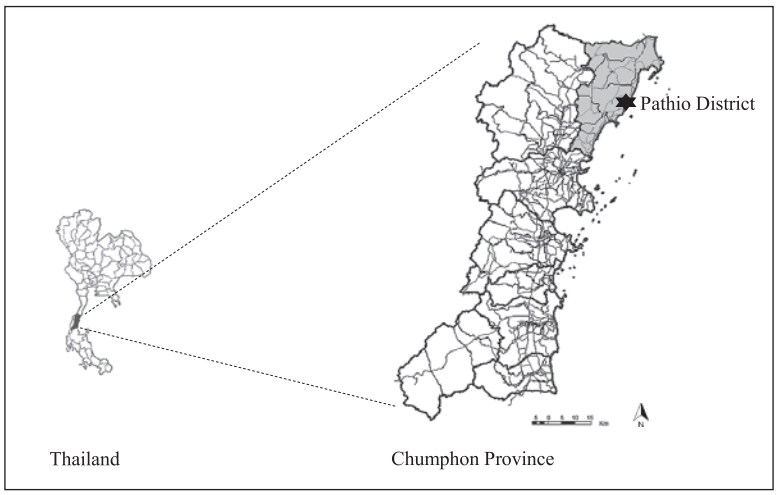

Fig. 1. Pathio District, Chumphon Province

Table 1. Rubber Cooperatives in Pathio District, Chumphon Province

	Year of establishment	No. of members	Total share (Baht)	Major businesses				Mode of payment to members
				RSS processing	Latex purchases/ sales	New rubber products	Fertilizer mixing	
A	1994	102	1,061,750	4 smokehouses		✓	✓	7 days after
B	1994	312	3,069,150	6 smokehouses			✓	6 days after
C	1995	1,000	4,340,940		✓		✓	at spot
D	1995	70	1,025,790		✓		✓	at spot
E	1996	160	1,942,400	4 smokehouses		✓	✓	15 days after
F	1996	140	137,100		✓			at spot

Source: Authors' survey in March 2017.
Note: Cooperative B constructed two additional smokehouses in 2014.

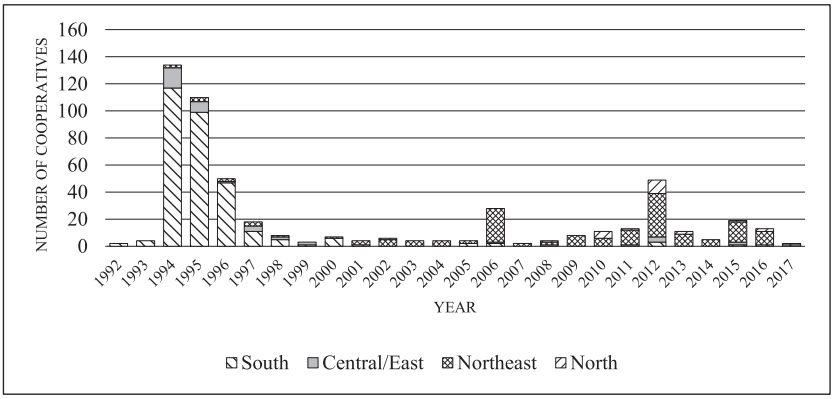

Fig. 2. Distribution of Rubber Cooperatives by the Year of Establishment
Source: Cooperative Auditing Department [2018]

per each; hence, the total capacity was eight tons/day. Cooperative B later established two more smokehouses. The cooperatives were also simultaneously granted fertilizer-mixing machines; they purchased different types of chemical fertilizers and mixed them to sell to their members. This business was profitable and contributed to the cooperatives' development.

Farmers seeking membership must pay a joining fee of 50–100 baht, and buy at least 100 shares (10 baht/share), but not more than 20% of the total shares. Generally, membership is limited to one

8) Rubber production itself was started only after the 2000s in north and northeast Thailand [Office of Agricultural Economics 2012].

person from a household. Further, Cooperative C had an exceptionally large number of members.[9)]

In 2017 only three cooperatives (A, B, E) still operated an RSS-processing business. The six cooperatives can be separated into three categories: 1) cooperatives that ceased operating smokehouses—primarily because of the outdated facilities—and began latex purchasing and sales businesses (C, D, F); 2) cooperatives that continued RSS processing after renovating their smokehouses (B); and 3) cooperatives that began a new rubber production business while continuing their RSS-processing business with renovated smokehouses (A, E). All the cooperatives except Cooperative F still operate a fertilizer-mixing business.[10)]

The latex purchase and sales business is based on a contract with a private factory that exports concentrated latex primarily to Malaysia. The cooperatives in this case can pay the members immediately after purchasing latex, as they can also receive immediate payment from the factory. However, the members receive lower prices due to a lack of rubber processing. Alternatively, in the case of the RSS-processing business, the cooperatives failed to pay immediately after purchasing latex. Cooperatives A and B paid approximately one week later, while Cooperative E paid two weeks later (Table 1). Delayed payments often present serious problems for smallholders, and especially if they are poor.

Cooperatives A and E have begun to produce new rubber products: rubber pillows and rubber blocks, respectively. The rubber pillow business began in Thailand in the mid-2000s with its major outlet market in China, where people prefer this product for healthier sleep. As the raw material is concentrated latex, Thai cooperatives must buy it from private factories. They must also invest in concentrated latex-mixing machines and ovens, and a skilled staff is indispensable. However, producing rubber blocks is quite simple: instead of selling RSS normally, cooperatives purchase machinery to compress RSS into cubes to export directly to foreign buyers. These cooperatives can bypass exporters and gain a higher profit.

1.2 *Household Survey*

We conducted a household survey to assess the impact of cooperatives' RSS-processing businesses on rubber smallholders' incomes. We selected Cooperative B for this purpose, as its members come from two sub-districts (*tambon*). The cooperative includes seven board members (the chairman, vice-chairman, and five general members) and employs eight permanent staff (the manager, vice-

9) The members of Cooperative C sharply increased from 491 in 2012 to 1,000 in 2013 after the government announced a rubber prices support program for the cooperative sector. Note that, however, the other cooperatives did not respond to the policy mainly due to the limited capacity of their smokehouses.

10) When we conducted survey, Cooperative F was facing conflict between owner of the land (where smokehouses and fertilizer mixing machine were located) and other members.

manager, an accountant, financial manager, and four general staff members). The cooperative included six smokehouses, and hired eight workers[11] for RSS processing. The total cost for constructing the two additional smokehouses in 2014 was 2 million baht, of which the government subsidized 1.8 million baht through its Cooperative Promotion Program. Regarding the fertilizer-mixing business, while any farmer could buy its processed fertilizers, only members were allowed to buy on credit, with payment due within a year without interest.

A household survey was conducted in the three villages (*muban*) in and near the cooperative, with 100 households (50 members and 50 non-members) selected using a multi-stage sampling procedure. First, a list was obtained of all the cooperative members in the three villages. They were categorized into four classes based on the size of their rubber farm (1 rai=0.16 ha): less than 10 rai, 10–19 rai, 20–29 rai, and 30 rai or greater. A stratified random sampling technique was then employed to select 50 member households. The same procedure was applied in selecting 50 non-members based on a list of all rubber farmers in the three villages, which was obtained from the Pathio branch office of the Rubber Authority of Thailand (formerly ORRAF).

Detailed data on rubber production was then collected from the 100 rubber smallholders through a structured questionnaire, as well as other data on households' socioeconomic characteristics. Statistical t-test was employed to confirm whether there is a significant difference between cooperative members and non-members with regard to various indicators.

2. Results

2.1 *Sample Description*

Table 2 displays the sample households' basic information. Approximately 70% of rubber smallholders had rubber-planted land of less than 20 rai (=3.2 ha), and around 50% of the household heads were women.[12] Nuclear families were dominant, with an average of three to five household members and two to three of them involved in labor. Approximately 8% of the labor force, especially relatively young people, worked outside as migrants. The household heads' average age was 57 years, with a statistically significant difference between the ages of cooperative members (55 years) and non-

11) The workers were from northeast Thailand and were paid on by-piece rate (2.1 baht/kg of RSS 3). If the quality was less than the RSS 3, the workers were not paid as a penalty. Roughly 95–97% of the cooperative's product was RSS 3.

12) The high percentage of female-headed households is not exceptional in Thai society. Household heads are the major decision-makers; for example, the household heads in the case of rubber smallholders decide whether they will continue rubber production or convert their lands to orchards. Gordon and Sirisambhand [1987] asserted that women play a major role in owning and managing rubber plantations in major rubber-producing countries, such as Thailand, Malaysia, and Indonesia.

Table 2. Household Members, Labor Force, and Land Use Structure for Sample Households

Type of farmers	Rubber farm size (rai)	No. of households[1]	No. of household members			No. of labor forces[2]			Rubber land (rai)		Non-rubber land (rai)
			Total	Male	Female	Total	Male	Female	Total	Tapped	
Members	Less than 10	17 (5)	3.88	2.12	1.76	2.41 (1.26)	1.24 (0.65)	1.18 (0.62)	6.5	6.4	2.9
	10–19	17 (10)	4.06	2.12	1.94	2.47 (1.18)	1.24 (0.38)	1.24 (0.79)	14.9	13.6	2.8
	20–29	8 (7)	2.63	1.00	1.63	1.63 (0.69)	0.63 (0.19)	1.00 (0.50)	24.0	23.3	11.4
	30 and above	8 (5)	3.88	2.25	1.63	3.25 (2.38)	2.13 (1.50)	1.13 (0.88)	56.5	56.5	2.1
	Total	**50 (27)**	**3.74**	**1.96**	**1.78**	**2.44 (1.32)**	**1.28 (0.62)**	**1.16 (0.70)**	**20.2**	**19.6**	**4.1**
Non-members	Less than 10	21 (9)	2.81	1.33	1.48	1.81 (1.00)	0.86 (0.48)	0.95 (0.52)	4.8	4.8	0.2
	10–19	14 (7)	4.14	2.14	2.00	3.14 (2.25)	1.50 (1.04)	1.64 (1.21)	13.6	13.6	4.6
	20–29	9 (5)	5.11	3.67	1.44	3.44 (2.17)	2.67 (1.78)	0.78 (0.39)	22.4	22.4	0
	30 and above	6 (3)	4.00	2.17	1.83	2.17 (1.42)	1.17 (0.42)	1.00 (1.00)	56.7	54.7	9.5
	Total	**50 (24)**	**3.74**	**2.08**	**1.66**	**2.52 (1.61)**	**1.40 (0.86)**	**1.12 (0.75)**	**16.6**	**16.4**	**2.5**

Source: Authors' survey during July and August 2017.
Note: [1] Numbers in parentheses show the number of female-headed households.
[2] Numbers in parentheses show the number of labor forces engaged in rubber production.

members (60 years).[13] Further, members had more years of education on average (11.3 years) than non-members (10.0 years).[14]

A statistically significant difference was observed between members and non-members in both total land holding and land used for rubber production.[15] Cooperative members had more than 20% larger areas of land; rubber was planted in 83–87% of the total land and the rest was used for non-rubber crops, such as oil palm, durian, and coconuts. Almost all the land used for rubber production was tapped, with an average of 21- to 22-year-old tapped rubber trees.

Table 3 summarizes the households' estimated income, indicated by income source. The average annual household income was 367,414 and 245,986 baht for members and non-members, respectively,[16] with members receiving 50% higher income. This income gap came from all income

13) See the Appendix for the statistical tests.
14) See the Appendix for the statistical tests.
15) However, no statistical difference was found in the tapped area of rubber. See the Appendix for statistical tests.

Table 3. Income and Income Sources for Sample Households

Type of farmers	Rubber farm size (rai)	No. of households	Rubber income (Baht)	Non-rubber agricultural income (Baht)	Non-farm income (Baht)	Remittance income (Baht)	Total income (Baht)
Members	Less than10	17	65,687 (32%)	26,471 (13%)	92,588 (45%)	19,412 (10%)	204,157 (100%)
	10–19	17	118,315 (35%)	85,294 (26%)	95,882 (29%)	34,118 (10%)	333,609 (100%)
	20–29	8	208,406 (38%)	201,250 (37%)	137,500 (25%)	0	547,156 (100%)
	30 and above	8	394,175 (65%)	11,250 (2%)	126,000 (21%)	75,000 (12%)	606,425 (100%)
	Total	**50**	**158,974 (43%)**	**72,000 (20%)**	**106,240 (29%)**	**30,200 (8%)**	**367,414 (100%)**
Non-members	Less than10	21	54,883 (39%)	4,762 (4%)	75,429 (54%)	4,286 (3%)	139,360 (100%)
	10–19	14	114,086 (50%)	21,429 (9%)	92,929 (41%)	0	228,444 (100%)
	20–29	9	123,515 (60%)	17,333 (8%)	35,000 (17%)	30,000 (15%)	205,848 (100%)
	30 and above	6	438,650 (61%)	40,000 (6%)	125,000 (17%)	116,667 (16%)	720,317 (100%)
	Total	**50**	**129,866 (53%)**	**15,920 (6%)**	**79,000 (32%)**	**21,200 (9%)**	**245,986 (100%)**

Source: Authors' survey in July–August 2017.

sources: rubber and non-rubber agricultural, non-farm, and remittance. On the one hand, the largest gap was found in non-rubber agricultural income, comprised of income from non-rubber crops and pig-raising or shrimp-farming businesses.[17] On the other hand, the gap in non-farm income was primarily derived from the difference in working sectors: the government sector for members versus the manufacturing sector for non-members.

2.2 *Rubber Plantations' Management*

Table 3 also reveals a gap in the income from rubber between the two groups. However, if the difference in the average tapped area for rubber production was considered, the gap disappeared, with incomes of 8,132 baht/rai for members and 7,919 baht/rai for non-members. A sharp difference was found in the major rubber products that smallholders sold (Table 4), as most members sold latex

16) The average baht exchange rate in 2017 was 33.93 baht/US$ [Bank of Thailand 2018].

17) Of the members' total non-rubber agricultural income of 72,000 baht, 30,000 came from pig-raising or shrimp-farming businesses, while the remaining 42,000 baht came from non-rubber crops. Note that the gap of the non-rubber agricultural income between the two groups mainly derived from the difference in the kind of non-rubber agricultural sector. The non-members invested only in oil palm and vegetables, while the members invested mainly in durian and pig-raising which were much more profitable.

while non-members primarily sold USS. This is simply because the cooperative purchased latex. Members consequently enjoyed higher unit prices (52.6 baht/kg for latex) than non-members (51.3 baht/kg for USS), and the latter needed to work more to process USS by themselves.[18)19)] Note that some non-members sold cup lump[20)] and received very low prices, although producing cup lump has the advantage of saving labor and time. Table 4 indicates that one-third of non-members with the smallest area (less than 10 rai) produced cup lump and allocated less labor for rubber production (Table 2).

Table 5 summarized the cost and return structure of rubber production per unit area (rai) of tapped rubber. The major findings from this table are as follows: First, both the rubber trees' age

Table 4. Rubber Product and Its Prices

Type of farmers	Rubber farm size (rai)	Total HHs	Latex		USS		Cup lump		Remarks
			No. of HHs	Average price (Baht/kg of DRC)	No. of HHs	Average price (Baht/kg of DRC)	No. of HHs	Average price (Baht/kg of DRC)	
Members	Less than 10	17	17	52.2					
	10–19	17	16	54.7	1	50.0			
	20–29	8	6	48.6	3	60.0			1 HH produced latex (60%) and USS (40%)
	30 and above	8	6	53.0	4	55.0			2 HHs produced latex (60%) and USS (40%)
	Total	**50**	**45**	**52.6**	**8**	**56.4**			
Non-members	Less than 10	21	7	52.6	7	51.7	7	25.7	
	10–19	14	7	51.3	7	48.1			
	20–29	9	3	48.7	4	49.7	2	25.0	
	30 and above	6			6	52.2			
	Total	**50**	**17**	**50.8**	**24**	**51.3**	**9**	**25.3**	

Source: Authors' survey in July–August 2017.

18) The price of latex is shown in terms of dry rubber content (DRC), and is comparable to the price of USS.

19) The price of latex for non-members (50.8 baht/kg) was lower than for members (52.6 baht/kg) as the former sold latex to private concentrate latex-producing factories. The price of USS for members (56.4 baht/kg) was higher than for non-members (51.3 baht/kg), as the members who produced USS had large stocking spaces and waited until the market prices became high.

20) Cup lump is the solid rubber produced by coagulating latex inside the collecting cup.

Table 5. Gross Revenue, Income, and Profit per rai from Rubber Production

Type of farmers	Rubber farm size (rai)	No. of HHs	No. of self-tapping HHs	Age of tapped rubber trees (years)	Yield (kg/rai)	Rubber sales price (Baht/kg)	Gross revenue (Baht/rai)	Current input cost (Baht/rai)	Fertilizer cost (Baht/rai)	Cost of hired labor (Baht/rai)	Paid cost (Baht/rai)	Imputed cost of family labor (Baht/rai)	Total labor cost (Baht/rai)	Total cost (incl. family labor cost) (Baht/rai)	Profit (Baht/rai)	Income (Baht/rai)
					A	B	C=A*B	D		E	D+E	F	E+F	D+E+F	C-(D+E+F)	C-(D+E)
Members	Less than 10	17	8	19.1	288	52.4	15,061	1,213	656	3,556	4,769	3,834	7,390	8,603	6,458	10,292
	10–19	17	3	22.1	297	54.3	16,169	1,202	987	6,259	7,462	1,126	7,385	8,587	7,582	8,707
	20–29	8	1	23.5	303	52.8	16,081	1,136	983	5,981	7,117	323	6,303	7,440	8,641	8,964
	30 and above	8	1	20.7	247	54.4	13,412	865	712	5,571	6,436	398	5,969	6,834	6,578	6,977
	Total	**50**	**13**	**21.1**	**274**	**53.9**	**14,754**	**1,035**	**822**	**5,588**	**6,623**	**937**	**6,525**	**7,560**	**7,195**	**8,132**
Non-members	Less than 10	21	17	19.0	299	46.4	14,089	1,226	842	1,337	2,563	9,260	10,597	11,823	2,266	11,526
	10–19	14	8	24.7	234	49.5	11,668	1,003	849	2,259	3,262	3,221	5,480	6,483	5,185	8,406
	20–29	9	2	23.4	237	44.6	10,566	912	821	4,151	5,063	832	4,983	5,894	4,672	5,503
	30 and above	6	0	25.2	303	52.6	15,831	1,126	1,072	6,681	7,806	0	6,681	7,806	8,024	8,024
	Total	**50**	**27**	**22.1**	**270**	**49.1**	**13,357**	**1,057**	**930**	**4,381**	**5,438**	**2,081**	**6,462**	**7,518**	**5,838**	**7,919**

Source: Authors' survey during July and August 2017.
Note: 1) Imputed wage rate of 400 baht/day is applied to the family labor cost.

and rubber yields on average did not differ between the two groups (21.1 years versus 22.1 years, and 274 kg/rai versus 270 kg/rai). Note that the major rubber clone in the study site was RRIM 600.[21] Note also that the rubber yield generally increases until 25 to 30 years of age [FAO 2001]. The members' higher average rubber prices (53.9 baht/kg versus 49.1 baht/kg) also created higher gross revenues per rai for them (14,754 baht/rai versus 13,357 baht/rai).[22]

Second, rubber production costs comprise the costs for current input and labor, with no significant difference observed between the two groups in total current input costs, although non-members used more fertilizer.[23] Labor costs, including family and hired labor, also indicated no significant difference. However, Table 5 reveals that the members depended more on hired labor (tappers) than non-members; therefore, the share of family labor costs to total labor costs was only 14.4% (members) versus 32.2% (non-members). Note that the tappers employed in the study area were mainly Thai laborers, with a small percentage of migrants from Myanmar and Laos. They are paid in kind by the share (40%) of rubber product, regardless of Thai laborers or migrants.[24] When we estimated the labor cost, we applied the imputed wage rate of 400 baht/day for family labor—higher than the standard wage of 300 baht/day in Thailand—considering the estimated (effective) wage rates for hired labors as demonstrated in Fig. 3.

Third, given the lack of difference in total costs between the two groups, and also given the members' higher gross revenues, we conclude that the members had higher profits (7,195 baht/rai) than non-members (5,838 baht/rai). However, note that because non-members used more family labor in rubber production, their income per rai (7,919 baht/rai) reached almost the same level as members' (8,132 baht/rai).

2.3 *The Cooperative's Contribution*

The major conclusion is that rubber cooperative members obtained higher profits per unit area (rai), primarily due to the higher rubber prices offered by the cooperative. The regression analysis results rigorously confirm this finding (Table 6). The dependent variable is the profits per rai, and the

21) RRIM 600, introduced from Malaysia, is a major high-yielding rubber clone in the area.

22) See the Appendix for statistical tests.

23) The major current input other than fertilizer is formic acid.

24) The major system observed in the study area (63% of total cases) included 60 farmers: 40 tappers, followed by 50:50. This finding is consistent with work by Kongmanee [2015], in that most of the rubber owners prefer a 60:40 system as a first choice. Our fieldwork identified three major determinants of this share: 1) the location of rubber plantations, as farmers offered a higher share to tappers working in remote plantations without electricity and clean water; 2) the age of rubber trees, as farmers offered a higher share to tappers working with old trees because the tappers must cut their bark at a height of 2–3 meters from the ground, which takes more time; and 3) the relationship between the farmers and tappers, as farmers paid a higher share to tappers with whom they had close relationships.

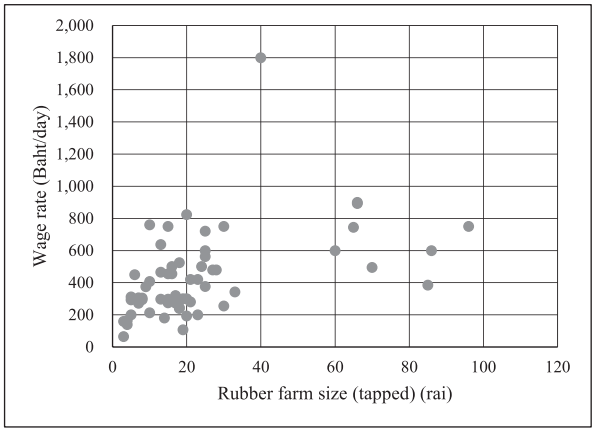

Fig. 3. Hired Tapper Wages
Source: Authors' survey in July–August 2017.

independent variables are as follows:

The rubber trees' age: Given smallholders have all adopted the same clone, the rubber trees' age is the major factor affecting yield. We hypothesize that this has a positive effect, although after a certain point this effect is negative.[25)]

Farm size: If economies of scale exist in rubber production, or if small-scale smallholders face some difficulties, such as capital constraints, the parameter can be positive.

Household head characteristics (gender, age, and education): These factors can affect both revenues (rubber yield and/or price) and cost. It is hypothesized that a dummy for sex (male=1 and female=0) has a negative effect, but age and education have a positive effect.

Factors influencing rubber prices: Smallholders get incredibly low prices from selling cup lump. Hence, a dummy variable is adopted for cup lump production (yes=1, no=0). Another important factor involves whether the smallholders are cooperative members (yes=1, no=0), which is our most important hypothesis, as previously mentioned.

The results presented in Table 6 are generally consistent with our hypotheses. The cooperative membership has positive effect on the profits, although with a weak statistical significance. Therefore, it can be concluded that keeping all other explanatory variables constant, membership in a cooperative increases the profit per rai by 1,407 baht (Equation 2).

25) The amount of fertilizer was also adopted as a factor potentially influencing yield, but it was found to be invalid in the regression analysis.

Table 6. Results of Regression Analysis

Independent variables	Equation Number			
	1	2	3	4
D (Coop-member)[a]	3,865.9***	**1,406.5***	1,389.8	1,411.0*
	(1,134.3)	**(841.7)**	(844.6)	(845.8)
D (Cuplump)[a]		**–13,750.9*****	–13,801.9***	–13,682***
		(1,470.3)	(1,476.8)	(1,490.6)
Age_tree		**117.3***	408.0	113.8
		(67.4)	(442.6)	(68.5)
$(Age\_tree)^2$			–7.6	
			(11.5)	
D (Sex_HHH)[a]		**–1,212.7**	–1,168.9	–1,162.6
		(772.3)	(777.4)	(789.3)
Age_HHH		**87.0****	87.9**	85.7**
		(35.7)	(35.9)	(36.1)
Edu_HHH		**384.4*****	384.8***	364.9**
		(137.4)	(137.8)	(149.2)
Farmsize				8.0
				(23.2)
Constant	3,044.4***	**–5,503.0**	–8,023.3	–5,322.0
	(802.1)	**(3,357.6)**	(5,071.4)	(3,413.8)
Prob > F	0.001	**0.000**	0.000	0.000
R^2	0.1060	**0.6132**	0.6151	0.6137
Adj. R^2	0.0968	**0.5883**	0.5858	0.5843
Number of observations	100	**100**	100	100

Note: [a] Dummy variables.
***, **, and * denote 99%, 95%, and 90% confidence levels, respectively.

2.4 *Allocation of Family Labor*

Let us now return to Table 3, which indicates the sample households' income-earning structure. Members enjoyed a 50% higher income than non-members, the most important factor of which was the gap in non-rubber agricultural income. Let us consider this from a family labor allocation perspective. Table 2 reveals that on average, the member households allocated 1.32 family laborers (54.1%) to rubber production and 1.12 family laborers (45.9%) to other work. In contrast, non-member households allocated 1.61 family laborers (63.9%) to rubber production and 0.91 family laborers (36.1%) to other work.

Regarding the allocation of family labor to work in the non-rubber sector, members allocated 0.31, 0.57, and 0.24 family laborers to non-rubber agriculture (27.7%), non-farm work (50.9%), and work outside as migrants (21.4%) respectively, compared to non-members allocating 0.05, 0.68, and 0.18 family laborers (or 5.5%, 74.7%, and 19.8% respectively). Hence, it can be concluded that member households allocated more labor to the non-rubber agricultural sector. Note that in non-

rubber agricultural activities such as durian or pig-raising, skilled labor is indispensable (much more than rubber), so the farmers engaging in non-rubber agriculture tend to use their family labor instead of hiring (migrant) labors, resulting in getting higher returns to their family labor.

It is noteworthy that such non-rubber agricultural sectors are highly profitable, especially considering the current low prices of rubber in 2017 [Stroesser *et al*. 2016].[26] Members allocated less family labor to rubber production by hiring tappers, and instead allocated a major part of it to more profitable agricultural sectors. In fact, the eight member households engaged in pig-raising—typically with 60 to 100 piglets per household—exclusively used family labor in their businesses.[27] The situation was mostly the same for orchard crops, such as palm oil, durian, and coconuts, as they require less labor than rubber but generate more income.[28]

2.5 *Discussion*

A question still remains regarding how the cooperative can offer higher prices to its members compared to the private sector, as the latter has much larger smokehouse capacities and are seemingly much more efficient than cooperatives.

The quality of rubber products is key, as the private sector's smokehouse capacity is larger (60–80 tons/day) and they must collect USS from numerous rubber smallholders. Non-member rubber smallholders typically process USS themselves in different environments and with different technologies, and hence, produce products in different qualities. Consequently, the USS collected by the private sector is overall of non-uniform, low quality. We reiterate that the final product's quality (RSS) is essentially determined in the initial process of producing USS from latex.

In contrast, cooperatives with small smokehouse capacities (6–8 tons/day) buy latex from their members and uniformly process USS to obtain high-quality RSS in terms of its uniform size, thick-

26) Rubber prices have fluctuated significantly in the last 15 years; rubber prices (RSS 3) prior to 2006 moved 1 to 1.7 USD/kg before reaching two peaks—2.7 USD/kg and 3.2 USD/kg in June 2006 and July 2008, respectively—primarily due to high economic growth in China [United Nations 2006] as well as generally high product prices worldwide. However, rubber prices dropped after July 2008 to as low as 1.2 USD/kg in December 2008, due to a sharp decline in oil prices [United Nations 2009]. A rapid recovery then occurred and prices peaked in February 2011 at 6.3 USD/kg because of a decrease in global production following climate change problems in major rubber-producing countries [United Nations 2011]. Subsequently, prices have constantly declined due to an oversupply and increasing inventory [United Nations 2015]. The average price in 2017 was 2.0 USD/kg, which is 68.3% lower than the peak price in February 2011 [IndexMundi 2018].

27) However, another important factor that impeded the non-member households to engage in pig-raising or shrimp farming was a lack of necessary funds. Note that members are generally wealthier than non-members; attaining 50% higher incomes, on average.

28) Although the members got a higher profit from non-rubber agricultural activities, they did not intend to reduce the land for rubber, because rubber requires relatively lower investment and maintenance costs and bears lower risk compared to the other agricultural businesses. Besides, they can expect the rise of rubber price in the future again.

ness, and purity; they thereby receive higher market prices.

A question arises here as to why private entrepreneurs do not purchase latex to process and produce high-quality RSS. Two major reasons include: 1) the difficulty in collecting large volumes of latex, as these must be delivered to factories within two to three hours after harvesting; and 2) the difficulty in finding enough (skilled) labor to process a large volume of latex into USS.

We have found that non-members have the option of selling latex to concentrated latex-producing private factories. In fact, some cooperatives were also engaged in latex purchases and sales. However, this is problematic for non-members, as private traders who purchase latex from smallholders are widely assumed to often manipulate the DRC content of this latex, which is difficult to assess visually. Thus, cooperatives' quality assessment of DRC content follows a transparent standard[29] and is more reliable. Consequently, non-members who sell rubber to private traders prefer USS to latex.

3. Conclusion

This study's major objective is to assess the impact of rubber cooperatives' processing and marketing activities on the economic welfare of rubber smallholders in Thailand, based on a 2017 case study in Pathio district of Chumphon province. A detailed economic analysis compared the costs, income, and profit per unit area of rubber between cooperative members and non-members, and included samples from an area in which a rubber cooperative as well as private firms operate. Collectively, 100 smallholders—with 50 cooperative members and 50 non-members—were sampled in the same proportion as their farm size distribution.

It was found that the profit per unit area (rai) obtained from rubber production was significantly higher for members than non-members. A major reason for this is because the cooperative offered higher prices for rubber. This became possible because the cooperative produced more high-quality RSS than the private sector, which had to purchase its USS from a large number of non-member rubber smallholders. Our regression analysis clarified that membership ensured a higher profit per rai (=0.16 ha) by 1,407 baht. It was also found that member households attained a 50% higher total household income than non-members, and the most important factor attributed to this was a higher income from the non-rubber agricultural sector, including non-rubber crops—such as oil palm, durian, and coconut—and pig-raising or shrimp farming. The members depended more on hired labor (tappers) in their rubber production, and allocated more of their family labor to other work

29) Rubber smallholders widely accept that the hot air oven technique typically adopted by cooperatives in measuring the DRC is more reliable than the microwave technique used by private traders.

opportunities, and especially in non-rubber agricultural activities.

Our finding in Thailand—in that cooperative members benefit from the higher prices offered by the cooperative because they produce high-quality rubber products—parallels the experience in India, particularly Kerala [Viswanathan 2008; Anjula *et al*. 2012; Varghese 2012]. In the latter case, the government's Rubber Board, in a joint venture with Rubber Producers' Societies, further established six rubber-processing companies and 11 rubber-trading companies during the early 1990s, with a 51% equity participation by the Board and 49% by the Rubber Producers' Societies [Santhakumari and Pillai 2011]. This strengthened the cooperatives' (Rubber Producers' Societies) position.

The present study in Thailand also clarified the fact that many non-members in the study area wanted to become cooperative members due to the higher prices offered from the cooperative.[30] However, the cooperative could not accept new members even if it wanted to do so due to its smokehouses' capacity limitations.

It seems that the private sector's smokehouse capacity (60–80 tons per day) is too large to produce high-quality rubber products (RSS 3). Their major products are graded as RSS 4 or 5, which are sold to such local users as tire factories or exporters that further sell this primarily to tire factories abroad. The market requires large lots of rubber to meet tire factories' larger capacity, as they have strong economies of scale. The high-quality RSS supplied by the cooperatives, with a market share of only around 5%, is used to meet the same tire factories' specific demands for such high-quality rubber.

This study implies that if demand for high-quality rubber is increasing, the low-capacity smokehouses (6–8 tons per day) run by cooperatives should increase in size and capacity. In fact, our survey of tire factory managers indicates that they are willing to buy more RSS 3 from cooperatives if prices remain at the same level. If the advantage of low-capacity smokehouses apply for those of larger sizes, for example 10–15 tons per day, the government has a rationale to support the existing cooperatives to expand their smokehouses, so that they can accept new members.

Finally, it should be noted that the quality of rubber that Thai cooperatives currently produce is actually higher than RSS 3; if exported, their products can be assessed as RSS 2. However, the biggest problem for cooperatives in exporting their products involves high market risk, particularly

30) However, small-scale rubber farmers were usually reluctant to join cooperatives even if allowed because they produce small volumes of latex, as they would be expected to deliver latex to be sold at the cooperative every day. Additionally, they would not be able to wait on cooperatives' delayed payment system, as they need payment daily. Therefore, they instead sell cup lump rubber to private traders and immediately receive reimbursement.

risk in meeting the demand of rubber that foreign buyers require, especially in terms of the minimum required lots. Cooperatives have addressed this problem in various locales, such as Trang province, in which the cooperatives formed a federation to collectively export their products [Tassanakul *et al.* 2012]. If each primary cooperative can increase its production by expanding its smokehouses, the federation can gain more bargaining power vis-à-vis foreign buyers.

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Appendix Table Definition and Summary Statistics of Selected Variables

Variable	Description	Total households (N=100)		Members (N=50)	Non-members (N=50)	Mean differences
		Mean	Std. Deviation			
ProfitRY	Profit from rubber per rai (Baht/rai)	4,977.3	5,967.8	6,910.26 (388.05)	3,044.40 (1,065.85)	3,865.85***
Infromrubpr	Income from rubber per rai (Baht/rai)	8,966.0	3,984.2	9,073.02 (3,237.62)	8,859.16 (4,643.83)	213.86
GrossRubIncom	Gross rubber income per rai (Baht/rai)	13,964.8	4,230.8	15,287.38 (465.52)	12,642.12 (659.69)	2,645.26***
Age_HHH	Age of household head (years)	57.3	11.9	54.70 (1.48)	59.86 (1.80)	–5.16**
Edu_HHH	Education of household head (years)	10.7	3.1	11.28 (0.48)	10.02 (0.37)	1.26**
HHsiz	Number of household members	3.7	1.9	3.74 (0.26)	3.74 (0.27)	0.00
HHlabor	Number of household labor	2.5	1.5	2.44 (0.22)	2.52 (0.21)	–0.08
LivingYear	Living year in the community (years)	51.2	12.6	48.30 (1.81)	54.12 (1.66)	–5.82**

Roller	1 if farmer owned a rubber roller, 0 otherwise	0.6	0.5	0.50 (0.07)	0.70 (0.07)	–0.20**
TotalLand	Total land area (rai)	21.7	21.8	24.27 (2.92)	19.16 (3.23)	5.11
Tapland	Total tapping area (rai)	18.0	18.9	19.53 (2.83)	16.40 (2.50)	3.13
Exinrub	Experience in rubber farming (years)	22.4	6.9	23.34 (1.15)	21.42 (0.76)	1.92
Self_tapping	1 if farmer have tapped rubber tree by him/ herself, 0 otherwise	0.4	0.5	0.26 (0.06)	0.54 (0.07)	–0.28***
Easygettapper	1 if farmer feels ease of getting tappers, 0 otherwise	0.9	0.3	0.88 (0.05)	0.96 (0.03)	–0.08
Agr_tree	Average age of rubber trees (year)	21.6	6.0	21.08 (0.86)	22.14 (0.83)	–1.06
Rubprice	Average rubber price (Baht/kg)	49.7	9.2	53.18 (0.79)	46.18 (1.51)	6.99***
Tapday	Number of tapping days per year (days)	138.7	21.5	138.60 (3.03)	138.80 (3.06)	–0.20
Yield	Yield (kg/rai)	279.1	62.8	287.52 (7.51)	270.68 (10.00)	16.84
Inputcost	Cost of current input (Baht/rai)	890.1	439.3	875.90 (65.37)	904.26 (59.30)	–28.36
LaborCost	Labor cost per rai (Baht/ rai)	7,834.4	4,320.2	7,184.54 (336.20)	8,484.22 (789.89)	–1,299.68
Nonfarmincome	Non-farm income (Baht/year)	92,620.0	146,673.1	106,240.00 (24,775.21)	79,000.00 (15,745.42)	27,240.00
Nonrubberincom	Non-rubber agricultural income (Baht/year)	43,960.0	125,192.7	72,000.00 (23,236.14)	15,920.00 (7,830.43)	56,080.00**
TotalHHincome	Total household income (Baht/year)	306,699.7	275,965.9	367,413.48 (41,152.05)	245,985.90 (35,120.15)	121,427.58**

Note: 1) Standard errors in parentheses
2) The average figures are the simple averages, not the weighted averages.
***, **,* denote 99%, 95%, and 90% confidence levels, respectively, by statistical t-test.