Ecosystems & Development Journal 4(2): 38-53
April 2014 ISSN 2012-3612

Production, Processing, and Marketing of Rubber in Laguna Province, Philippines

Arturo Mark A. Castillo II[a*], Roselyn Furoc-Paelmo[b], Lilia P. Retes[c], George M. Maloles[d], Albert D. Sanfuego[e], and Ma. Cecilia P. Carranza[f]

ABSTRACT

The province of Laguna, Philippines is a new player in the rubber industry; hence this study on production, processing, and marketing of rubber in the province. Key actors in the production-marketing continuum were identified as well as the facilitating and limiting factors of the business were determined. Respondents to the key informant interviews were rubber farmers, including tappers and caretakers of rubber farms, who supply cuplumps to Rubberfields Inc., the lone latex processing plant in Laguna. Staff members and technicians from Rubberfields Inc. and representatives from the Department of Trade and Industry (DTI) Regional IV-A office were interviewed. Primary and secondary data were analyzed using thematic categories and descriptive statistics. There are 124.30 ha rubber farms distributed across 11 towns, with 53 farmer-stakeholders in the province. Agroforestry is the most common production scheme, where rubber is intercropped with various fruit-bearing trees. Most farmers used 70% unbudded and the remaining 30% were budded seedlings of RRIM 600, PB 235, PB 260, PB 311, PB 330, and USM 1 varieties. Most farmers employed 3m × 3m spacing, while the age of rubber trees ranged from 2 to 14 years. On average, farms produced 405 kg of latex per month. Production and marketing agreements between farmers and Rubberfields Inc. determined profit sharing. Rubberfields Inc. provides a regular marketing channel for the Laguna-based rubber farmers but there are other buyers who seasonally trade in the province. The pricing in Laguna largely depends on movement of latex prices in Mindanao. The province's rubber agribusiness system has five sub-systems that open possibilities for expansion and improved contribution to the provincial economy while becoming more acceptable to farmers as they were already profiting from it. The estimated household's annual net income from a 1.5-ha rubber-based farm is PhP 161,264.64.

Keywords: agroforestry, rubber, non-traditional rubber farms, rubber production, processing, and marketing

INTRODUCTION

Rubber and the Rubber Industry

Rubber is the latex produced by tapping para rubber (*Hevea braziliensis (*Willd. ex A.L. Juss.) Muell.-Arg.) trees and is an important raw material in the production of various industrial, commercial, and household products, most commonly the manufacture of tires and footwear. It is an agroforestry species that can be grown alongside agricultural crops such as coffee (*Coffea* species*)*, cacao (*Theobroma cacao)*, coconut (*Cocos nucifera*), calamansi (*Citrus microcarpa)*, eggplant (*Solanun melongena)*, tomato (*Lycopersicom esculentum)*, and papaya (*Carica papaya)* (Castillo *et al*. 2012). Rubber trees are also used for rehabilitating degraded areas.

Early rubber plantations in the Philippines were located in Mindanao, specifically in Basilan, Zamboanga Del Sur and Cotabato but is now mainly cultivated in Regions 9, 11, and 12 in Mindanao, accounting for 41%, 29%, and 8% of the country's total production (Costales 2006).

The use of cultural management practices and high-yielding clones increased rubber productivity in the country. Through the Department of Agriculture (DA) and participating Local Government Units (LGUs), the government sponsored the Rubber Development Program (RDP) in early 2000 geared towards improving the local rubber industry, including empowerment of small farmers, plantation owners, cooperatives, as well as new investors.

Rubber is ideally suited for plantations, but rubber growers in the Philippines discovered that rubber can be grown in smaller land areas. In fact, about 95% of rubber producers are smallholders. Rubber is also a better income provider than other crops such as coconut, coffee, and cacao (PCARRD Philippine Recommends for Rubber 1997).

[a]*Lecturer, Institute of Renewable Natural Resources, CFNR, UPLB, College, Laguna 4031, Philippines*
[b]*University Researcher II, Institute of Agroforestry, CFNR, UPLB, College, Laguna 4031, Philippines*
[c]*Owner and proprietor of LPR Enterprises, Sta. Cruz, Laguna*
[d]*Farm Supervisor at Makiling Center for Mountain Ecosystems, and Project Staff under the UPLB Foundation Inc. (UPLBFI) and Department of Agriculture-Bureau of Agricultural Research (DA-BAR) Rubber Project*
[e]*Forester and Research Assistant under the UPLB Foundation Inc. (UPLBFI) and Department of Agriculture-Bureau of Agricultural Research (DA-BAR) Rubber Project*
[f]*University Research Associate 1 at the Institute of Renewable Natural Resources, CFNR, UPLB, College, Laguna 4031, Philippines*
**Corresponding author: amacastilloii@gmail.com*

In Laguna, the oldest rubber plantation was established in 1961 at the Mount Makiling Forest Reserve, College of Forestry and Natural Resources, University of the Philippines Los Baños. However, it was only in 2011 when it was effectively managed for production and research. Current data shows that rubber farms already exist in several towns in Laguna, namely: Sta. Maria, Sta. Cruz, Pagsanjan, Nagcarlan, Pangil, Calauan, Siniloan, Cavinti, Magdalena, Alaminos, and Majayjay. These farms vary in hectarage and year of establishment. The earliest rubber tree farm was established in 1988 in Calauan while the most recent was in 2011 in Sta. Maria. Castillo *et al*. (2012) described the rubber production scheme of Laguna as agroforestry-based.

According to Bagaforo and Camacho (2012), intercropping practices improved farm productivity and profitability during the first five years in Zamboanga, Mindanao plantations. In Indonesia, coffee as a rubber intercrop is more profitable than a monoculture of coffee and rubber (Rosyid and Suryaningtyas 2012).

The growing interest in planting rubber is due to its high industrial value and rising demand in the world market projected at 4.7% annual growth (Cruz 2012). Likewise, the International Rubber Study Group (IRSG as cited by Cruz 2012) predicted that global demand for natural rubber would increase by 4.6% in 2012, and may reach 16.5 million mt by 2020. About 95% of the country's rubber production supplies the requirement of the country's tires, footwear, and related industries. The tire and footwear industries combined consume 70% of the country's total rubber production. Seventy percent of the natural rubber produced was used domestically and only 30% was exported (Jain 2012).

Chronic Issues in Rubber Production in the Philippines

Rubber is considered to be one of the most profitable agro-industrial crops in the Philippines. It is one of the most important sources of employment in Mindanao (Jain 2012). Expanding the country's rubber hectarage by more than 250,000 ha would help meet local demand without the need for importation. Moreover, to gain presence in the export market, the Philippines has to maintain 400,000 ha of rubber plantation (Costales 2006).

However, issues on sustainability of supply and demand have to be addressed first for the country to get a bigger share of the global market (Bureau of Agricultural Research 2012). Stronger support for rubber research, development, and extension is also needed.

Despite being profitable, versatile, sustainable, and environment-friendly, the rubber industry faces several challenges as follows (Alcala 2005): 1) low yield per hectare due to poor management practices; 2) poor nutritional condition of trees; 3) lack of training for proper tapping; and 4) poor infrastructure and marketing systems.

Only a fraction of rubber farmers in the Philippines receive suitable information about rubber production technologies through trainings, seminars, and meetings given by LGUs and extension workers (Mojica 2005).

Costales (2006) claimed that production has been the major bottleneck in the supply chain of natural rubber. Inadequacies in the supply chain limited the expansion of the industry and eroded competitiveness in terms of long-term cost efficiency, responsiveness, and reliability.

Product quality was also found to be relatively lower compared to Thailand and Malaysia (Costales 2006). Industry support system was likewise lacking, further contributing to problems in the industry. Pamplona (2012) listed several factors to consider in successful rubber tree plantation expansion: 1) availability of suitable land, 2) favorable climate, 3) abundant supply of farm labor, and 4) appropriate technologies and viable government support to smallholders to overcome poverty through rubber farming.

Although most rubber plantations are found in Mindanao, existing plantations in Laguna are likewise beset with similar problems such as lack of trained and skilled human resource, lack of a budwood garden to supply the needed bud sticks, limited planting stock supply and availability, and absence of market competition.

It is important to explore the existing production, processing, and marketing practices to help address issues besetting the industry in Laguna. This study would answer the research question, "What are the current production, processing, and marketing practices of rubber enterprises in selected areas in Laguna?" The study was designed to find out the key actors in the production-marketing continuum, the facilitating and limiting factors affecting rubber production in a nontraditional area like Laguna, and recommendations needed to transform Laguna as a production niche for rubber.

METHODOLOGY

This exploratory study employed descriptive research design to characterize the production, processing, and marketing practices of rubber enterprises in the towns of Sta. Cruz, Pagsanjan, Sta. Maria, Calauan, Alaminos, Cavinti, and Majayjay.

Key informant interviews (KIIs) were conducted among 53 rubber farmers who supply rubber blocks to Rubberfields, Inc. as well as processing plant operators. Data gathered from farmers included area planted in hectares, year of planting, number and types of seedlings used, latex yield per month, production practices, and marketing strategies. On the other hand, data on processing practices were gathered from Rubberfields, Inc.

Field visits were also conducted in several rubber farms including the processing plant in Sta. Cruz, Laguna. Various operation aspects and products of the processing plant were observed during the visit. Among those observed were the classification, drying, and storage of rubber.

Data Analysis

Data were analyzed by using thematic categories as the data gathered were mostly qualitative in nature. Descriptive statistics were employed to process data sets gathered from desk review of documents.

RESULTS AND DISCUSSION

Profile of Rubber Plantations in Laguna

In Laguna, 11 towns have rubber plantations (Figure 1), with the establishment of rubber farms starting as early as 1988 to as recent as 2011 (Table 1). The total area of rubber farms in Laguna is 124.30 ha, which are owned and maintained by 53 farmers. Majority of the farmers (96%) implemented a 3m × 3m planting distance between rubber trees.

In aggregate, the farms used 121,935 planting materials, almost 70% of which were unbudded seedlings. The remaining 30% were budded seedlings of the following varieties -- RRIM 600, PB 235, PB 260, PB 311, PB 330, and USM 1. RRIM 600 was reported to have greater stability and wide adaptability in a diverse environment (Meenakumari *et al.* 2010).

Farmers in Sta. Maria and Cavinti, with 42 ha and 27.5 ha of rubber farms, respectively, planted more than half of the total rubber plantation in the province. The newest plantation was established in early 2011 in Sta. Maria. Alaminos, and Majayjay have the smallest area. These plantations are privately owned. The oldest rubber plantation, established in 1988, is located in Calauan. In Alaminos, farmers intercropped rubber trees with eggplant, tomatoes, and papaya for additional cash while waiting for the rubber trees to mature. In Sta. Maria, intercrops of coconut, citrus, and other fruit bearing trees were observed during the site visits (Figure 2).

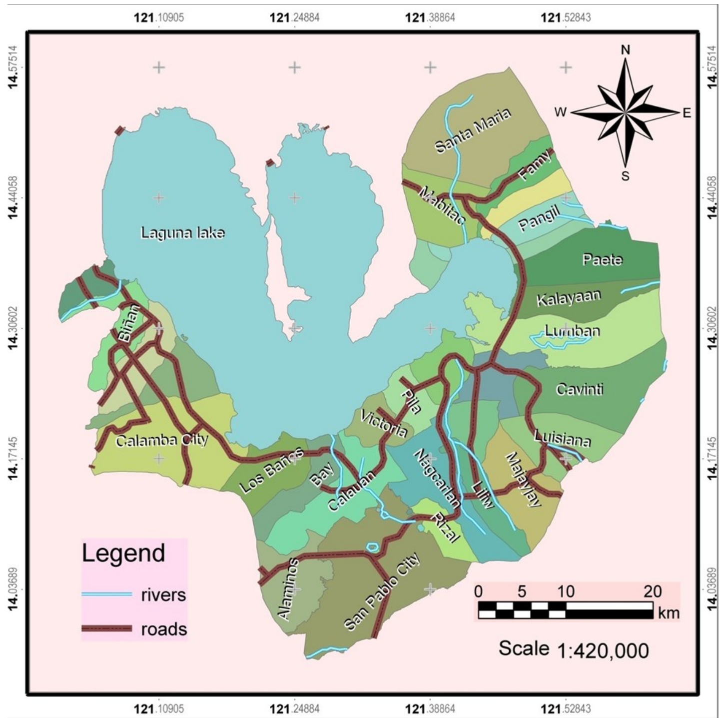

Figure 1. Provincial map of Laguna showing 11 towns (with stars) with rubber tree plantation

Table 1. Profile of rubber plantations in Laguna by area

Town	No. of Farmers	Year Planted	Area in Hectares	Spacing (m)	Total No. of Planting Materials Used	Type of Planting Materials Used	
						Budded	Unbudded
Sta. Cruz	1	1996	1.0	3 × 4	737	737	-
	2	1998	2.0	3 × 3	2100	-	2100
	3	1998	1.0	3 × 3	1200	900	300
	4	1999	2.0	3 × 3	2000	1200	800
	5	2010	1.0	3 × 3	1000	-	1000
Total	*5*	-	*7.0*	-	*7,037*	*2837*	*4200*
Pagsanjan	1	1997	2.0	3 × 3	2200	1800	400
	2	1998	3.0	3 × 3	3100	1100	2000
Total	*2*	-	*5.0*	-	*5,300*	*2900*	*2400*
Nagcarlan	1	1998	1.5	3 × 3	1500	-	1500
	2	1998	1.0	3 × 3	1000	-	1000
	3	1998	1.5	3 × 3	1500	700	800
	4	2010	1.0	3 × 3	1089	-	1089
	5	2010	3.0	3 × 3	3000	3000	-
Total	*5*	-	*8.0*	-	*8,089*	*3700*	*4389*

Table 1. Profile of rubber plantations in Laguna by area (continued)

Town	No. of Farmers	Year Planted	Area (ha)	Spacing (m)	Total No. of Planting Materials Used	Type of Planting Materials Used	
						Budded	Unbudded
Pangil	1	2008	1.0	3 × 3	1000	-	1000
	2	2008	2.0	3 × 3	2000	-	2000
Total	2	-	3.0	-	3,000	-	3000
Calauan	1	1988	1.0	4 × 4	625	625	-
	2	2010	1.5	3 × 3	1600	1600	-
Total	*2*	-	*2.5*	-	*2,225*	*2225*	-
Sta. Maria	1	1997	3.0	3 × 3	3000	1200	1800
	2	1997	3.0	3 × 3	3000	-	3000
	3	1997	1.0	3 × 3	800	-	800
	4	1997	4.0	3 × 3	4000	2000[a]	2000
	5	1997	4.0	3 × 3	4000	1400[b]	2600
	6	1997	5.0	3 × 3	5000	1200[c]	3800
	7	1998	2.5	3 × 3	2500	500[c]	2000
	8	1999	4.0	3 × 3	4200	100	4100
	9	2008	11.0	3 × 3	11000	8000	3000
	10	2008	1.5	3 × 3	1500	-	1500
	11	2008	1.0	3 × 3	1089	-	1089
	12	2009	1.0	3 × 3	1000	-	1000
	13	2011	1.0	3 × 3	1089	-	1089
Total	*13*	-	*42*	-	*42,178*	*14400*	*27778*
Siniloan	1	1993	3.0	3 × 3	2600	-	2600
	2	2002	0.3	3 × 3	267	-	267
	3	2006	2.5	3 × 3	2500	-	2500
	4	2007	2.5	3 × 3	2500	-	2500
	5	2007	3.0	3 × 3	3000	-	3000
Total	*5*	-	*11.3*	-	*10,867*	-	*10867*
Magdalena	1	1998	6.0	3 × 3	6000	-	6000
	2	2009	6.0	5 × 4	3000	3000	-
	3	2009	1.5	3 × 3	1700	-	1700
	4	2009	2.0	3 × 3	2000	-	2000
Total	*4*	-	*15.5*	-	*12,700*	*3000*	*9700*

Table 1. Profile of rubber plantations in Laguna by area (continued)

Town	No. of Farmers	Year Planted	Area in Hectares	Spacing (m)	Total No. of Planting Materials Used	Type of Planting Materials Used	
						Budded	Unbudded
Alaminos	*1*	*2009*	*1.5*	*3 × 3*	*1500*	*1500*	-
Majayjay	*1*	*2006*	*1.0*	*3 × 3*	*1000*	-	*1000*
Cavinti	1	2003	1.5	3 × 3	1500	-	1500
	2	2003	2.0	*3 × 3*	2000	-	2000
	3	2003	1.0	*3 × 3*	1000	-	1000
	4	2005	7.0	3 × 3	7000	-	7000
	5	2008	2.0	*3 × 3*	2000	1000	1000[d]
	6	2008	1.7	*3 × 3*	1800	1800	-
	7	2009	1.5	3 × 3	1500	-	1500
	8	2009	3.5	*3 × 3*	3500	-	3500
	9	2009	1.5	*3 × 3*	1600	1600	-
	10	2009	1.5	3 × 3	1600	1600	-
	11	2009	1.0	*3 × 3*	1089	1089	-
	12	2009	1.5	*3 × 3*	1600	1600	-
	13	2010	1.8	3 × 3	1850	1850	-
Total	13	-	27.5	-	28,039	10,539	17,500
Grand Total	**53**		**124.30**		**121,935**	**41,101 (37 ha)** 33.7%	**80,834 (73 ha)** 66.3%

a – Burned b – Cut due to land dispute
c – Damaged by typhoon d – Converted to poultry

Figure 2. Rubber tree plantation in Sta. Maria, Laguna, with intercrops

Out of the 11 towns that have rubber farms, five have already commenced tapping and harvesting of latex to produce rubber: four in Sta. Cruz; two each in Pagsanjan, Nagcarlan, and Cavinti; and one in Magdalena (Table 2). Each farmer produced an average of 405 kg of latex per month, which could increase as the rubber trees mature. The average yield for dry rubber in the Philippines is 950 kg ha^{-1}, which is lower than those of India, Malaysia, and Thailand with averages of 1,700 to 1,900 kg ha^{-1} (Cena 2012). Laguna's rubber production yield is still below the national average primarily because of the smaller number of plantation areas and the still young planted rubber trees.

Table 2. Status of production and average yield of rubber farms in Laguna, Philippines

Town/ Municipality	Number of Farms Continuing Production of Rubber	Average Yield of Latex per Month (kg)
Sta. Cruz	Farm 1	450
	Farm 2	580
	Farm 3	650
	Farm 4	421
Pagsanjan	Farm 1	413
	Farm 2	530
Nagcarlan	Farm 1	230
	Farm 2	180
Magdalena	Farm 1	750
Cavinti	Farm 1	130
	Farm 2	120

A few farms were unable to produce rubber. In Sta. Maria, rubber trees in three farms were burned; felled due to land dispute; while others were damaged by typhoons. In Cavinti, one rubber tree farm was eventually converted into a poultry farm.

Productivity varied among the rubber farms. One farm in Sta. Cruz, Laguna has a 1-ha planted with 737 budded seedlings. After five years, the farm was already producing 450 kg of latex per month. This farm was the most productive among the farms surveyed. Four farms with a total of 7 ha in Sta. Cruz yielded 1,741 kg of latex per month.

In Sta. Maria, 13 farms have an aggregate area of 42 ha. Six of these farms, established in 1997 with a combined area of 20 ha, could produce latex at 3,110 kg $month^{-1}$. The remaining 22 ha were planted from 2008 until 2011. Two other rubber plantations established in 1997 and 1998 remained untapped.

Some farms were producing meager volumes of latex. For example, one particular farm in Calauan planted in 1988 with 700 trees remained untapped due to poor maintenance and management practices. Growth of trees was stunted, which led to its abandonment by the owner. In another farm, the 2 ha area planted with 2,100 unbudded seedlings only yielded 650 kg of latex per month.

Production Practices

Laguna farmers follow the proper procedure in establishing rubber plantation by conducting site preparation, staking, procurement and transportation of rubber seedlings, budding (for rubber trees to mature early to have better yield), seedling planting, as well as farm and seedling maintenance (brushing, replanting, and fertilization). Technical supervisors also recommend additional silvicultural treatments in managing farms.

Most farmers planted both budded and unbudded seedlings, while others used only unbudded seedlings. Unbudded seedlings were easier to produce, cheaper, and presumably have longer production years than budded seedlings. However, budded seedlings have better latex production, can be tapped earlier, and can assure growth of a known and better clone.

Rubber production in Laguna is agroforestry-based wherein rubber trees are intercropped under both mature and newly-established agroforestry systems. In 2009, a farmer couple in Barangay Apasan, Calauan developed a 1.5 ha land into rubber-based agroforestry system with 3m × 3m planting distance in an East to West direction. After a year, the rubber trees were field-budded with RRIM 600, which was characterized to be resistant and tolerant to environmental stresses. Complete fertilizers were applied once during planting through basal method. Another application was done during the second year through side-dress method. The total amount of complete fertilizers used by the farmer during this period was 300 g $tree^{-1}$. As an added maintenance activity, mulching was also done around the intercropped rubber and papaya trees.

About two-month-old papaya seedlings numbering around 1,000 were planted in between two-year-old rubber trees on July 28, 2010. In February 2011, the harvested papaya fruits weighed a total of 126,000 kg and were sold at a farm gate price of PhP 10.00 kg^{-1}. Fertilization was done every two months using complete fertilizer and muriate of potash. Moreover, organically produced fish emulsion was also applied as foliar spray to induce flowering of papaya. In 2000, a landowner in Pagsawitan, Sta. Cruz, Laguna planted rubber in her 3 ha farm using the same 3m × 3m spacing. Of these, around 2,000 rubber trees were initially tapped in 2006. Since then, cuplumps harvested were between 200 to 300 kg within a three-month period during the year. Unlike the farm in Calauan, no regular weeding was done in this monoculture rubber plantation in Pagsawitan since the dense canopy growth suppressed weed growth. As a result, maintenance cost on the part of the owner was considerably reduced.

In Tungkod, Sta. Maria, Laguna, two-year-old rubber trees were intercropped within a fruit tree-based agroforestry system, thereby showcasing the performance and feasibility of planting rubber in a mature agroforestry system together with citrus, calamansi, lanzones, and coconut.

The budded rubber trees were expected to be ready for harvesting after three-and-a-half years. In addition, the oldest rubber trees documented in Tungkod, Sta. Maria, Laguna were already 13 years old. Seven years after planting, the rubber trees were tapped and cuplumps collected averaged about 2 g per rubber tree. Weekly weeding was the only maintenance activity. More recently, cuplumps were collected at an average of 0.5 kg tree^{-1} tapping^{-1}.

Maintaining spacing between rubber trees at 3m × 3m provided a shelterbelt effect, with every tree supporting and protecting one another, especially during windy weather. This close planting distance can help the planted rubber trees withstand strong winds. Moreover, providing physical support such as trellising can increase wind resilience. However, Mindanao farmers invoke rubber growers to plant at a density not exceeding 500 trees ha^{-1}.

Tapping. Some farmers started tapping six-year-old rubber trees, regardless of whether these were from budded or unbudded seedlings. Tapping height (Callano 2008) starts at 1.5 m from the ground and at angle of approximately 30° along the longitudinal axis of the tree. The cut is made downwards from top left to bottom right of the tree, at a length of about a quarter of the tree's circumference.

Tapping or latex collection was done every other day. According to Alcala (2007), the distance of the previous cut to the next should not exceed 2.54 cm in a month. As such, tapping width was about 1.5 mm per harvest period. Tapping was done early in the day at about 4 a.m. to maximize latex flow and to take advantage of the high turgor pressure in latex vessels before sunrise (Alcala 2007; Santosh *et al.* 2010). Also, collection during this time of the day preserved the latex better due to favorable temperature (Santosh *et al*. 2010). Collection of latex for storage or for transport was done when the collection cup was already full.

Unfortunately, these recommended tapping practices were usually neglected by some farmers and tappers in Laguna. Improper tapping practices were observed in the field like tapping twice a day, damaging the cambium that later produced calluses. The prevalence of improper tapping methods threatened both the life of the trees and sustainability of latex production (Figure 3).

Weeding was also observed to be critical during the first year of plantation establishment. The common practice was ring weeding.

Production of rubber at the farm level is in the form of cuplumps. Price varied depending on moisture content and the number of days the cuplumps are stored prior to selling. Cuplumps sold a week or less after harvesting fetched a lower price per kg than those stored for more than a week. The buyer determines the difference by the appearance and dryness of the cuplumps (Figure 4). The lower the moisture content and the fewer contaminants or foreign materials in the cuplumps, the better is the price per kg of rubber.

Production Agreements. During the initial years of establishment of rubber plantations in Laguna, three primary production agreements between rubber farmers and the latex buyer existed. The first mode involved farmers buying the planting materials, while the buyer provided the necessary technical assistance in growing rubber trees, including care and maintenance, harvesting, and storage of latex. The second mode involved the buyer providing the planting materials, preparing the land, doing the actual planting, and maintaining the rubber trees until harvesting period. The farmers, in this case, provided the land. The third mode involved farmers providing the land for rubber planting and 25% of the total cost of plantation establishment and maintenance, while the buyer provides the remaining 75% of all costs, including purchase of planting materials.

Figure 3. (a) Rubber tree that is excessively tapped for its latex and (b) rubber tree stand showing extent of damage to improperly tapped rubber trees

Figure 4. Cuplumps stored more than a week (three leftmost cuplumps) and cuplump stored less than a week (rightmost cuplump)

By 2012, other production agreement modes were implemented using varying cost sharing ratios between farmers and buyer as agreed in the contract.

In the first and second modes of production agreement, the latex produced was exclusively sold to the buyer who provided the planting materials and technical assistance. This buyer is Rubberfields, Inc., a company that started its operations in Brgy. Palasan, Sta. Cruz, Laguna in 1995. It has organized several seminar-orientation programs on propagation of rubber trees in various places in Laguna and in nearby provinces of Quezon, Rizal, Batangas, and Mindoro as well as in the Bicol region. The company buys the latex at the agreed quality and prevailing market price in Mindanao. As such, Laguna farmers have to be up-to-date with latex prices in Mindanao.

In the first mode, the farmer owns and has rights to 100% of the latex produced in the farm. However, in the second mode, Rubberfields, Inc. gets a share of 22% of the total latex volume, while the farmer owns the remaining 78% to cover the cost of hiring tappers and other expenses incurred in the care, maintenance, harvesting, and transportation of the cuplumps. This sharing system is binding for a 35-year duration.

Processing of Rubber at the Village Level

Newly collected latex is thoroughly mixed with water using a 50:50 volume ratio. The mixture is made to pass through an ordinary plastic or wire screen to remove impurities. Usually, a tiled vat is constructed, measuring 2ft × 3ft × 6ft with a two-inch graduation or grooves to hold the water-rubber mixture (Figure 5). Acetic acid at 50:50 water-acid ratio is prepared. About 10% of this water-acid mixture is added to the water-rubber mixture and thoroughly mixed. This same procedure was also mentioned by Callano and Gutierrez (2008) and Alcala (2007) for village-level latex processing.

The bubbles that form on top of the mixture is removed but not thrown away. This is saved because it has market value, although the price is low. When all the bubbles are skimmed-off, plywood panels are inserted in the grooves and then left covered for 24 hours as the treated latex hardens. The hardened rubber mixture will be converted into 2in × 6in × 3ft sheets and then soaked in water until ready to pass through the sheeter (Figure 6). The rubber will then be pressed to one-centimeter thickness and hanged to air dry. In Mindanao, some rubber processors constructed dryers similar to that of tobacco kilns, which hastened the drying period.

Latex quality is mainly determined by its dry rubber content. Latex color is also considered, but it is not a significant factor in fetching higher selling prices. Freshly coagulated latex is whiter and softer, but is traded at a lower price per kg. Latex stored more than five days after harvest has a harder texture because of lower moisture content, has a pale white to brownish color, and sells at a higher price per kg.

Figure 5. Newly collected latex being transferred to the tiled vat

Figure 6. Mechanized sheeter in North Cotabato, Mindanao

Actual conversion of coagulated blocks into processed rubber was not observed during the visit due to insufficient number of collected cuplumps and coagulated blocks. The plant enforces a minimum weight requirement of eight tons of coagulated latex on blocks per day before starting the refining process. Processing will not start until this weight requirement is met.

The coagulated rubber blocks pass through a mechanized sheeter, like the ones used in Mindanao, and processed into dried rubber sheets. This mechanized sheeter is not yet available at the village level in Laguna (sample shown in Figure 6). Dried rubber sheets could fetch a higher price per kg and could be more easily transported or stored for a longer period.

Marketing Practices

Marketing of rubber in Laguna starts from the rubber farmers up to the processing plant in Sta. Cruz. Rubberfields, Inc. is vertically integrated as it has both upstream operations comprised of rubber production agreements with farmers as well as downstream operations like processing and manufacture of rubber sheets that are sold to its affiliate company engaged in footwear manufacture.

Its agreements with rubber farmers secure latex supply for Rubberfields, Inc. It has roving technicians that assist farmers in growing rubber trees and harvesting latex as well as a liaison officer in-charge of sourcing and buying latex either in cuplumps or as coagulated blocks from other independent rubber farmers both within and outside of Laguna. The processing plant serves as the main supplier of air-dried rubber sheets to a footwear manufacturing company in Metro Manila.

The costs of delivery of latex from farm gate to the processing plant are borne by the farmer. Rubberfields, Inc. offers pick-up and delivery services within Laguna but the costs will be borne by the farmer-seller or deducted from the farmer's gross sales. The costs depend upon the location and proximity of the farm to the plant.

Sales personnel of Rubberfields, Inc. dominate the buying of latex in Laguna, having established themselves through production agreements, training-seminars, and linkages developed with long-time and new farmers. The DTI Region IV-A office has also linked with the company and assists in promotion of rubber farming. There are also latex buyers from Metro Manila but their visits to Laguna are infrequent and seasonal. These occasional buyers regularly source their latex from Mindanao. The latter would compete with the sales force of Rubberfields, Inc. in the buying price and ability to cover and locate latex ready for sale.

Farmers have no issues on where to sell their cuplumps since Rubberfields, Inc. always has an undersupply of coagulated latex. The processing plant operates once or twice a month depending on the amount of latex purchased. There are Laguna farmers who are able and willing to wait for longer periods before selling their cuplumps in anticipation of increases in latex selling prices. Commonly, farmers sell their latex on a monthly basis, but there are others who sell on a semi-annual or even annual basis.

In a survey conducted in 2010 and during the first half of 2011, one-week-old latex were bought by Rubberfields, Inc. at prices ranging from PhP 48 to 63 (Table 3). Meanwhile, latex that are more than one-week-old were bought at a price ranging from PhP 60 to 78 during the same period. Almost the same prices were observed in the town of Pagsanjan from October 2010 to August 2011 (Table 4).

Price difference exists between cuplumps sold in Mindanao and in Luzon, with Mindanao buying at PhP 12-15 higher than in Luzon.

Table 3. Latex price offered by Rubberfields, Inc. from October 2010 to August 2011

Month/Year	Price of 1 week old latex (PhP kg^{-1})	Price of more than 1 week old latex (PhP/kg^{-1})
October 2010	48	60
November 2010	48	60
December 2010	54	74
January 2011	54	74
February 2011	63	78
March 2011	63	78
April 2011	63	78
May 2011	63	74
June 2011	63	75
July 2011	56.10	77
August 2011	60.75	75

Key Actors in the Production and Marketing Continuum of Laguna

In Laguna, five subsystems cover the natural rubber agribusiness system: input, production, processing, marketing, and support (Figure 7). The input sub-system includes suppliers of seeds, seedlings, bud-sticks, or planting materials both budded and unbudded. Suppliers of chemical and organic fertilizers and other agro-chemical products also belong to this subsystem.

The production subsystem consists of farmers, tappers, labor workers, and owners of transport animals like carabaos and horses that bring the cuplumps from the interior farms to access roads. The processing subsystem is comprised of primary processors and manufacturers of rubber products. As mentioned, there is one rubber processor in Laguna that produces air dried sheets and crepes and sells to tire and footwear manufacturers in Manila.

The marketing subsystem consists of local middlemen and traders as well as delivery and transportation service providers who buy rubber from farmers within Laguna and deliver these to processors. The subsystem also includes traders that link the

Table 4. Production and yield of cuplumps in a 1.5-ha area containing 1,500 trees in Pagsanjan, Laguna for one year

Month	Yield (kg)	Price per kg of Two-Week-Old and Above Cuplumps (PhP kg^{-1})	Price per kg of One-Week-Old and Less Cuplumps (PhP kg^{-1})
October 2010	471	60	48
November 2010	578	65	47
December 2010	510	74	54
January 2011	397	74	54
February 2011	253	78	63
March 2011	205	75	60
April 2011	144	75	60
May 2011	150	75	60
June 2011	474	75	60
July 2011	547	77	56.10
August 2011	443	75	60.75
September 2011	479	73	-

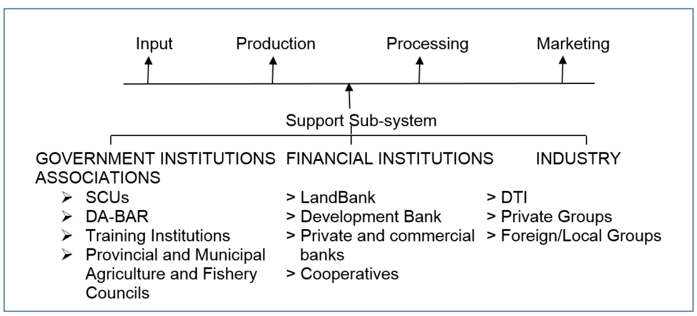

Figure 7. The natural rubber agribusiness system in Laguna

processor to manufacturing companies in Metro Manila. Farmers also handle selling and delivery of their rubber produce. Farmers from as far as Kalinga, Apayao, Mindoro, and Quezon deliver coagulated cuplumps and rubber blocks to the processor in Sta. Cruz, Laguna.

The input, production, processing, and marketing subsystems are supported by government, financial institutions, and cooperatives. Research and development, as well as training and extension activities are given by state universities such as the University of Southern Mindanao (USM), Southern Luzon State University (SLSU), and the University of the Philippines Los Baños (UPLB). Researches done in the academe are designed to improve efficiency in rubber production and are mostly funded by the government such as the Department of Agriculture – Bureau of Agricultural Research (DA-BAR).

There are also financing programs provided by Land Bank of the Philippines (LandBank) and Development Bank of the Philippines (DBP) for interested rubber farmers and processing plant owners. These loan packages provide special low interest and easy payment plans to farmers who would like to start rubber plantations or expand their current rubber production.

Other programs include lower custom taxes for imported equipment or machinery to be used in rubber production and processing. The Department of Science and Technology (DOST) offers special loans to applicants who have production or processing technologies that have high potential for commercialization. These special financing programs are available for qualified applicants subject to screening, selection, and approval by respective government institutions.

DTI has also taken an active role in promoting rubber farming and production by linking buyers and producers within the rubber supply chain. Rubber Industry Core Group (DTI-RICG), developed a framework to expand domestic market base, and at the same time encouraged local businessmen to invest more in the rubber industry to generate more jobs in the country side (Jain 2012).

Yield Levels vis-à-vis Economic Profit. A 1.5-ha farm in Brgy. Cabanbanan, Pagsanjan, Laguna was evaluated for its annual income to gain a better understanding of profit generation in rubber farming (Table 5). Farmers derived four types of products from the rubber farm: cuplumps, seeds, germinants, and budsticks. Yield for cuplumps was 4,651 kg for the 12-month period, worth PhP 335,968. Of this amount, the farmer's share was only PhP 161,264.64, equivalent to 48% of the gross income. 30% was the tapper's share (PhP 100,790.40) and 22% (PhP 73,912.96) went to the processing plant.

As mentioned earlier, production sharing is embodied in the joint venture agreement between the farmer who owns the plantation area and the processing plant owner. But the farmer solely owned the seeds, germinants, and budsticks collected and harvested from the plantation, which provide another source of income amounting to PhP 31,400.00 from their sale.

Farmers of a nine-year-old rubber farm incurred expenses associated with production of cuplumps, seeds, germinants, and budsticks as shown in Table 6.

Cuplump production entailed costs for transport, cleaning and weeding operations, gasoline for brush cutting, and others. Seed collection and removal of impurities, pricking and packaging of germinants, and climbing the tree to cut budsticks were activities done for seed production, germinant collection, and budstick collection, respectively.

The total cost in these activities was PhP 11,415.25. Cuplumps production accounted for about 82% of the expenses or PhP 9,415.25.

Income Potentials. The most recent prices involved in establishing a hectare of rubber tree plantation, which gives an idea of how much a farmer or businessman will spend to start a farm, is shown in Table 7.

Expenses are estimated for five years since the ideal farm period for tapping starts at the sixth year after plantation establishment, when physiological maturity begins (Obouayeba *et al*. 2012). Maintenance and technical supervision starts at the second year. At the end of the fifth year, total expenditure for a one hectare rubber tree plantation would range from PhP 169,000 to 174,000.

For high yielding varieties with early maturity, the trees will be ready for latex production at year 6. Sulaiman *et al*. (2012) claimed that 500 to 700 trees ha^{-1} can have higher productivity compared to 1000 trees ha^{-1}. The study assumes 500 trees ha^{-1} for a more reliable estimate (Table 8). Since most of the plantations in Laguna province are agroforestry-based (Castillo *et al*. 2012), 4m × 5m spacing was also found appropriate for intercropping.

Table 5. Total production, value, and percentage share of farmer, processing plant, and tapper in a rubber farm with an area of 1.5 ha containing 1518 rubber trees aged nine years for one year covering the period of October 1, 2010 to September 30, 2011

Seeds (kg)	180
Value in Pesos (PhP) 120kg^{-1}	21,600
Germinants (number)	2,600
Value in Pesos (PhP) @ 3.00 $plant^{-1}$	7,800
Budsticks (pieces)	100
Value in Pesos (PhP) @ 20.00 $budstick^{-1}$	2,000
Cuplumps (kg)	4,651
Value in Pesos (PhP)	335,968
% Share of Farmer (48%) in Pesos (PhP)	161,265
%Share of Tapper (30%) in Pesos (PhP)	100,790
%Share of Processing Plant (22%) in Pesos (PhP)	73,913

Table 8 also shows the calculation and estimation of a 1 ha farm's net earnings from latex. This provides comparative estimates and forecasts of survival and tapped trees percentages as well as number of trees per hectare from years 6 to 10. Forecasts on latex yield per tree, and total daily, monthly, and annual yields of the whole farm are also shown.

A deduction owing to 30% moisture on the total monthly yield of latex was computed to get the net weight of the latex for sale. An average selling price of PhP 50 was used for each kilogram of latex sold to the processing plant. Total days of production per month was only 15 days since tapping is usually done every other day. Production period in the rubber farms was estimated to be 10 months a year since tapping is stopped during the dry season.

The annual net earnings after removing 30% share of tappers, were PhP 73,500.00; PhP 110,250.00; PhP 143,325.00; PhP 192,937.50; and PhP 331,668.75, respectively starting from year 6 to year 10. Potential income from the sale of seeds, germinants, and budsticks were not included in the table.

Facilitating Factors that Make Rubber Potentially Sustainable in Laguna

a. Movers/Drivers of Rubber-Based Production Systems Initiative Individual Initiative (Technology Transfer from the Rubber Region in Mindanao). Rubber was planted in the Mount Makiling Forest Reserve within UPLB-CFNR in 1961. It was only in 1993 that a private individual from Dipolog City, Mindanao, had the interest to tap latex from these rubber trees. As she used to work in a rubber production company in Mindanao, she wanted to bring the technology to Luzon, particularly in Laguna. She established a village-type machine to process the cuplumps, satisfying all contract requirements for latex harvesting and tapping within UPLB. Her persistence resulted to a meeting with Rubberfields Inc. for production arrangements. In 1995, her initiative was successfully translated into a model rubber production system in Sta. Cruz, Laguna, which catalyzed the spread of the crop in the province.

b. Farmer-to-Farmer Approach. Rubber farming spread through farmer testimonials and by word-of-mouth. The farmer-to-farmer approach is an effective extension strategy because farmers usually regard their co-farmers to be credible or trustworthy. Experience sharing is an avenue for adaptive learning, hence, encouraging farmers to venture into and eventually adopt rubber-based production technologies.

Farmers' rubber plantation areas serve as actual learning sites for other interested farmers. The farmers themselves provide guidelines in identifying problems that need to be addressed for successful and sustainable rubber production. These guidelines also include the implementing plans to solve production concerns.

c. Joint Venture. Rubberfields, Inc. launched a support program where they provided planting materials and technical assistance to farmers who would want to partner with them. In return, the farmer is obliged to sell his/her cuplumps to the company, with profit sharing of 20:80 for the company and the farmer, respectively.

Table 7. Activities and expenses for establishing a 1-ha rubber tree plantation

Activities	Prices for Each Activity	Year-1 (PhP)	Year-2 (PhP)	Year-3 (PhP)	Year-4 (PhP)	Year-5 (PhP)	Total Expenses (PhP)
Site preparation (cleaning and clearing)	for 1 ha (type of site) free of weeds/brushes	2,500					2,500
	with dense weed growth	5,000					5,000
Staking (4m × 5m)	500 spots ha^{-1} @ PhP 5 pc^{-1}	2,500					2,500
Procurement of Rubber Seedling	500 seedlings/ha. @ PhP 25 - 30 $seedling^{-1}$	12,500 to 15,000					12,500 to 15,000
Transportation of Seedlings	500 pcs. @ PhP 10 $seedling^{-1}$	5,000					5,000
Budding Activity	500 seedlings @ PhP 1015 $seedling^{-1}$	5,000 to 7,500					5,000 to 7,500
Planting	500 seedlings @ PhP 5 $seedling^{-1}$	2,500					2,500
Maintenance	Brushing 4 times $year^{-1}$	20,000	20,000	20,000	15,000	15,000	90,000
	Replanting						
	Fertilizer	4,000					4,000
		2,000	2,000	2,000	2,000	2,000	10,000
Technical supervision (optional/ negotiable)	Per visit of once a month	6,000	6,000	6,000	6,000	6,000	30.000
TOTAL		67,000 to 72,000	28,000	28,000	23,000	23,000	169,000 to 174,000

This scheme addresses the problem of capital requirements for farmers with limited funds. It also inspired other farmers to be involved in nursery operation and seedling production, which is important to ensure the stable supply of seedlings. This situation prompted Rubberfields, Inc. to revise its support scheme in terms of providing technical assistance to farmers; *i.e.,* farmers would have to buy their planting materials from the company at cost. Currently, the same company provides accessible processing of cuplumps to farms in Laguna. The joint venture scheme emphasizes the importance of recognizing the contractual obligations for long-term sustainability.

d. Public-Private Partnership (DA-BAR funded initiative). This helps farmers in capability building and in identification of sites and appropriate clones for selected planting areas including modification of spacing to accommodate other crops that can be interplanted with rubber. DA-BAR also assists in implementing promotional programs and creating avenues for capability building on rubber farming and establishment of rubber modular production systems.

These activities are jointly implemented by cooperating agencies and organizations such as UPLB Foundation, Inc., UPLB-CFNR's Institute of Renewable and Natural Resources, rural and urban community organizations, including private entrepreneurs. The private entrepreneurs are represented by farmers and while government provides the technical and funding assistance to ensure the successful establishment and performance of the rubber farms as a whole.

Other opportunities. Vast marginal and open areas in Laguna, including those planted with coconut, citrus, among others (but now with canopy structure appropriate for the growth of intercrops), have become available for establishing rubber-based agroforestry systems in the province. The potential of these resources need to be maximized, not only for site productivity, but also for ecological conservation. Farmers could venture into an innovative farming system especially if the product is non-perishable. Moreover, the farm gate price of PhP 76 kg^{-1} of cuplump is attractive enough to encourage farmers to plant rubber.

Other facilitating factors are as follows:

1. Funds for research, training, and seminars on rubber production and marketing from both government and private sectors as well as state colleges and universities;
2. Availability of financial support (*i.e.,* loans) from financial institutions like LandBank, DBP, and cooperatives;
3. Support from other government institutions with respect to watershed protection, rehabilitation, and production like NDC, LGUs, DA-NAFC, PCARRD, and DOST;

Table 8. Sample computation of net profit for a 1-ha rubber tree farm

Year 5-6	Year 7	Year 8	Year 9	Year 10
500 trees × 40% =200 trees	500 trees × 60%= 250 trees	500 trees × 60%= 300 trees	500 trees × 70%= 350 trees	500 trees × 95%= 475 trees
200 trees × 100 mg = 20.0 kg day^{-1}	250 trees × 120 mg = 30.0 kg day^{-1}	300 trees × 130 mg = 39.0 kg day^{-1}	350 trees × 150 mg = 52.50 kg day^{-1}	475 trees × 190 mg = 90.25 kg day^{-1}
20.0 kgday^{-1} × 15 days mo^{-1} = 300 kg mo^{-1}	30.0 kg/day × 15 days mo^{-1}= 450 kg mo^{-1}	39.0 kg day^{-1} × 15 days mo^{-1}= 585 kgmo^{-1}	52.50 kg day^{-1} × 15 days mo^{-1}= 787.50 kg mo^{-1}	90.25 kg day^{-1} × 15 days mo^{-1}= 1,353.75 kgmo^{-1}
300 kg. less 30% moisture= 210 kg mo^{-1}	450 kg less 30% moisture = 315.0 kg mo^{-1}	585 kg less 30% moisture = 409.5 kg mo^{-1}	787.50 kg less 30% moisture = 551.25 kg mo^{-1}	1353.75 kg less 30% moisture = 947.625 kgmo^{-1}
210 kgmo^{-1} × PhP 50.00kg^{-1}= PhP 10,500.00 mo^{-1}	315.0 kg mo^{-1} × PhP 50.00 kg^{-1} = PhP 15,750.00 mo$^{-1.}$	409.5 kg mo^{-1} × PhP 50.00 kg^{-1} = PhP 20,475.00 mo^{-1}	551.25 kg mo^{-1} × PhP 50.00 kg^{-1} = PhP 27,562.50 mo^{-1}	947.625 kg mo^{-1} × PhP 50.00 kg^{-1}= PhP 47,381.25 mo^{-1}
PhP 10,500.00 less tapper 30% (PhP 3,150.00)	PhP 15,750.00 less tapper 30% (PhP 4,725.00)	PhP 20,475.00 less tapper 30% (PhP 6,142.50)	PhP 27,562.50 less tapper 30% (PhP 8,268.75)	PhP 47,381.25 less tapper 30% (PhP 14,214.38)
PhP 73,350 mo^{-1}. × 10 mo yr^{-1}	PhP 11,025 mo^{-1} × 10 mo yr^{-1}	PhP 14,332.50 mo^{-1} × 10mo yr^{-1}	PhP 19,293.75 mo^{-1} × 10 mo yr^{-1}	PhP 33,166.87 mo^{-1} × 10 mo yr^{-1}
PhP 73,500.00 yr^{-1} (Net Income)	**PhP 110,250.00 yr^{-1} (Net Income)**	**PhP 143,325.00 yr^{-1} (Net Income)**	**PhP 192,937.50 yr^{-1} (Net Income)**	**PhP 331,668.75 yr^{-1} (Net Income)**

4. Increasing demand for natural rubber due to the production of rubber related products (Pamplona 2012);
5. Generation of employment and income for farmers, businessmen, and other stakeholders;
6. Availability of various clones that are considered primary and ideal for latex production (Singh *et al.* 2010; Meenakumari *et al.* 2010);
7. Favorable conditions for the establishment of big, medium, and village-type processing plants;
8. Increasing demand for seeds, planting materials, and budsticks for production of budded seedlings;
9. Favorable price of budded planting stocks; and
10. Practice of rubber-based agroforestry system where short- and long-term crops are interplanted.

Limiting Factors in the Production-Marketing Continuum

Environment-related factors. Negative climate change occurrences are a threat to latex production during harvesting period. The farmer couple in Brgy. Apasan, Calauan noticed that rubber seedlings, budded on field or on site, have low survival rates. The high mortality rate was attributed to exposure to extreme weather condition of the newly inserted buds.

On morphological features, rubber seems to have a shallow root system thereby making them prone to wind throw. However, this could be addressed through narrower planting distances. This change in spacing also affects production in terms of latex quantity. In addition, a Rubberfields, Inc. technician reported that Laguna farmers commonly use seedlings rather than the budded planting materials. The outplanted seedlings are budded on-site once the root system is established. While this also has some disadvantages such as direct exposure to extreme weather changes resulting to mortality, the long-term impact of having sturdier roots have greater economic and ecological benefits.

Production factors. The use of good planting materials can affect future production. Laguna lacks budwood gardens as sources of budsticks. Budwood gardens are needed to ensure higher quality of planting stocks, better adaptability of the tree in changing climatic conditions, and higher expected yield of latex. Furthermore, lack of suitable infrastructure for better rubber production technologies can affect species performance.

The provincial rubber industry is still underdeveloped, therefore rubber production technologies are still being fine-tuned to make it sustainable. Innovations based on needs and capacities of plantations within Laguna and in neighboring provinces have yet to be made to meet the quality standards of consumers in the local and international markets.

Human-resource related factors. Farm workers' skills, particularly those in-charge of budding (budder) and harvesting (tapper) activities, are essential factors in the sustainability of rubber farming, achievement of optimum volume of latex, life span of rubber trees, as well as physiological and morphological health status of trees. Such problems were encountered by a landowner in Pagsawitan, Sta. Cruz.

Also, infrequent and unreliable services of tappers were observed in Magdalena and Sta. Maria, Laguna. Irregular harvesting of latex from trees resulted to low volume of production. Moreover, the harvesting or tapping skill of a farm worker is very crucial. In tapping, the cambium must not be scraped, otherwise healing of the bark is delayed.

Callus formation then occurs, which consequently obstructs latex flow as shown in Figure 8. This improper tapping practice results to a rough surface in the stem. This will then lead to the difficulty of conducting succeeding tapping activities, resulting to lower latex production.

The presence and availability of skilled workers in rubber farms are vital to meet increasing market demand. The lack of training on appropriate nursery and plantation practices further leads to: a) production of low quality planting stocks and b) shortage of skilled and trained human resource for budding and tapping activities.

Production of quality planting stocks is one of the challenges that the plantations in the province face due to absence of reliable sources. Unavailability of high-quality clones in the province and in neighboring provinces makes it difficult for farmers to trust suppliers.

Secondly, the available labor force in rubber farms and nurseries is still low since rubber farming is new in Laguna. Participants in rubber production seminars, workshops, and trainings are those already involved in planting rubber. Also, these training opportunities are limited and still not widely known in the province.

Thirdly, low yield per hectare in rubber farms is aggravated by poor management practices. Since the industry is in its growing stage and there are still few existing farmers with relatively small plantation areas, management practices were not yet formally established. Both poor farm management and improper practices during budding and tapping lead to low yield and poor latex quality.

Uncontrolled situations. Another problem was passers-by damaging the rubber trees. Sometimes newly planted seedlings, and even robustly growing trees, were cut and damaged, especially those along foot paths. Burning was also a cause of mortality in one of the rubber farms visited.

Marketing infrastructure. There were several issues that limit the growth of rubber industry in the province. One issue is the lack of promotional programs for rubber production needed to inform people about rubber planting, care and maintenance, as well as associated costs and potential income.

Moreover, attracting the interests of investors and local business persons is severely lacking. Second, the price fluctuations of rubber further cause uncertainties on expected sales and income.

As such, investors may have apprehensions in future rubber-related capital investments due to possible risks and losses. Finally, the province still has poor infrastructure and marketing systems because these are not yet developed nor prioritized as compared to the fruit- and coconut-based agribusiness systems. The existence of one processing plant in Laguna monopolizes contracts and production agreements with the farmers, especially in pricing of cuplumps.

Buying prices of raw cuplumps or coagulated blocks are controlled and dictated by the sole latex processing plant. The absence of competition within Laguna in terms of processing ventures or enterprises further limits the options of farmers on where to sell their latex.

Figure 8. Callus formation resulting from improper tapping and damaged rubber trees due to anthropogenic factors

Determining the right combination of cash crops, tree crops, and livestock that can be raised and grown with rubber trees should be encouraged so that farmers will have a better opportunity to earn a higher income.

CONCLUSION

The study found that rubber industry in Laguna is still in its growing stage and is slowly evolving from the traditional, customary production systems involving fruit trees and coconut farms. This is indicated by the small number of farmers or adaptors engaged in rubber production and the relatively younger age of the rubber trees in the study sites. Farms are mostly privately owned and intercropping is a common practice. Due to absence or lack of skilled farm workers especially for tapping, improper practices were observed during field visits.

In terms of profit, rubber farms showed promise because of better returns from sale of cuplumps. Budsticks and seeds were also high potential products that can add more income to farmers. Agreements existed between farmers and the processing plant, which gave assurances that the latex produced will be purchased and paid accordingly by Rubberfields, Inc. The high demand of rubber in the local and international markets, as cited by IRSG, could ensure a good return for the rubber farmer in the long-term. These facilitating factors will definitely help the industry prosper in the province. However, limiting factors still hinder the sustainability of the industry in the province and these should be holistically addressed.

The province of Laguna is a possible niche for rubber production because of its physiographic characteristics. Institutions are also willing to contribute to further establishment of plantations and processing plants because of Laguna's close proximity to Metro Manila.

People who are involved in farming are willing to learn the proper and appropriate way to establish and manage a sustainable rubber farm, given the positive testimonials of current rubber farmers within and outside of Laguna, some of whom had participated in rubber production training funded by DA-BAR and implemented by UPLB. In summary, the agribusiness system of the province can help expand the rubber farming industry, with valuable assistance from the support subsystem composed of government, financial, and trade-industry institutions.

RECOMMENDATIONS

To further improve rubber production in Laguna as a non-traditional planting site for rubber, new entrants to the Laguna rubber industry should explore opportunities in establishing rubber seedling nurseries and budwood gardens to ensure availability of rubber planting materials to ease access to good quality clones and planting materials.

Continuous training of rubber workers on proper tapping of rubber trees should still be done by pertinent training and research institutions with assistance from DA and DOST. In addition, proper training of workers in budding, as well as in the selection of quality budsticks, should also be organized. Skills of farmers in budding techniques and their awareness of using known and quality clones should be developed to ensure production of quality rubber seedlings. Investment opportunities to establish small-to-medium scale processing plants in other CALABARZON areas should also be explored. The processing plant in Sta. Cruz, Laguna is the only medium-scale processing plant in the province but since Laguna rubber farmers are still few and only small land areas are devoted to rubber, the processing plant still gets its supply from other areas, like Mindoro, Bicol, and Quezon.

Small-scale rubber processing plants at the village level could be established to lessen costs in transporting the cuplumps. This will help farmers process their own cuplumps with the end result of getting higher prices for the processed rubber sheets. The village level processing plant will provide higher income to farmers and more options on where to sell their products.

Cooperatives or farmer associations can be established to manage the small-scale processing equipment through a leasing arrangement or a rent-to-own arrangement. Forward integration to primary rubber processing can lead to higher income since the processed rubber sheets commands higher prices compared to cuplumps.

Furthermore, determining the right combination of cash crops, tree crops, and livestock that can be raised and grown with rubber trees should be encouraged so that farmers will have a better opportunity to earn a higher income. In the future, more farmers and investors would hopefully enter the rubber production business in Laguna.

REFERENCES CITED

Alcala, E.A. 2007. Rubber: Manual for rubber smallholders in the Philippines. Kabacan, North Cotabato. USM and PRBI. 72 p.

Alcala, T.B. 2005. The world of rubber. A paper presented at the Training on rubber production and management. ATI, University of Southern Mindanao Kabacan, Cotabato . June 13-23, 2006.

Bagaforo, R.O. and Camacho, E.C. 2012. Rubber-based farming system in a challenging industry: Development and expansion in Southern Philippines. Paper presented at the International Rubber Conference, Kovalam, Kerala, India. October 28-31, 2012.

Callano, R.S. 2008. Tapping management. In: Handbook on rubber production. 3rd ed. Kabacan, Cotabato: Philippine Industrial Crops Research Institute (PCRI), University of Southern Mindanao. pp. 1-33.

Callano, R.S and Gutierrez, H.M. 2008. Village level-latex processing. In: Handbook on rubber production 3rd ed. Kabacan, Cotabato: Philippine Industrial Crops Research Institute (PICRI). University of Southern Mindanao. pp. 34-47.

Castillo, A.S.A., Visco, R.G., Paelmo, R.F., Cabahug, R.D., Mariano, R.R.E., Castillo, A.K.A., and Reyes, J.A.. 2012. Rubber-based agroforestry initiatives in the Philippines. In: Tangonan R.G. (ed.) Rubber production and management in the Philippines. Kabacan, Cotabato: DA-BAR-University of Southern Mindanao. pp. 211-221.

Cena, R.L. 2012. Overview of the rubber industry. In: Rubber production and management in the Philippines. Kabacan, Cotabato: DA-BAR-University of Southern Mindanao. pp. 1-7.

Costales, C.P. 2006. Natural rubber industry cluster assessment for trade liberalization in line with the finalization of DOHA development agenda. A research proposal submitted to the Universal Access in Competitiveness and Trade, Philippine Chamber of Commerce and Industry, and Angelo King Institute – De La Salle System . 45p.

Cruz, M. M. 2012. The Philippine Rubber Industry. Lecture, The Philippine Rubber Investment and Market Encounter 2012. Department of Trade and Industry 3, Clark, Pampanga, September 18, 2012.

Jain, S.A.M, 2012. The rubber industry in the Philippines. Paper presented at the 1st Philippine rubber investment and market encounter. Holiday Inn, Clark, Pampanga. September 18-19, 2012.

Meenakumari, T., Soman, T.A., Dey, S.K., Gitali D., Shammi R., Sailajadeva, T., Nair, R.B., Raman K.A. and Mydin, K.K. 2010. Yield of modern *Hevea* clones and their response to weather parameters across diverse environments. Paper presented at the International workshop on climate change and rubber cultivations: R&D priorities. Rubber Research Institute of India, Kottayam, Kerala, India and International Rubber Research and Development Board, Kuala Lumpur, Malaysia. July 28-30, 2010.

Mojica, M.J. 2005. 100 years of rubber in the Philippines: Some glimpses. The BAR Chronicle, Vol. 6 No. 11. http://www.bar.gov.ph/barchronicle/2005/nov05_1-30_100rubber.asp. [date accessed: October. 28, 2011].

Obouayeba, S., Soumahin F. E., Modeste, K.K., Fanlegue, C.L., Okama, K.M., Badou N'guessan, A.E., Kouame, C., and Severin, A. 2012. Influence of age and girth at opening on rubber yield, biochemical and tapping panel dryness parameters of Hevea brasiliensis in determining tapping norms. Paper presented at the International rubber conference, Kovalam, Kerala, India. October 28-31, 2012.

Pamplona, P.P. 2012. Positioning the Philippines as a major player in the global rubber industry. Paper presented at the 1st Philippine rubber investment and market encounter. Holiday Inn, Clark, Pampanga. September 18-19, 2012.

Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD). 1997. Philippine Recommends for Rubber. The National Rubber Publication Committee. Technical Bulletin Series No.33. Los Baños, Laguna. 181p.

Rosyid, M.J. and H. Suryaningtyas. 2012. Cropping pattern of coffee as rubber intercrop at farmer level in Muara Enim and Musi Rawas districts of South Sumatra Province, Indonesia. Paper presented at the International rubber conference. Kovalam, Kerala, India. October 28-31, 2012.

Santosh K., Vinayaraghavan C. and Ragesh P.M. 2010. Global warming? Tap early morning for better yield. Paper presented at the International workshop on climate change and rubber cultivations: R&D priorities. Rubber Research Institute of India, Kottayam, Kerala, India and International Rubber Research and Development Board, Kuala Lumpur, Malaysia. July 28-30, 2010.

Singh, M., Jacob J., Chandrashekar, T.R. and Annamalainathan, K. 2010. Performance of rubber plantation raised from bud grafted clones and polycross seeds under different moisture regimes in North Konkan Region of Maharashtra. Paper presented at the International workshop on climate change and rubber cultivations: R&D priorities, Rubber Research Institute of India, Kottayam, Kerala, India and International Rubber Research and Development Board, Kuala Lumpur, Malaysia. July 28-30, 2010.