Rubber Plantations in Southern Thailand: management and social and economic functions.

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1 INTRODUCTION

1.1 Background

The description of historical events of rubber trees is mostly based on Polhamus 1962.

Historically, rubber is a non-wood forest product that has been utilized since ancient times. Its geographic distribution has been present in all continents within the tropical forest areas. Many tree species were utilized until the starting of large scale rubber plantations in the early 1900s.

It has been found that rubber was an important commodity in the ancient cultures of Latin America where people used it to have protective clothes, balls for playing games and syringes. Also it has been found that Castilla rubber was an important element of religious rites (rubber was preserved and used in the liquid form and was related in ceremonial use to the blood of living sacrifices: statuettes of gods).

According to the historical evidence, the first rubber trees to be tapped extensively belonged to Castilla species. Native tappers started to harvest latex from Hevea species when Castilla tree population almost disappeared. After the disappearance of the primeval stands of Castilla, Hevea became the first choice of the rubber gatherers, particularly near the streams.

Rubber-producing plants are found all over the world – Ficus in India, Funtumia in Africa, Cryptostegia in India and Madagascar, Langdolphia in Africa and hundreds of latex-producing Apocynaceous vines and shrubs in southern China and the Malayan Peninsula. At least some species of Hevea and at least two species of Castilla and guayule had been used for rubber production in the western hemisphere before the time of Columbus. The only usage for latex in the East was as a bird-lime.
Already in the old times, the methods of tapping the rubber tree and processes for making crude articles from latex had been developed. Primitive technology for obtaining latex had been used nearly three and a half centuries after the discovery of rubber in the West. Once technical improvement of rubber tapping took place, the use of rubber increased; but the overall consumption of rubber was not greatly changed during that time. The merged civilization of the East and the West made their first big joint contribution to rubber technology when vulcanization was discovered in 1839.

Rubber was imported into the European market in crude bottles nearly four centuries after the discovery of America by Columbus. This raw material was used for manufacturing crude footwear, waterproof raincoat and other coverings.

The sixteenth and seventeenth centuries were a period of incubation in the history of rubber. Europeans considered rubber a curiosity and found no particular use for it.

By the end of the eighteenth century four species of rubber-bearing plants had been identified and described (Hevea, H. brasiliensis and H. guianensis; one species of Castilla, C. elastica; and an Indian vine, Urceola elastica).

In Europe, the usage of rubber in the eighteenth century was to manufacture pencil-mark erasers (rubbers, whence the name), catheters, surgical products and toys.

The nineteenth century had new contributions to rubber development. Vulcanization was discovered, Hevea was introduced to the East, and new methods of tapping and coagulation were introduced. Also other important developments directly caused increasing level of rubber consumption during this century. The automobile industry was developing fast, scientific research increased the knowledge of chemical structure of rubber, and the first rubber-like material was produced synthetically.
In the twentieth century, rubber consumption was significantly increasing due to fast developments that took place in the automotive industry. This event forced the auto manufacturers to establish thorough research to discover new rubber-bearing trees and to deepen knowledge on elasticity properties of rubber, and the synthesizing of new rubber-like materials. The wild-rubber industry almost disappeared in the first half of the twentieth century and at the same time the synthetic-rubber industry increased at a high speed.

1.2 History of rubber utilization in Southeast Asia

In Southeast Asia there have been found a lot of rubber-bearing plants. Most of them are members of the one family, Apocynaceae, but there are also some important species from other families, like Ficus elastica Roxb. and Bleekrodea tonkinensis Dub. & Eber., which both belongs to the family Moraceae.

The first seeds for the cultivation of the rubber were sent to Asia, Sri Lanka, in 1876, but these first attempts to grow the rubber trees (Hevea brasiliensis Muell. Arg.) were not successful. It was not until 1877 when 22 rubber trees were plated in Singapore. From these individuals many new rubber trees were reproduced and planted throughout the South-East Asia countries. (STATUS OF... 2000)

1.3 History of rubber cultivating in Thailand

At the beginning of the 1900s the first rubber tree seeds came to Thailand from Malaysia. Those seeds were planted at an experimental plot at Amphur Kantang, Trang province, Southern Thailand. To Chanthaburi province, eastern Thailand, seeds have been brought from this first plantation in 1908. After that, rubber trees have also been spread to the eastern and southern
part of the Thailand. Nowadays Thailand is one of the world’s largest rubber producers and exporters. (STATUS OF... 2000)

Fig. I.-World map showing native areas of main rubber-producing plants. Native habitat of plants that have been exploited for rubber. A, Phartenium; B, Castilla; C, Castilla and Sapium; D, Hevea, Castilla, and Sapium; E, Manihot; F, Apocynaceous climbers, shrubs, and trees; G, Cryptostegia; H, Taraxacum; I, Taraxacum and Scorzonera; J, Ficus; K, Apocynaceous climbers and trees (Polhamus).
2 RUBBER INDUSTRY

2.1 Economic significance of rubber in Thailand

The current production of rubber is 2.87 million tonnes per year and export is 2.57 million tonnes per year. The remnants are domestically used. The important trading partners of Thailand are China, Japan, Malaysia and USA.

The rubber price during 1999-2003 gradually decreased from 1998 until 2000. The government had to interfere in the mid-2000. However, the rubber price has been increasing since the end of 2000 due to the world demand and expansion of world economy.

The rubber plantation industry is dominated by the small holding sector accounting for 95% in terms of area. Ninety percent of smallholders are in the southern peninsula while others are distributed in the east, the northeast and the north.

2.2 Rubber exports and domestic use

In 1997, Thailand exported 2 million tonnes of latex, which accounted for the world latex production (ITTO 2000).

Natural rubber is produced mostly in three countries: Thailand, Malaysia and Indonesia. The following are the specifications scheme for each country: Standard Thai Rubber (STR), Standard Malaysia Rubber (SMR); Standard Indonesia Rubber (SIR).

Thailand leads the rubber producing countries in research and development of natural rubber.
A majority of rubber products are exported in their raw form such as Technically Specified Rubbers: Standard Thai Rubber (STR), Ribbed Smoked Sheet (RSS), Skim Block, Air Dried Sheet (ADS) and Concentrated Latex. The types of rubber grades are briefly explained as follows..

2.2.1 Standard Grades

1. Standard Thai rubber (STR)

STR are types of rubber grade which are packed in blocks. They are widely used in US and European markets. STR is subdivided into 6 categories: 
STR5L and STR5CV60 which are made from latex coagulate grades
STR10, STR10CV, STR20 and STR20CV which are made from uncooked sheet (USS)

2. Ribbed smoked sheet (RSS)

RSS is mainly used in automobile tyre manufacturing.
RSS is subdivided into five grades namely RSS1, RSS2, RSS3, RSS4, and RSS5.

3. Natural rubber latex

Latex is used as raw material in the industry of Rubber Gloves, Condom, Balloon, etc. Latex is subdivided into 2 main grades:

1. Low Ammonia (LA) with maximum 0.29% of ammonia added
2. High Ammonia (HA) with minimum 0.60% of ammonia added
4. Air dried sheet (ADS)

This product looks like RSS (Ribbed Smoked Sheet), but it is more transparent than RSS because of being processed in smokeless room. It is widely used in Collared Rubber Products.

5. Skim block

Skim Block is the by-product from the latex production

In terms of rubber exports, 80 – 90 % of the rubber produced by Thailand is exported to consuming areas. The majority of the rubber export in 1995 is ribbed smoked Sheet (67%), block rubber (17%), concentrated latex (10%). The remaining 6 % is distributed between other types of rubber like air dried sheet and skim rubber.

Of the 10-20 percent of total production that is utilized domestically, 55 percent of it is processed as value-added goods.

The main rubber products of Thailand are tyres and tubes for motorcars, airplanes, motorcycles and bicycles (46-51%) and gloves (13-15%), rubber band (8-10%) and elastic (8-9%).

Nearly all types of natural rubber exports increase annually. In 1987 RSS export was 706,602 metric tons and increased to 1,086,865 metric tons in 1995 (Table 1). STR and concentrated latex were highly increasing as well. From 1987 to 1995, ribbed smoked sheet export decreased from 88.9% to 66.5% while block rubber increased from 13% to 17% and concentrated latex also greatly increased from 1.2% to 10%.
Table 1. Thailand’s rubber exports by types 1987-1995 (metric tons) (Sinchareonkul & Thainugul 1996).

<table>
<thead>
<tr>
<th>Year</th>
<th>RSS</th>
<th>STR</th>
<th>Conc. latex</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>706,602</td>
<td>113,638</td>
<td>10,362</td>
<td>42,610</td>
<td>873,212</td>
</tr>
<tr>
<td>1989</td>
<td>909,395</td>
<td>128,708</td>
<td>26,440</td>
<td>36,037</td>
<td>1,100,580</td>
</tr>
<tr>
<td>1991</td>
<td>977,073</td>
<td>156,974</td>
<td>61,076</td>
<td>34,823</td>
<td>1,231,946</td>
</tr>
<tr>
<td>1993</td>
<td>985,279</td>
<td>216,171</td>
<td>137,301</td>
<td>58,032</td>
<td>1,396,783</td>
</tr>
<tr>
<td>1995</td>
<td>1,086,865</td>
<td>279,281</td>
<td>169,109</td>
<td>100,278</td>
<td>1,635,533</td>
</tr>
</tbody>
</table>

2.3 Quality of raw rubber

Natural rubber (NR) consumers are conscious of high quality, consistency and cleanliness of raw materials that they buy. Industrial standard series ISO 9000 emphasises quality control, which is required in the rubber manufacturing industry. Since its inception in 1987, the ISO 9000 scheme has spread throughout Europe and the world.

Realizing the importance of this matter, Thai Industrial standards Institute, The Federation of Thai Industries and The Thai Rubber Association jointly arranged the ISO 9000 workshop training for 8 concentrated latex factories in Songkhla and Surathance province, southern Thailand, for the period of 9 months, starting from December 1996 to August 1997.

The above training will lead to ISO 9000 certification. This is the first pilot scheme for quality control management of raw NR production in Thailand to improve the competitiveness of Thai rubber in the world market. This will assist Thailand in the promotion of its rubber exports, as more and more buyers require the ISO 9000 standard to be implemented for their rubber imports.
2.4 Ribbed smoked sheet (RSS) production

The traditional RSS production process begins with filtering the fresh latex to rid it of any foreign particles. In the filtered latex some water and acid, typically formic or acetic, is added. The mixture is left standing in moulds for up to 24 hours to allow coagulation, depending on the amount of acid added. The coagulated latex is then pressed into sheets of approximately 0,5 cm of thickness by means of hand or machine powered rollers or even manually using a dough roller or similar device. The final roller has a ribbed pattern, which imprints into the sheet to increase the evaporation area, hence the name: ribbed sheet. In the pressing process most of the water is squeezed out of the latex. The ribbed sheets are hung on racks or even cloth lines to dry. After drying, the sheets are moved to a smoke house and smoked for some hours in order to achieve the desired moisture content and to prevent subsequent spoiling by microbes. The finalized product is graded, packed into bales and shipped. A small-scale rubber farmer can sell his product as fresh latex or dried sheets. Smoking is seldom practised by the farmers.

**FIG 2. Freshly squeezed latex sheet waiting to be smoked.**
3 MANAGEMENT OF RUBBER PLANTATIONS

3.1 Rubber cultivation

3.1.1 Land preparation and layout

The area selected for rubber cultivation should be cleared of wild growth. Good drainage and suitable soil is required for rubber. Square planting is suitable for level and near level lands. Rectangular system with planting lines oriented in the East West direction can be adopted in flat lands and slopes. In undulating and hilly areas, planting should be done in rows across the slope along the contour lines. Along the rows, terraces of 2 m width must be formed. The planting density is 420 to 445 plants per hectare in the case of buddings and 445 to 520 plants per hectare in the case of seedlings (Edgar, 1947; Rayong, 2003).

3.1.2 Planting material

The most commonly used technique for planting is stump budding using improved varieties or clones (Status of... 2000). The quality of the planting material is the most important factor affecting the profitability and economics of the plantation and has to be judiciously selected depending on the local situation. Different situations warrant planting of particular types that have the capability to resist the adverse factors and produce good results. Accordingly different varieties like RRII 105, PB 217, GT 1 are commonly cultivated. Research efforts have yielded outstanding varieties like RRII - 100 series, RRII - 200 series, the latest being RRII 400 series. These varieties may be planted in not more than 50% of the area selected for rubber cultivation. Polyclonal seeds, budded stumps and poly bag plants are used for planting.
However poly bag plants are more popular since they start yielding latex a year earlier.

3.1.3 Seeds and planting

Freshly collected seed loses around 50% of its moisture in the first three days. It has also been found that germination rate decreases with the loss of moisture, and therefore seeds are planted as soon as possible after collection. If planting is not possible straight away, they are placed in a tin of charcoal to help retain moisture levels. Seeds are planted after being raised in special germination beds, around 90cm wide, with spaces between to allow room for walking. They must be planted horizontally to avoid twisted shoots, and generally in numbers ranging from 5-9 seeds allowing for some failure although 20% failure is still regarded as being good. Heavier seeds tend to produce more vigorous seedlings whilst those seeds that fail to germinate within 14 to 21 days should not be used as they will tend to produce weak seedlings (Edgar, 1947).

3.1.4 Growth

The growth of the rubber trees is defined by the perimeter of the trunk, measured at 1 m above the soil surface. When the trunk measures 46 cm girth at 150 cm above ground or seven years old, it is time to start harvesting the rubber (Rayong 2003). In poorer soils, the trees may not be ready for harvesting until the eighth year.

3.1.5 Weeding

Weeding between the trees is done 2 - 6 times a year, especially when the trees are small. Weeds are cleared from a diameter of 1.5 meters around the tree. Weeding between the plantation sections is done by hand, machines or
by applying herbicide. Within the plantation, weeding can also be done by machine when the trees are 2 - 3 years old and in this case, the machines are only allowed to operate at least 1.5 m away from the foot of each tree (Rayong 2003).

3.1.6 Fertilization

Mineral fertilizers are applied every year. Two applications of 0.5 kg fertilizer per tree are made during the rainy season each year. The fertilizers are broadcast beneath the canopy of the rubber trees. Fertilizer can also be applied by digging holes in the spaces between the trees, and placing manure in the holes. This practice helps to maintain the humus content in the topsoil (Rayong 2003).

3.1.7 Mulching and pruning

Mulching is done at the end of the rainy season, using rice straw or dried weeds. The mulch layer should cover the soil under the tree canopy and should begin 10 cm from the tree foot. A thin layer of soil should be used to cover the mulching material. To help aerate the roots, the soil surrounding the foot of the tree is turned over. Pruning of shoots is done regularly and selectively, making sure to maintain 1 - 2 leaf layers under the main shoot to create favorable conditions for photosynthesis and nutrition of the trees (Rayong 2003).

3.1.8 Fire prevention

Prior to the dry season, the vegetation and debris are cleared from a broad band six meters wide all around the plantation. This ring of bare earth acts as a firebreak, protecting the plantation from fire.
3.1.9 Intercropping

While the rubber trees are immature, selected legume cover crops such as *Pueraria phaseoloides*, *Culopogonium mucunoides* and *Centrosemu pubescens* may be grown on rubber plantations. Intercropping can be carried out with coconut trees and banana plants within the rubber plantation. Sometimes banana alone is used as an intercrop. Intercropping can also be carried out with rice, longgong, mangosteen, satow, bamboo, jampada, riang, durian, pineapple, coffee trees, neem and hot pepper (ITTO, 2000).

Intercropping while the rubber trees are immature can generate extra income, and make farming at the rubber plantation more intensive. The highest potential for integration of crops occurs during the first three years. After this period, decreasing light intensity increasingly restricts the growth of arable crops. However, rubber is a high-value crop and the owner may not accept integration for fear of a possible reduction in yield of the main crop and the extra labour requirements (Rayong 2003).

3.2 Tapping

*Hevea brasiliensis*, like many plants produces latex that oozes from injuries to the stem in the form of a milky sap. Latex is produced by special cells called laticifers and is thought to be a defence against insect pathogens and possibly a medium for depositing metabolic waste of the tree. Latex flows from the living parts of a rubber tree in response to wounding, tapping being in fact controlled wounding using the sap for the manufacture of rubber without seriously damaging the tree (Edgar, 1947).

Tapping is carried out preferably early in the morning as it produces more latex (Rayong 2003). Trees are usually tapped every or every second day. Special knife is used to shave off a thin layer from the intact section of bark at an angle of 25-30 degrees from the top left to the bottom right in order to expose the maximum number of latex vessels. The cut must be neither too
deep, nor too thick. Either will reduce the productive life of the tree. This starts the latex flowing, and the tapper leaves a little cup underneath the cut (Figure 1). Once cut, the latex will flow from vessels for 1-3 hours before the vessels become plugged by coagulum. In ordinary circumstances, this latex will normally coagulate into a lump in the bottom of the cup, called the *cup lump*.

![Fig. 3. Latex tapping](image)

The tapper returns a few hours later and collects the latex. Rain guarding of rubber trees is practiced to extend the tapping period by preventing the loss during rains. About 35-40 additional tapping days could be obtained every year by rainguarding the trees. Since chances of black rot disease are high, systematic application of panel protectants at frequent intervals is necessary. Rainguarding is recommended only in areas where the yield is 675 kg/ha/annum or more and 25 or more tapping days are annually lost by rain. The popular types of rain guards are Polythene Skirt, Tapping Shade and Tapping Shield. Today, skilled tappers can tap the same trees for around 25 years because damage to the tree is minimised (Rayong 2003).
4. RUBBER AND SMALL-SCALE RUBBER FARMERS

4.1 The role of rubber in small-scale rubber farmer’s livelihood

Rubber production on small-scale farming systems in Thailand is a secured way for farmers to gain constant income for their livelihood. Besides, rubberwood farming systems are easy to maintain because silviculture costs are mainly present at the preparation and planting stages.

Economic risks to small-scale rubber farmers are not that significant because farmers always have the possibility to substitute their income source by switching into alternative farming products. For instance, if latex price is low, farmers may decide to clear their land and sell rubberwood to a sawmill. Also, farmers have the possibility to intercrop other cash crops or valuable tree species such as *Dipterocarpus* for construction wood.

According to the basic data, it could be observed that the small-scale rubber farmer obtains higher income than the average national income in Thailand. Thus, it seems that rubber production is a profitable activity for small-scale farmers since rubber tapping can only be done on average 140 days per year. This means that rubber production secures a basic minimum income to rubber farmers in a short period of time. If the farmer has good management plan income can be significantly increased by incorporating intercropping or animal husbandry into the farming system.

**Table 1. Small-scale rubber farmer characteristics (Chantuma 2006; Eakwanich 2006; Royal Forest Department 2003).**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Small-scale rubber farm holding</td>
<td>7-8 rai</td>
</tr>
<tr>
<td>Average yield:</td>
<td>1787 kg/ha/year</td>
</tr>
<tr>
<td>Production cost:</td>
<td>32, 03 baht/kg</td>
</tr>
<tr>
<td>Harvesting/tapping cost:</td>
<td>46, 95 per cent</td>
</tr>
<tr>
<td>Proportion of annual rubber income within</td>
<td>Up to 95 per cent</td>
</tr>
</tbody>
</table>
overall family income:

Tapping days:

- Northern and North-eastern Thailand: 180 days/year
- Eastern Thailand: 150-180 days/year
- Upper Southern Thailand: 100-120 days/year
- Lower Southern Thailand: 150-180 days/year

Average small-scale rubber production: 280 kg/rai/year
Average small-scale rubber income: 50,00 baht/kg
Average small-scale rubber farmer gross income: 98,000 baht/kg (approx.)

4.2 Office of rubber replanting aid fund (ORRAF)

ORRAF was established in 1960 to improve the livelihood of small-scale rubber producers, especially those that are located in Southern Thailand. ORRAF is a government enterprise under the administration of the Ministry of Agriculture and Cooperatives. The three main objectives of ORRAF are: (1) to encourage farmers to replant their farmland by adopting improved rubber tree clones as well as high value economic tree species; (2) to help farmers to establish new rubber plantations; and (3) to encourage small-scale rubber producers to engage in the formation of cooperatives in order to have more efficient production costs, higher rubber sheet grades, and group bargaining capacity.

The objective of ORRAF representations is to provide information on available (1) rubber and valuable tree species clones; (2) training services: tapping techniques and rubber processing; and (3) an efficient marketing network. The extension activities provided by ORRAF to small-scale rubber producers are divided into two main groups of services: (1) replanting program and (2) establishment of new rubber plantations.
4.2.1 The ORRAF replanting program:

This program focuses on farmlands located in Southern Thailand. ORRAF supports the initial budget to cover costs of clear felling, site preparation, seedlings, fertilizers, weeding and labour. The budget for the initial costs is 7300 baths per rai for a 7-year period, that is, until the farmer is allowed to conduct the first rubber tapping activities. Full payment of benefits is delivered to the small-scale farmer in seven instalments. The extension officers perform yearly auditing visits to the farmland sites in order to verify the proper use of funds. If the extension officer finds irregularities or some difficulties at farmland site, direct instructions are given to the farmer. The farmer has the obligation to correct the outcomes before receiving the next payment. ORRAF expects the farmer to fully participate in the replanting project, that is, only 70 per cent of labour costs are fully covered. The main restriction to the farmer is that tapping is denied until the seventh year after planting the seedlings. The tapping restriction is compensated with an economic allowance to the small-scale farmer in the form of low interest loans. These loans are for establishing intercropping (valuable tree species, pineapple, watermelon, sweet corn or rice) or animal husbandry activities (chicken or goat) on the farmland. If the farmer decides to intercrop valuable tree species with rubber trees, ORRAF will only provide a maximum of 15 species of intercrop trees per rai. The largest amount of loan is 30000 baht at 3 per cent interest rate per person.

4.2.2 Establishment of new rubber plantations

This program is known as the One Million Rai Project. The main objective of the program is to establish new rubber plantations in Northern and North-eastern Thailand. In Northern Thailand, the program aims at encouraging longan (Sapotaceae) farmers to convert to rubber cultivation because of longan overproduction and low market prices. In North-eastern Thailand, the objective is to expand the green area. The government pre-establishes provincial quotas for designating the new rubber plantation areas. Farmers
are eligible to participate in this program if they have full land ownership and if their farmland is not located in the natural forests or national reserved forests. The 3-year program consists of three phases (1) in year 2004, establishment of 200000 rai; (2) in year 2005, establishment of 300000 rai; and (3) in year 2006, establishment of 500000 rai. The central government of Thailand supports the small-scale farmers with 90 seedlings per rai. The price for each seedling is 16 baht. Besides, the government arranges affordable loans for the small-scale rubber producer at a zero interest rate for the first seven years after establishment of the new plantation.

4.2.3 Marketing services by ORRAF

Before the last extension services are provided to the farmer, ORRAF organizes a meeting with the farmer to promote the formation of rubber processing cooperatives. With these meetings ORRAF intends to inform the farmer about the advantages of producing higher and more uniform qualities of rubber sheets. If a group of farmers decides to form a processing cooperative, the central government will provide a free production facility.

The structure of rubber marketing networks available to the small-scale rubber producer is divided into three different types of market activities as follows:

1. Middlemen visit villages and negotiate directly with the farmer. They usually trade lower rubber sheet grades (4 and 5).
2. Local Auction Market: The maximum amount of rubber sheets sold per transaction is 100-150 tons. The farmer needs to pay a fee for the services provided by the Auction Committee. The service fee is 0.10 baht per kilogram.
3. Central Auction Market: The minimum amount of rubber sheets sold per transaction 1000 tons. The farmer needs not to pay any services fee provided by the Auction Committee. Administrative cost of auction services are financed by the Rubber Research Institute.
5. RUBBERWOOD SAWING

5.1 Background for rubberwood sawing

Until the early 1990’s latex production has been the main objective for rubberwood cultivation in Thailand. In 1989 the Thai government established a national natural forests logging ban. This law raised an immediate demand for construction and furniture wood in Thailand. Previously, the rubberwood trunks left over after the latex production, were either used as firewood at the plantation site or in charcoal production. Rubberwood offers qualities to ease off the demand for natural tropical forest trees and this way helps to decrease the pressure on illegal logging. Rubberwood has mechanical properties close to Teak and its pale colour and beautiful grain make it highly suitable for demanding export markets around the world. Today, more than 75 % of all rubberwood released from latex production is being used in mechanical forest industry. Currently, rubberwood logging reaches quantities of more than 5 million m\(^3\) per year; this wood comes from 36,800 hectares. Even the smallholders are now profiting from the rubberwood in addition to the harvesting of latex. However, the rubberwood sawing industry is still quite undeveloped in Thailand and small and medium sized sawmills control the market.

Usually there are contractors or merchants who buy the wood from rubberwood plantations and wood-procurement is also in their responsibility. This includes the fellings and the transportation to the mill sites by trucks. There are two main felling systems applied in Thailand. The other one consists the felling of the whole tree, including the root system, with bulldozer and thereafter cutting and delimbing the trunk with chainsaw. The root system is used as firewood, or just burnt at the site. The other method is cutting the trunk above the ground level and cutting and delimbing the trunk with a chainsaw. The stumps can be cleared by the owners using two methods; with chemical treatment or using tractors to uproot the stems. After the felling, the
rubberwood log is cut to length between 1,0 – 1,3 metres, favourable length is 1,3 metres. The logs are transported from the plantation to the sawmills by trucks. No chemical preservatives are used at this point. The transportation distances from the plantation to the mills vary between 30-50 km, but distances around 200 km are also possible. The freshly cut logs are very vulnerable to insect and mould attacks, so the transportation time is kept at minimum; between 1-3 days.

The pricing system used in this occasion describes how much money a smallholder earns from selling the trees from one rai. In case of a high latex-yielding clone the farmer can sell the wood for average price of BHT 50 000 from one rai. If the smallholder has been harvesting a clone combining high latex yield and high wood yield, he can get as much as BHT 70 000 per rai. The yield per hectare is in average 138,9 m$^3$, but due to inaccessibility of plantation areas only 75 % of available logs will reach the sawmills in estimated saw log supply of 104 m$^3$/hectare (STATUS OF... 2000). Rubberwood’s rotation time in average latex production is between 25-30 years and smallholder usually decides to sell the trunks after the latex productivity has begun decreasing significantly. At this age the average height of the trees is 25 meters and average log size is 0.63 m$^3$ of stump wood (Sethuraj and Mathew 1992).

For the smallholder the additional value-add obtained from rubberwood is having more and more importance, since the market price of rubberwood timber has increased. Even in North-eastern Thailand, where the conditions are not so favourable for latex production, rubberwood is harvested only for timber producing. There only the high timber-yielding clone is cultivated.

5.2 Physical and mechanical properties of rubberwood

The rubberwood’s texture is fairly straight with a slightly interlocking grain. The colour is whitish when freshly cut but later seasons to yellow or light brown. The wood is soft to moderately hard with an average density of 515
24 kg/m³ at 12 % moisture content. It is diffuse porous and the pore size is medium or large. Hence, the annual rings are not visible; concentric false rings can though still exist. The length of the fibres is more than 1,0 mm on the average and the width is about 22 µ when dry. The cell wall thickness is about 2,8 µ. The tension wood may vary from 15 to 65 % and such erratic distribution tends to give a woolly appearance on the surface of the wood. Such distribution and variation are assumed to be responsible for some of the commonly observed defects that may occur during drying and processing (Sethuraj and Mathew 1992).

Rubber wood seldom has natural defects, which could affect its usability. Sometimes growth stresses and induced drying stresses could cause splits, cracks and checks. These can be avoided by applying appropriate measures during storage and drying. Decay or rot, are commonly observed in rubber wood during machining. Many species of fungi and defects due to other biological agencies like insects and birds or due to weather can also be suitably minimised by chemical treatments (Sethuraj and Mathew 1992).

5.3 The rubberwood sawmill operation

Most rubberwood sawmills in present day Thailand are of the band saw type. Only the oldest ones still utilize circular saws despite the small diameter or the raw material. A typical sawmill consists of two production lines of one break-up saw and some four additional saws for resawing. The disadvantage of the bandsaw is the high level of maintenance required. The saw blades need sharpening every six hours by specially trained personnel using special equipment (Status of… 2000).

Many sawmills utilize the method of two-man operated single bandsaws that perform all stages of sawing. These can be installed in desired numbers in parallel. This method can allow to some extent individual processing of logs of different dimensions but on the other hand it is somewhat inefficient compared to series style sawing on multiple saws.
Wood unloading is usually done inefficiently by hand. Logs are piled, often on forklift handled steel frames, to wait the subsequent feeding into the process. Bark is not removed. Log grading is seldom practiced. Usually the wood is processed within 2 to 3 days from logging to prevent fungi and insect attack. The sawn timber is sunken in borate or other protective chemical either in pressure chambers or under normal atmospheric pressure. Pressure applied borate stays in the wood even after planing. The borate treatment lasts usually 1,5 – 2 hours under 10,5-14,0 bar pressure (Status of… 2000).

Most of the sawn timber is dried in kilns. Drying times vary from 7-15 days. Otherwise extensive bending of sawn wood during drying process is easily avoided by placing heavy weights on top of the drying stacks, or by means of tying the stacks with cargo ties. Kilns are of the steam-heated type, often utilizing scrap wood as fuel. The final moisture content is 8-12 %.

5.4 Rubberwood markets

Rubberwood comes from plantations where old, native rubber trees are not anymore used for latex production or from plantations where poorly latex producing clones are being harvested. It has been used as a substitute for other mixed deciduous timber species / woods that are now under the commercial logging ban. Its strength and white timber with a finely patterned texture caused it to be popular among consumers, particularly those in Japan and the United States. Presently 80 % of Thai sawn rubber wood is exported, mainly to China, Vietnam and Malaysia, the remaining 20 % being used in Thai furniture factories.
The following products are in favour both in Thailand and abroad:

- Rubberwood products such as furniture, toys, particle board, MDF board, parquet board, cooking utensils, photo frames etc
- Construction poles, scaffoldings
- Poles for electricity lines
- Firewood and charcoal
- Food containers

Chart 1. Rubberwood utilization (Status of ...2000).
REFERENCES

ACIAR, 1985, “Smallholder Rubber Production and Policies: Proceedings of an international workshop held at the University of Adelaine, South Australia, 18-20 February 1985”, ACIAR Proceeding Series No.9, pp 151


INTERVIEWS AND PRESENTATIONS
