

RUBBER AND THE ECONOMY OF SOUTHERN SIAM*

by

Laurence D. Stifel

I would like to introduce the topic of the rubber industry by briefly quoting a Western expert who has studied the industry and well summarized its present plight.

The world market has been glutted with rubber in the past few years and we may doubt if it will ever again pay as much for rubber as it has in the past. In addition to this is the fact that isoprene derivatives and other synthetic substitutes for rubber can now be produced almost as cheaply as natural rubber can be bought in the countries which make most use of this commodity. For many purposes the substitutes are better than the real thing, and there is every reason to believe that they will come into much wider use. If this be so there is little use in attempting to increase the rubber production of Thailand.

These are the words of Dr. Andrews of Harvard whom the Siamese Government had requested to survey the economy of the Kingdom and they were published 35 years ago. Last year the rubber industry boomed to a production level almost 20 times the volume when Dr. Andrews made his gloomy assessment of the future prospects for rubber. His error should caution us in present attempts to chart rubber's future role in the South.

In order to understand the nature of rubber production, I intend, firstly, to describe an ordinary rubber growing village in the South, then indicate the economic significance of rubber to Thailand, and very briefly describe its historical development. Finally I would like to contrast present rubber growing practices with the potentiality created by new technology in rubber production and conclude by speculating about the long range viability of natural rubber in Siam.

* A paper presented at a meeting of the Siam Society on September 24, 1970.

An Ordinary Rubber Growing Village

Let us first look at a rubber growing village in Trang where I have been working and which may reflect many of the characteristics of rubber production in Thailand. At this time of year, most villagers arise at dawn to start tapping, although some will have already been tapping for many hours by the light of acetylene lamps fastened to their heads. If there has been no rain in the night and the trees are dry, the villagers walk or cycle to their holdings, usually comprising a number of irregular sized plots of land at different locations around the village. Some rubber holdings consist of neat rows of regularly spaced trees; others present a jungle-like appearance as the ancient, thick trees are mixed with recent replacements and stunted trees from natural regeneration. Here the weeds are trampled down to make paths for the tappers. Particularly in the old stands of rubber, many of the trees are dry, they yield little latex, and the villager stops to tap only those which experience indicates are worth the effort at the prevailing price. Tapping consists of making a shallow incision into the bark with a tapping knife. On the better trees this may be a careful, thin half-spiral cut which conserves the bark panel and prolongs the tree's productive life. On old trees, hasty, thick and deep tapping often damages the tree's cambium and causes the gnarled bark so common on old rubber trees in the South. On these old trees there may be multiple cuts, high and low, and completely circling the tree. Latex flows down the incisions to half coconut shells attached to the trunk or propped on the ground.

A family may have more or less rubber than it can tap with its own labor and land parcels may be inconveniently separated. Some balance is provided by share-tapping within the village. Those with surplus rubber trees let others tap for them on a 50-50 sharing basis. There may be a few migratory tappers temporarily living in the village and engaged in this activity as well. Tapping is a family enterprise and women and children are particularly active in mid-morning when it is time to collect the latex in pails and carry it to a shed with a set of cast iron mangles used to press the latex into sheets for sale.

At the shed the villager strains the latex through a sieve of rice straw or coconut husk and then coagulates it in half kerosene tins with

a cheap acid purchased in the market. After setting for about 40 minutes, the block of coagulum is placed on a wooden board and kneaded either by hand or by foot. Then it is rolled through the mangles and hung outside on poles to dry. There is little effort to keep the area clean and impurities are pressed into the sheet. More expensive acids are recommended by the *amphur* agricultural officer but the villager does not feel their use would provide adequate additional returns and they lengthen the period of setting. Every week or so the villager will sell the sheets to one of two Chinese shopkeepers in the town. The dried sheets are called unsmoked sheet and they are often thick, dirty and inadequately dried before sale. These practices are reflected in the poor quality grades of Thai rubber exports and the relatively low prices received by the villagers. The villager economizes in his use of time and money with little regard to the quality of the rubber which he sells in bundles of ungraded sheets.

Rubber cultivation provides a highly satisfactory way of life for the ordinary villager. Rubber has a unique adaptability to different environmental conditions; it requires little care. Tapping is not arduous and it can be practiced all year long except during the brief period of defoliation; the villager therefore has a regular stream of cash income. Although these cash earnings fluctuate widely the returns exceed earnings from alternative crops even when rubber prices are at their lowest. Moreover most of the families have some paddy land to grow rice for their domestic needs, so when prices have fallen in the past, as during the Second World War, they have been able to withdraw from the market without excessive hardship.

Rubber was planted in this village before the memory of any present living inhabitant and the gnarled, 50 year old trees are still being tapped. Consequently the villagers' average yields are declining markedly and there is no land in the area for planting new rubber stands. During periods of low prices, some villagers have cut down their old trees and replanted new rubber but many of the parcels are so small the canopy of leaves on the surrounding trees retards their growth. Moreover, this is expensive and the greatest cost is the absence of income during the 6-8 year period of immaturity.

For about the past ten years the villagers have increasingly sought a solution by planting new rubber trees in the forest reserve area on the nearby hills, although this is contrary to the law and they cannot secure any valid claims against the land. They typically burn the dry land in March and April and then plant rubber when the rains come, with an intercrop of upland paddy for the first two years. Many of the fields are abandoned to weeds until maturity, or longer if the rubber prices are low. However villages adjacent to the far sides of the reserve have been similarly encroached with rubber plantings and there is little land of this nature left here now.

This introductory sketch of a rubber growing village is meant merely to be suggestive of the general rubber growing conditions in the South. In fact there is considerable diversity, ranging from a few relatively large, modern plantations owned by Bangkok or Penang businessmen to farmers with only a rai or two of rubber trees to supplement another main crop. There is also a geographical diversity between the poor and small average holdings of the Thai Muslims in the border changwats where about one third of the rubber is produced; the concentrated areas of largely Chinese planting as in Phuket, Betong, and Ranong for instance; and the large areas, such as this Trang village, cultivated by Thai Buddhists and Sino-Thais.

Nevertheless the industry as a whole consists predominantly of small-holder enterprises. This contrasts sharply with other producing countries. Malaysia, for example, is divided into two sectors: the estate sector with holdings over 250 rai producing about 60% of Malaysian output and the smallholder sector with holdings under 250 rai. The Malaysian industry is led by the estate sector which is capitalistic, scientifically managed and progressive; contrast Thailand which has only 9% of its holdings over 140 rai. The national average rubber holding for Thailand equals 17 rai but this is the combined area of fragmented plots of rubber, rice, perhaps coconuts and other crops. The small average size of holdings provides a stability which is a cushion against adversity and a constraint against change.

The Economic Significance of the Rubber Industry in the South

The southern region, extending from *changwat* Chumporn to the Malaysian border, contains about 12% of the population and 14% of the area of the Kingdom and it is heavily dependent upon rubber production.

Professor Pataya Saihoo of Chulalongkorn University has conducted the only anthropological study of a Southern rubber growing village and he reported his research results to the Siam Society two years ago. Of his Malay village in *changwat* Yala, he wrote, "The economic life of the village, Khala, largely revolves around rubber, practically everyone is engaged in some aspect of rubber production . . . Thus, the economy of Khala can be summed up in one word – rubber." This observation may be generalized to the entire southern region of the country.

The value of rubber production is about half of the agricultural gross domestic product in the South. It was roughly twice the value of rice production during the six year period for which regional data are available. The South's second largest industry is tin mining but this has a relatively small local employment effect and the profits flow to the highly concentrated ownership, much of which is British and Chinese.

During most of the last two decades rubber has been Siam's second most important foreign exchange earner, even briefly surpassing rice. The direct taxes upon rubber exports in 1969 produced government revenue of 426 million baht which represented over 40% of the controversial tax on rice, the rice premium, which is widely believed to place an undue burden on the rice farmer.

The dimensions of employment in rubber in the South are difficult to define because agricultural families typically have several sources of income. However just half of the agricultural holdings in the South have rubber. The working members of the farm families engaged in rubber tap only about 150 days per year and on the average, only about 4.5 rai, compared to an estimate of 7-8 rai for a reasonable day's work. This apparently small task or work load is partly compensated by employment

in other pursuits and it may partly represent underutilization of the labor force, disguised unemployment, but statistics are not available to differentiate the two phenomena.

Statistical definition of the area, distribution, and production of rubber plantations is even more uncertain because of the poor reliability of the data. The best source of detailed statistical information is the 1963 Agricultural Census, but it merely confirms that production estimates based upon the small rubber growers' ability to recall past production are simply not useful. In addition to a possible reporting bias due to the fear of quotas or taxes, the farmers do not know the precise number of days they tap or the number of sheets they produce for a period of more than several weeks. They decide to tap or not to tap from day to day depending on the weather, the price, and alternative activities, and they sell irregularly without a record. The total production reported in the Census is far below total actual rubber exports, which is the most reliable single source of data on the rubber industry.

To provide a basis for defining the size characteristics of the industry, the Census enumerators asked the rubber holders for the number of their trees rather than the area of their holdings, since experience has demonstrated they do not know, or will not tell, their precise area. Unfortunately the Census is evidence that they do not accurately report the number of their trees either. After the completion of the Census, a very small sample survey in one changwat included a physical count of the number of trees and just 7 trees were found for every 10 trees reported. The FAO is assisting the Department of Land Development in a valuable project to interpret aerial photographs of the South in order to measure the area planted with rubber. Until the results are known, however, planning for the rubber industry must be carried out in the face of ignorance of the basic facts of the industry's size, geographical distribution and productivity.

Historical Development of the Rubber Industry in the South

The rubber boom which rapidly swept through the Malayan states was curiously slow in moving into Siam proper, although the northern tier of Malay states was under Siamese suzerainty until the Anglo-Siamese Treaty of 1909.

On the east coast, bordering the present *changwat* of Narathiwat, the British adviser, W.A. Graham, in 1907 reported the "feverish" rush toward rubber planting in the Siamese Malay State of Kelantan. Malay travelers had brought news of the great forests of rubber in states to the south. A private British firm acquired large planting concessions in 1906, and by the following year 21,700 acres of rubber and coconuts had been planted. On the other side of the peninsula in Kedah, the British Adviser also described the spread of rubber planting as "feverish", as small-holders cut down coconut and betel nut trees to plant rubber, which covered more than one third of the State over the next five years.

Various factors may have been responsible for the slow transmission of the "rubber boom" into Siam proper. Firstly, the popular belief in British Malaya during this early period was that Siam was not well suited to rubber production. More important probably was the absence of direct government encouragement of foreign plantation development. Under the existing treaties with the Great Powers, foreigners could not possess real property without the permission of the Siamese Government, and potential plantation owners must have been discouraged by the need to negotiate land rights in each case. The Siamese were also reluctant to promote the massive influx of plantation labor which had been found necessary in Malaya. Estates were situated in jungle areas, with few roads or large towns. The sparse population consisted of cultivators or fishermen, frequently tied to the land which afforded both security and a congenial pattern of life lacking in estate work. As labor shortages threatened, the Europeans in the Siamese Malay States turned to their government for assistance, and after Siam relinquished its rights to the four Malay States Indian labor was permitted to pour into the new plantations, just as it had earlier into the Federated Malay States. Within Siam proper, the absence of estate labor was

cited in early accounts as an important deterrent to European plantation development.

Whereas Siamese policy discouraged foreign interest in plantation development, the diffusion of smallholder rubber into the border *chang-wats* of Siam occurred only slowly and gradually during the early decades, but there was one, apparently successful, government program to introduce rubber to Thai Buddhist villagers. Smallholder rubber entered Siam in somewhat distinctive patterns for the Thai, the Chinese and the Malay planters, and since this racial division of the industry is still significant, each of the three patterns will be considered.

Official accounts attribute the first planting of rubber in Siam to *Phya* Ratsadanupradit, the Chinese governor of Trang and superintendent of *Monthon* Phuket. When the price of pepper fell, *Phya* Ratsada studied the production of rubber in Malaya and brought back seeds in 1901 to promote rubber as a substitute cash crop. He established large scale plantings for himself and other officials in order to demonstrate the profitability of rubber and to produce seeds for distribution. His objective was to promote rubber smallholdings in the rice-growing villages and he strenuously urged, one account says "forced", the local officials to disseminate the seeds in their villages. Much of the central producing area is believed to have spread from his official promotion program for smallholdings, and some of these first trees, now greatly distended from the wounds of repeated tapping, are still standing in Trang where his deliberate extension effort started.

The first Chinese plantings occurred quite independently in the Betong salient and in *changwat* Songkhla on the Malayan border. The Chinese had been active in tin and in commercial agriculture during the 19th century. The movement across the border was simple, the Chinese were attracted by somewhat higher wages in Siam, and they were the only alien group to enjoy rights to own land equal to the Siamese. In Betong during this period the Chinese tin laborers gradually cleared the surrounding forest land, staked their land claims, planted rubber and worked in the low yielding mines until the maturity of their smallholdings. When rubber prices fell there was some consolidation of holdings under the

control of Penang capitalists but the first stimulus came from these small clearings for family farms.

A similar, although slower diffusion process was occurring in the Thai Muslim *changwats*. The common Siamese suzerainty over the areas above and below the present border did not create a similar political organization or an economic integration conducive to the rapid transmittal of the new crop. In Kelantan the principal mode of transportation, both internally and externally, was by water. There were no roads into Patani on the north and connection with Bangkok was by the East Asiatic weekly mail. However the Malay travelers into Patani gradually carried the news of the rubber phenomenon to the south and the great profits to be made from rubber plantings. Professor Pataya's village of Khala may illustrate the process. Let me quote again from his paper; "Khala was originally a rice-growing community and rubber was introduced only about 50 years ago. The first person who brought the seeds and the necessary knowledge for their cultivation was a man from a village in Patani about 40 kilometers away and a friend of one of the villagers. . . The first generation owners obtained their holdings from the jungle on the high ridges between the rice-valleys. These holdings are the oldest and the best located although not necessarily the best planted. The second-generation owners have cleared their own holdings from parts of the jungle further up the hill. . . . Later owners, residents or otherwise, could only obtain land by purchase."

The rubber industry expanded by a multiplication of smallholder units along each of these three racial lines. The few European and Penang-Chinese plantations did not significantly alter this pattern of development. The Thai and Malay peasants and the Chinese laborers typically cleared jungle lands to plant unselected rubber seeds in response to the high prices in the first decade of the century and on a larger scale when prices rose as the Stevenson Plan restricted production in the 1920's. The poor maintenance, and even temporary abandonment of the stands, meant that the periods of immaturity were longer than the 6-7 years for plantation rubber trees. When the plantings of the mid-twenties were maturing in the early 1930's, the world price had fallen so low that tapping ceased on many producing plantations; there was inadequate

incentive to return to clear away the weeds on these new plantings reaching maturity until prices rose in 1935 and 1936. In that year Siam's production, as measured by exports, jumped to 4% of world production and the country for the first time because a factor, albeit a small one, in the world rubber market.

Similar waves of new plantings occurred before the outbreak of World War II and during the Korean War but production increases lagged because output depends both upon the capacity of mature trees and the ratio of the rubber to the rice price. Statistical studies confirm that high rubber prices stimulate greater short term rubber production, whereas rice competes to some extent for the villager's time and higher rice prices somewhat depress rubber production. The postwar growth of rubber production transformed the south into a booming and market-oriented, cash economy. The expanding road network reached into rubber areas previously accessible only by elephant. The economy which had been geared to the Malayan market become more oriented towards Bangkok and the international market. This great, relative prosperity continued until prices started to decline in the 1960's and, combined with falling yields on the old trees, created concern about the future viability of rubber in the South.

While the export data permit us to trace the pattern of total production reasonably well, the statistics permit only a few tentative conclusions about the patterns of growth of the Muslim, Chinese, and Thai centers of expansion. The 4 Muslim *changwats* apparently accounted for well over half of the rubber area before 1940, but postwar data indicate that production is gradually shifting northward. The 1963 Agricultural Census attributes only 25% of total trees to these *changwats*. Chinese and Thai holdings expanded and intermixed in the other *changwats*. However data on the nationality, not the race, of rubber holders may give a rough picture of the Chinese position. In addition to almost completely controlling rubber marketing and supplying much of the tapping labor for large plantations, Chinese nationals in 1949 had 9% of the total holdings and 26% of the total rubber area, but their share dropped to 20% by 1953. It is widely accepted that the Chinese holdings are larger and more progressive.

Dr. Uthis Naksavasdhi in his comprehensive survey of the industry seven years ago wrote, "The Chinese plantations are clean and orderly, the Thai plantations are rather overgrown and dirty and the Muslim plantations are more appropriately called rubber jungles than rubber plantations."

The Chinese in most areas have now assimilated to the extent that no meaningful definition is possible with the available data, although in the northern part of the peninsula there are large replantings and new plantings of rubber which are attributed to Sino-Thais moving from the traditional areas where land is no longer readily available. The average size of rubber holding remained constant, according to official data, from 1938 to 1953, but the 1963 Census shows a large increase, especially in these same *changwats*.

The rubber industry has revived during the last several years. Many have wondered where the production came from. After a period of very gradual increase during the 1960's, production abruptly jumped by 30% during the last 2 years of the decade. The high prices a decade ago apparently stimulated plantings which started to mature in 1968; the 1969 rubber prices rose sharply and brought out the full potential of these plantings. This year the price has fallen very low but the export statistics are not yet available to show the effect on production.

Advanced Technology of Natural Rubber Production

The future of the natural rubber industry depends upon whether it can survive the technological competition with the synthetic rubber industry. When Professor Andrews made the gloomy assessment of natural rubber in 1935, cited earlier, the prospects seemed poor indeed. As recently as a decade ago, much of the industry felt that natural rubber was fated to eventual extinction as a significant commodity of world trade, in spite of the decades of experimental work on the rubber stations of the producing countries, notably the Rubber Research Institute of Malaya. However in recent years the demonstration of the feasibility of massive replantings of old rubber with high yielding varieties, the development of new packaging and marketing techniques, and encouraging research on

dramatic new cost-reducing methods have created a sense of optimism that natural rubber can survive in the long run, if it takes full advantage of the new technology.

Fortunately for Thailand these advances in the technology of rubber production are available to the smallholder. There are no significant economies of scale derived from large plantation operations which might keep the Thai smallholders backward. However there is a great gap between today's typical production pattern and the advanced methods now feasible—and large plantations have resources to realize these potential advances much more readily than the smallholders of Thailand. This places a great burden on the government to assist in the transition if it desires to preserve the smallholding character of the industry.

I started this talk with an impressionistic account of a rubber growing village in Trang to illustrate the ordinary, present pattern of rubber production. Let us contrast this with the potential afforded by the advanced technology of production. Let us describe what a modern rubber growing village in Trang, for example, would be like.

Firstly and most importantly the village, in a decade or so, would have completely cut down old rubber stands and replanted with high yielding planting materials. The rubber in Trang, and all of Thailand, is descended from the original seeds carried from the jungles of Brazil in 1876; they produce trees with great variations in yield, disease resistance and other characteristics. Research in Malaya and other producing countries led to the development of high yielding varieties or clones which can be propagated either through seedlings or budded stumps. The declining yields of the old rubber, combined with spectacular improvements possible with the new varieties, make the replanting of rubber the most significant measure to increase productivity and lower costs.

In Malaysia where replanting has progressed rapidly, especially in the estate sector, average yields for this sector have risen from 60 kilograms per rai in 1939 to 180 today and an estimated 240 by 1980. Sophisticated research continues into methods of improving rubber's heritable characteristics and the efficiency with which it utilizes photosynthesis to produce latex. In the future rubber trees may be transformed in appearance to become more efficient producers of latex. But at the

present, good Malaysian estates are realizing yields of 270 kilograms per rai per year and experimental trials indicate the capability of reaching 550—about 10 times the prewar average.

My estimate is that the present average yield in the Trang village is about the prewar estate level in Malaysia and that replantings could produce a maximum yield four times higher. The tapping and collecting activities would not change, except the pails of latex would be heavier and emptied more frequently. At the present low price levels, the smallholder earns about B320 per rai, as opposed to a potential of about B1,300 per rai after replanting. This would raise the daily earning from a normal task of 7.5 rai of rubber from the present level of about B16 to B65 after replanting.

The Thai villager does not receive the full value of the rubber he produces because of his poor processing and because the sheets are sold in wet, unsmoked form before accurate visual grading for export is possible. The few large plantations in Thailand smoke their own sheets and sell them in bulk form directly to the large exporting firms. The smallholders might gain up to 10% higher returns by organizing group processing and drying centers to realize similar benefits.

But a more dramatic and significant measure to improve the quality of the product is the block rubber or crumb rubber process which is being vigorously promoted in Malaysia. Crumb rubber is natural rubber which has been broken into particles, by one of several processes, then pressed into small bales and wrapped in polyethylene bags for shipment. This process permits the technical grading and certification of physical quality standards, as opposed to the traditional system of grading sheets on purely visual criteria. Natural rubber can thus be marketed with consistent properties and technically specified characteristics as has long been true of synthetic rubber. Moreover this process has led to techniques to control and manipulate the properties of natural rubber and facilitate natural-synthetic blends to reduce costs and serve special applications.

The villages will need better means of transportation to carry latex or partially coagulated rubber to a block rubber factory for processing,

since the minimum economic size of a plant would require a supply area about six times the size of this small Trang village. However, block rubber is already being produced in Thailand in a number of plants and the Rubber Research Center in Haadyai has established what is known as the Thai Tested Rubber Scheme—TTR—for grading on technical specifications. The director of the Rubber Research Institute of Malaya told me that he believed that block rubber would completely replace export of the traditional rubber sheets from Malaysia within ten years. There are problems in organizing and supplying a block rubber factory from village smallholdings, as opposed to a large plantation, but there are no technical reasons why the smallholder industry of Thailand cannot realize the benefits of block rubber.

There are other significant new techniques on trial which promise to keep natural rubber competitive with synthetic rubber. Since labor is the primary cost of rubber production, cost reduction is possible if the latex is not collected every day but is permitted to accumulate in plastic bags which can be gathered by unskilled workers at weekly intervals. A technique which is now creating excitement in Malaysia is the use of a new chemical stimulant to increase the flow time and the yield of latex on ordinary trees at little additional cost.

However the most critical aspect of the new rubber technology is replanting with high yielding new trees; therefore the experience of Thailand's replanting program will be reviewed.

Programs to encourage the replanting of rubber with high yielding varieties in Thailand have been based upon the Malayan model. While large companies in the Malayan plantation sector had long implemented policies for the systematic replanting of old stands, the smallholder sector's apparent inability to replant attracted government attention. An Enquiry Committee reported in 1952 that "the alternative to large scale replanting with high yielding material is the virtual extinction of the smallholding industry as it is known today." The Malayan government then imposed a replanting tax on rubber exports and established a series of funds to subsidize replantings and this has been expanded and renewed to the present time,

The Thai smallholders were similarly reluctant to invest in replanting. According to my study the cost of replanting is about B2,300 per rai for Thai smallholders but the loss of income from the trees which have been destroyed, the opportunity cost of replanting, has been even greater at price levels of the last decade. The Thai smallholder has preferred to clear new land to avoid this loss of income during immaturity and new plantings are responsible for most of the great increase of mature rubber land during the last decade. During the early 1950's high yielding planting materials were imported from Malaya and then local nurseries were established here. Unfortunately there are no reasonable estimates of the percentage of new rubber area planted with high yielding varieties although it was probably rather low.

The Thai Rubber Plantation Aid Fund Act received cabinet approval in 1955 but it was not enacted until five years later, and the first authorized replantings occurred in 1962. Like the Malaysian scheme, the replanting act depends upon an export tax to create a special fund for replanting grants. The act is administered by a special Office of the Rubber Plantation Aid Fund, which is independent of the regular government machinery and which has an outstanding reputation in the South for integrity and dedication to its difficult task of promoting, advising and inspecting replanting on the small rubber parcels. The replanting officers make replanting grants-in-aid to the growers in installments of cash and kind. The value of the grant, B2,000 per rai, approximates the replanting cost but makes no contribution to the loss of income caused by removing the old trees.

The rate of actual replanting started slowly as the Replanting Fund Office developed its staff and publicized its program to plantation owners. With the exception of large grants to repair the damage from the terrible 1962 hurricane, the rate of replanting leveled off until 1968 when a new program was initiated to accelerate the rate significantly. However, at the end of last year, only about 7% of mature area had been replanted and replantings equalled only about 20% of the area which had matured since the Fund Act had become operative. Not only was this rate far below the normal 3% rate per year necessary for sustained coverage of rubber area at the time of the Act, but most plantings during this period

were made outside of the provisions of the Fund. The result may be to accentuate the racial division within the industry. The replanting rate has been the slowest in the Muslim *changwats* and Trang, where the poorest smallholders are believed to have been heavily engaged in illegal planting with low yielding native stock. To the extent this is true these areas may be committed to a generation of dependence upon rubber of marginal value if expected price declines occur. The *changwats* with the largest average size of replantings and the largest immature areas are noted for a predominance of Chinese or Sino-Thai planters who will be able better to withstand the price competition with synthetic rubbers.

The slow pace of replanting indicates that the smallholder typically will not replant in the absence of even greater government effort. However, the benefits to the South and to the economy as a whole may exceed those perceived by the smallholder and the government may wish further to encourage him to replant because of the potential national benefits. Thailand's partial commitment to the rubber industry still permits review of whether replanting is the proper policy for the South—whether the replanting program should be abandoned or whether it should be intensified. If the smallholder is doomed to falling prices and returns that eventually will force him to switch, with great hardship, to other crops, the government should discourage replanting of rubber and focus on identifying possible alternatives. Although theoretically there are no barriers preventing the smallholder from realizing the economies of the new technology, the real difficulties in administering smallholder modernization programs may warrant promoting new plantings in a modern plantation sector with the organizational capacity and the capital to keep pace with the rate of innovation in the industry.

Whether the South should continue to specialize in rubber production depends primarily upon the cost of producing rubber, the future price trend of natural rubber, and the nature of the alternative means of employing these resources.

The initial question concerning the costs of producing rubber in Thailand must be answered before any reasonable judgment can be made on future rubber policy. Nevertheless no satisfactory estimates of costs of smallholder rubber production are available. Cost surveys based

upon answers from the villagers are not reliable. A more serious obstacle is the conceptual difficulty of valuing family labor and the uncertain effect of rising yield upon traditional compensation patterns. The prime component of production cost is the labor for tapping, collecting and pressing the rubber sheets. Probably about half of the rubber is tapped by family labor and the rest by hired tappers who share in the value of their production. The estimated costs of production of family tapped rubber, therefore, depends on the imputed valuation of family labor, while the cost for rubber tapped by employees depends upon fluctuations in yield and price and possible variations in the sharing formula.

I have attempted to calculate the overall social benefits and costs of replanting rubber using various assumptions concerning labor costs, ranging from the relatively high wages paid for tappers by the government rubber stations to the extreme that the true cost of this labor is equal to the low amount it could earn on the most feasible general alternative to rubber, which is subsistence, upland paddy and vegetable production. While the real opportunity cost of village labor is probably below the wage rate in the limited, commercial labor market, the lower assumption also appears unreasonable in a growing economy with relatively mobile labor. Let us use the working assumption that the cost of labor is B10 per day, which is the lower limit of unskilled village wages and seems to be the earnings level at which is it just barely possible to secure tapping labor. At a daily labor cost of B10, the discounted value of the stream of costs and benefits over the 30 year cycle of replanting, immaturity and tapping would give a benefit-cost ratio, at a 12% interest rate and present rubber price levels, of 1.5. The internal rate of return would be 17% from an investment in rubber replanting. Under these circumstances the present value of replanting benefits exceeds the costs; if the assumptions hold in the future and if there are no better uses for these resources, then continued effort should be focused on encouraging replanting. Under the same assumptions the benefit-cost ratio for *new* plantings would be 1.8, as opposed to 1.5 for replantings, because there would be no loss of income from the old trees.

These calculations are based upon constant costs and prices over a generation, which is clearly not realistic. Present rubber technology will largely determine the physical productivity of present investment in replanting but the benefits will depend upon trends in production costs and prices. The uncertainty about prices is most critical. At the 1969 price level the benefit-cost ratio for successful replanting would be 1.8, at today's prices it is 1.5 and if prices fall to 40 Singapore cents per pound the benefit-cost ratio would be 1.2. But if the Singapore price were to decline to 30 cents the benefit-cost ratio would fall to .6 and the owners of even the most productive replantings would be forced to accept very low returns or abandon rubber tapping completely. This prompts us to conclude with an examination of the future market prospects for natural rubber.

The Future Market for Natural Rubber

Technological advance has blurred the traditional boundaries of the natural rubber market, for natural rubber is only one of many types of rubber products, all of which share a high degree of elasticity while possessing other differentiated properties. Synthetic rubber is a generic term referring to the wide variety of man-made rubbers, which increasingly include blends with one another, with plastics and with natural rubber. While the world consumption of all rubber products has grown rapidly since the end of the Second World War, natural rubber's share has declined from about 75% to 40% of total consumption. The world market for rubbers thus consists of multiple markets with discrete supply and demand schedules which are unstable because of a rapidly changing technology.

Nevertheless, the market can be divided into three broad zones. In the first zone of the market, natural rubber was technically superior prior to 1960 and competition between natural and synthetic rubbers did not exist. The second zone was occupied by natural rubber and general purpose synthetic rubbers which were technically substitutable and competed on the basis of price. In the third zone various specialty synthetics were technically superior and did not compete with either natural or general purpose synthetic rubber.

The general purpose synthetic, SBR, is the most important and the cheapest synthetic rubber. The great expansion of synthetic rubber capacity during the Second World War was based upon SBR because it could compete with the original general purpose rubber, natural rubber, in many applications. However SBR is somewhat inferior to natural rubber in some properties, such as resiliency and heat dissipation and less suitable for such products as heavy duty tires.

In the late 1950's the relative security of natural rubber in the first zone of the market was undermined by the commercial development of a new group of synthetics, the stereo regular synthetics, with properties almost identical to natural rubber. They are called the chemical analogue of natural rubber since they can be completely substituted for natural rubber in almost all of the uses in the first zone of the market.

The future demand and price of natural rubber will depend upon the interaction of many factors, such as the level of world industrial activity and the supply of natural rubber placed on the market, with the prospects of large producers such as Indonesia being very unclear. Nevertheless, the most important consideration in the long run will be the relative costs of production of natural and the synthetic rubbers and this will be briefly examined here.

The manufacture of synthetic rubber, such as SBR, consists of a chemical process to bring about the copolymerisation of raw materials, the basic monomers, which may be obtained from various raw materials and diverse processes. This raw material cost accounts for about half of the production cost and critically determines the market price of the final product. There are significant economies of scale in the production of the general purpose synthetic rubbers whereas the optimum scale of a rubber plantation is quite small. The capacity of an average size synthetic rubber plant is about half of Thailand's total annual production. Manufacturing plants much below this size suffer significant diseconomies of scale. Expansion of synthetic capacity, therefore, occurs in large discontinuous steps and when capacity is installed manufacturers attempt to continue operations to cover their high fixed costs.

Although the market for rubbers is highly differentiated, natural rubber's primary competition comes from the other general purpose rubber, SBR, and the new stereo regular rubbers. Firstly concerning SBR, the list price of SBR remained constant from 1953 to 1965. The high and fluctuating price of natural rubber encouraged shifting to SBR where technically feasible and this switch is not easily reversible. The high price differential between natural rubber and SBR has brought only temporary gains to Thailand. The longer term effect has been to accelerate the shift away from natural rubber and the construction of more synthetic capacity. Higher prices of natural rubber encouraged successive quality improvements in SBR and factory investment in equipment for processing synthetics. Natural rubber price fluctuations have tended to decline because SBR supply can be expanded in the short run by more intensive use of capacity or, in a period of several years, by the construction of new plants. Thus, in order to maintain its relative position in this market the prices of natural rubber will be affected by the price and the costs of producing SBR, which in turn depends primarily upon the costs of its constituent monomers. The primary monomer in the past has been produced directly for this use but technical developments now permit adjusting the petro-chemical production stream to derive it as a byproduct of other petroleum products. This can be expected to reduce the cost of SBR and to create a continued downward pressure on natural rubber prices.

In contrast the prices of the stereo regulars are higher and dependent upon the direct costs of producing the special monomer used for this process. Since the stereo regulars are the chemical analogue of natural rubber, their price and production costs will exercise the major effect upon natural rubber's prices and share of the market. The potential for cost improvements consists of further realization of economies of scale in production, in the short run, and the possible derivation of the monomer as a byproduct rather than a major product. Although there is no immediate expectation that the latter is possible, continued research may lead to a break-through which could significantly reduce costs.

The natural rubber officials in Malaysia feel that planning for the 1970's should be based on the assumption that price levels will fluctuate around or below the present level of 50 Singapore cents per pound, although

market imbalances may cause the sort of temporary price rise experienced last year. If a technical break-through in stereo regular production occurs, prices may be lower in the following decade, when today's Thai replantings will reach their maximum yields. The natural rubber industry of Malaysia feels that it can produce profitably at a Singapore price of 40 cents and our analysis shows that Thai replantings would be profitable at that level. Without replanting, which is the major factor in improving productivity, the returns would be so low at that price level that the standard of living would decline seriously, hired tappers could not be found and many village plantations would have to be cleared to plant other crops.

The South has the highest per capita rural income in the country but it was the only region of the country with falling income per capita during the period for which regional data are available. Rubber is the principal cause of both the high level of living and the decline, which was arrested by the high prices last year. The main economic problem for the South is the choice of an appropriate policy for the rubber industry. Alternatives to rubber would mean some immediate reduction in the standard of living. Until more attractive alternatives can be identified, rubber appears to be the most profitable activity even at the low prices expected in the 1970's and 1980's—but only on the condition that replanting can be widely implemented.

The South may well heed the slogan which was common in Malaysia over a decade ago—"Replant or Die".

