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Southeast Asia

*The market for tree crop technology:
a Sumatran case*

Colin Barlow

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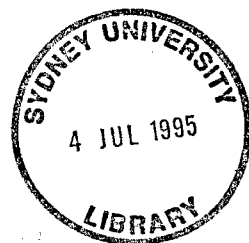
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- n.a. Not applicable
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Colin Barlow is a senior fellow in the Economics Department of the Research School of Pacific and Asian Studies, The Australian National University. He has studied regional economic development for many years. Since 1992 he has been working in the outer-island Indonesia region.

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*a*bstract

Small farmers have often been slow to adopt new high-yielding tree crop varieties, owing partly to plentiful land and the persistent profitability of land-intensive low-yield techniques. This has been true in many contexts, including that of the huge Indonesian smallholder rubber sector where most trees are still traditional varieties. But now as land frontiers are being reached, investment in high-yielding trees is becoming more desirable. It is usually constrained, however, by scarce information and capital.

A recent case of small private Indonesian nurseries supplying improved trees to rubber farmers through an appropriate marketing network was examined in a 1990–93 study. The factors underlying this successful, dynamic, and private-profit driven process of change are examined, including the economic elements impinging on those involved. Government policies which might further encourage such change are scrutinised, with special focus on how to provide greater technical and other information to the persons concerned.

the market for new tree crop technology: a Sumatran case

Introduction

New technologies have been vital in the economic growth of agriculture, especially as land has become more expensive, encouraging farmers to raise productivities per hectare. Many technologies have been generated during this century, induced by changing relative prices of outputs and costs of resources.

But while shelves of new technologies have been generated, frequently they have been partly unused. This is attributable to market failure and to scale diseconomies of small farmers who have found it costly to marshal necessary resources and handle what are often lumpy inputs. In addition, and as part of market failure, certain observers have alleged that small farmers are unresponsive to profitable opportunities arising from new technology adoption; this criticism is underpinned by perceived scarcities of local entrepreneurs who could bring technologies to the attention of those around them.

Such difficulties are severe for tree crop technologies, which usually require more information and greater capital inputs. Also, long gestation periods of at least several years before the first harvest mean heightened uncertainty and greater subjective discount rates. Because of these drawbacks governments have frequently set up extension and credit services to make more technologies available to farmers, and to bridge apparent social-private divergences.

These problems have tended to decrease with economic development, and even with tree crops some private entrepreneurs are now successfully selling new technologies to small farmers. This paper studies one such case involving high-yielding rubber on the island of Sumatra in Indonesia, and aims to elucidate the factors encouraging the development. The paper also discusses what limited government interventions might

assist this private profit-driven process of change. The fieldwork was undertaken in 1990–93 and will be reported at length in a monograph (Barlow et al. forthcoming).

Sumatran rubber

Rubber or *Hevea brasiliensis* is the most extensive tree crop in Sumatra. It provides full-time employment to over one million persons, and is chiefly grown by smallholders with planted areas of 2–3 ha per farm. In 1990 to 1993 most smallholders were still using traditional 'unselected seedling' rubber introduced early this century, and depending on the intensity of land use, secure poor yields of around 450 kg per tapped ha.¹ Such cultivation is part of a swidden or shifting cultivation system, where rubber trees are planted together with upland rice and other food crops directly after clearing jungle or old rubber. Following one to two years of food cropping, nutrients are exhausted and the areas are abandoned until rubber trees grow to maturity.

Typical smallholding yields are about one-third of those usually obtained by estates (commercially operated plantations, sometimes extending to thousands of hectares), which also grow rubber in some districts. These enterprises exclusively use high-yielding 'budgrafts', and are characterised by scale economies entailing good access to information and capital and high levels of skill.² The first rubber budgrafts, which were developed at Bogor in Java in 1916, were widely planted by estates within 10–20 years (Dijkman 1951). But now, almost 80 years later, only 16 per cent of smallholders have adopted these and other high-yielding trees, largely through capital and management-intensive programs run by the Indonesian government in selected places (Direktorat Jenderal Perkebunan 1992a and b).

One reason for smallholders' use of traditional techniques has been a continuing availability in most locations of free or very cheap land. Planting under extensive traditional rubber systems involving large land areas and low labour inputs per hectare, gave high expected financial rates of returns and labour incomes (Table 1: Strategy 1). Expected returns are those anticipated by smallholders, based on information available to them. An additional aspect of the Strategy 1 situation was the substantial economic attraction of securing cultivation rights over land very likely to rise in value by planting rubber trees (Sumana et al. 1991).

- 1 Unselected seedlings are grown by planting seed from traditional unimproved stands. Sometimes farmers exercise a measure of selection by only taking the seed of better yielding trees. Selected seedlings are improved seedlings obtained by planting seed of special mother trees. Their yields are generally lower than those of budgrafts, but they are more robust. They are normally marketed as seedling stumps.
- 2 Budgrafts are clones derived through grafting a bud from an improved tree on to a selected rootstock. They commonly give two to three times the yield of traditional unselected seedlings. They are usually marketed as budded stumps.

Table 1 Expected financial rates of return and labour incomes^a from four rubber smallholder planting strategies, remoter rubber-growing areas of Sumatra, 1990/91

Strategies ^b	FRR	Labour income
(1) Extensive traditional cultivation with unselected seedlings. Free land	26 per cent (falling to 3 per cent if land values increase from Rp 0 to Rp 350,000 ^c per ha)	Rp 4,562 per person-day
(2) Intensive traditional cultivation with unselected seedlings. Land price Rp 350,000 ^b per ha	18 per cent	Rp 3,603 per person-day
(3) Improved cultivation with selected seedlings. Land price Rp. 350,000 per ha	(on incremental changes over Strategy 2) 25 per cent	Rp 3,905 per person-day
(4) Improved cultivation with budgrafts. Land at Rp 350,000 per ha	(on incremental changes over Strategy 2) 25 per cent	Rp 4,181 per person-day

^a (Gross revenues per year during tapping) - (non-labour inputs during tapping) + (person days on tapping and associated activities)

^b The calculated returns assume the following:

1991 prices of Rp 350,000 per ha for land (annual Rp 70,000 per ha at 20 per cent opportunity cost of capital) (except for Strategy 1), Rp 3,000 per day for labour (mixed male and female), Rp 210 per kg for fertiliser, Rp 1,050 per kg for rubber output (at farm gate), Rp 0 per unselected seedling, Rp 60 per selected seedling, and Rp 238 per budgraft.

A planting density for trees in all strategies of 600 per ha, with 10 years to first tapping for unselected and selected seedlings and 8 years for budgrafts.

For Strategy 2. Land clearing inputs for rubber of 22 person-days per ha (1/6 of total clearing inputs which also pertain to other crops) and rubber tree planting inputs of 11 person-days per ha. Tapping and associated inputs of 115 person days per ha per year for 18 years of tapping, and a yield of 468 kg per ha.

Compared with Strategy 2, Strategy 1 has 60 per cent clearing and planting inputs, 50 per cent tapping inputs, and 55 per cent yield (giving 257 kg per ha). Strategy 3 has the same clearing inputs, 200 per cent planting inputs, 120 per cent tapping inputs, and 126 per cent of the yield (giving 590 kg per ha). Strategy 4 has the same clearing inputs, 200 per cent planting inputs, 125 per cent planting inputs, and 150 per cent of the yield (giving 796 kg per ha). Strategy 4 also has applications of 50 kg fertiliser per ha per year throughout immaturity and maturity.

All these assumptions are drawn from detailed field survey data, and commensurate clearing and tapping tool expenses are also included.

^c 2,000 Indonesian rupiah are taken to equal 1.00 US dollar throughout these tables.

But today with rising populations and increasing economic activities, land frontiers have often been reached, making land higher priced and giving lower returns even from traditional cultivation that has become much more labour-intensive (Table 1: Strategy 2). Investment in improved cultivation through planting selected seedlings and budgrafts on such land, however, has appeared profitable for a subset of progressive farmers who were defined in the study as those who were actually purchasing (or had recently purchased) improved materials. At 1990–91 output prices, expected yields, and

expected costs of necessary inputs, the financial rates of return from planting high-yielding materials were 25 per cent (Table 1: Strategies 3 and 4). These calculations presume more knowledge than is generally available to all but the minority of progressive operators, meaning that only these few currently want to plant improved rubber. This aspect is explored later in the paper.

For most smallholders in rubber-growing areas, *Hevea* is the chief available cash-earning opportunity barring migration; most alternative ventures are limited for soil and climatic reasons. The active expansion of small Chinese estates into high-yielding rubber growing in smallholding areas (where local authorities permit it) is another sign of that crop's profitability in such places.

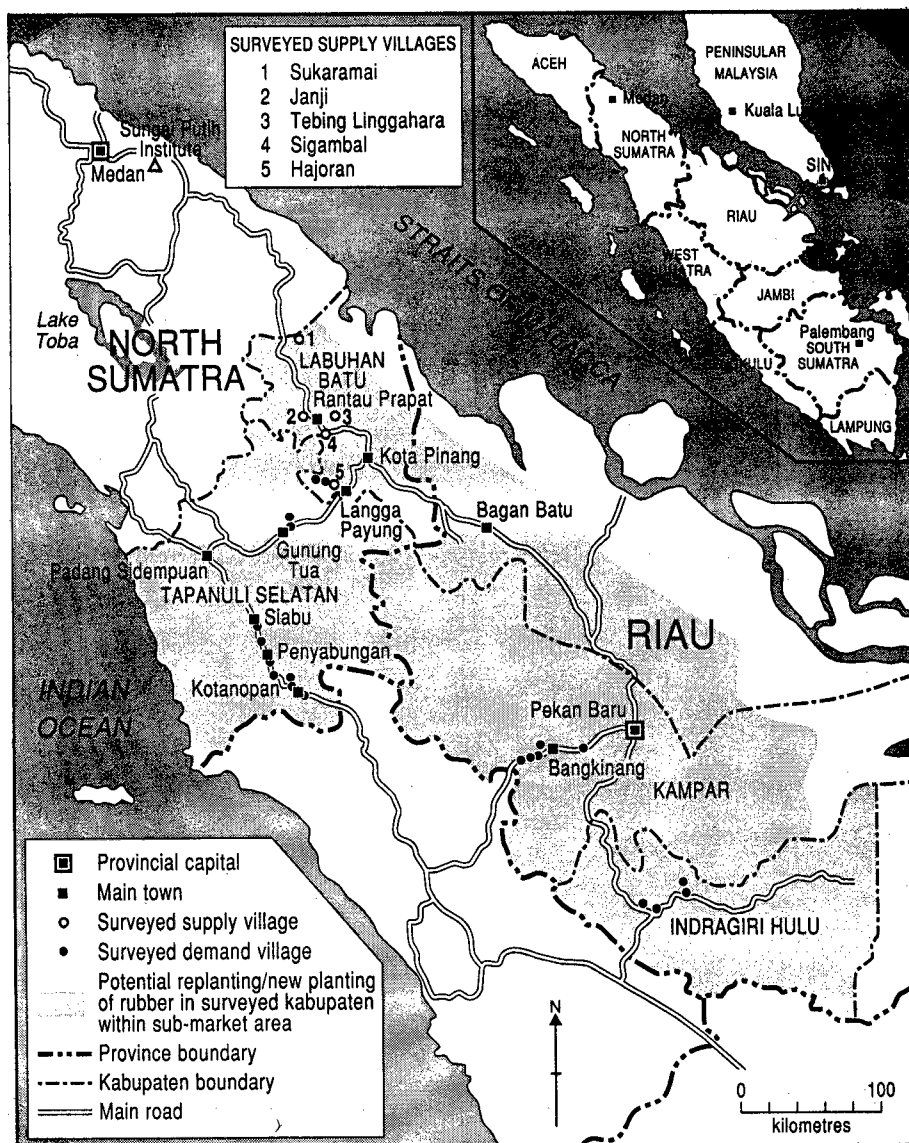
The selected planting materials submarket

A portion only of the private market for planting materials in Sumatra was chosen for the study. This submarket, which was largely self-contained in the sense that most transactions occurred within the selected region, was located in the districts [*kabupaten*] of Labuhan Batu and Tapanuli Selatan in North Sumatra province, and the districts of Kampar and Indragiri Hulu in Riau (Figure 1).

Basically the submarket comprised private suppliers or planting materials production nurseries situated in Labuhan Batu, traders who marketed these materials, and the consumers who were farmers producing rubber. The consumers were estates which were mainly in Labuhan Batu, smallholders in that same district, and far more remotely situated smallholders in Tapanuli Selatan, Kampar and Indragiri Hulu. The smallholders in Labuhan Batu normally purchased their materials direct from production nurseries without involving intermediate traders. The rubber planting materials submarket in North Sumatra and Riau operated for about four months from October to January. This was the time when materials become ready for sale, and when because of rain, land was suitable for planting rubber.

The procedure of the study was to conduct an in-depth survey of small samples of nursery producers, traders and smallholder consumers. While estates were important, they were enumerated more broadly. This was because the chief purpose of the work was to discover how good quality private planting material supplies to smallholdings could be enhanced. The locations of five surveyed supply villages containing sampled nursery producers, and of 25 surveyed demand villages in the areas of smallholder consumers, are shown in Figure 1. The focus of the smallholder sample was the progressive farmers who took the lead in adopting new technologies, since understanding their motivations was judged the key to encouraging others to do likewise. But some typical (meaning non-progressive) smallholders were also investigated.

Figure 1 The kabupatens, main towns and surveyed supply and demand villages of the chosen planting materials sub-market



Labuhan Batu was the most advanced of the four districts. Here there were many rubber and oil palm estates as well as smallholdings, with better infrastructures than in the other districts. This was reflected in its greater economic product (Kantor Statistik Sumatera Utara 1992; Kantor Statistik Riau 1992) and much higher land prices. Following a recent upgrading, all main roads from Labuhan Batu to other districts within the submarket were good, and there was comparatively easy access of traders to both estates and the market towns serving smallholder customers. The other three districts of the submarket were less developed than Labuhan Batu, with smallholder rubber production being one of the biggest economic activities.

The extent of rubber estates in Labuhan Batu was some 80,000 ha, but estates were a relatively minor factor elsewhere (Table 2). Not only were estates producing superior yields in Labuhan Batu, but smallholder productivity was also greater than in the other districts (Table 2).

Table 2 Estate and smallholding rubber areas and production in North Sumatra and Riau, 1987-89^a

Provinces and districts	Total ('000 ha)	Area Immature (per cent)	Tapped (per cent)	Output ('000t)	Yield (kg/ha) ^b
North Sumatra					
Estates—whole province ^c	107.4	14	86 (-) ^d	119.8	1305
Smallholdings					
whole province	307.6	17	72 (11)	128.9	579
Labuhan Batu	80.5	27	70 (3)	80.5	583
Tapanuli Selatan	86.1	9	80 (11)	34.7	502
Riau					
Estates—whole province ^c	9.9	85	15 (-)	2.3	1514
Smallholdings					
whole province	320.6	19	60 (21)	86.9	455
Kampar	88.8	29	52 (19)	19.5	420
Indragiri Hulu	89.7	19	59 (22)	25.6	481

^a Estate figures for 1989, and smallholding figures for 1987.

^b Per tapped hectare.

^c Estate figures available for whole province only.

^d Figures in parentheses are percentage of total planted rubber area exhausted.

Suppliers

Total nursery areas were large in Sukaramai and Janji, but smaller elsewhere (Table 3). Individual nurseries were small, and except at Hajoran, below 0.5 ha. Although Janji, Sigambal, and Tebing Linggahara were close to the busy district capital of Rantau Prapat, Sukaramai and Hajoran were more isolated (Figure 1). There were no private nurseries in other districts of the submarket, although in compensation these contained 15 large government-run nurseries, each comprising several hectares. The private nurseries were nonetheless the dominant suppliers, producing 72 per cent of all improved planting materials in the submarket in 1990/91. Seventy-five per cent of private nursery output was budded stumps, with the balance mostly selected seedlings (Table 3). Two-thirds of the planting materials consumed went to estates, which used budded stumps almost exclusively (Table 4). The balance went to smallholdings taking a majority of selected seedlings.

The villages producing planting materials in Labuhan Batu were almost exclusively inhabited by Javanese descendants of persons imported to North Sumatra earlier this century to work on what were then largely Dutch estates (Thee 1977; Stoler 1985). These people are a minority of the regional population, living amongst a huge preponderance of native Sumatrans.

Table 3 Details of private nurseries producing rubber planting materials in Labuhan Batu

	Production					
	Area (ha)	No. of operations	Total (‘000 plants)	Polybags (per cent)	Budded stumps (per cent)	Selected seedlings (per cent)
Five surveyed villages						
Sukaramai	117.7	370 (0.32) ^a	7356	-	75	25
Janji	58.6	136 (0.43)	3654	5	73	20
Tebing Linggahara	3.0	19 (0.16)	228	-	70	30
Sigambal	12.3	39 (0.32)	125	40	58	92
Hajoran	17.5	24 (0.73)	173	-	92	8
Sub total	209.2	588 (0.36)	11546	2	75	23
Thirteen other villages						
Sub total	12.4	134 (0.10)	997	1	86	13
Total	221.6	722 (0.31)	12543	2	76	22

^a Figures in parentheses are average areas per nursery.

Table 4 Amounts and kinds of rubber planting materials going to estates and smallholdings from Labuhan Batu private nurseries, 1990/91

	Annual total (‘000 items)	Percentage of		
		Polybags	Budded stumps	Selected seedlings
Estates	8,354	1	99	-
Smallholdings	4,189	1	33	66
Total	12,543	1	77	22

The 41 sampled nursery producers displayed a characteristically wide range of smallholder economic activities, with the only marked specialisation in rubber nurseries being at Sukaramai (Table 5). Nurseries there accounted for over half of total gross returns in 1990/91, and enabled a much higher average income level than elsewhere. In other villages nurseries only contributed 16–28 per cent of gross returns. The overall average total gross returns of Rp. 3,136,000 (US\$1,568) for sampled producer nurseries were 30 per cent above that of typical rubber smallholders. Even after subtracting reasonable costs two to three times the Indonesian 1990 rural household poverty line, their disposable income was Rp 781,746 (US\$391) per year for an average family size of 4.9 persons.³

The average farm-gate planting material prices paid to Sukaramai nursery producers located far from markets are low, the high rates paid at Hajoran reflect its closeness to demanding farmers (Figure 1; Table 5). These prices were those paid by smallholder customers only—prices paid by estates in contracts entailing special quality specifications were sometimes considerably higher, but the details on private contracts could not be obtained.

The average costs of purchased inputs and land, including all kinds of planting materials, were especially high at Sukaramai and Janji which had better quality outputs, and low at Hajoran with its high proportion in output of less input-intensive selected seedlings (Table 5).

Although the data collected were not comprehensive, good returns to labour and management were earned by most nursery producers. This underpinned the dynamic expansion in planting material production in the late 1980s and early 1990s.

3 The Indonesian rural poverty line in 1990 was defined as a disposable income of Rp 13,295 (US\$ 6.64) per person per month (Biro Pusat Statistik 1992).

Table 5 Major features^a of sampled nursery producers in surveyed villages, Labuhan Batu, 1990-91

Features	Sukaramai (13) ^c	Janji (7)	Linggahara (8)	Tebing Sigambal (5)	Hajoran (8)	All ^b (41)
Personal						
Age (years)	34.2	45.7	45.3	50.0	45.6	44.2
Education (years)	6.2	4.7	2.6	2.8	6.3	4.5
Persons per family	5.1	5.6	4.4	5.0	4.5	4.9
Total land use (ha/producer household)	2.3[0.4] ^d	2.3[0.2]	2.5[0.2]	1.4[0.2]	1.4[0.1]	2.0[0.2]
Annual gross returns ^e (Rp '000/producer household)	4,663	2,880	2,426	3,417	2,296	3,136
	(\$US2332)	(US\$1440)	(\$US1213)	(US\$1708)	(US\$1148)	(US\$1568)
(percentage from each source)						
Rubber nursery	55	24	27	16	28	33
Rubber plantation	23	35	33	35	11	28
Labouring work	4	20	21	8	30	14
Trading						
Rubber planting materials	6	1	4	-	-	3
Other	5	9	-	-	28	7
Oil palm plantation	-	-	-	14	-	3
Irrigated rice cultivation	5	1	5	-	-	2
Government employment	-	-	-	5	-	1
Oil palm nursery	1	-	-	-	-	-
Other	-	10	10	22	3	9
Total	100	100	100	100	100	100
Prices and costs of planting materials (Rp/plant)						
Budded stump prices ^f	93.5	120.8	113.6	115.0	165.6	121.7
Selected seedling price ^f	11.0	27.0	27.5	22.5	45.0	28.6
Purchased input cost ^g	42.5	41.8	36.6	32.6	9.5	28.3
Land costs ^h	10.5	8.9	12.8	9.7	1.4	8.7

^a Averages within each category.^b Unweighed means of individual village figures.^c Figures in parentheses are numbers of producer nurseries sampled in particular village.^d Figures in brackets are mean areas of sampled nurseries.^e Gross returns before deduction of costs.^f For materials sold to smallholders at the 'nursery gate'.^g Averages for all categories of material.^h 20 per cent interest per year on land values of Rp 2,500,000/ha for Sukaramai, Janji, and Sigambal, Rp 2,000,000/ha for Tebing Linggahara, and Rp 730,000/ha for Hajoran.

Other economic features

While output from Labuhan Batu nurseries was by 1991 sufficient to plant the large area of 20,000 ha per year, such capacity was relatively new. The response of private nursery producers to profitable opportunities took years to grow from modest beginnings in the 1950s, and only saw substantial increases from the 1980s. This growth can be ascribed to significant improvements in rural roads, to widening availability of efficient low-cost transport, to spreading knowledge about new technologies following improved education from the 1970s, and to activities of local entrepreneurs. It was also vastly encouraged by a key demand factor, the entry of estates to the private nursery planting materials market.

The response which occurred was also facilitated by the inherent flexibility of rubber planting materials production, whose broad technology comprised a wide array of subsidiary techniques each embodying varying quality outputs from differing land, labour, material, and management mixes. Hence techniques ranged from making high quality polybags from labour, material, and management-intensive methods to producing low quality and land-intensive selected seedlings.⁴ There were also subsidiary methods within each class of output (Barlow et al. forthcoming). The outputs from these techniques were variously priced in a competitive market, with wide quality differentials around the averages shown in Table 5, and with higher-quality materials generally going to estates and those of lower quality going to smallholdings. Such technological flexibility not only permitted appropriate economic responses to consumer needs, but also made it easier for producers to move upwards gradually through an array of techniques which they learned by doing. The quality level reached was most advanced at Sukaramai and Janji, and was assisted there by both economies of scale and technology spread effects from meeting large high-quality estate contracts.

While some analysts might expect money from local capital markets to have financed these profitable opportunities, the survey showed that this rarely occurred. Like most small Indonesian agricultural producers, small nursery operators paid for expansions through personal savings, with good proceeds in successive years enabling expanded activity. As in other instances this was due to the absence of an active short-term capital market and the consequent high price of borrowing.

This flexible response to demand by private nurseries compared dramatically with the supply-side determined and essentially one output response of government rubber nurseries in submarket districts outside Labuhan Batu. There it was usual to produce only one medium quality of budded stumps, with the goal of giving smallholder

4 Polybags are budgrafts established in polybags, and hence less susceptible to planting problems. They are very expensive to produce, and mostly used only to replace dead trees.

producers the means of moving to a higher technological level at one go. Unfortunately, such materials were not often purchased by the smallholders for whom they were intended, partly because they were more expensive than private nursery plants, having a high farm-gate price and the time-consuming buying procedures not incurred with private suppliers. A further factor was the perception by many smallholders that using budded stumps would subsequently involve them in more cash and input-intensive cultivation than they could afford.

One interesting aspect of the private nursery growth observed in the study was its progressive outward expansion, through linkages from existing nodes. By the early 1990s nursery production had begun to extend outwards from Sukaramai and other early villages to new sites with less costly land; this spread was underpinned by members of nursery households moving to these other places, taking skills and market connections with them.

Traders

The trading network for planting materials linked private nurseries in Labuhan Batu with growers throughout the submarket and beyond (Figure 1). The network was similar to that in other Indonesian agricultural markets, and at first and second levels resembled the vegetable and cash crop arrangements analysed by Hayami and Kawagoe (1993). It basically comprised first or village-level collectors linked to and financed by second-level dealers, who either sold direct to estates or smallholdings or worked through third-level retailers (Table 6; Figure 2). The latter operated in periodic town markets in regions of demand. Most traders had other activities, and their scope of operations in rubber planting materials varied considerably.

The key position in this structure was that of second-level dealers, who reached out and negotiated contracts with estates and development schemes, financed at zero interest rates the assembly of planting materials by collectors, and often organised nursery operators to establish appropriate planting materials production techniques to meet consumer needs (Table 6). They further arranged transportation, passing some materials directly to estates and combining all this activity with the carriage of other produce. Certain big dealers purchased materials from several nursery villages, and also specialised in particular estate or smallholding markets and types of material. Sukaramai and Janji with their many producers were generally less costly for dealers to trade with, in what were commonly months of preparation and supervision.

The planting materials marketing structure varied considerably between situations, so that at Sukaramai there were two groups of four collectors, each trading with all of the second-level dealers. Elsewhere each collector group usually traded with the same

Table 6 Types of planting material traders

Collectors (first-level traders)

Village agents who collect planting materials from supplying nurseries on commission, normally for particular second-level dealers but sometimes for demanding smallholders. Main occupations as smallholders, tappers, or petty traders. Generally handle from a few thousand to 30,000 plants per week, although some manage larger amounts.

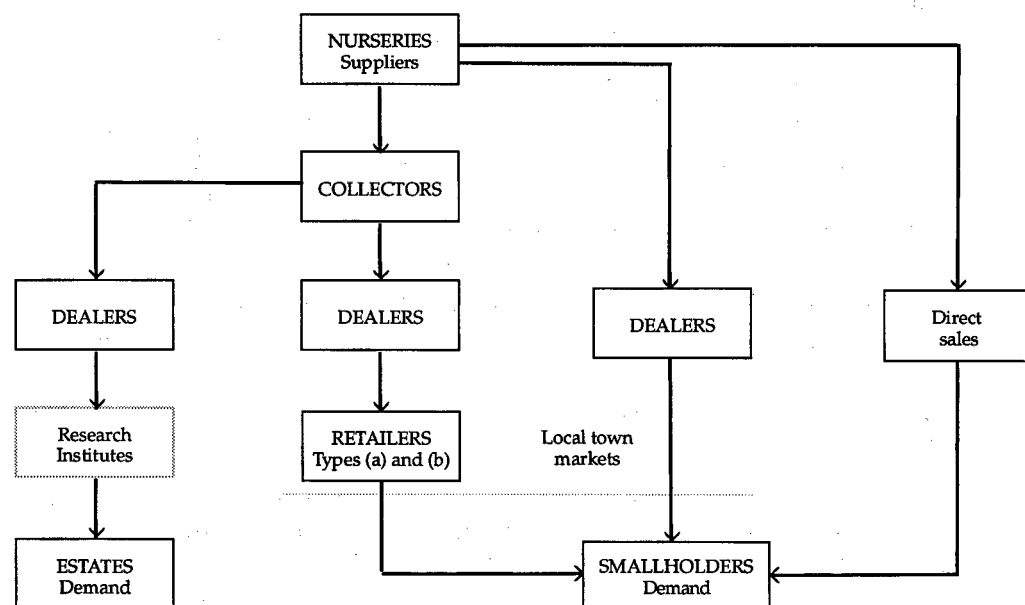
Dealers (second-level traders)

Inter-district traders who usually secure planting materials from collectors, although some small operators buy direct from nurseries. They then sell materials either direct to estates or through third-level retailers in town markets to smallholders. Other occupations as fruit and vegetable traders and smallholders. Handle 5,000 to 100,000 plants per week, although some manage more than this.

Retailers (third-level traders)

- (a) Traders who work in a series of local town markets, ordinarily in conjunction with particular inter-district traders, for whom they sell on commission. Main occupation as petty traders. Handle 500 to 1,000 plants per week.
- (b) Traders who work in a series of local town markets, buying planting materials from second-level traders and reselling them at a margin. Main occupation as petty traders. Handle up to 5,000 plants per week.

Figure 2 The planting materials marketing channels



dealer or dealers. The latter were in fact active rural entrepreneurs, whose vital political role in negotiating contracts and organising surrounding society was seen by Lin (1989:20) as fundamental to effective market mediation, in the sense of ending market failures and internalising externalities.

Dealers who earned the highest gross incomes had activities which involved rubber plantations and 'other trading' as the main contributors apart from trade in rubber planting materials. The other activities were especially significant during the eight months each year when planting materials markets were quiescent. There was a wide range of incomes within the sampled dealer group, with the top three members earning almost twice the average (Table 7). These three also had longer average educations of around 10 years, reflecting previous backgrounds as teachers, public servants, and agricultural advisory officers; such features helped them greatly in gathering and disseminating information to promote what at the high end of the planting materials spectrum was quite a sophisticated technology.

Collectors came second in gross incomes, earning substantial returns from rubber nurseries and plantations as well as trading (Table 7). That both dealers and collectors had relatively few years of experience, reflected a dynamic situation, where traders' exposures to particular roles were brief as they then moved to more profitable trading ventures. Several sampled collectors were in transition to becoming dealers, while at least one of the latter was about to drop out and move to non-rubber trading operations.

The sampled retailers appeared to largely depend on rubber planting materials trading, although it is surprising that other trading was so insignificant for these petty agents (Table 7). It should be mentioned that these retailers sometimes offered short-term credit to smallholders buying planting materials in town markets, charging no interest but expecting principal repayments within a few months. This was presumably an effective marketing tool under circumstances of little information about new varieties, and shortages of cash on the part of potential end buyers. Repayments were often aided by the fact that retailers, though not apparently those sampled, often dealt in other commodities with the same customers and thus had a hold over them.

Smallholder consumer prices showed wide ranges for given kinds of material depending on locations of sale, quantity, and quality (Table 8). Market shares of smallholder materials from private nurseries also showed big differences between districts. The advanced smallholders of Labuhan Batu mainly demanded budgrafts, while selected seedlings were more popular in Tapanuli Selatan and dominant in Kampar and Indragiri Hulu. Some unselected seedlings were sold in these latter districts, but they did not come from the sampled nurseries.

Estimated margins for budgrafts and selected seedlings in smallholder trade, the differences between gross returns and marketing costs, were calculated for the trading

Table 7 Major features^a of sampled traders, 1990-91

Features	Collectors (9)	Dealers (7)	Retailers (4)	All ^b (20)
Age (years)	42.4	40.1	36.0	39.5
Experience as traders	5.2	4.0	10.0	6.4
Education (years)	6.5	7.3	6.8	6.9
Persons per family	6.5	5.3	5.0	5.6
Gross returns ^c (Rp '000 per household) (Per cent from each source)	4,443 (US\$2,221)	5,041 (US\$2,521)	3,905 (US\$1,953)	4,463 (US\$2,232)
Rubber nursery	23	4	-	9
Rubber plantation	22	22	8	17
Trading				
Rubber planting materials	36	28	77	47
Oil palm planting materials	1	-	-	-
Other	-	37	3	14
Irrigated rice cultivation	3	2	5	3
Official employment	7	-	-	3
Other activities	6	5	1	4
Other family income	2	2	6	3
Total	100	100	100	100

^a Averages within each category.^b Unweighted means of figures for 3 types.^c Gross returns before deduction of costs.

channel involving collectors, dealers, and type (b) retailers (Table 9). The calculations were based on careful scrutinies of costs, and are judged to provide a good picture of the average situation. The margins, or the returns to entrepreneurship, were very low.

The study revealed an effective planting materials marketing structure, based on a loose organisation of village-based collectors and town-based dealers and retailers. Within this structure, village-level collectors with lower labour costs undertook the labour-intensive work of first level collection, while second-level dealers provided credit as well as entrepreneurial impetus for the whole operation. A few well-educated dealers dominated this group. With larger operations, this group secured scale economies in transportation and credit together with gains from specialisation in particular markets. Retailers operating in town markets were basically dependent on second-level dealers, albeit without credit links.

Table 8 Smallholder consumer price ranges and market shares for planting materials, districts of the sub-market, 1991 (Rp per plant)

Kinds of material ^a	North Sumatra		Riau		Whole sub-market
	Labuhan Batu	Tapanuli Selatan	Kampar	Indragiri Hulu	
Polybags ^b	550 (neg) ^{cd}	700 (neg)	500 (neg)	n.a.	500-700 (neg)
Budded stumps					
From private nurseries	150-200 (90)	175-300 (30)	175-300 (2)	17-250 (6)	1-300 (32)
From government nurseries	-	-	282	282	282
Selected seedlings	25-50 (10)	60-70 (50)	40-80 (95)	50-80 (90)	25-80 (61)
Unselected seedlings ^e	-	20-50 (20)	7-15 (3)	10-15 (4)	7-50 (7)

^a Prices are for materials from private nurseries, unless otherwise indicated.

^b Single prices only secured for this rarely sold grade.

^c 'Neg' = negligible.

^d Figures in parentheses are estimated percents particular materials form of all private nursery smallholder nursery materials sold in the districts. These estimates were made following on-the-spot observation of conditions and wide consultation with traders and others involved. The per cents in the whole sub-market columns are weighted averages for all districts.

Table 9 Mean gross returns, marketing costs and marketing margins^a of sampled traders in smallholder trade, 1990-91 (Rp. per plant).

Kind of material	Gross returns ^b	Collectors' costs			Dealers' costs				Retailer labour ^f	Planting material losses ^{fh}	Total marketing cost	Marketing margin ⁱ
		Buying ^c	Handling and transport ^d	Comm- issioned	Labor ^e	Onward transport	Working capital	Other ^g				
Budded stumps	156.1	131.4	0.9	5.0	3.0	4.2	0.7	1.3	4.5	2.8	153.8	2.3
Selected seedlings	53.9	31.7	0.7	5.0	3.0	4.1	0.7	0.4	4.5	2.8	52.9	1.0

^a Calculated in respect of the marketing channel passing through collectors, dealers, and type (b) retailers (Table 6).

^b Also the mean sale prices of plants at point of purchase by smallholder consumers.

^c Also the traders' purchase prices of plants at the nursery.

^d Hired labour and transport.

^e To point of sale by retailers.

^f These are overall average costs per plant, they were actually rather higher for budgrafts, and lower for selected seedlings.

^g Mainly government taxes and levies.

^h Total from purchase to sale.

ⁱ Gross returns less total marketing costs.

The data on marketing margins do not suggest excessive profits by traders, and reflected a situation of active submarket competition with no major barriers to entry. Several dealers operated in each centre, and while some trade was always between the same parties that could be attributed to familiarity which lowered transaction costs. Both suppliers and demanding farmers always had options of trading with other

parties, and sometimes took these up. This finding of an efficient, competitive market parallels that of Hayami and Kawagoe's (1993) vegetable study.

A last feature of traders meriting attention is that they were almost all ethnic Javanese; this identity, which did not apply to demanding smallholders, had important cost implications, including the reduction of uncertainty in consignment and credit arrangements.

Consumer farmers

The estates consuming the largest share of nursery planting materials had strong preferences for high quality budded stumps (Table 4). The estates planted under normal estate management techniques with complementary fertiliser and maintenance inputs and produced high yields of over 1,300 kg per hectare (Table 2). While early land costs for estates were almost as low as for smallholdings, the former even then followed much more capital and labour-intensive cultivation than smallholders. This was chiefly due to much lower unit costs of capital and high fixed costs of imported labour and management. Each succeeding vintage of estate plantings usually comprised further improved planting materials resulting from continuing rubber research.

Until recently most rubber estates either produced their own planting materials or purchased them from other estates. But in the 1980s it was seen that good quality trees could be produced more cheaply on small production nurseries, and the market grew quickly. Estate transactions normally involved large contracts negotiated through second-level dealers, with careful specifications for quality and other characteristics. Subcontracting to the nurseries with lower labour and management costs reduced total expenditures, and thus had strong economic justification. In turn the estate connections not only underpinned nursery expansions, but resulted in the transfer of information and skills to the operators concerned. That was especially seen in large-scale arrangements made with Sukaramai and Janji farmers.

The smallholders purchasing the balance of private nursery materials either did this direct or secured supplies from town markets (Table 4). For them the crucial condition of availability, stipulated by Griliches (1957:507) in his classic work on hybrid corn seed diffusion, was met. Rubber smallholders' demand for or acceptance of high yielding materials only occurred when they perceived it profitable to make changes (Griliches 1957:515). This began in the 1980s, when Strategies 3 and 4 (Table 1) appeared attractive to a small but growing minority of progressive individual cultivators. These people had adequate knowledge to justify expectations of higher profits, and even without long-term capital markets, were prepared to pursue planting through small purchases of plant materials over 2–3 months, whenever they had cash. Such materials were stored in water until stocks were sufficient to allow field establishment on the desired scale.

While progressive farmers led this trend, others followed as the former were seen to be likely to secure improved results.

It is interesting that most smallholders preferred selected seedlings (Table 4), which were both cheaper (Tables 5 and 8) and far more robust under prevailing rough conditions with low external inputs. When smallholders purchased budgrafts they usually chose the GT1 variety which was more reliable although less productive than the varieties preferred by estates. Smallholders also tended to buy relatively lower qualities within desired kinds of material, owing to cash constraints. All such smallholder behaviour appears rational, given their conditions. Supply nurseries adapted well to this demand, and made available selected seedlings and budgrafts of the qualities required.

Once selected seedlings or budgrafts had been adopted, a crucial move to a higher technology stratum had been made. The way was now open to move up further technology gradients, in a process of learning-by-doing and earning profits over and above the levels of Strategies 3 and 4 (Table 1). This process comprised progressively better tapping techniques, accompanied by higher maintenance and other inputs (Direktorat Jenderal Perkebunan 1991). But it was not possible to start this progression until the basic high-yielding materials had been adopted.

Differences between typical and progressive smallholders included different levels of diversification (Table 10). Typical smallholders only earned about one-third of their total average gross returns of Rp 2,386,000 (US\$1,193) from rubber planting, in a situation closely matching that of most smallholding rubber households as shown in census data (Biro Pusat Statistik 1987). In contrast, progressive farmers secured well over twice their typical colleagues' returns, with 60 per cent of their income coming from rubber plantations. The much better cash position of progressive farmers helps explain their lead in adopting improved materials. They had likewise attended courses run by government extension agencies, and this undoubtedly raised their knowledge levels about the specific aspects of materials (Table 10).

In 1990/91 the proportion of immature areas was larger than that of tapped, old or exhausted rubber areas for sampled smallholders. This fact reflects the active expansion of planting in the late 1980s. The immature portion usually comprised several differently aged parcels of 0.5–1.0 ha each, essentially the limit of a normal family's capacity to clear in one year.⁵ Each parcel comprised a different vintage of rubber trees, and those adopting improved materials could in theory gradually enhance their quality of planting. As might be expected, progressive farmers had much bigger average areas of rubber, and were better placed to experiment with successive vintages of improvements.

5 Clearing was estimated by Barlow and Muharminto (1982) to take 129 person-days per ha, to which was added a further 460 person-days for cultivating *padi* and other intercrops. This was extremely arduous work.

Table 10 Major features^a of sampled rubber smallholders, all four districts of the submarket, 1990-91

	Progressive (50) ^b	Typical (11) ^b
Personal		
Age (years)	41.5	38.5
Education (years)	7.0	6.6
Courses (days) ^c	9.8	0.6
Persons per family	4.4	4.4
Annual gross returns ^d (Rp '000/smallholder household)	5041	2386
(Percentage from each source)	(US\$2,521)	(US\$1,193)
Rubber plantation	61	34
Labouring work		
Rubber tapping	6	24
Other agriculture	-	2
Trading	7	10
Coconut plantation	-	5
Irrigated rice cultivation	3	8
Other cultivation	7	5
Other ^e	14	12
Total	100	100
Rubber land use (ha/smallholder household)		
Immature ^f	3.5	1.5
Tapped	2.3	0.6
Old	0.9	0.2
Total	6.7	2.3

^a Averages within each category.

^b Figures in parentheses are numbers of smallholders sampled in each instance. A much larger sample was taken of progressive smallholders, on whom the study of demanders was focused.

^c Days over 3 years to 1991.

^d Gross returns before deductions of costs.

^e Income from other household activities.

^f Period when young rubber trees are not yet large enough to tap.

Conclusions and policy

The growth of the submarket for improved planting materials from small private nurseries is a significant development for Indonesian smallholder rubber. It highlights potentials for profit-driven change, showing that agents will respond vigorously given appropriate economic opportunities. It and a similar development in South Sumatra (Gouyon et al. 1991) now hold out good possibilities for improving the vast small farms rubber sector of Indonesia. The foregoing analysis of the private nursery submarket has useful lessons for all tree crop planting material enhancement, in Indonesia and other similar countries.

- The chief enabling factors behind submarket development appear to have been
- infrastructure improvements including roads, education and research
- the flexible nature of the technology involved
- the vigorous response to new opportunities by local nursery suppliers
- the pressure of the estate market with its important demand
- the further response to opportunities by progressive demanding farmers.

Indeed, the latter's initial choice of robust basic materials which could be built on with knowledge and experience denoted perceptive economic rationale. This, as well as the subsequent spread of materials from progressive to surrounding farmers, has optimistic implications for the future.

It is helpful to compare the 1990s juncture of smallholder rubber development with that of Indonesian rice in the 1950s. Then Geertz (1963) looked at subsistence rice production in Java, and at the increasingly labour-intensive efforts of small farmers to raise yields under growing land constraints. He described this as 'involution' where 'peasants', supposedly unable to adopt modern technology, were trapped in conditions which would ultimately defeat them. But Booth (1988) showed that seemingly static involution was really a transition from extensive land-using rice cultivation to new technology and capital-intensive rice agriculture appearing since the 1970s. Hence whilst dire prognoses are sometimes also made about stagnation in smallholder rubber, that too now appears capable of progressing to modern production systems.

In looking to the future it is crucial consider positive ways in which government can further encourage this important development. Public road infrastructures have already contributed substantially to reducing trade risks and transaction costs, thus promoting new entry and competition in the market. Public research has generated relevant technologies. These public goods programs should be continued, but must be supplemented by more direct measures for improvement. The apparently simple

solution of allowing estates to expand onto smallholding areas is out of the question for political reasons. Any solution must entail the more equitable approach of basing improvements on the needs of individual smallholders.

One direct measure undertaken by government has been the capital and management-intensive official planting programs focused on restricted farmer groups. These have involved packages of high-yielding materials, capital, and qualified supervision, and have enabled such groups to secure much higher yields. While sometimes they have been economically successful, their spread effects have been small owing to lack of private funds to promote such capital-intensive packages. Although one solution would be comprehensive government extension of such packages throughout smallholder rubber areas, the funds necessary for this are not available. While the very expensive and universal official rice programs of the 1970s and 1980s certainly accelerated adoption of modern rice cultivation, the political support required does not exist for rubber. Indeed many rice programs were uneconomic (Ifzal 1987).

Practical measures

It is necessary to pinpoint less costly direct means of effecting smallholder improvement. One possibility is setting more nurseries to make available materials of good minimum quality to surrounding farmers: this could be usefully extended in places far from private nursery developments, with better adaptation than at present to smallholder demand.

A further positive measure would be removing current restrictions which have tried to ban private nursery development on grounds it produces inferior quality materials judged of no benefit to smallholders (Center for Policy and Implementation Studies 1993). This restriction has fortunately proved almost impossible to implement, although its provisions should still be eliminated.

In light of spontaneous private nursery growth, however, the most economically effective policy would attempt to accelerate this advance, and that of associated planting activity, by providing more technical information to those involved. These parties not only include nursery operators, but also progressive and other smallholders with little knowledge about new possibilities. It is suggested that this information spread be achieved by carefully targeted extension services working specifically with nurseries, and with smallholder groups in places of dynamic planting. The efforts with nurseries could include furnishing good planting material stock for multiplication in special 'mother' gardens, giving a better basis for improvement for a minimal investment than the current indifferent albeit improved materials. This has actually been done already in some places by the Indonesian Association of Private Rubber Traders and Processors, acting to secure the economic advantages that members

perceive they will reap from higher smallholding production (Center for Policy and Implementation Studies 1993).

Outer island Indonesia possesses a distinct global comparative advantage in natural rubber growing owing to low land and labour costs, but faces information and other constraints over diffusing new technologies (Barlow, Jayasuriya and Tan 1994). The development described here raises hopes that such constraints might be overcome. There are lessons here for smallholder tree crop development in many other contexts.

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