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Factors Associated with Non-adoption of Technology by Rubber Smallholders

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ABSTRAK

Penerimaanguna ataupun penolakan teknologi oleh pekebun kecil adalah satu proses membuat keputusan dan perubahan yang kompleks. Kajian ini mengandaikan bahawa maklumat adalah punca bagi memudahkan proses membuat keputusan dan perubahan dan seterusnya boleh membawa kepada penerimaanguna teknologi di kalangan pekebun-pekebun kecil. Untuk menentukan tahap penerimaanguna teknologi di kalangan pekebun kecil dan faktor-faktor yang berkaitan dengannya, kajian ini telah memilih sejumlah 787 pekebun kecil, ketua dan pemimpin masyarakat pekebun kecil dan pegawai-pegawai RISDA barisan hadapan di Semenanjung Malaysia. Kajian ini menggunakan teknik perbincangan kumpulan terfokus (focus group discussion) untuk mengumpulkan data. Secara keseluruhannya, tahap penerimaanguna teknologi di kalangan pekebun kecil getah adalah rendah. Ada beberapa faktor yang menyokong penemuan ini, antaranya adalah: sikap pekebun kecil terhadap teknologi baru, masalah kewangan, limitasi fizikal (kebun yang kecil dan kebun yang terpencil yang susah untuk dikunjungi), ketidaksuaian setengah teknologi bagi sektor pekebun kecil, pemilikan tanah dan perkhidmatan pengembangan dan sistem sokongan komunikasi yang lemah. Tidak terdapat satu faktor yang dominan, malahan semua faktor ini saling mempengaruhi penyaluran maklumat untuk memudahkan proses membuat keputusan dan perubahan di kalangan pekebun kecil bagi menerimaguna teknologi. Kekangan-kekangan yang dihadapi oleh pekebun-pekebun kecil merupakan satu rangkaian kuasa yang mempengaruhi secara negatif terhadap penerimaanguna amalan-amalan yang disyorkan. Maklumat dari penyelidikan pengembangan seharusnya meliputi aspek-aspek 'principle', 'bagaimana' di samping maklumat-maklumat 'lingkungan' dan pembangunan sumberdaya manusia. Maklumat dari pengembangan kepada pekebun kecil seharusnya memfokuskan kepada 'bagaimana' dan faedah-faedah yang boleh didapati dari menerimaguna sesuatu teknologi.

ABSTRACT

This study argues that information holds the key to decision-making and change processes, and hence technology adoption among smallholders. To determine the levels of technology adoption among smallholders and factors associated with it, a total of 787 smallholders, key informant smallholders and field officers from selected areas in Peninsular Malaysia were interviewed in groups using the focus group discussion technique. Generally, technology adoption level among rubber smallholders was relatively low. Several factors accounted for this finding, among them were: smallholders attitudes towards new technology, financial constraints, physical limitations (uneconomic holding size and accessibility of holdings), labour shortage, inappropriate technology, land ownership and weakness in extension service and communication support system. These factors were found not to act singly but in various combinations which compounded the problem of information flow decision making and change among smallholders in technology adoption. The constraints faced by the smallholders form negative forces that act against the adoption of recommended practices. Some of these barriers can be overcome or minimized with the provision and implementation of a systematic flow of information from research to extension and from extension to smallholders. Information from research to extension should cover 'principle', 'how-to' information, besides relevant circumferential and human resource development information. Information from extension to smallholders should focus mainly on 'how-to' and benefits to be accrued from adopting a technology.

INTRODUCTION

Adoption or rejection of a technology by clients is a complex process. It involves a dynamic decision-making process often influenced by deliberate plans or strategies made by change agents as well as the perceived positive or negative attributes of the technology. Adoption of a technology requires some form of structural, functional as well as behavioural changes on the part of the clients. These changes must not be perceived by clients to be disruptive but must harmonize with existing values and practices. More importantly, these changes must translate into practical ways of solving clients' problems and needs. In other words, adoption of a technology requires clients to change – a complex process but not an impossible goal to achieve, as long as there is a firm commitment from all parties concerned to ensure that the complex process of change happens smoothly and systematically.

On the other hand, rejection of a technology by clients involves a similar process of decision-making except that it may be suspended temporarily until a final decision is made; in such cases, adequate information on the technology is unavailable or more time is required to fully understand the technology and the implications of its adoption. In cases where clients fully understand the technology but decide not to adopt it, the technology may be perceived to have negative attributes or clients are not convinced that the technology will solve their problems and fulfil their needs; or they may perceive the technology to have a minimal effect on existing practice in terms of benefits to be accrued. Whatever their reasons for rejecting a technology, they follow a process of decision-making which Rogers and Shoemaker (1971) term "The Innovation-Decision Process". It is a mental process through which an individual passes from first knowledge of an innovation to a decision to adopt or reject and to a confirmation of this decision (Rogers and Shoemaker, 1971).

Assuming a technology reaches the client, adoption or rejection of the technology passes through two basic processes: (1) decision-making and (ii) change. Both processes are critical in technology adoption or rejection as they motivate individuals to act when they acquire *knowledge* about the need for change. The provision of knowledge and awareness and the stimulation of interest to change are usually done by change agents. Clients are persuaded and encouraged to evaluate the technology in the socio-cultural and economic context of their situation to ensure that the technology is more advantageous than the existing practice (*relative advantage*), *compatible* with the norms and values of society, easy to understand (*not complex*), easy to be tried out on a small scale (*triability*), and its performance is easy to be *observed* for comparison with existing technologies.[1]

Natural rubber production is a major industry in Malaysia, contributing 2.3% of Malaysia's total export value of primary commodities (Economic Report 1993/94). Rubber is produced both by the estate and smallholder sector. Although occupying 82% of the total planted area, production by the smallholder sector was very much less than that of the estate. For example, in 1992 the average yield per hectare for the smallholder sector was almost 30% less (Rubber Statistic Handbook, 1992). One of the factors associated with higher production by the estate was good agronomic and processing practices. A few studies had been carried out to determine the adoption rate of rubber technology by the smallholders (Sulaiman Yassin *et al*, 1985, Raja Badrul Shah *et al*, 1986a and 1986b). Although these investigations revealed that the technology adoption in the smallholder sector was generally low, specific constraining factors associated with technology adoption have not been examined in detail. This study was undertaken to fill that information gap.

Objectives of the Study

The general objective of the study was to determine the constraints faced by rubber smallholders in adopting a technology especially factors related to socio-cultural, economic, physical and technological attributes. Specifically, the study aimed to determine:

1. levels of technology adoption among smallholders; and
2. factors associated with technology adoption and rejection.

METHODOLOGY

Data for the study were collected from four main sources: (i) the smallholders; (ii) key informant smallholders and field officers; (iii) field observation; and (iv) office records.

The smallholders were grouped into three categories: (i) those having immature holdings (trees less than 7 years); (ii) those having mature holdings (trees 7 - 20 years); and (iii) those having old holdings (trees more than 20 years). The rationale for grouping the smallholders according to age was that some technologies were unique to each category. For example, deep planting technology was applicable to the immature holdings while opening tapping panels was applicable to mature holdings, and control upward tapping (cut) was applicable to old holdings.

Key informants were smallholder leaders and field officers. Smallholder leaders comprised progressive farmers, Village Development and Secu-

1. For a detailed discussion on each attribute of an innovation (technology), see Rogers and Shoemaker, 1971:135-155.

rity Committee Members, religious and social leaders and other influential individuals in the community. The Rubber Industry Smallholders Development Authority (RISDA) officers at district and sub-district (mukim) levels were key informants for officers.

Field observation was carried out mainly for verification purposes after the data had been collected through interviews, focus group discussions and office records. Data from office records were obtained from district officers of RISDA and the Rubber Research Institute of Malaysia (RRIM).

Location and Subjects of the Study

For the purpose of this study, Peninsular Malaysia was divided into four regions namely, the northern region, the eastern region, the southern region and the central region. Within each region, areas with a heavy concentration of smallholders were identified and selected. The following areas were selected: Baling, Grik, Lenggong, Selama and Taiping for the northern region; Tanah Merah, Machang, Besut and Setiu for the eastern region; Segamat, Muar and Jasin for the southern region; and Sepang, Seremban and Temerloh for the central region.

The main subjects of this study were the independent rubber smallholders[1] selected from the regions cited earlier. The selection of the independent smallholders was carried out with the help of the local RRIM and RISDA staff.

Field officers of RISDA and smallholder leaders were also the subjects of the study as they served as key informants on smallholders' problems and needs. It was assumed that these key informants were knowledgeable about rubber cultivation, constraints facing the crop and the smallholders and the community in which they themselves worked and lived.

Data Gathering Techniques

The study relied heavily on the rapid rural appraisal techniques using semi-structured interviews and/or discussions. Focus Group Discussion (FGD) was used to gather in-depth qualitative data from smallholders, smallholder leaders and field officers. A focus group comprising eight to 10 smallholders with a homogeneous background and interests was formed. For example, a group of smallholders with immature holdings formed a focus group. A similar focus group was formed for mature and old holdings.

Under the guidance of a trained research facilitator, smallholders in each FGD group were encouraged to discuss and interact with each other, to comment on the major themes presented to them, to question researchers and to respond to each other's comments on the issues that emerged out of the discussions. In each FGD, there was at least one biologist, one extension/communication specialist and one process observer who also acted as a recorder.

The FGD used prepared guidelines on major and minor themes for discussions. In this study, critical technologies for immature, mature and old holdings were prepared to guide the discussion. Also prepared were major extension/communication themes especially those that have a direct bearing on dissemination techniques, programmes of smallholders development and constraints facing the extension system.

Focus Group Discussion was also used to gather information from the key informants. In these groups, general themes such as level of technology adoption among smallholders, problems associated with technology adoption, strengths and weaknesses of extension services, etc. were discussed.

Field observation verified information gathered through FGD and office records. Selected holdings of smallholders in the identified areas were visited to see whether or not certain technologies were practised and to note the conditions of the general surroundings especially those related to infrastructure, planting of other crops and other economic activities carried out by smallholders.

Technology adoption and rejection by smallholders was the focus of data analysis. Reasons for rejecting a technology were isolated and screened and this was done for the three types of holdings i.e., immature, mature and old holdings. In all cases, percentages and means were used for the analysis.

1. Independent rubber smallholders refer to the "unorganized" and scattered smallholders under the jurisdiction of RISDA. The term "independent" is used to denote unorganized versus organized smallholders of FELDA and FELCRA.

RESULTS

The following outlines the status of adoption of some recommended practices by smallholders at different holding stages.

Immature Holdings

New and proven technologies, when applied during the immature years of rubber, would result in the enhancement of productivity and efficiency when rubber entered its mature stage. Responses from 66 FGDs, involving a total of 173 smallholders with immature rubber, are summarized in Table 1.

When land clearing is carried out manually, any tree stumps left behind should be poisoned with 2, 4, 5-T or Garlon 250. The cut surface should immediately be treated with creosote to prevent root disease spore colonization. This study indicated that only 17% of respondents practised stump poisoning after felling the trees. Many respondents were not aware that root diseases affecting young rubber were caused by rotted stumps of roots that were not poisoned.

The contribution of legume cover crops in controlling weeds and the returning of nitrogen to the soil has been widely accepted. In the im-

TABLE 1
Percentage adoption of recommended technology by smallholders

Holding stage	recommended technology	% adoption				
		North * (n=16) %	East (n=16) %	South (n=16) %	Central (n=16) %	Mean %
Immature	1. Stump treatment	8	12	24	22	17
	2. Planting legume cover	14	16	18	13	15
	3. Rock phosphate application	86	100	94	100	95
	4. Sulphur application	6	0	10	10	7
	5. Deep planting	1	9	21	16	12
	6. Weed control	21	41	70	36	42
	7. Fertilization frequency					
	year 1	0	0	0	0	0
	year 2	0	0	0	0	0
	year 3 - 5					13
	8. Control pruning	20	13	22	10	16
	9. Root disease treatment	24	25	36	42	32
Mature	1. Chemical weed control	50	60	76	64	62
	2. Fertilization (rate)	40	77	51	64	58
	3. Root disease treatment	20	24	20	14	20
	4. Yield stimulation	2	0	0	0	1
	5. Tapping aids					
	RRIMGUD	0	2	3	0	1
	JUS Knife	0	0	0	0	0
Old	1. Fertilization (rate)	59	42	5	NA	35
	2. Pest and disease treatment	29	19	20	10	20
	3. Yield stimulation	12	0	5	2	5
	4. Tapping aids					
	RRIMGUD	0	0	0	0	0
	JUS Knife	0	0	0	0	0
	Motorray	0	0	0	0	0

*n represents number of focus group discussions carried out in the district. Each focus group comprised 8 - 10 smallholders.
NA - not available

mature holdings studied, establishing and maintaining the common legume cover crops such as *Calopogonium caeruleum, Centrosema pubescens* and *Pueraria phaseoloides* was practised by only 15% of the respondents. To supplement their incomes, the majority of the smallholders planted cash crops. Research carried out by RRIM on intercropping showed that intercrops did not affect rubber growth if adequate fertilizers were used.

To promote root growth at planting, rock phosphate mixed in the planting hole is recommended. As rock phosphate was normally provided in the replanting programme, this practice was carried out by the majority (95%) of the respondents. The use of sulphur for prevention of root disease was limited to only 7% of the respondents. Sulphur was not easily available in the local market and neither was it supplied in the replanting programme.

An increase in the yield of rubber as the tapping panel approaches the stock-scion union could be made possible by the absence of the union through deep planting. This technique also provides firm ground anchorage for the tree. Despite its advantages, deep planting was only adopted by 12% of the respondents. Many were not aware of the technology; others complained that extra labour was required to dig the deeper holes. Where holes were dug mechanically, the technology incurred extra costs.

Proper and scheduled manuring practices are necessary as adequate amounts of nutrients are required to maintain a high level of growth and productivity. The frequency of application recommended by RRIM is 7 times during the first year, followed by 5 applications in the second year and 3 times each in the third and fourth year respectively. The frequency is further reduced to only twice a year in the following years.

Smallholders are advised to plant legumes in their immature holdings. Under such a practice, the frequency of weed control is not fixed. If the legume cover crop is not established, weeding should be done before fertilizing about 3 times a year, using the strip, circular or interrow methods. This recommended frequency by RRIM was practised by 42% of the respondents.

The frequency of fertilizer application was reported to be far less than that recommended. None exercised the recommended frequency from the first to second year while 13% fertilized their third to five years old rubber three times a year. The manuring frequency did not change much with age of trees; one or two applications per year was the usual practice adopted. According to the respondents, fertilization practice was based on their own judgement and observation and advice from friends or neighbours. Advisory service on proper manuring application schedules was minimal.

Research findings conducted by RRIM have shown that low branching trees have higher growth rate and girthing than high branching trees. Better growth and thus girthing rate can be induced by low and controlled pruning methods as opposed to estate pruning. This study demonstrated that only 16% of the respondents practised controlled pruning.

The most common disease in young rubber is white root disease which can cause widespread damage if it is not controlled effectively. The disease was reported by 46% of the respondents. Only 32% of the smallholders with holdings affected by the disease treated the problem (either by root exposure, or root exposure and chemical treatment).

Mature Holdings

The status of technology adoption for mature rubber was determined through 64 focus group discussions involving 178 smallholders who operated mature holdings in the fifteen districts sampled. The technology adoption level of this category is presented in Table 1.

Based on RRIM recommendations, mature rubber should be fertilized at least once a year at recommended rates, based on soil foliar analysis. The practice of manuring mature rubber at 1 - 2 times a year was reported by 86% of the respondents. The rate of application varied from 1 bag per hectare to 8 bags per hectare without due consideration to the number of tappable trees and soil types. Only 58% of the respondents applied 2 - 4 bags per hectare of fertilizer to their holdings. The field visits showed that the rubber planting density varied from as few as 200 tappable trees to 370 tappable trees/ha. Thus, if smallholders practised what they reported, it would mean that in some cases they used insufficient fertilizer while in other cases they used fertilizers excessively.

To facilitate tapping, application of fertilizer and minimizing competition with the crop for nutrients, weed control is recommended. When chemical is used, it should be applied at the frequency of 1 - 2 times per year. About 62% of the smallholders studied practised chemical weeding; 24% used a combination of chemical and manual weeding and 14% relied solely on manual weeding. When manual weeding was adopted, it was carried out minimally, sufficient enough to facilitate tapping operations. Safety precautions when weedicide was used were not stressed by extension agents. A partial adoption of the technology was attributed to insufficient subsidies for weedicide, financial constraints and a dearth of labour due to old age.

To increase latex production, smallholders are advised to practise yield stimulation. Unaware of the technique and its benefit, almost all operators (99%) of mature holdings did not adopt the technology. Similarly, non-utilization of tapping aids such as RRIMGUD and JUS knife has been altributed to poor advisory service or the less frequent visits to the mature holdings by extension agents.

Old Holdings

A total of 178 smallholders of old rubber were interviewed in 64 focus group discussions to determine the status of adoption of technologies recommended for old holdings. The responses obtained are shown in Table 1.

Fertilization was carried out only when cost of fertilizers was subsidized. Only about 30% of smallholders applied fertilizer to their old holdings. When fertilizers were used rate, method and frequency of application differed among holdings. Only some (35%) fertilized their holdings at the rate of 2 - 4 bags/ha/year as recommended by RRIM.

Old rubber were reported to be affected by a number of diseases which include white root disease, pink disease, secondary leaf fall, panel disease and brown bast. Among these, the most common was white root disease (reported by 69% of the respondents). Termites and wild aminals were two pests identified by the smallholders (7%). Control measures against both pests and diseases were relatively low (20%). Non-adoption of pest and disease control was attributed to unawareness of the problem, not knowing appropriate techniques for treatment, unavailability of fungicide/pesticide locally, exhorbitant price of some chemicals and the techniques involved were too laborious (for root disease treatment).

In relation to tapping, no tapping aids such as RRIMGUD and JUS knife were used. The practice of yield stimulation was adopted by only about 5% of the smallholders.

Factors Associated with Non-Adoption of Technology from the Perspective of Key informant Smallholders

To gain a better insight into the reasons for non-adoption of recommended technology, selected smallholder leaders were interviewed. Focus group discussions with these informants were carried out in 11 districts: Baling, Grik, Taiping, Tanah Merah, Besut, Segamat, Muar, Jasin, Temerloh, Seremban and Sepang. Table 2 summarizes the perceptions of the key informants for the low level of technology adoption among rubber smallholders. The factors were grouped into the following sub-headings:

Attitudinal

Informants from all the districts rationalized that often a recommended technology was not adopted when the practice called for laborious and time consuming work. For example, they reported many smallholders did not carry out root disease treatment by trenching due to the above factor.

Another often (91% of the focus group) cited reasons that have to do with the availability of subsidy. Many smallholders indicated that a recommendation like fertilizer and pesticide application was practised only when the relevant inputs were subsidized. To quote a respondent from Jasin "smallholders generally do not apply fertilizer or chemical unless subsidy is available".

The focus group interview in nine of the districts (see Table 2) revealed that some smallholders were not interested in any technology recommended to them. Neither were they interested in attending courses, demonstrations, etc. which were carried out to deliberate on the technology. Others showed some interest in a certain recommended practice. However, being doubtful about the expected benefits and concerned with costs involved, these smallholders decided not to adopt the technology.

TABLE 2
Factors associated with non-adoption of technology from the perspectives of key informant smallholders

	Baling	Grik	Taiping	Tanah Merah	Besut	Segamat	Muar	Jasin	Temerloh	Seremban	Sepang	% **
Attitudinal												
Preference for less labourious and time consuming work	x	x	x	x	x	x	x	x	x	x	x	100
Dependency on subsidy		x	x	x	x	x	x	x	x	x	x	91
Not interested in the technology		x	x		x	x	x	x	x	x	x	82
'Wait and see' attitude			x	x	x			x	x	x		56
Used to 'old' practice			x	x					x			27
Physical												
Uneconomic size of holdings	x	x		x	x	x	x	x	x		x	82
Scattered holdings			x		x	x					x	36
Hilly holdings		x			x				x			27
Accessibility of holdings	x	x	x		x				x			45
Technology not available locally	x	x		x	x				x			45
Labour												
Old age	x		x	x	x	x	x	x	x	x	x	82
Insufficient labour				x	x				x		x	36
Holdings Ownership												
Multi-ownership		x				x	x				x	45
Absentee landlord					x	x				x	x	36
Financial												
Technology recommended expansive	x	x	x	x	x	x	x	x	x	x	x	100
Insufficient money to purchase input	x		x	x	x		x		x	x	x	73
Appropriateness of Technology	x	x	x	x	x					x	x	65
Extension Service & Communication Support												
Not aware of technology	x	x		x	x	x			x	x		64
Insufficient information on technology	x	x		x	x	x		x	x		x	73
Lack of advisory service	x	x	x			x			x			45

** % : Percentage of response "yes" of the total number of districts.
x : Responses given by the districts.

Lack of interest in a recommended practice seems to be related to the contribution rubber makes to a smallholder's income. When rubber was not the main source of income, or the income derived from rubber could not meet family requirements, then smallholders were less concerned with investing in a recommended technology. This was mentioned by smallholders in seven districts visited by the research team.

The rate of technology adoption was also affected by the smallholder's inclination to see the impact of a practice before trying it out. This 'wait and see' attitude was reported in six districts.

Informants from Grik, Taiping and Temerloh reported that many smallholders had been operating their holdings in the same manner for many years. Over time they had adopted certain practices which have become an acceptable method of managing their holdings. Familiarity with the 'old' practice was one of the reasons cited for non-adoption. For example, it had been an "accepted" practice for many smallholders in Taiping not to fertilize their mature and old rubber. Whether or not fertilization was done made little difference in terms of impact to rubber yield or their income.

Physical

Several physical problems were associated with non-adoption of technologies (see Table 2). The main physical constraint identified by the key informant smallholders (from 9 out of 11 districts studied) was uneconomic holding size. They felt that small holding size rendered it uneconomical for smallholders to adopt certain high cost technologies such as tapping aids, weedicide and pesticide treatment and fertilizer application.

Remoteness and inaccessibility of some of the holdings due to hilly terrain, swamp and river barriers prevent smallholders from practising technology such as mechanical land preparation. The cost of bringing a tractor from town to a remote holding would inflate the capital cost. Hilly holdings also faced water accessibility problems. As water is required to dilute pesticide, fungicide and weedicide, a lack of it affects the adoption of those practices (Grik, Besut and Temerloh).

Informants from Baling, Grik, Tanah Merah, Besut and Temerloh reported that some chemicals and tapping aids were not available in their areas. Unavailability of 2, 4, 5-T and Garlon 250 in the local stores affected stump treatment practices. Similarly, difficulty in acquiring sulphur, herbicide and fertilizers limits adoption of practices that call for their inputs.

Labour

According to the majority of the informants (see Table 2), most of the smallholders were old. They associated advancing age with lack of strength to practise intensive labour like weeding, pest and disease treatment and thus the low adoption of these practices.

The younger generation showed little interest in operating smallholdings. Labour shortage forced many smallholders (Tanah Merah, Besut, Temerloh, Sepang) to resort to hired labour or to leasing their holdings to other operators. Hired labour and leased operators were more interested in maximizing profit from the holdings. Thus, they were often not interested in practices which might raise expenses financially or physically. Neither did they care much about the long term effect of cultivation practices on the rubber trees.

Holdings Ownership

A sizeable percentage of holdings was owned by more than one owner. Multiple ownership of holdings was reported (by informants from five districts) - (see Table 2) to be a deterrent to technology adoption.

Technology adoption was also affected by absentee landlords (Besut, Segamat, Seremban, Sepang). In the absence of owners, hired workers concentrated more on the latex extraction than on maintaining the holdings.

Financial

The majority of the informants (from all the districts studied) attributed non-adoption of a technology to financial constraints. According to them, smallholders could not afford a technology due to two main reasons:

(i) recommended implements like RRIMGUD, Motoray, and chemicals (weedicide and fungicide) were too costly (reported by informants from all the districts studied).

(ii) Insufficient money to purchase inputs (reported by informants from 8 districts).

Appropriateness of Technology

The appropriateness of a recommended technology had been questioned by a number of the informants from seven districts. They viewed tapping implements such as Motoray and RRIMGUD, and JUS Knife to be inappropriate as most smallholders have limited resources and operate their holdings on a small scale basis. Based on their observation and experience, respondents from Besut, Seremban and Dengkil claimed that con-

trolled upward tapping (CUT) resulted in tappers suffering neck pain. Motoray was reported in Besut and Seremban to be damaging to the tree while yield stimulants caused the bark to burst.

Extension Service and Communication Support

To many informants (from 7 districts - see Table 2), smallholders failed to adopt a technology when they were not aware of it. This was especially so in the case of non-adoption of tapping aids, and pest and disease control.

Even though smallholders were aware of a technology, insufficient information on the practice might discourage them from adopting it (Baling,Grik, Tanah Merah, Besut, Segamat, Jasin, Temerloh and Sepang). For example, most smallholders did not know that controlled pruning could induce the plant to grow faster. The lack of information on the advantage of control pruning made them believe that it was an obstacle to getting a smooth cylindrical tree trunk in the future, thus discouraging them from doing it. Similarly, it was reported that smallholders did not adopt yield stimulation technology because they associated it with the final procedure before the old rubber trees were due for replanting within a year or two.

Some of respondents reported that they had heard of the availability of tapping aids such as Motoray from the television or/and extension agents. Some even had the advantage of observing the change agents demonstrate how it worked. However, even after attending the method demonstration, many still did not use the aid. They complained that they had little opportunity to try the implement themselves, and were thus not sure of its practicality.

Another factor often cited as being responsible for low technology adoption was inadequate communication support strategies. To these informants (Table 2) the weakness and lack (in certain areas) of the communication support strategies prevented smallholders from practising a recommended technology. For example, although fertilizers were given to smallholders at the replanting stage, advice on correct timing, frequency and rate of application of the fertilizer was minimal. Such smallholders had to resort to friends and fertilizer dealers, or use their own judgement.

A number of respondents complained about the difficulty in meeting extension agents, particularly after their rubber reached maturity. The frequency of the extension agents' visits was closely associated with the age of the rubber trees. Most visits by extension agents were made during the immature stage (replanting grant period). More often these visits have to do with the inspection of the holdings for replanting grants disbursement rather than for educational and technology transfer purposes. As the trees reached maturity, the frequency of visits by extension agents declined until finally there was minimal extension activities once the trees were 20 years old and more.

Since many respondents associated technology adoption with the quality of extension service, they were encouraged to share their view on the agents' competency. Many felt that the extension personnel skill and knowledge on current rubber technology were considerably low. Similar observations were made by the respondents on the change agents' skill and knowledge on extension method and delivery techniques.

Factors Associated with Non-adoption of Technology from the Perspective of Key Informant Officers

To further understand the rationale for the relatively low level of technology adoption among the rubber smallholders, focus group discussions were also conducted with selected field officers in the areas studied. These interviews revealed that from their perspective, non-adoption could be attributed to various reasons. The factors identified by them are almost similar to those provided by the key informant smallholders. The reasons could be classified into five categories namely, attitudinal, physical, labour, ownership, and financial.

Attitudinal

The smallholders were perceived to be contented with their old practices and were not keen on new ways of managing their holdings. Many were doubtful about the appropriateness and benefits of the technology. Others feared the risk involved in practising new methods. Their preference for less labour and less time-consuming work and dependence on subsidies (e.g. fertilizers,

chemicals) were the other main factors identified by the informants as hindrances to adoption of a technology.

Physical

Size, location and accessibility of a holding affected the rate of technology adoption. The officers reported that about 60% of the holdings were less than two hectares. The small holdings made it uneconomical for many smallholders to adopt some technologies. Remoteness and inaccessibility of holdings, because of hilly terrain and swampy areas, further hindered technology adoption. The absence of a local outlet where smallholders could purchase inputs (for those who could afford it) was another factor for non-adoption of technology.

Labour

Poor technology adoption rate had often been associated with smallholders' age. According to the informants, the majority of smallholders (60% - 70%) were more than 50 years old. To assist them with farm work, these smallholders employed hired labour or leased their holdings to other operators. Technology adoption rate in holdings utilizing hired labour or leased workers was reported to be much lower.

Land ownership

The officers estimated that a sizeable percentage (18% - 20%) of holdings had multiple ownership. It was observed that adoption of new practices in these holdings was slower. A similar phenomenon was reported in cases where the owner stayed far away from the holding. In the absence of the owner, it was extremely difficult to organize activities for transfer of technology.

Financial

Many informants felt that financial constraint was another major obstacle in technology adoption. This constraint was due to the nature of smallholders and their holdings; being relatively poor and drawing a marginal income from their small sized holdings. With limited cash, relevant inputs required for the adoption of some practices become too expensive for many smallholders to afford.

To provide a comprehensive picture on the factors associated with non-adoption, this study utilized three sources of data; the smallholders, key informant smallholders and key informant officers. Table 3 summarizes these factors.

The three groups of respondents identified six common problems related to the adoption of a recommended technology: physical, labour, holdings ownership, financial, appropriateness of technology and attitudinal. Although key informant smallholders and officers identified a longer list of attitudinal problems (see Table 3), the smallholders themselves reported only two. Constraints related to extension and communication support were identified only by the smallholders and key informant smallholders.

DISCUSSION

Decision-making in technology adoption is a complex process and requires an individual to select from a series of choices based on information he/she receives. These series of choices are based on information on technology attributes, cost, labour, and appropriateness of a technology or they could be circumferential factors such as credit, market price of product and land tenure situations. For a rubber smallholder, these choices become extremely difficult especially when he/she is constrained by inadequate labour, inadequate finance, small-sized operation, remoteness of holding, and inadequate information on the benefits of a technology. This is further aggravated by the fact that the outcome of adopting a technology in rubber cultivation usually takes from six months (effect of fertilizer) to 10 or 15 years (yield performance of a clone) and this extends the period of uncertainty and therefore, increases the complexity and difficulty in making decisions.

Closely related to the physical and circumferential factors is the attitude of rubber smallholders towards adopting a technology. This study identified several factors related to attitude of smallholders that affect decision-making whether to adopt or to reject a technology. Examples of these attitudinal factors are smallholders' dependence on subsidy for adoption of a technology, smallholders preference for less laborious and less time-consuming work and 'wait and see' attitude.

TABLE 3
Factors associated with non-adoption of technology from the perspectives of smallholders, key informant smallholders and key informant officers

Factors	Perspectives		
	Smallholders	Key informant smallholders	Key informant officers
Attitudinal			
Preference for less laborious and time consuming work	✓	✓	✓
Dependency on subsidy	✓	✓	✓
Not interested in technology		✓	✓
'Wait and see' attitude		✓	
Used to 'old' practices		✓	✓
Unwilling to take risks			✓
Physical			
Uneconomic holding size	✓	✓	✓
Scattered holdings	✓	✓	✓
Hilly holdings	✓	✓	✓
Accessibility of holdings	✓	✓	✓
Technology/inputs not available locally	✓	✓	✓
Labour			
Old age	✓	✓	✓
Insufficient labour	✓	✓	✓
Holdings Ownership			
Multi-ownership	✓	✓	✓
Absentee Landlord	✓	✓	✓
Financial			
Technology recommended expansive	✓	✓	✓
Insufficient money to purchase input	✓	✓	✓
Appropriateness of technology		✓	✓
Extension service and communication support			
Not aware of technology	✓	✓	
Insufficient information on technology	✓	✓	
Lack/insufficient advisory service	✓	✓	

The physical, circumferential and attitudinal factors combined to compound the complexity of the decision-making process and technology adoption among rubber smallholders.

What is portrayed here is not a totally hopeless situation, but rather a reality facing the rubber smallholder sector which provides cues for research and extension organizations to plan and implement strategies to overcome such constraints.

Adoption or rejection of a technology by clients is a conscious and deliberate effort to change from existing practice to a new one. Therefore, a decision to adopt a technology is a decision to change. For a change to occur, clients must be provided with as much information as is possible so that they are fully aware, able to diagnose and evaluate the change according to their situations. With rubber smallholders, information dissemination becomes a critical prerequisite for tech-

nology transfer. The information is usually relayed by the extension service.

With a gamut of external and internal factors surrounding a change situation facing the smallholders, the extension service has to be competent to disseminate information. And this is not an easy task especially when extension agents themselves also face numerous constraints in their effort to disseminate technology information. This study has found that an agent spends most of his time on enforcement and administrative activities rather than on extension activities (advisory service, method demonstration). Examination on the extension agents' working schedule revealed that only about one-fifth of their time was spent on extension activities (Rahim M. Sail *et al.* 1990).

Change is a slow and complex process similar to that of the decision-making process. With the constraints faced by smallholders and the extension agents, change becomes even slower and more complex and this accounts for some of the delays and rejection of technologies recommended to rubber smallholders through the extension service. In line with this, we can establish a strong premise that it is not only the smallholders' knowledge, beliefs and practices in technology that need to be changed, but also those of the extension agents. For example, this study showed that many extension agents needed to be equipped with knowledge and skills of current technologies as well as effective dissemination strategies. Change is, therefore, basically to reduce restraining forces while at the same time to increase promotional forces that affect both the smallholders as well as the extension service.

RECOMMENDATIONS

Several recommendations could be forwarded for the consideration of research and extension organizations to further improve existing practices in technology transfer and adoption. These recommendations are as follows:

1. Training of trainers programmes (from research to extension) should cover all technology attributes in detail besides discussing relevant circumferential (e.g. costs, markets and credits) factors. The 'how-to' and 'principle-information' should be the focus in these training programmes as this would enhance the processes of decision-making and change in technology transfer.
2. In developing technologies for smallholders, attributes such as simplicity, cost and appropriateness to smallholders' farming situation and cultural practices should be given priority and careful consideration by research organizations.
3. Publication meant for extension agents and smallholders should be simple in the form of 'how-to' to follow steps about a technology. If inputs are required, information on cost, how and where the inputs can be obtained should be furnished.
4. *In situ* training and lecture/discussion should be followed by demonstration of 'how-to' to increase effectiveness of technology transfer. Ideally, the demonstration of 'how-to' should be repeated a number of times by the demonstrator. The participants should try out the skills themselves with close guidance by the demonstrator. This process is slow but effective as it reinforces knowledge, skills and builds up confidence in the participants about a new technology. This is applicable to both processes of information flow from research to extension as well as from extension to clients.
5. Extension effort (particularly for smallholders with mature holdings) has to be increased in order to increase the level of technology adoption among smallholders. This could be done through reducing the administrative and enforcement functions of field extension officers while at the same time increasing field extension effort of supervisory officers.
6. In-house training programmes of extension organizations should include, besides the detail technical aspects of current practices in rubber cultivation, HRD aspects (e.g. problem solving skills, decision-making skills, leadership skills and motivational skills) which would put the process of technology transfer in a proper perspective among extension agents. This is also applicable for smallholder training programmes. The inculcation of HRD aspects is important to ensure an overall success of technology transfer and technology adoption.

7. Inputs for adoption of a new technology must be made available in local areas and where inputs are expensive, they must be made available on easy term credits to smallholders.
8. To increase the level and effectiveness of technology adoption among smallholders, extension effort should be directed towards group approach as in the group replanting programmes. The group approach would overcome some of the constraints faced by individual smallholders who operate small-sized farms.

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