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Smallholder Rubber Production and Policies

Proceedings of an international workshop
held at the
University of Adelaide, South Australia
18–20 February 1985

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Contents

Foreword

The Rubber Workshop was held primarily to help identify priority problems facing the natural rubber industries of Southeast Asia. The focus was on the processes of structural change which had been occurring in the recent past, especially in the two major producing countries, Malaysia and Indonesia. The roles of research, technology, economic trends and policies were examined, with particular emphasis on their implications for the development of the smallholder rubber sectors. Smallholders now produce the bulk of the world's natural rubber whereas the plantation sectors had this distinction less than 25 years ago.

The other major objective of the Workshop was to identify the potential contribution which could be made by Australian social scientists to collaborative research on priority themes with colleagues in major rubber-producing countries in the region. A range of disciplines was represented at the Workshop including economists, sociologists, communicators, agronomists and plant breeders from Indonesia, Malaysia, Papua New Guinea, Thailand and Australia.

This volume contains the papers which were presented by participants from the five countries together with a summary of the major recommendations on research topics. The latter are candidates for collaborative research that could be considered for support by ACIAR.

The Workshop was held at the University of Adelaide and jointly organised by Dr Christopher Findlay of that University, together with Professor John Western and Dr Shankariah Chamala of the University of Queensland. ACIAR is grateful to the two universities and the organisers for their contribution to the success of the Workshop. Special mention is made of the support of the staff and students of the Faculty of Economics of the University of Adelaide, particularly Amelia Giammona, Kerrie Round, Victor Lye, Tan Hock-Eng and Mark Crosby. Jack Mertin is thanked for his assistance with the editing of the Proceedings.

James G. Ryan
Deputy Director
ACIAR

Summary of Discussions and Recommendations

Natural rubber is an important product for both consumers in industrialised countries and producers in developing countries. Changes in both rubber production and processing have the potential for influencing the socioeconomic conditions of the 22 million people in developing countries whose livelihood depends on this industry.

More than 80% of natural rubber production comes from adjacent regions of Malaysia, Indonesia and Thailand where smallholdings predominate. Malaysia and Indonesia together account for more than two-thirds of the world's natural rubber where smallholders grow 73 and 80% of the total area respectively. Since 1960, there have been marked structural changes in the economies of both Malaysia and Indonesia which have had significant impacts on the rubber industries in these countries.

In Malaysia over the period, rubber's share in exports declined from 71% to 14%. Not all agricultural exports declined. Timber, for example, increased from 2 to 13% and palm oil from 3 to 10%. Similar changes took place in the Indonesian rubber industry and by 1980 it was contributing 5% of national export revenue, behind oil products and timber.

In both countries adjustment has been a greater problem for smallholders than for the large estates. This has been due to a number of factors. At one level the general growth of the economy had an effect. At another, the growth of secondary industry, the changing demographic structure of the population and government approaches to technology transfer were also important. Other more general exogenous factors such as the oil crisis, the recession in developed countries and price fluctuations further aggravated the situation. At a more specific level, differential rates of adoption of technological innovations in agronomy—plant breeding, tapping methods and yield stimulants—have also reacted against the smallholder.

The Adelaide workshop funded by the Australian Centre for International Agricultural Research was initiated to address some of these questions. It was hoped that from the workshop a number of viable research projects would be identified and that these could be developed collaboratively between Australian researchers on the one hand and Malaysian and Indonesian researchers on the other.

The workshop had three main objectives:

1. To review the problems of smallholders in the natural rubber industry.

2. To establish research priorities for the rubber industry. It was anticipated that the workshop would examine the need for a comparative study of how a traditional agricultural export sector adjusts to changing world and domestic prices; why transfer of technology is slow; the nature and extent of constraints to the adoption of new technology in the rubber industry; and the complementarity of economic and sociological models of the diffusion and adoption process.

3. To develop a set of proposals for collaborative research between Australians, Malaysians and Indonesians which would be consistent with the role of the Australian Centre for International Agricultural Research.

A total of 34 economists, sociologists, extension specialists and agricultural scientists from Malaysia, Indonesia, Thailand, Papua New Guinea and several Australian States attended this workshop held at the University of Adelaide from 13 to 20 February 1985.

The workshop opened with overview papers from Australian participants setting out some of the economic and sociological parameters of the problem. These were followed by country papers from overseas participants covering the adjustment process of rubber smallholders and the future research needs in this area. A review paper, based on presentations and discussion, including some suggestions for research was prepared by the workshop organisers in the penultimate session. Finally, the Malaysian and Indonesian spokespersons presented their research proposals based on the review paper and further discussions among country representatives.

A brief summary of recommendations from the two groups including topics for further research is presented below.

From the Malaysian group research proposals came within the framework of farming systems research and extension with a focus on small rubberholders. The issues nominated covered technical research and development as well as the extension of technology to smallholders. The research priorities were:

1. A study of approaches to extension, with the goal of delineating the factors determining rates of adoption, the process of diffusion and the institutional linkages between research and extension agencies.

2. Research and development of a 'technical' nature relating to smallholders in two areas:

(a) The development of a technical package to benefit smallholders during the initial phase as well as the mature phase of rubber production;

(b) The development of biological methods for income supplementation, firstly by the introduction of cross-breed sheep to achieve weed control, and secondly, by the introduction of honey-bee rearing.

3. The development of management strategies to be used to ensure the effective adoption of new technologies.

4. A study of the impact of industrialisation on the agricultural sector, particularly the impact of migration processes, labour cost and farm productivity.

5. The further investigation of rubber processing and the manufacture of innovative rubber products.

The Indonesian group identified the need for macroeconomic studies dealing with the taxation system and the position of the rubber industry in the context of the international economy. They saw these topics, however, as outside the scope of the workshop but important to discuss with relevant organisations in Indonesia on their return. Their research priorities involved a consideration of technical matters as well as an examination of the sociological characteristics of smallholders. Both concerns were incorporated under the general theme, 'The development and diffusion of improved technology in the rubber smallholders sector'.

The research proposal had two parts:

1. The development of rubber technologies; and

2. The diffusion of improved technologies among smallholders.

Under the development of technology the following research possibilities were suggested:

(i) Technology of the plantation itself;

(ii) Intercropping between the rubber plantation of smallholders with a view to providing initial income and overcoming food scarcity;

(iii) Processing of rubber latex; and

(iv) Marketing.

It was argued that research concerned with the diffusion of improved technology would need to take account of the difference between organised smallholders in government schemes and unorganised smallholders who lack already established channels for advice about technology transfer and available services.

While some differences in research priorities existed, many common themes emerged. The following summary identifies the major research priorities:

(1) The socioeconomic and technical determinants of adoption and diffusion of technology options and the role of research, extension and infrastructure agencies in the design, evaluation and transfer of technology;

(2) Farming systems research, with particular emphasis on the generation of additional income during the establishment phase of rubber; the possible roles of intercrops, sheep (for weed control), and honey bees were mentioned as examples: use of multidisciplinary diagnostic surveys to determine constraints on smallholder systems and construction of forecasting and simulation models to assess the value and desirability of changes in smallholder systems;

(3) A comparative analysis of land consolidation schemes, mini-estates, nucleus estates and independent smallholder rubber enterprises to determine their past and potential role in the development of the sector, including the enhancement of adoption of technology options;

(4) Impact of industrialisation on labour supply, costs, cropping systems, output, productivity and the implications for policy; and

(5) The impact of macroeconomic trends and policies on the rubber industry.

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Rubber Industry Research Programs in Malaysia and Indonesia: An Overview

S. Chamala,* C. C. Findlay and J. S. Western*****

THIS chapter contains a personal review by the workshop coordinators of the discussion at the meeting. The aim of the meeting was to produce an agreed list of topics for further research and these are itemised in the Introduction to this volume. This chapter also covers those items but with a different emphasis. It presents some of the discussion at the meeting which was of special interest to the coordinators and which they thought was worthwhile recording in more detail. While the workshop discussed the rubber industry in a number of Southeast Asian countries, we concentrate here on Malaysia and Indonesia.

Development Criteria

The Workshop was concerned with the nature of development in Southeast Asia. A number of criteria of development were discussed and the emphasis put on various items differed among the speakers. Economists tended to emphasise the efficiency of resource use in the economy, that is, maximising the goods available from the resource endowment. Economists recognised that questions of goods distribution are significant but that in the first instance it is important that resources not be wasted, that the economy grow rapidly as a result, and that this growth create the opportunities for the pursuit of social welfare targets. Their stress would be to match targets and instruments. Some policy instruments are suitable for particular goals, for example, an open economy with few distortions between world and domestic prices has been found to facilitate growth. The redistribution of the goods is better pursued, according to this view, by alternative instruments, such as the tax and social welfare systems. Another way of looking at this would be to concentrate on maximising every person's absolute level of income and correct differences in relative income levels as a separate exercise.

In contrast, people with a sociological background appeared to be more cautious in their appreciation of the situation and recommendations for action. For example, policy toward technology, which economists might regard as a device for expanding the set of production possibilities (more goods for less inputs), is seen as an instrument of 'development', which could have both desirable and unanticipated and dysfunctional consequences. An alternative in terms of a problematising approach to analysis was suggested. This involved a review of the 'total reality', and use of impact assessment and of systems approaches. The desirability of adjusting strategies to situations was stressed. Just as the economists would not ignore the equity questions, but instead would put them aside as a separate problem in comparison to the analysis of policy toward resource use, sociologists would not ignore efficiency. They would severely criticise wasteful development projects. The differences were in the approaches to thinking about policy problems and in the design of policy. These differences were apparent in the discussion but not resolved. An examination of these methodological differences is a potential research project of great interest but one which is a long way distant from industry policy.

There was some discussion of the environmental impact of policy decisions of new technology. For example, there could be soil erosion despite increases in yields on the farm. There was no disagreement between economists and sociologists that these sorts of social costs, which farmers might ignore in their private calculus, should be incorporated in a social cost-benefit analysis.

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There was further common ground in the discussion of the equity questions. The argument was that while the tax and social welfare systems were used in some countries to transfer incomes this approach could be relatively expensive in developing countries because of the lack of a developed fiscal system. A qualification of this view is that some structural changes in the economy, such as a resource boom created a new tax base, which could be accessed at fairly low cost and could therefore alter some of these perceptions about the choice of instruments for equity goals. Monitoring of the potential for new fiscal instruments is important work with great relevance to, although not directly connected with, industry policy. However, there could be another constraint on the use of such explicit policy instruments, due to the lack of widespread political support for the transfer that would be implemented. Further, it was argued that policy makers feared that the strategy of promoting economic growth would not work fast enough or indeed might not work at all and would, instead, generate disruption, which has been observed in Malaysia and Indonesia in recent times, and which would eventually destroy the strategy. Given the view that direct interventions were not available, and that action had to be taken soon, the problem (one which economists would describe as 'second-best') was to design instruments that would achieve the welfare targets without too much cost of loss of goods. Indeed, this interest in action to correct the income distribution appears to have been increased by economic growth and the associated structural changes in the economy.

Growth and Structural Change

The rapid growth of the economy has been associated with a number of booming sectors. In aggregate these booms would be described as good for the economy. However, booms in some sectors inevitably put the squeeze on other sectors of the economy. This could be reflected in lower profit margins, labour 'shortages' in the declining sectors (although their decline may only be relative) and higher input prices. The redistribution of income, such as the decline in the relative incomes of those tied to the declining sectors, associated with this growth in the whole economy generates a concern to take offsetting policy action. Before considering what action to take, there are a number of useful background research projects that would be of use. These are *to extend the work on the general equilibrium (GE) modelling of the macro-economy, both in attempts to understand previous events and to predict the effects of policy changes. The latter involves the development of fairly sophisticated computable models and the use of up-to-date data for estimating the parameters of those models.*

There is another interest in the effects of structural change on relationships between economies. General growth, which is associated with the decline of some industries, of course creates opportunities for other countries' exports to take up the space left by the adjusting country. For example, a decline or even a stationary output of rubber in Malaysia could create opportunities for Indonesia, Thailand, PNG, and the Philippines. The scale of this opportunity could be estimated by comparing results of GE models of each of these countries, as well as projections of world demand. It may also create opportunities for established exporters, like Malaysia, to export rubber management or research services. *It would therefore seem useful to extend the macro-modelling work beyond Malaysia.*

One rationale for government action during this adjustment process is that some markets fail to facilitate the process. For example, one question is whether there are failures in the capital markets. In the presence of such failures, farmers might find it difficult to raise funds to finance new technologies that will help them adjust to the new set of input prices they face. *A research topic is whether problems in capital markets simply reflect the risks and transactions costs associated with lending to smallholders or whether there is some more fundamental problem in the market.* Other concerns about market failure relate to markets for information. The failure of markets to produce information in appropriate amounts leads to the efficiency case for extension and research programs, which are discussed below.

Another rationale for government action is to correct problems created by previous actions. For example, what are the impacts of protection of the manufacturing sector and what is the incidence of the rubber export tax, bearing in mind that the tax revenue is used to fund research and development. This work on tax incidence should focus on the different effects on smallholders and estates, and on the extent to which the tax is borne by foreign consumers of rubber. *These questions about the impact of policy could be examined using macro-models, although they would require some extensive preliminary data collection.*

These motivations for intervention are related to the efficiency of resource use and interest in them is to some extent stimulated by the growth of the economy and its impact on particular sectors. However, reforms on efficiency grounds will also have an impact on some equity targets and it is important to measure those impacts. This would be a product of the modelling approach. It could be used to highlight some of the contradictions in industry policy making, for example, the burden placed on the rubber sector by taxation in the form of general manufacturing sector protection.

The view that the macro-modelling work was valuable, and provided necessary information about the general economic environment in which decisions on new technologies and their diffusion were being made, was endorsed by the meeting. However, it was felt that neither the Indonesian and Malaysian visitors nor the institutions that they represented had any special expertise in that area and therefore could not contribute significantly to further macro-modelling work. It was therefore suggested that the macro work be coordinated through other agencies or institutions in those countries, but that contact be maintained between the macro and micro perspectives.

Planned Development Programs

A number of papers focused on comprehensively planned programs aimed at increasing rubber production and at the same time improving living standards for smallholder producers. In Malaysia, FELDA, RISDA, FELCRA and a number of other agencies (apparently over 30) were responsible for ambitious programs, while in Indonesia, NES/PIR also had the twin aims of improving overall productivity and improving living conditions of smallholders and their families. The importance of monitoring the impact of these programs and if appropriate suggesting some redirections of activity was recognised. *As these intervention programs were major government initiatives, their assessment by systematic research was seen to have a high priority.*

As noted above, there is a large number of government agencies involved in the development programs. *It was recognised that there is a need to examine the institutional linkages to avoid duplication thereby achieving better communications and increased efficiency in generating new technology and in its transfer.*

It was apparent that the major motivation for these activities was to improve the economic condition of the smallholder, that is, primarily an equity objective, which for reasons discussed above is pursued by intervention in markets where smallholders earn their incomes. However, some of these activities may in principle be justified on efficiency grounds, also as noted above. One problem with these mechanisms is that, in the context of structural change in the economy, they become increasingly expensive. For example, applying a rate of return criterion for research or extension, input prices may alter over time to reduce the economic returns. Application of these types of criteria needs to take account of these changes and this would be facilitated by the use of the results of the macro-modelling. Another aspect of the evaluation of the returns to research is the possibility that the benefits are actually passed on to foreign consumers. Evaluation of the extent to which this happens would be a component of the work on the incidence of the export tax/technical research policy combination.

Technical Research and Development

An important component of programs for rubber smallholders has been technical research and development. Some of the major areas for future technical research identified in the meeting were:

- Selection of broader varieties of intercrops
- Selection of appropriate *Rhizobium* for intercrops
- Rubber tree breeding for increased yield and for new management practices
- Adaptation of tree varieties for various environmental conditions in the smallholder sector
- Improved efficiency of the use of fertilisers in the smallholder sector
- Improvement of seed production for legume covers
- Refinement of tapping practices, such as reduction of the skill levels required or of the frequency of tapping
- Improving the breeding and management practices of small ruminants such as sheep to be reared under smallholder rubber
- Use of honey production technology (bees)
- Soil classification
- Improving use of agricultural tools on smallholdings

The interests of the participants in these technical topics varied. For example, the Malaysians were most interested in the sheep and bee breeding programs. The Indonesians were more interested in the development of rubber tree breeding and of intercrops (with particular reference to choice of soybean *Rhizobium* suitable for local soils). These differences appear to reflect the different stages of development of the industry in the two countries.

There was some discussion of the methods by which these research topics were chosen and of the criteria used. For example, the questions asked were whether there was too much distance between physical scientists and social scientists, or between practitioners and researchers. This distance or lack of communication, it was feared, would lead to inappropriate solutions to the problems of smallholders. It was observed that in Malaysia for example, there is extensive consultation between the research community and the practitioners in the Transfer of Technology Committee and that more agricultural researchers were spending time in the field as well as in the laboratory. However, *the problems of establishing criteria for technical research are large and further work on that process could be a useful research project, especially in the context of the structural change that is occurring. Using farming systems methodology was also seen as a link between technical and social research.*

Extension Services

There was a great deal of discussion of the yield gap, either the gap between results achieved in research stations or the gap between the estate and smallholder sectors. On the former, the observation was made that high yields in research stations could reflect their use of uneconomic practices in order to achieve the preset scientific targets and that therefore station yields would overstate the potential for productivity gains on the farm. If this is the case in Malaysia or Indonesia it raises some questions about the incentives facing researchers, the consistency of these incentives with solutions to farmers' problems and about the information the researchers have on farmers' management practices. This topic could be considered within the research project mentioned in the previous section.

The source of the yield gap was identified as the slow rate of adoption of new technology by smallholders and the low levels of final adoption. The slow rate of diffusion appeared to be related to the remoteness and scattered nature of smallholdings, the small farm-size, the old age of the smallholder, the lack of family or hired labour, the inability to bear the interim loss in income after replanting, the low skill levels and the limited scope of other on-farm activities. There was some discussion of the relative importance of financial factors and other 'human factors' in explaining the level of adoption. One view was the latter were very important and that they offered the source of explanation of low or slow diffusion, although it was clear substantial theoretical work was required to identify these factors and then decide how to measure them, and to relate them to adoption levels. Another view was that human factors were significant, such as attitudes to new technology and preferences about work and leisure, but that the fundamental explanator of diffusion rates was private net benefit as perceived by the farmer. *Research on the process of diffusion would be a valuable topic and its results would be relevant both to the design of extension programs and to the choice of topics for basic research.* An example of the latter application is the observation that sometimes farmers who appear to have very similar characteristics, adopt innovation at very different rates. Sometimes this can be traced to slight physical differences in their land and if so, there may be a case for developing more tree varieties that will grow in the range of conditions experienced by smallholders (and in fact this work is underway in Malaysia). Within the diffusion work there are a number of smaller questions. For example, is it better to focus extension on progressive rather than non-progressive farmers? How can progressive and non-progressive farmers be identified and what are the conditions that determine this classification? What is more important, the final level of adoption or the rate of adoption?

Comparative studies of rates of adoption of new technologies by smallholders in organised programs, such as FELDA or NES/PIR, and those by scattered smallholders is a specific example of this type of research. Studies of diffusion processes that would generate benefits would examine differences in adoption rates in a four way classification, i.e. organised/non-organised and progressive/non-progressive farmers. These studies could be cross-sectional but, in the longer term, there could be great benefit from the development of panel data in a longitudinal study. One possible source of this data in Malaysia is the RISDA Tri-delta data bank, although it may be useful to review as soon as possible the methods of data collection and the conceptual basis of the procedures employed. RISDA personnel may find it useful to be involved in a simultaneous review of their in-house extension program. In Indonesia, there is no immediate source of such longitudinal data.

Management Services

One source of poverty for smallholders is the small size of their plots. The plot size would in some societies not be regarded as a problem because there would be a natural tendency to consolidation if larger plot sizes were appropriate given factor prices and technology. However in Muslim societies that sort of consolidation is inhibited by inheritance law. As noted above, one of the government's responses has been to invest in new technology and in extension services as a way of trying to raise smallholder incomes. However the small plot sizes and the associated management practices inhibit the adoption of new technology. As a result smallholders seem to gain relatively little, although possibly still in significantly large absolute amounts, compared to richer and larger holders or the estate sector.

The recent response to this problem appears to have been to invest heavily in providing management services for smallholders and to run consolidation schemes. However, some management schemes seem unlikely to offer a long-term solution because of the burden they will place on government budgets. *The performance of the consolidation schemes, such as mini-estates and small group projects, especially with respect to the adoption of new technology, is a topic for further work in both Indonesia and Malaysia.* An incentive related to these and some other schemes is the provision of free crown land or land purchased with concessional finance. This is another way in which in-kind transfers are being made to rubber smallholders.

Marketing and Further Processing

There is a view that there are significant benefits from government intervention in the marketing chain. One reason is the perception that intermediaries have some market power, which causes prices received by smallholders to be lower than otherwise. Another concern is that there are social gains from further value added to domestic raw materials. *There are potential problems with both strategies and these could be the topics for further research.* For example, does Malaysia have a competitive advantage in further processing? If not, this strategy could actually lower returns to smallholders. Also it is not clear whether lack of competition in the marketing chain is due to other government regulation, and similarly whether lack of rubber processing activity in Malaysia is not related to regulations on foreign investment. There is the possibility of establishing joint ventures between foreign firms, including those from Australia, and the Malaysian processing industry, such as Ansell's glove production.

Concluding Remarks

It is of great interest that the research programs suggested by the Workshop often involve the examination of particular problems in a broader perspective. This occurs on two levels. First, at the industry level, rubber industry policy is more usefully evaluated in a macroeconomic context, ideally with the aid of computable general equilibrium models. Examples of the application of this work were presented in previous sections.

Second, at the farm level, there were identified a number of specific projects, such as plant, rubber tree, sheep and honey bee breeding. However, the development of these new technologies and their diffusion is much more effectively done if considered in the context of farming systems. This approach can provide a link between the technical and social research.

Another item of interest was the potential role of Australian researchers in this work. Not all research priorities nominated by each country obviously involved skills possessed by Australian researchers. For example, there was some doubt that Australians had much to contribute to work on farming systems for small-scale agriculture. However, a number of areas of potentially valuable cooperation were identified. These were, firstly, in the technical areas, such as animal breeding, soil testing, and plant breeding. Secondly, it was thought that Australian social scientists could make a valuable contribution to research designs, to database management activities and to computer software designs that were necessary for the farming systems work. A third advantage of using Australians could be that the research involved would sometimes uncover some politically sensitive areas, particularly in work related to marketing, and faster progress could be made by a disinterested but concerned observer, working in collaboration with local people, than might be possible by a team of local researchers. Finally, it was hoped that a foreign presence might give the research effort greater continuity than is sometimes achieved by solely local projects.

strategies between equity on the one hand and the desire for economic growth on the other. He suggests, we believe, that on occasions economic growth is achieved at the expense of equity.

Finally, a concern for social factors in development may include a consideration of what in some quarters has been called 'integral human development'. Integral human development calls for development in a social and ecological milieu.

Following Conyers (1982) it is suggested that there are two major reasons to consider social factors in any development strategy. One is the simple one that plans often fail if social considerations are not taken into account. Family planning, for example, will not be effective if planners fail to consider people's attitudes to family size and alternative methods of contraception. Agricultural extension programs that reach only wealthy farmers will not in the long run solve a country's rural development problems. The second reason for consideration of social factors has to do with the fact, now recognised in many countries, that social goals or objectives are an important end in themselves, not merely as a means of ensuring that economic objectives are achieved. Quality of life has come to be a legitimate goal of development programs.

We want to turn now and briefly consider the question of technology in this context. The notion that technology is the key to successful development is entrenched in much development thinking and perhaps needs little elaboration. The voluminous publications on technology transfer, i.e. the transfer or exchange of technical know-how, which is normally required in setting up and operating new production facilities and which is normally in short supply or absent in developing economies, if saying nothing else, at least confirm the assumption that development will be elusive if such technology is not circulated and adopted by the less developed.

It is undeniable that technology has brought to the developed countries many benefits, in particular a high material living standard through greater production and productivity. It would also be difficult to argue against the notion that technology is the single most important resource needed to create other resources, and that technology almost certainly offers the best hope of improving the quality of life in developing countries. Yet one also has to recognise that the dominant and pervasive role played by technology is basically unique to modern society. Because it is linked directly to science, which has high prestige value, and since it has demonstrated practical utility, modern technology enjoys lofty status not only as reflected in our contemporary social values but also in much current development thinking: specifically, the road to modernity necessarily passes through technology.

The reality, however, is that technology has been experienced ambiguously in the developing countries. The smallholders in the Malaysian rubber industry are a case in point. Despite the active encouragement from both the government and extension research units, and there are not great problems in the availability of appropriate technologies, many smallholders remain reluctant to adopt and participate in the specific arena of technology created for them. In order to understand their participation (or lack of it) in 'modern' technology, it is important to re-examine the assumptions underlying the notion of technology diffusion and the related Western notions of rationality, efficiency and problem-solving.

Three basic values are embedded in contemporary technology. The first is the particular Western approach to rationality. To be rational, in the Western mind, signifies viewing every experience as a problem that can be broken down into its elements, reassembled, manipulated in practical ways, and measured in its effects. In other words, if there is truth, it has to be supplanted by the verifiability of technology. Related to this is the second value embedded in modern technology that emphasises a particular viewpoint on efficiency. Efficiency is a general relationship, and its dynamics can be laid bare by analysing a specific expression drawn from industry, i.e. productivity. Production looks to the amount of final output; and productivity is the balance between what is put in and what comes out. But central to these are also the concepts of 'externalities' and 'internalities' in the cost/benefit efficiency calculus: factors and values that do not have a direct bearing on the production and profit-maximising calculus are considered to be an 'externality'.

If by definition technology is merely interested in getting things done, especially by ways of rationality and efficiency, it exhibits a predilection for a problem-solving stance in the face of nature and human events. The technocratic problem-solving stance differs diametrically from the 'problematising' stance advocated by Friere (1972). In problem-solving, an expert steps back some distance from reality, breaks it into its component parts, analyses them, devises means for solving difficulties in the most efficient way, and then develops an appropriate strategy or policy. To problematise, on the other hand, is to engage one in a total reality to generate a critical consciousness and alter the person's re-

Sociological Perspectives on the Smallholder Rubber Industry in Malaysia and Indonesia

A. Cottrell, D. Ip and J.S. Western*

THIS paper examines the question of technological change in the smallholder rubber industry in Malaysia and Indonesia from a sociological perspective. It is in three parts. In the first, the issue of technological change is located more broadly in the context of development. In the second, the significance of rubber as an export commodity in the economies of the two countries of concern is noted. Finally, the problem of inducing change to improve production, both at the national level and so contribute to economic growth, and at the level of the individual smallholder and so improve his standard of living, is considered.

Technology and Development

Development is frequently seen in terms of modernisation and of change from traditional lifestyles to those more characteristic of persons and groups in the industrialised world. In *The Passing of Traditional Society*, Daniel Lerner (1958) was one of the first sociologists to look systematically at this question; he has been followed by many others. Among the more recent are McClelland (1961), Bose (1962), Hagan (1962), Belshaw (1965), Doob (1965), Hyman et al. (1967), Kahl (1968), Rogers (1969), Inkeles and Smith (1974), Conyers (1982), and Hardiman and Midgley (1982). All these authors have taken the view that attempts to build modern states are little more than empty exercises unless these attempts take account of the attitudes, values, beliefs and capacities of the people. There is increasing evidence to suggest that it is impossible for a state to adapt to technological change unless its people are attuned to and recognise the value of that change. The fact of culture must loom large in any development strategy.

The importance of so-called social factors in development has come to recognition only recently (Apthorpe 1970; Conyers 1982), and in a relatively short period a great deal has been written about the significance of these factors for development. Not all writers however have defined social factors in the same way. One of four general matters has normally been identified. Apthorpe (1970), for example, discusses the 'human factor' in development. This includes a variety of aspects of people's social and cultural environment that influence the way they perceive their needs and react to development strategies. The concept of the human factor is important in discussions of human rationality. Before the importance of social factors was fully recognised, individuals in developing countries were often criticised, especially by economists, for acting 'irrationally'. However, when their behaviour was studied carefully, it was realised that although in economic terms they were not technically 'rational' because they were not choosing an option that would maximise income or output, their behaviour was perfectly rational when social factors were taken into account.

The second interpretation of the concept of social factors concerns an emphasis on the provision for social needs including basic social services, health, education, housing or welfare, and less easily defined needs such as the preservation of traditional culture. Many development programs, while focusing solely on the attainment of economic goals, have failed to take account of these various social needs as well.

Taking account of social factors in development also means considering what impact development will have on inequalities that already exist between individuals and groups. For example, will an agricultural extension program benefit all farmers or only the wealthier ones? If it benefits only the wealthier ones, will the gap between the more and the less affluent be greater at the end of the development program than it was at the beginning? Rickson (1985) notes the tension in development

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lations with nature and social forces. In other words, problem-solvers see themselves as outside viewers of the reality they are investigating and ignore the totality surrounding them of which they are a part. Problematisers, on the contrary, see themselves as part of the totality, with that totality itself being subjected to the influence of their own actions once they have gained a new critical understanding of it.

These embedded values and assumptions of modern technology have helped to construct and display a particular 'existence rationality', i.e. strategies devised to cope with survival, to exercise control over nature, resources, or any other destructive social forces at work within a certain community boundary. Underlying the preoccupation with historical rationality, it is assumed that other realms of cognition are less important because their elements are not amenable to direct observations. What emerges from this approach is that modern technology tends to be reductionistic in its approach to rationality. In emphasising efficiency, any values or considerations that do not enter a cost calculus would tend to be excluded since all that matters is the objective of 'getting the job done' and 'doing it right'. Out of this framework comes the judgment that machines and productivity, i.e. the inner efficiency and logic of technology, should exert control on the external demands reflected in social values.

By reducing the organic totality of human experience solely to those dimensions that can be treated as mere difficulties to be removed, the problem-solving stance encourages not only a technological approach to life itself but gradually also legitimises this partial view as normal. Behind this approach lies a somewhat mechanistic mentality that encourages the view that human institutions and natural forces are objects that can be manipulated by technology. Additionally, the value of their existence tends to be equated with their usefulness, which is in turn being rendered or conferred by technology.

In addition, there is the erroneous assumption that technology can be 'transplanted' from Western to developing nations. In terms of farming, this is an assumption fraught with difficulties. In the West, farmers are involved in the political process in such a way that they have lobbying power with governments, while in developing nations this is seldom the case. The assumption that the goals of farmers and researchers coincide is often queried in the West, but is more open to question in developing agriculture. In the West, when government intervenes to protect an industry, farmers still maintain their autonomy—they can decide what they grow. In developing areas this may not occur. Non-competitive farmers may more easily be absorbed into the wage structure of the West than in developing nations, making it easier to decide that land reforms are possible.

Finally, a farming system is a combination of biological, technical, managerial and social phenomena that must be treated as an interacting system (Flora 1983).

It should be pointed out that the major concern of this paper is not to refute the basic value and contribution of modern technology to the development of the less developed nations. What we are pointing out is that the great difficulty in implementing development does not rest so much on developing new technologies as ensuring their diffusion. We feel certain that after decades of development efforts, it is not technical knowledge that we lack, rather it is the fetish of technology that has developed over the years that prohibits us from further understanding the knowledge of human situations, which has resulted in our development efforts remaining haphazard. It is with these concerns in mind that we propose to study the case of the smallholders in the rubber industry in Malaysia and Indonesia.

Industry Changes in Malaysia

Over the two decades to 1980, there were significant changes in the structure of the Malaysian economy. These are reflected in the sectoral shares of GDP where the agricultural sector share contracted (41 to 22%), while the manufacturing sector (9 to 20%) and the service sector (39 to 47%) shares both expanded. Over this period, nominal GDP grew at an average annual rate of about 8%. Commodities exported reflect these changes with rubber declining from 71 to 14% of exports. Not all agricultural sector shares of exports declined, e.g. sawn logs and timber increased from 2 to 13% and palm oil increased from 3 to 10%. However, there is little opportunity for rubber smallholders to transfer to these other commodities (Barlow and Jayasuriya 1984a).

There have been a number of responses to these structural changes in the Malaysian economy and to the pressure they placed on the rubber industry. These have included innovations in agronomic practices, a limited transfer to alternative crops, and very limited consolidation of holdings. However to date, these responses are not considered to be adequate to meet current problems.

Rubber Industry Changes in Indonesia

Until 1957 Indonesia was the largest producer of natural rubber in the world. However, since then production declined, largely as a result of disruptions in plantation ownerships. In 1957, 227 Dutch-owned plantations and later in 1964, 104 British-owned plantations and 5 U.S.-owned plantations were confiscated. Since 1963, rubber production has increased irregularly.

However, rubber is a major product of the Indonesian economy (Barlow and Muharminto 1982). In 1980 it contributed 5% of national export revenue coming third in value to oil products and timber, and comprising 19% of non-oil items. Rubber provides the main livelihood for over one million families. Most of these families are smallholders and more than two thirds of all production comes from smallholders.

There are many modes of rubber production. While estates and smallholdings provide the chief distinction in mode of rubber management, each sector covers a range of approaches in both Indonesia and Malaysia. In Indonesia some government estates were created through nationalisation of private concerns. Private estates of various sizes still exist.

In both countries there is a smallholding sector. However, according to Barlow and Muharminto (1982) rubber smallholders face many serious problems apart from this fall in prices. Because they are short of cash, they cannot afford improved planting materials or other purchased inputs. They are unskilled and know little about improved practices. Their yields and product qualities are consequently poor. They also have bad access to markets, and accordingly high transport costs. Government attempted various approaches to improve the economic condition and productivity of rubber in India and is very keen to evaluate some of its approaches, especially nucleus estates.

Smallholder Production

Rubber smallholders in all of Southeast Asia share similar structural positions. The situation is characterised by a dichotomy of estates and smallholders with the estates having an historically institutionalised advantage. Estates are in a better position to take advantage of innovations in technology partly because of their bureaucratic nature that is geared towards Western-style technology, partly because they are situated on transport routes making them more accessible to innovative practices that tend in general to be far more readily utilised, and also because research has traditionally been oriented toward the estate sector (Barlow and Jayasuriya 1984a). Until the introduction of government initiated programs, smallholders have largely been expected to gain their information by the process of diffusion; a process that Barlow and Jayasuriya (1984b) indicate takes up to three decades.

In terms of smallholders themselves, basic infrastructure such as access to roads and other transport, and proximity to urban development was found by Gibbons et al. (1980) to be a major predictor of utilisation of new technology. The authors implied that ease of access through transport was a major factor. In addition, it may be that those closer to urban development may also be closer to influences that encourage adoption of new technologies. Of the two countries, Malaysia has the benefit of a relatively confined geographical area. Conversely, Indonesia has geographical constraints that make the provision of infrastructure particularly difficult in the remoter areas.

In general, government intervention in smallholder development has been greater in Malaysia than Indonesia. This resulted in Malaysian smallholders in the 1970s, who were involved in programs such as FELDA (the Federal Land Development Authority (Malaysia)) and FELCRA (the Federal Land Consolidation and Rehabilitation Authority (Malaysia)), adopting more technological innovations than their counterparts in Indonesia (Gibbons et al. 1980). However, Barlow and Jayasuriya suggest that the type of highly structured intervention found in FELDA and FELCRA may in some cases be stifling independence and flexibility and that at least in Indonesia a more laissez-faire response has provided encouraging results. This however may be at the expense of equity, a feature of government planned developments in Malaysia.

Consolidation of land parcels in all smallholding sectors is clearly a vital issue for both Malaysia and Indonesia. The minimum plot size recommended by RISDA (the Rubber Industry Smallholders Development Authority) (1977) is 1.5 ha. Rationalising land tenure systems is not always easy. Although some smallholders may be prepared to relinquish land, this appears most likely within kin networks and in any event is not an extensive practice (Ho 1967). Land resumption also involves factors such as adequate compensation and in some cases retraining to allow for adequate employment elsewhere. Flexibility is important. If jobs are not to be found, elsewhere, the farmer's only alternative is to remain on a plot of inadequate size that provides inadequate returns for his efforts. It is little wonder that education to enable children to obtain work in urban areas is often seen as an investment of high priority by many rubber farmers (Gibbons et al. 1980), which in itself implies a readiness to adopt new technologies suited to the situation.

There is little evidence to suggest that people in developing nations actively resist technological change. To the contrary, where it is perceived as appropriate, it is readily adopted, e.g. weaving and shipbuilding in Indonesia (Dick 1980; Hill 1980). Rubber as a crop is itself an example of readiness to adopt a new technology. It was a crop that was initially readily accommodated into agricultural practices and lifestyles, i.e. a flexible crop that was not too demanding on time and resources and easily manipulated depending on the cash flow required, marketing restrictions and price fluctuations.

The current situation with rubber smallholders is one in which a wide range of technologies is used. In some areas such as parts of Sumatra, unselected seedlings are still being used as basic stock and with inadequate tapping and management techniques the level of technology represented would have to be described as minimal. At the other extreme, are the highly organised government programs in Malaysia and Indonesia where many of the new technologies have been adopted. However, even here, management techniques and use of credit facilities have shown little development. In broad terms however we can identify the innovative, the intermediate, and the inadequate smallholder in terms of resources and/or motivation (Barlow and Jayasuriya 1984b). For each general group there are a number of questions that need to be asked in the cultural context:

1. In what ways can a fatalist attitude to life be circumvented in terms of agricultural production?
2. What cultural and legal processes will facilitate land consolidation?
3. Who would manage land consolidation?
4. What alternatives are there for those who leave the land, e.g. re-training, credit loans etc.?
5. How is information to be conveyed to farmers to be meaningful?
6. How autonomous are farmers likely to be, i.e. will the land be freehold; will they be able to decide what to grow?
7. Who will pay for basic transport infrastructure?
8. How do the new marketing systems accommodate to traditional practices?
9. How are credit sources to be administered and how do they accommodate with traditional practices—does it need to be centrally controlled?
10. What are the management strategies achievable in the short, medium, and long term?

More questions of this nature will inevitably arise. For each locality the questions may be different and even within localities different strategies may be required depending on the situation.

In the past smallholders have adopted rubber cultivation despite dissuasion from larger interests. The general question now becomes one of how to present improved technology, whatever its form, to enable its ready adoption by the great majority of smallholders in contradistinction to the lengthy periods of delay that diffusion models typically predict.

Rural Development

The problem of rural development is of increasing concern in the world today. Despite this concern the problem often seems as intractable as ever. The gap between rural and urban areas in many places continues to widen in terms of incomes and services and within rural areas the gap between the rich and the poor shows little sign of diminishing. National plans have recently paid greater attention to the rural sector in an attempt to redress the balance of earlier plans that had concentrated in many developing countries more on industrialisation. In a great majority of these countries this planning has met with little success, either because of the nature of the plans themselves or because of difficulties of implementation.

In assessing the situation it is clear that much is known at the macro level about the dimensions of the problem. This knowledge is important in estimating the scale of action needed but in order for action to be effective there is need for a deeper understanding of rural communities at the micro level. Indeed, the variety of rural situations is so great both in ecological and social terms that it is doubtful whether general prescriptions for action can be valid. There is much to be said for focusing on individual village communities in examining questions of the dynamics of change and continuity, and the impact of technology.

Linear notions of diffusion and adoption of new technologies of the past have been seen not to necessarily accord with the facts. Non-adoption of new practices is frequently not because the 'laggard' or the 'late adopter' is a laggard or a late adopter, but because there are very good reasons for the persistence of traditional practices. New practices may simply require the expenditure of resources that the individual does not possess and benefits in terms of increased production, while they are experienced at the national level, may not find their way to the individual producer.

The rubber smallholder, whether he is the resident of a FELDA village or FELCRA or RISDA in Malaysia or one of the new experimental village communities in Indonesia has available to him a range of innovations in agronomy, plant breeding, tapping methods, and yield stimulation. But these new technologies have been slow to diffuse to smallholdings. Some of the 'technical reasons' for this situation have been given as low capital intensity, lack of information, rising wages, lack of management skills, smallholding sizes, and technology that is more appropriate to the estate sector. While it is doubtless true that those factors play a part, it is also probable that they are not the only critical ones.

Cultural considerations are significantly absent from analyses. If we are to understand problems at the local level and propose alternatives to current practices, then the simple transplantation of 'Western science' is not the way to proceed. A critical rethinking of strategies for change should have at its base the intention of starting where the community is and building on the cultural elements that are paramount within it rather than attempting to graft onto the community a set of proposals that originated from outside. Research in this area needs to focus on village communities and needs to start from the point of view of the villagers. In saying this, we are not suggesting that all past strategies for change have been wrong, although demonstrably there have been spectacular failures, or that there is a magical panacea. What we are suggesting is that if some of the beta weights in the equation of change have social referents its predictive power will be significantly enhanced.

References

Apthorpe, R. ed. 1970. People, planning and development studies. London, Frank Cass.

Barlow, C., and Jayasuriya, S.K. 1984a. Bias towards the large farm subsector in agricultural research. The case of Malaysian rubber. Research and Development in Agriculture, 1(3), 153–164.

Barlow, C., and Jayasuriya, S.K. 1984b. Problems of investment for technological advance: the case of Indonesian rubber smallholders. Journal of Agricultural Economics, 35(1), 85–95.

Barlow, C., and Muharminto 1982. Smallholder rubber in South Sumatra: towards economic improvement. Balai Penelitian Perkebunan, Bogor and Australian National University.

Belshaw, C.S. 1965. Traditional exchange and modern markets. Englewood Cliffs, N.J., Prentice Hall.

Bose, S.P. 1962. Peasant values and innovation in India. American Journal of Sociology, 67, 552–560.

Conyers, D. 1982. An introduction of social planning in the Third World. Chichester, John Wiley and Sons.

Dick, H. 1980. The rise and fall of dualism: the Indonesian inter-island shipping industry. In: Fox, J.J. et al. Indonesia: Australian perspectives. Research School of Pacific Studies, Australian National University, 349–372.

Doob, L.W. 1965. Attitude scale items suggested for studies of modernization. New Haven, Conn., Yale University, Department of Psychology.

Flora, C.B. 1983. Farming systems research and the land-grant system: Transferring assumptions overseas. In: Flora, C.B. ed., Farming Systems Research Paper Series, Paper 5, April 1983. Manhattan, Kansas, Kansas State University.

Friere, P. 1972. Pedagogy of the oppressed. New York, Herder and Herder.

Gibbons, D.S., De Konnick, R., and Hasan, I. 1980. Agricultural modernization, poverty and inequality: the distributional impact of the Green Revolution in regions of Malaysia and Indonesia. Hampshire, Gower Publishing Co.

Hagan, E.E. 1962. On the theory of social change: How growth begins. Homewood, Ill., Dorsey Press.

Hardiman, M., and Midgley, J. 1982. The social dimensions of development. Chichester, John Wiley and Sons Limited.

Hill, H. 1980. Dualism, technology and small-scale enterprise in the Indonesian weaving industry. In: Fox, J.J. et al. Indonesian: Australian perspectives. Canberra, Research School of Pacific Studies, Australian National University.

Ho, R. 1967. Farmers of Central Malaya, Department of Geography Publication G/4. Canberra, The Australian National University.

Hyman, H.H., Levine, G.L., and Wright, C.R. 1967. Inducing social change in developing communities: An international survey of expert advice. Geneva, United Nations Institute for Social Development.

Inkeles, A., and Smith, D.H. 1974. Becoming modern: Individual change in six developing countries. London, Heinemann.

Kahl, J.A. 1968. The measurement of modernism: a study of values in Brazil and Mexico. Austin, University of Texas.

Lerner, D. 1958. The passing of traditional society: Modernizing the Middle East. New York, Free Press.

McClelland, D.C. 1961. The achieving society. Princeton, N.J., van Nostrand.

Rickson, R.E. 1985. Impact assessment and the role of the social scientist in rural development. These Proceedings.

RISDA (Rubber Industry Smallholders Development Authority, Malaysia). 1977. Laporan Sementara Banci Pekebun Kecil Getah Semenanjung Malaysia 1977. Analisa Profail Socio-Ekonomi Kemiskinan dan Penyertaan Dalam Rancangan. (In Malaysian).

Rogers, E.M. 1969. Modernization among peasants. New York, Holt, Rinehart and Winston.

Impact Assessment and the Role of the Social Scientist in Rural Development

R.E. Rickson*

MODERN conceptions of rural development necessarily focus on the relationship between agricultural productivity, changing technology and social equity (Geisler et al. 1981). Rather than an exclusive focus on increasing crop yield, programs need to consider and understand the history and nature of local institutions and their relationship with agricultural cropping systems (Zandstra et al. 1979; Spijkers 1983). Increasing production does not always result in an improved standard of living for most rural families in developing nations and they are likely to have a greater concern for health services, education, and other community development programs (Bartlett 1980).

Growth is a relatively simple concept and, by itself, is not a sufficient test of development. For example, a nation may, in the short term, increase its grain production, but technologies for doing so may engender or magnify social inequities (Soemardjan 1972; Basuno 1984). Environmental costs of soil erosion or environmental pollution may represent costs that nullify gains from increased production. Development, on the other hand, is a behavioural concept. Strictly speaking, development implies that an activity system is transformed in the mode of its behaviour (Dunn 1971). This means that plans and technology may be revised as implementation proceeds. To do so, however, requires a continual flow of information from the field to the research and planning team so that the short-term effects of policies and technology can be realistically evaluated and altered, if necessary. It implies an open system in which those who are the targets of development participate in the formulation of plans, implementation and evaluation (Dunn 1971; Zandstra et al. 1979; Spijkers 1983). For example, many analyses of agricultural development in Asia stress the critical significance of small farmers and their participation in planning (Hansen 1973).

The transformation of agriculture in Asia involves innovations by millions of small farmers, studies of the socioeconomic, as well as the biophysical, constraints to adoption they face, and their perceptions of constraints. In turn, information from small farmers as to what kind of technology and institutional arrangements (credit systems, for example) will be most beneficial to them and their on-going evaluation of these factors are the types of positive information that should be part of development planning.

Development, as defined here, requires information considerably beyond what is required for the creation of new technology. The focus of this paper is on the type of information needed and how research and planning teams may be structured to ensure that such essential information is available and used.

The different types of information considered essential for effective development programs are:

1. Social, land, environmental, impact assessment on a cumulative basis so that negative impacts are anticipated early in the planning process and procedures are established so that problems can be mitigated as they arise (Finsterbusch 1980; Geisler et al. 1981; Rossini and Porter 1983).

2. The necessary conditions determining whether the farmer would be able to adopt improved practices. Such conditions would include technical feasibility, social acceptability, and compatibility with external institutions, i.e. support systems (Norman 1983).

3. Sufficient conditions determining whether the farmers would be willing to adopt the improved practices. Obviously the necessary conditions will be influential in determining this willingness. Sufficient conditions will include compatibility of the improved practices with the goal(s)—self-

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sufficiency, profit maximisation, etc.—of the farming family and of the farming system they currently practice.

Impact Assessment

We see that social impact analysis and environmental impact analysis as critical concepts to be included in the thinking of development research teams. Dusseldorp (1977: 215) says that a major contribution of social scientists in agricultural research is to '. . . ascertain in advance what effects the development and introduction of new crops and/or crop technologies could have on the existing social and economic situation.' A more technical definition of social impact analysis is that it is concerned with identifying and predicting probable impacts on social relationships at both the individual and institutional levels. This definition includes impacts on individuals, groups, organisations, communities, and larger social systems (Clark et al. 1980).

In theory, at least, international development agencies such as the United States Agency for International Development (USAID) and the World Bank now require a form of social and environmental impact assessment as a prerequisite for funding projects. They use the term 'social soundness' that includes analyses of existing social organisations, how to incorporate them into project design, an assessment of project impact on local populations, and the potential spread effects of new technologies to other areas (Hansen and Erbaugh 1983).

There are several different models for social impact assessment. One of the most comprehensive is that by White and Hamilton (1983: 50–51). They advocate evaluating projects in terms of the full range of information that policy-makers need to make policy choices. These are effectiveness, efficiency, equity, flexibility, and implementability.

Environmental Impacts

Environmental impact assessment essentially refers to determining the relative 'additions' of materials to the natural ecosystem and what is 'withdrawn' as the result of development projects in rural or urban areas. Materials added to the natural ecosystem range from toxic pesticides, herbicides, and other agricultural chemicals as the result of introducing certain production programs. An example may be the 'green revolution' varieties of wheat that require larger amounts of nitrogen fertiliser than conventional varieties. If there is any soil finding its way into public lakes and streams, highly fertilised soil speeds up the eutrophication process by rapidly consuming dissolved oxygen.

While additions to the environment refer to what is conventionally considered to be pollution, withdrawals from the environment can potentially lead to depletion of soils, water systems, or natural areas such as rain forests. For example, Schnaiberg (1980: 24) refers to the effects that much of Western agriculture has on the natural ecosystems: (1) adds pesticides, herbicides, and fertiliser to land and water; (2) adds new animal species and new plant species; (3) adds animal wastes to land and water (through run-off); (4) withdraws existing flora (trees, weeds); (5) withdraws existing predators and rodents (hunting, trapping); (6) withdraws water (by intensive irrigation).

Heady (1975: 19) further notes that 'The increased use of chemical fertilisers and pesticides in agriculture results in residual inputs transported by water to endanger stream and groundwater supplies. It also encourages and allows intensified row-crop farming, which is accompanied by silt exports and the degradation of water supplies.'

Social and environmental impact assessment are different sides of the same argument; information about the social and environmental impacts of development projects is essential for their long-term acceptance by farmers. Unless small farmers accept a technology, over time, it cannot contribute to increased farm production, incomes and overall community welfare. Social and environmental impact assessment are related since social impacts of technology such as involuntary rural to urban migration ultimately affect urban living standards and environmental quality. Alternatively, sustaining agricultural soils and ensuring at least minimal standards of air and water quality are associated with general quality of life. The relationship is noted by Bennett (1976: 3) as '. . . a study of how and why humans use Nature, how they incorporate Nature into Society, and what they do to themselves, Nature, and Society in the process.'

Social Impact Assessment

EQUITY

These two concepts, equity and mitigation, can be used to illustrate the relationship between social and environmental assessment and planning in development programs. First of all, social welfare issues and environmental quality are neither socially nor politically separable (Schnaiberg 1980). Programs designed to enhance social welfare can have adverse environmental consequences and, from a sociological perspective, '. . . it is never sufficient to point to the environment as having been protected. The question must always be asked, for whom and from whom has it been protected?'

In accordance with Geisler et al. (1981), equity is used in two ways as temporal and intergenerational. Temporal equity refers to the fairness of policies and actions to present groups and persons and can be equated with a concern for social impacts of programs. Regarding rural communities in developing countries, we specifically refer to land tenure, environmental pollution and health, local economic multipliers, viability of local community institutions and the effects of new ones designed to further development (e.g. 'buffer' institutions, discussed below).

Intergenerational equity refers to maintenance of natural resources necessary for crop production and is equivalent to the concept of sustained yield (Bennett 1976). That is, what effect does the introduction of a certain technology have on existing soils, soil nutrients, and water supplies? Heady (1975) and others have discussed basic equity problems of Western agricultural systems in terms of their effects on soil quality and retention, and social impacts on rural communities. Geisler et al. (1981) say their findings suggest that: '. . . massive injections of capital-intensive technology into the U.S. food and fiber production system may in fact be masking the rise of unsustainable production, even at present levels of output, while also incurring a complex array of inequitable consequences for rural people and communities.'

The particular interest of this paper would be the impacts of development programs on the small landholder in agriculture. Concepts of temporal and intergenerational equity can be applied to this problem in both the developing and developed countries. The point of assessment would be whether new technologies are neutral according to farm size and income and how to mitigate the consequences if they are not. If technologies benefit primarily large farmers, then unemployment, hunger and uncontrolled rural to urban migration are the results. None are socially or environmentally desirable.

The social welfare function of small farms notwithstanding, small landholders can make a substantial contribution to agricultural production provided that both policies and technologies are designed to mitigate socioeconomic constraints faced by small farmers. Recognition of the potential productivity of small farms in developing countries follows the recognition in more industrially developed nations that large farms are not necessarily more efficient or productive than small farms.

According to Sen (1977: 10) effective land reform is one condition necessary to satisfy so that the green revolution may give a massive boost to job-creation and farm productivity, rather than massive unemployment. Policies and technologies should be neutral regarding farm size. Sen suggests that of the three separate facets of the green revolution (biological, technological, and mechanical), the first two are neutral regarding size while the latter (mechanisation) is not. Small farmers, if given equal access to knowledge, facilities, and services can, by their more intensive effort, outproduce big farmers in terms of actual productivity per acre. What needs to be resisted in the green revolution is the creation—or even retention—of large farms spearheading unbridled mechanisation and consequent displacement of farm labour (Sen 1977: 10).

When agricultural organisations act only as 'dispensers of information,' large, well-educated farmers with influential political contacts have a clear advantage. Even though a technology may be profitably used by small as well as large farmers, bureaucratic methods for implementing agency policies often are not (Hassan, These Proceedings). Therefore, impact analysis should be extended to policies and programs and not just to the evaluation of specific technologies.

Some of the most dramatic effects of single-minded planning for agricultural development have occurred in the United States and serve as a reminder to developing nations of the importance of considering temporal and intergenerational equity in development programs.

Automated cotton harvesting with the use of tractors and mechanised cotton pickers to gather cotton revolutionised the plantation system, converting it quickly from a labour intensive system to one that is highly mechanised and capital intensive (Geisler et al. 1981). Mechanisation led to the breakdown of the share-cropper system and adversely affected small farmers. Neither policies nor technologies were size-neutral. The widespread displacement of tenants, sharecroppers, and small operators illustrates the relationship between social justice and equity in land (Geisler et al. 1981). Insofar as land dispossession was inherent in cotton harvesting, the new technology caused widespread deprivation; the effects spilled over to massive problems for urban areas as displaced farmers and farm labourers drifted to the cities.

Mechanised cotton harvesting also had negative consequences for soil quality. Capital intensive cotton farming seems to have significantly contributed to soil loss and degradation (Geisler et al. 1981). Considering long-term sustainability of agricultural lands in the rural South, it may be that the substitution of machines for labour, instead of staving off soil infertility, has disguised the exhaustion of southern lands (Perelman 1977). A cogent comment considering equity or social impacts in technical development is that by Kelso and Hillman (1969: 10): 'When the cotton picker was developed, agricultural intellectuals . . . should have studied the problems of adjustment forced on cotton field hands, should have assessed the social costs, should have devised institutional reforms to cushion the shock and the cost-a-cost which should have in some way been shared by cotton producers, the cotton processing and merchandising industry and, of course, by the cotton consumers. . . . And partly because we failed to learn from that experience, we blindly go forward developing tomato harvesters, field lettuce cutters and field lettuce packing technologies, milk production factories and the thousand and one other forms of improved technological efficiencies'.

MITIGATION OF IMPACTS

Mitigation and equity are companion concepts in impact assessment. A major contribution of social scientists to development programs is to help ascertain in advance how programs such as the introduction of new crops and cropping systems will affect local institutions and community social structure (Dusseldorp 1977). However, assessment is never an exact process and unanticipated consequences are inevitable. Furthermore, sometimes local change is the goal of programs and it may involve altering local power relationships so that more widespread public participation is possible. In either case, restitution, of some form, for loss is generally built into the planning process. Without attention to mitigation, early adoption of programs and technologies may turn to rejection as farmers experience unexpected negative consequences. Geertz's (1963) concept of involution describes a situation of Indonesian farmers in Java reverting to traditional institutions and farming practices in such circumstances (White 1976; Basuno 1984).

An example of adverse social impacts of otherwise successful programs is cited by Dillon (These Proceedings) in his analysis of the North Sumatra Smallholder Development Project (NSSDP). It was introduced to provide land, high yielding rubber clones, credit and extension to participants. However, initial use of new rubber varieties was very labour intensive requiring weeding and introduction by the farmer of new cultivation practices. At the same time, according to Dillon (1985): 'these families had to work off the farm in order to obtain adequate funds to procure food and other subsistence needs.' The result was significant increases in work responsibility for spouses and children as male heads of households were forced to hire themselves out. Dillon reports that spouses in participating households spent 78% more of their time on rubber production than did women in non-participating households where trees were already producing and providing a steady flow of income from rubber sales. Furthermore, the education of children was delayed and, in some cases, sacrificed.

Current studies, e.g. *Caqueza* (Zandstra et al. 1979), find that knowledge of socioeconomic constraints on farmers to adoption and the development of new social institutions that help spread the risk of using new technology are associated with the diffusion and adoption of culturally accepted practices. Spijkers (1983) also cites research criticising traditional adoption/diffusion research that operates under a model as assuming that technologies are neutral in terms of social class and farm size. When technology is designed with the socioeconomic constraints faced by small farmers in mind, those formally defined as 'laggards' are 'early adopters.'

Ascroft et al. (1972) and Rölling (1983) both report studies that show that when farming systems are heterogeneous in terms of either physical characteristics (soil types, access to water, climate) or in terms of socioeconomic differences, the same innovation cannot be assumed to be useful to all farmers.

Ascroft et al. (1972) found that when technology was specifically designed to cater to the specific needs of small farmers, it was adopted very rapidly by those that would otherwise be classified as laggards.

A great deal of research in anthropology and social psychology has concluded that peasants are conservative and nonchanging in character (Rogers 1969). Peasants are depicted as poor candidates for adoption of new ideas and techniques that would make them more modern (Bartlett 1980). This model reinforces a view that the principal impediments to change by peasants are their values, attitudes, and motives. Major theories of sociocultural change reinforce this view (McClelland 1961; Rogers 1969), but even though there is some validity in these theories, Bartlett (1980: 291) points out that '. . . they conveniently shift the burden of failure to modernize the peasants, leaving the larger societal structure free of criticism.' There is then a built-in excuse for the failure of development programs. Bad planning and inadequate support for change are not the reasons for failure, but the conservatism of peasants who refused to cooperate with benevolent agents of socioeconomic modernisation.

A different approach is taken by Zandstra et al. (1979). They cite the experience of the Caqueza project in attempting to modernise traditional production systems and to improve social welfare that both technical and socioeconomic changes were more constrained by weaknesses in existing institutional structures than by lack of knowledge. Introduction of new activities, in their experience required the creation of what they referred to as 'buffer' institutions. They found an important factor in the change process was the creation of new institutional forms or buffer institutions, which would facilitate transitional phases between traditional and modern technology. It assumes that the positive impact of new technology in agriculture is likely to be very limited unless it is closely associated with institutional change.

Credit systems specifically designed for small farmers is an example of a buffer institution. Other examples used in the Caqueza project were farm cooperatives and dissemination programs designed to realistically meet conditions on local farms. The philosophy behind the dissemination programs was that technology developed in experimental stations with known or controlled soil, water, and microclimatic conditions is not readily transferable to the heterogeneous soil, water, and climatic systems found on many farms. Lengthy adaptation and adjustments of technology were required before it could be recommended to small farmers. It also required development of extensive and intensive networks of communication with farmers where they were involved with evaluating and altering the technology to meet their individual requirements.

Critical Input

A USAID analysis, cited by Hansen and Erbaugh (1983), of programs aimed at small farmers found that the most successful were based on knowledge about the sociocultural system of the farming community (Morss 1975). Several different types of information were relevant. Information about the cropping system used by the farmer is significant for project success (Flora 1982). So too are analyses of traditional priorities, which may be based on traditional religious, political, family or economic values. These factors can function to facilitate adoption or, if not well understood, can act as socioeconomic constraints to certain types of technologies (Saint and Coward 1977).

Spijkers (1983) points to the analysis of relationships between broad categories of farmers (social classes, different types of farmers) and relevant aspects of agricultural technology. For example, how mechanised is the existing agricultural system used by farmers and is there a difference between farmers on small, medium sized, and large properties? Anticipating the demographic effects of new technology (rural to urban migration, for instance) and other socioeconomic impacts, Spijkers (1983) also emphasises the importance of studying the material basis of the farmers' cropping systems, especially from the point of view of the farmer.

Hansen and Erbaugh (1983) suggest another category of information necessary to develop programs. This includes data on income and land tenure, the power structure of the local community in which a project takes place, and existing local organisations that may impede or facilitate program implementation. Recognising the problems of 'institution building' in development programs, the success of programs is facilitated if pre-existing organisations, accepted in the community, participate in planning and implementation. A number of researchers conclude that when local organisations are incorporated into research designs, the willingness of farmers to risk adoption of new practices is increased (Wharton 1969; Whyte 1975).

Multidisciplinary Teams

The dual and complementary goals of agricultural productivity and rural community development require multidisciplinary teams, which include agricultural production and social scientists. Even though modern development programs sponsored by such agencies as the World Bank, USAID and FAO recognise, in their policy statements, that research teams should bring together production and social scientists, the reality is often quite different from the ideal (Campbell et al. 1981; Rickson and Rickson 1982; Spijkers 1983).

Basuno (1984), in his study of adoption of animal husbandry practices at the village level in Indonesia, found that the role of social science in development is not widely recognised. He found that social research relating to animal husbandry is very rare at the present time. He cites an example of official views that any research on animal husbandry must be conducted by animal scientists, yet past experience with village programs shows that the lack of understanding of village people is the most important reason for program failure—the type of information that is most validly provided by social scientists.

Social scientists as part of multidisciplinary research teams often experience role ambiguity and conflict, and this usually reduces the contribution they can make to program success. For example, Spijker (1983), in his study of rice production in Colombia, says that: 'As a social scientist in an environment dominated by agricultural scientists, I have had considerable difficulty in defining my role and I became convinced that the institute's administration did not have a clear understanding of possible contributions of the social sciences to their program.' He cites Almy (1981) who adds that the most critical part of the job of a social scientist in an international agricultural research centre is to define one's responsibilities and to understand and clarify the expectations of others.

Although the social scientist may conceive of his/her role as integral to the research or development team, agricultural scientists sometimes define the role of the social scientist as a legitimiser (Rickson 1976). The sociologist, for example, may be seen as someone with communication skills who can help the agricultural scientist communicate with the target population after a technology has been developed. On the other hand, agricultural scientists may fully embrace the potential contributions of social scientists and, in the process, expect more than can be delivered.

Agricultural scientists, in the experience of Campbell et al. (1981), seem more willing to work with social scientists and Third World settings than in industrially developed countries. They note that: 'Perhaps they (agricultural scientists) more easily recognize the need for increased social understanding in third-world settings which they do not understand as well as they *think* they know the social situation in the United States.' In these circumstances, there is the tendency for too much to be expected of the social scientists and that they are capable of solving all problems of the research beyond the reach of the physical scientists (Campbell et al. 1981). The importance of the social scientist contribution to development programs is readily visible, but misunderstanding by other disciplines of the potential contributions and limitations of the social scientists can negatively affect team cohesion in development programs (Rickson and Rickson 1982).

The contribution of social scientists is essential to the success of development projects. However, successful collaboration between agricultural production scientists and social scientists cannot be taken for granted. Therefore, development of the research team so that collaboration occurs is an essential part of the overall development process. In line with the earlier definition of development, we reiterate that the sooner socioeconomic factors are considered in development plans, the more likely are we to understand the conditions in which farmers will use specific production or conservation technologies.

Summary and Conclusion

In a well-known paper, the sociologist Robert K. Merton (1968: 115) discussed the significance of the unanticipated consequences of socially purposive action. He argued, as others have, that it is very difficult to do just one thing at a time. Any action, plan or implementation strategy is likely to have multiple consequences, some or many of them unanticipated, and some probably will be highly undesirable.

Even though it is impossible to preclude unanticipated undesirable effects completely, social and environmental impact analyses present a theory of planning and a set of methodological procedures that serve to increase the amount of information that government and planning teams have about (1) target populations and the social and economic constraints to innovation and change they operate under, (2) alternative technologies and the relative suitability of each technology for a particular type of farmer, and (3) the type of institutional development (credit systems, for example) that is necessary to reduce the short-term impacts of change and to deal with undesirable consequences as they arise.

Impact analyses easily integrate with current conceptions of development, focusing on equity balances with economic growth and overall rural community development rather than just agricultural productivity. Since equity concerns and community development are long-term objectives, it is important that planning and implementation teams be structured so that socioeconomic information is gathered, processed and applied to problems as they arise. Dunn (1971), cited above, refers to this process as the fundamental dimension of development; plans and technology may be revised as implementation proceeds and information becomes available.

The direct implication of the points we mention is that socioeconomic information needs to be used at all points in the development process and that the role of the social scientist is critical. The latter part of the paper deals with some difficulties in the relationship between social and agricultural scientists in agricultural research centres, but shows also that when socioeconomic information is available and used in the implementation of agricultural technology, peasant farmers can show high rates of adoption. A USAID analysis found that programs aimed at small farmers were most successful when there was information about the sociocultural systems of the farming community.

In conclusion, impact analysis is seen as a positive factor in development. Such analyses need to be considered in the earliest stages of planning structural changes and transfer of technology in any area of development. However, considerable work remains to be done at both a theoretical and practical level so that this type of information may be effectively used. Impact analysis depends on adequate theory directing us toward the types of information most relevant to structural change and transfer of technology, and that which can be used by farmers and official policymakers. On a somewhat more pragmatic level, we need to understand the structure of policy organisations (government bureaus, planning teams, for example), which ultimately determine what kinds of information are collected, processed and applied.

References

Almy, S.W. 1981. The anthropologist at international agricultural research centres. Presented to the IRRI Workshop on the role of anthropologists and other social scientists in interdisciplinary teams in developing food production technology. Los Baños.

Ascroft, J.R., Chege, F., Kariuki, J., Ruigu, G., and Rölling, N. 1972. Does extension create poverty in Kenya? East African Journal, 9(3).

Bartlett, P.E. 1980. Introduction: Development issues and economic anthropology. In: Bartlett, P.F. Agricultural decision: Anthropological contributions to rural development. New York, Academic Press, 1-18.

Basuno, E.D. 1984. Small scale animal husbandry at the village level: A case study in Desa, Pandansari, Kecamatan Ciawi, Bogor, West Java. Unpublished Master of Philosophy Dissertation, School of Australian Environmental Studies, Griffith University, Queensland.

Bennett, I.W. 1976. The ecological transition. New York, Pergamon Press, Inc.

Campbell, R.R., Nolan, M.F., and Galliher, J.F. 1981. Reflections on Title XII: The case of sociology in the small ruminants collaborative research support program. The Rural Sociologist, 1 (January), 2-10.

Clark, B.D., Bisset, R., and Wathern, P. 1980. Environmental impact assessment. London, Mansell Publishing.

Dunn, E.S., Jr. 1971. Economic and social development. Baltimore, Johns Hopkins Press.

Dusseldorp, D.B.W.M. van. 1977. Some thoughts on the role of social sciences in agricultural research centres in the developing countries. Netherlands Journal of Agricultural Sciences, 25, 213-228.

Finsterbusch, K. 1980. Understanding social impacts. Beverly Hills, Sage Library of Social Research.

Flora, C. 1982. Women in farming systems. Presented to a meeting of U.S. Directors of International Agricultural Programs. Lincoln, Nebraska.

Geisler, C.C., Cowan, J.T., Hattery, M.R., and Jacobs, H.M. 1981. Sustained land productivity: Equity consequences of alternative agricultural technologies, Bulletin No. 119, Cornell University Agriculture Experiment Station and Department of Rural Sociology, Ithaca, New York.

Geertz, C. 1963. Agricultural innovation: Process of eco logical change in Indonesia. Berkeley, University of California Press.

Hansen, D.O., and Erbaugh, J.M. 1983. Different modes of participation by rural sociologists in interdisciplinary team development efforts. The Rural Sociologist, 3, 11-16.

Heady, E.O. 1975. The basic equity problem. In: Heady, E.O. and Whiting, L.R. eds., Externalities in the transformation of agriculture: Distribution of benefits and costs from development. Ames, Iowa State University Press.

Kelso, M.M., and Hillman, J.S. 1969. Social and political dilemma of agricultural industry and agricultural institutions. Presented at 4th Meeting of the Western Agricultural Economics Association, Corvallis, Oregon.

McClelland, D.C. 1961. The achieving society. New York, Van Nostrand.

Merton, R.K. 1968. Social theory and social structure. New York, The Free Press.

Morss, E. 1975. Strategies for small farm development: Executive Summary. Washington D.C., Development Alternatives Inc.

Norman, D. 1983. The farming systems approach to research. In: Flora, C.B. ed., Proceedings of Kansas State University's 1982 Farming System's Research Symposium. Office of International Agricultural Programs, Manhattan, Kansas, 6-19.

Perelman, M. 1977. Farming for profit in a hungry world. New York, Allenheld, Osmun.

Rickson, R.E. 1976. Knowledge management in industrial societies and environmental quality. Human Organization, 35 (Fall), 239-251.

Rickson, R.E., and Rickson, S.T. 1982. Problems and prospects of cross-disciplinary research. The Rural Sociologist, 2(March), 95-103.

Rogers, E. 1969. Modernization among peasants: The impact of communication. New York, Holt, Rinehard and Winston.

Rölling, N. 1983. Agricultural knowledge: Its development, transformation, promotion and utilization. Presented at the 3rd Expert Working Group on Information, Analysis and Consolidation. 12-16 September, Kuala Lumpur, Malaysia. UNESCO/UNISIST.

Rossini, F.A., and Porters, A.L., eds. 1983. Integrated impact assessment. Boulder, Colorado, Westview Press.

Saint, W., and Coward, E.W. 1977. Agriculture and behavioural science: Emerging orientations. Science, 197 (August), 733-737.

Schnaiberg, A.D. 1980. The environment: From surplus to scarcity. New York, Oxford University Press.

Sen, S. 1977. Reaping the green revolution. Maryknoll, New York, Orbis Books.

Soemardjan, S. 1972. Imbalances in development: The Indonesian Experience. Centre for International Studies, Ohio State University.

Spijkers, P. 1983. Rice peasants and rice research in Colombia. Wageningen, Department of Text Processing of the Wageningen Agricultural University.

Wharton, C. 1969. Subsistence agriculture and economic development. Chicago, Aldine.

White, B. 1976. Population, involution and employment in rural Java. Development and Change, 7, 3-19.

White, I.L., and Hamilton, M.R. 1983. Policy analysis in integrated impact assessment. In: Rossini, F.A. and Porter, A.L. eds., Integrated impact assessment. Boulder, Colorado, Westview Press, 39-55.

Whyte, W.F. 1975. Organizing for agricultural development. New Brunswick, New Jersey, Transactions Books.

Zandstra, H., Swanberg, K., Zulberti, C., and Nestel, B. 1979. Caqueza: Living rural development. Ottawa, Canada, International Development Research Centre.

Transfer of Rubber Technology Among Smallholders in Malaysia and Indonesia: a Sociological Analysis

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NATURAL rubber is an important manufacturing raw material. Over 65% of all rubber produced in the world is directly used by the automotive industry. Over 80% of natural rubber production comes from adjacent regions of Malaysia, Indonesia, and Thailand (Table 1). Smallholdings have been a major and dynamic component of the rubber industry from its very early years. By the 1980s they covered about three-quarters of total world rubber lands and contributed over two-thirds of total output (Barlow and Jayasuriya 1984).

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The rubber industry, like many others in the past, has undergone orderly structural change, due mainly to technological evolution. However, in the last two decades the world rubber industry has been subjected to severe exogenous shocks; first the oil crisis and then a deep economic recession in industrialised countries. As well, price structure, labour supply, growth of secondary industries and demand for agricultural products within the major rubber producing countries have further aggravated the changes in the industry. For the first time in more than two decades, there are serious doubts about the future of this industry, which depends on auto-

Table 1. Features of natural rubber production.

Country or region	Production 1980 (000 t)	Area (000 ha) and high yield material[a] (%) Estates	Small-holdings	Total	Yield[b] (kg per planted ha)
Malaysia	1552	542.5 (98)c	1454.5 (70)c	(90) [1978]c	777
Indonesia	1020	465.6 (30)	1862.0 (3)	(6) [1977]	438
Thailand	501	46.2 (n.a.)	1493.8 (n.a.)	(24) [1980]	357
Africa	184	237.8 (n.a.)	222.8 (n.a.)	[j]	383
India	155	60.4 (n.a.)	175.5 (n.a.)	(79) [1978]	657
Sri Lanka	133	105.6 (n.a.)	122.0 (n.a.)	(76) [1975]	584
China	100	n.a.	n.a.	n.a.	n.a.
Indochina[d]	60e	147.7 (79)	—[f]	(79) [1965]	406
Middle & South America[g]	48	n.a.	n.a.	(n.a.) [1975]	1853[h]
Other Asia[i]	90	103.6 (n.a.)	27.5 (n.a.)	(n.a.) [j]	686
Total	3820[k]	n.a.	n.a.	n.a.	n.a.

Sources: International Rubber Study Group [26]; Discussions [16]; Rubber Trends [12]

Notes: a. Proportion of improved materials in the total area.
b. 1980 yield per planted ha (mature and immature) in the year shown.
c. Figures in round () brackets are percentages of improved material; figures in square [] brackets denote years to which country data apply.
d. Vietnam and Cambodia.
e. Estimating Cambodian 1980 production at the 1979 level of 10,000 tonnes.
f. Smallholdings in Vietnam have been collectivised into 'estates'.
g. Mexico and Brazil.
h. Including wild rubber, whose area is not given.
i. Including Papua New Guinea.
j. For different years in the 1970s.
k. Total of national figures is 3.843 million tonnes. The figure given approximates the actual world total.

Source: C. Barlow (1982). The natural rubber industry. Outlook on Agriculture, Vol. 12, No. 1.

mobile production in the industrialised countries. These changes have the potential to influence markedly the socioeconomic conditions of the 22 million persons in the developing countries whose livelihood depends on this industry.

Grilli et al. (1980) after examining the world rubber economy for the World Bank state that:

> There are several reasons to expect a strong expansion in the world natural rubber economy during the next fifteen years. Yet, if the industry is to take full advantage of its market population a number of important conditions will have to be fulfilled:
>
> (a) The supply of natural rubber (NR) will have to keep pace with the expected growth of demand for isoprenic rubber (IR), and the supply will have to be made secure; this is the only way for NR to maintain its polyisoprene (IR) and to prevent a new wave of investment in IR.
>
> (b) Existing production technologies will have to be adopted and spread within and across countries, and
>
> (c) Research and development on production and utilisation of NR will have to continue and be intensified.

Rubber Smallholders

Malaysia and Indonesia together accounted for 75% of total world exports in 1977 and are undergoing structural changes because of development interventions such as research and extension support, land development schemes, land right policies, replanting schemes, economic factors like rubber prices, exchange rates, other industrial developments and more profitable innovations in agriculture such as oil palms, etc.

The rubber industry can be divided, in both countries, into two sectors, estate and smallholding.

In Malaysia in 1982 the smallholding sector covered 75% (1.5 million ha) of the total area under rubber cultivation and contributed 62% of total rubber production. There are two categories of smallholders in Malaysia, viz. individual (independent) smallholdings and organised smallholdings. Individual smallholdings cover 52.8% of the total area planted to rubber while organised smallholdings under Land Development Schemes, each consisting of separate holdings of 2-4 ha and being centrally managed on an estate basis, cover 20.5% of the total rubber planted. Individual smallholdings services are under the agency of the Rubber Industry Smallholders Development Authority (RISDA) while the organised smallholdings come under agencies such as the Federal Land Development Authority (FELDA) and the Federal Land Consolidation and Rehabilitation Authority (FELCRA). It is estimated that there are 500,000 rubber smallholders in the country including those in land development schemes. Some three million people (about a quarter of the country's population) are dependent directly or indirectly on rubber smallholdings for their livelihood and welfare.

Of 2.4 million ha planted to rubber in Indonesia in 1983, 81% was under smallholdings, 8% under government estates, 3% foreign estates, and the rest was locally owned private estate. It is estimated that 71% is produced by smallholders, 18% by government estates, 6% by foreign estates, and the rest by local private estates.

During the late 1970s, the government initiated Nucleus Estate and Smallholders (NES) projects for rubber, oil palms, and cocoa plantations. To date 55 NES projects have been established on the main islands of Indonesia with part of these projects being fully financed by the Indonesian Government through bank and State enterprises. A limited number are financed with World Bank loans. The Social Science Foundation has been assigned to examine the factors affecting the successful implementation of NES projects.

In Indonesia rubber provides the main livelihood for over one million families (at least eight million people).

Government Policy Interventions

The entire rubber industry can be identified in somewhat distinct stages of development with each being characterised by rather different relative endowments of land, labour, capital, institutional development and different technology use. Theoretically one progresses from one stage to the other depending upon the endowments of the nation and general progress in the other sectors of the economy. Barlow and Jayasuriya (1984) identified three stages in the rubber industry based on the above-mentioned endowments. According to them 'Stage 1 emerges from an essentially subsistence agriculture, practiced at the frontiers of cultivation where land is abundant and labour relatively plentiful. The market for capital is both poorly developed and fragmented, and credit thus extremely scarce. Under such circumstances the real prices of land and labour are low, whilst that of capital is very high'. The technology is simple with unimproved tools and planting material. The early Sri Lankan smallholding advance was similar to that in Malaysia while the rather later Thai development paralleled that in Indonesia.

Stage II, characterised by substantial commercialisation of the economy, has occurred. Much progress has also been made in modifying rubber technology, which has now moved from its primitive first stratum to the second stratum involving mechanised techniques for land clearing and much higher yielding planting materials that positively respond to fertilisers in the production phase.

There is a difference between rubber estates and smallholdings because of the endowment supports. In this situation the move of smallholding farmers from Stage II to Stage III requires a more appropriate production technology, resources price change and also external replanting and new planting grants. These were supplied in Malaysia and Sri Lanka in the 1950s, and in Thailand in the 1960s. Financial support was not provided in Indonesia until the 1970s. The vast majority of farmers still use Stage I technology and in the absence of alternative enterprises most farmers have continued to expand profitably with the old technology of their traditional land use (Barlow and Jayasuriya 1984).

In Stage III commercialisation of the economy has advanced much further. Agriculture is no longer dominant, being increasingly dwarfed by manufacturing, services, and other sectors. The infrastructures are further improved. This is actually the stage of industrial revolution and so far among natural rubber producing countries it has been reached only by Malaysia (Barlow and Jayasuriya 1984).

Poverty among Smallholders

In general terms conceptualisation of the stages in rubber production provides a framework in understanding where a particular country is positioned and how it could move progressively from Stage I to III. But the major question that still remains from a sociological point of view is why certain sections of smallholders are still poor (relatively poor) even though the country as a whole has moved to advanced Stage III. Also, how can poor smallholding farmers from countries classified as Stage I or II be developed progressively?

In Malaysia, in spite of active government *support* through research, extension, and replanting schemes there was according to Samsudin bin Tugiman and Raja Badrul Shah bin Raja Shab Kobat (These Proceedings) a high incidence (41.3%) of poverty among smallholders in 1980. They still form the largest single poverty group in the country (about 26.4%), numbering about 175,900 poor households. In terms of average monthly family income, individual smallholders were earning about M$240. However, rubber smallholders who were rehabilitated in land development schemes (FELDA) enjoyed a much higher level of net income, i.e. M$450/month owing to their larger farm size in 1983. Those with landholdings of 12 acres earned a net average income of M$1,044/month during the same period. When the poorest smallholders, i.e. landless, were rehabilitated in FELDA schemes, a new group of relatively poor smallholders emerged from scattered individual smallholders.

Published information on the economic condition of smallholders in Indonesia is very scarce. The general scenario of smallholdings ranges from 0.5 to 10 ha with an average of 1.5 ha. Smallholders are generally living at a subsistence level and rubber production for some of them is a secondary source of cash income. It is generally felt that the extent of poverty (both absolute and relative) in Indonesia is greater than in Malaysia. Like Malaysia, smallholders covered under NES or Smallholders Rubber Development Projects (SRDP) are relatively better off than the scattered, individual smallholders. The uneven development among the rubber producers and consequent disparities in income is a cause for socio-political tension and is given emphasis in the Malaysian and Indonesian Programs. However, there are not many systematic studies to examine the various causes for these low income conditions. Some of the associated problems are discussed below.

Structural Differences

In Malaysia, smallholding is defined as an area of less than 40 ha (100 acres). However, nearly 52% of the smallholders own less than 2 ha and another 35% have between 2 and 4 ha whilst only 13% own more than 4 ha. About 25% of the total area is in holdings of less than 2 ha. Persistent poverty among rubber smallholders has been attributed mainly to uneconomic holding size, scattered holdings and unorganised smallholders who have little education, no reserves, no credit and little equipment. Some of the poor smallholders were settled in FELDA and other schemes.

There are no comprehensive data on smallholdings in Indonesia, but they range from 0.5 to 10 ha with an average of 1.5 ha. Distribution differences will be similar as smallholders predominate in South Sumatra and Kalimantan. They are scattered with little infrastructure facilities and with low education and cash reserves for investment. They are subsistence farmers. Similar differences can be observed between SRDP and NES groups and scattered smallholders. Once again the structural factors could contribute to the lower level of income.

Variations in Yield

The Rubber Research Institute of Malaysia (RRIM) is the source of new technology. The proven annual yields on RRIM fields are stated to be at least 2000 kg/ha and smallholders annual average yield is 1000 kg/ha. Within RISDA, smallholders annual yield in 1982 was 1162 kg/ha as compared with about 800 kg/ha obtained annually by the individual smallholders.

Similar yield gaps exist in Indonesia. Comparative annual yields have been estimated at 400 kg/ha for smallholders, 740 kg/ha for private estates, and 1100 kg/ha for government estates.

It is believed that socioeconomic factors like small size of holding, ageing labour, scattered holdings, low education and capital were responsible for yield gaps. However, there are no systematic studies on factors affecting diffusion and adoption of rubber technology.

Farming Systems Approach

To what extent high technology fits into smallholders' farming systems and their resource endowments and stages of development is not examined thoroughly. This information will, however, help define the need for developing technology similar to the farming systems approach.

In view of the socioeconomic structural problems of scattered individual smallholders coupled with institutional constraints on technology transfer and management and the limitation of high-input technology, RRIM has embarked upon a more comprehensive agricultural development by way of Integrated Development Projects organised on a group basis. (For details see Samsudin bin Tugiman and Raja Badrul Shah bin Raja Shah Kobat, These Proceedings). Studies using farming systems research can help this approach to generate appropriate technology for rubber production as well as other appropriate agricultural and animal production projects to supplement the income of smallholders.

More recently Ryan (1984) provided an excellent review on this topic of efficiency and equity considerations in the design of agricultural technology in developing countries. He put forth 10 criteria (Table 2) for determining regional research resource allocation priorities.

Commenting on problems of investment for technological advance for Indonesian rubber smallholders, Barlow and Jayasuriya (1983) stated that the information available on the dispersal approach, and its possible attractiveness as an alternative policy, are grounds for exploring in detail the adoption behaviour of small farmers presented with this route to improvement. This exploration should involve an interactive modelling and empirical study process, where the long-term behaviour of adopters was observed as the dispersal policy was presented to them. Modelling should particularly take account of the time lag faced with perennial crops, and the consequent effects of time preference in the adoptive process. It should also explore the income distributive consequences of adoption, and review the behavioural patterns and economic implications associated with the upward gradient of the selected seedling technology.

There is a need to study the social benefits and costs of developing a range of appropriate techno-

Table 2. Criteria for determining regional research resource allocation priorities.

Criterion	Highest priority	Justification	
		Efficiency	Equity
Income per capita	Lowest income		x
Income growth/income per capita	Lowest ratio		x
Population	Highest population	x	x
Population growth rate	Highest growth		x
Crop production growth rate	Lowest growth	x	
Current food consumption status per capita (calories, protein, fat intake)	Lowest intake		x
Crop contribution to current food status per capita	Highest contribution	x	x
Regional contribution to total crop production	Highest contribution	x	
Yield stability (R^2 of trend lines)	Highest instability (i.e. lowest R^2)	x	x
Person/land ratio	Highest ratio	x	

Source: Ryan, 1984.

logies in order to facilitate increases in rates of diffusion and adoption among smallholders.

Institutional Approaches

Various approaches to extension and support schemes have been used in effectively transferring technology.

They could be classified into two categories: (1) the focus strategy and (2) the dispersal strategy. The examples of focus strategy are SRDP and NES in Indonesia and FELDA, FELCRA and RISDA's Mini Estates in Malaysia, where the efforts are focused with packaged information, inputs, infrastructure, marketing, finance, etc. The dispersal strategy where low cost inputs such as improved seedling material are freely distributed with relevant advisory services to scattered or non-organised smallholders. To date the effectiveness of these approaches in closing the yield and income gaps, has not been examined thoroughly.

There is need to conduct in-depth studies to delineate the factors affecting the successful implementation of technology transfer programs in the organised as well as the non-organised smallholding sector.

In Malaysia, RISDA has drawn up a seven-point development plan (for details on RISDA's Extension Strategy see Syed Barkat Ali, These Proceedings) and has formulated the Tridelta Extension System, which can be briefly described as a data-based systems approach to extension with potentials for computerisation. This system has much potential in successfully implementing new technology among scattered smallholders. As the Tridelta Extension System was introduced recently, no studies have been conducted as yet. The data collected from this system have great potential for classifying scattered individual smallholders into smaller 'homogeneous groups' for developing farming models for extension and research. Armed with this information much more informed decisions can be reached on what policy (focused or dispersed) or mix of technologies and policies could be followed in rubber improvement in general and smallholder socioeconomic development in particular.

Conclusions

In the last two decades the rubber industry in general, in Malaysia and Indonesia in particular, has undergone marked changes due to the general economic growth and development of manufacturing industries and other service sectors. Some of the other marked developments in progress are due to various government interventions in developing new rubber technology and to the establishment of various organisations such as RRIM, RISDA, FELDA, and FELCRA in Malaysia, and SRDP and NES in Indonesia. Some of these programs are very successful in bringing about structural changes while others are not as efficient and are creating dysfunctional effects on smallholders.

To date the rubber industry seems in general, to have endured structural changes and planned interventions while other social problems arising from uneven development are brewing. A systematic understanding of socioeconomic issues will facilitate changes in this industry.

Studies focused at some of the identified knowledge gaps in this paper would therefore have considerable practical and theoretical relevance. However, massive structural changes such as natural migration of the labour force, pressures from development interventions in the manufacturing and service sector, and socioeconomic rehabilitation under land development schemes and transmigration schemes are generating new social balances or imbalances. Many extension strategies have been tried to facilitate the transfer of technology to increase productivity, and likewise other development programs to supplement the income of smallholders in Malaysia and Indonesia. However, improving the socioeconomic condition of smallholders is still a baffling question to researchers, planners, and administrators alike. The complex process of bringing about planned economic development with social and ecological balances on a sustainable basis requires systematic studies.

References

Barlow, C. 1982. The natural rubber industry. Outlook on Agriculture, Vol. 12, No. 1.

Barlow, C., and Jayasuriya, S.K. 1983. Problems of investment for technological advance. The case of Indonesian rubber smallholdings. Mimeo. Canberra, Australian National University.

Barlow, C., and Jayasuriya, S.K. 1984. Stages of development and government policy in rubber smallholding agriculture. Paper prepared for the International Rubber Conference. 17–19 September 1984. Colombo, Sri Lanka.

Grilli, E.R., Agostini, B.B., and t' Hooft Welvaars, M.J. 1980. The world rubber economy. Baltimore, Johns Hopkins University Press.

Ryan, J.G. 1984. Efficiency and equity considerations in the design of agricultural technology in developing countries. Paper prepared for the Series in Rural Development, 1984, Australian National University, Canberra.

Invited Comments:
The Need for More Research on the Role of the Human Factor in Technology Transfer: An Economist's Perspective

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ALTHOUGH I have no expertise with regard to the Malaysian rubber industry, and only superficial knowledge about the Indonesian rubber industry, I do have some knowledge of the economic analysis of technological change. It is from that perspective that I wish to comment on the first three papers in these Proceedings. Also by way of introduction, I want to acknowledge the contribution made by the rural sociology profession to the study of innovation adoption and diffusion. In particular, all researchers in this area are indebted to rural sociologists for carrying out the vast amount of detailed empirical work that has provided the foundations for all modern theories of adoption and diffusion, including those developed by economists. The insights gained from these studies have been especially influential on my own work in this area, so I want to make it plain that if I am somewhat critical of these papers, such criticisms simply reflect a difference of opinion about the lessons to be learnt from the available evidence, much of it produced by their own colleagues.

While some sociologists share Cottrell, Ip, and Western's perspective, it is interesting to note that Chamala and Rickson in their respective papers have come to substantially different conclusions that are much closer to those of economists. In my view, Cottrell, Ip, and Western's message is summarised best by the following two quotes from their paper, where they argue that: 'Despite the active encouragement from both the government and extension research units, and there are not great problems in the availability of appropriate technologies, many smallholders remain reluctant to adopt and participate in the specific arena of technology created for them. . . . the great difficulty in implementing development rests not so much on developing new technologies and ensuring their diffusion . . . (as on) the fetish of technology that has developed over the years that prohibits us from further understanding the knowledge of human situations which has resulted in our development efforts remaining haphazard.'

I must say at the outset that I hold almost exactly the opposite view, and I will spell out my reasons for doing so shortly. For the moment, let me merely observe that there is a serious inconsistency between the arguments quoted above and the following further quote from their paper: 'There is little evidence to suggest that people in developing nations actively resist technological change. To the contrary, where it is perceived as appropriate it is readily adopted'.

The latter proposition is one with which I agree, and for which I will provide supporting evidence shortly. Furthermore, to the extent that it is true, then the real reason for non-adoption is inappropriate technology, and not other human or social factors as argued by Cottrell, Ip, and Western.

Before moving on to Chamala's paper, there is one other aspect of the paper by Cottrell, Ip, and Western with which I wish to take issue, and that is: 'Before the importance of social factors was fully recognised individuals in developing countries were often criticised—especially by economists—for acting 'irrationally'.'

I find this assertion rather strange, especially as it is not hard to find instances where sociologists have argued against the notion of rational behaviour by peasant farmers. For instance, consider the following quote from the eminent rural sociologist, E.M. Rogers in *Modernization Among Peasants* (1969: 31–32): 'Available evidence seems to indicate that peasant behaviour is far from fully oriented toward rational . . . considerations. Undoubtedly, however, the degree to which peasants are efficiency-minded and economically rational depends in a large part on their level of modernization.'

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Furthermore, even though it might be possible to cite the odd reference in support of the above claim, such a statement grossly misrepresents modern economic thought. At least from the time of publication by T.W. Schultz (1964) of *Transforming Traditional Agriculture*, and the many subsequent supporting studies, most economists have accepted the proposition that farmers, including subsistence farmers, allocate their resources efficiently, provided only that the decision-making environment is essentially static. Where rapid changes in either the technical or economic environment are taking place, the concept of rationality needs to be defined more precisely, as not all farmers will possess perfect, or even complete information. Nor for that matter will they all share the same amount of information, so even attempts to act rationally so as to maximise self-interest may not produce the desired result. This is the basis of the 'efficient but poor' hypothesis promulgated by Schultz, in which the only impediments to economic growth are lack of knowledge and/or profitable investment opportunities.

As I mentioned earlier, the views expressed by both Rickson and Chamala provide an interesting contrast to those of Cottrell, Ip, and Western. The former are perhaps best captured by the following quote from Chamala's paper: 'This lack of compatible technology was one of the main problems (sic) for slow rates of widespread diffusion and adoption among small farmers. Lack of adoption was not just because of peasant attitudes and values or extension strategies only' and from Rickson: 'when technology is specifically designed to cater for the specific needs of small farmers, it was adopted very rapidly by those that would otherwise be classified as laggards.'

This view that the primary problem is one of technology design rather than of technology transfer is shared by many economists working in the area, and has been an important reason behind the recent popularity of farming systems research also advocated by Chamala.

I would like to comment on the following statement by Chamala: 'There is a need to study the social benefits and costs of developing a range of appropriate technologies to facilitate increases in rates of diffusion and adoption among smallholders.'

I should point out that often there is a difference between technologies that are 'appropriate' (i.e. best) for society at large, and those that are merely 'appropriate' for an individual smallholder to adopt (i.e. innovations that the smallholder should, in his own best interest, adopt). The reasons for possible differences between these two concepts of appropriate technology are varied and complex, including price distortions of various forms, socially undesirable distributional consequences and/or technological externalities arising from innovation adoption, and differences in private and social attitudes to risk. Some of these issues are discussed in a book on the design of appropriate technology for smallholders *(Economics and the Design of Small Farm Technology)* edited by Valdes, Scobie and Dillon (1979). Some issues are discussed by Rickson in his arguments in favour of social and environmental impact analysis of new technology, while others are covered in standard texts on cost-benefit analysis. As this Workshop is concerned with technology transfer rather than design, I will confine the rest of my remarks to the relation between innovation adoption and diffusion and the private net benefit to the individual potential adopter.

The discussion of yield gaps by Chamala also warrants comment. Part of the reason why it is no longer so popular to refer to these yield gaps in the economic development literature is the realisation that they are an almost universal feature of all forms of agriculture, in both developed and developing countries. For instance, Davidson and Martin (1965) in a study of *The Relationship Between Yields on Farms and in Experiments* for Australian crop and livestock industries, found that average farm yield often was less than two-thirds of that obtained on research stations. Furthermore, closer investigation typically reveals that reasons other than those cited by Chamala are responsible for much of observed yield gaps. For instance, often it is necessary for scientific reasons to engage in superior agronomic practices (such as intensive weeding) on experimental stations that would be uneconomic under normal commercial conditions. Therefore only part of the yield gap should be attributed to failure to take up new technology, and it is to this issue of innovation adoption (and non-adoption) that I will devote the remainder of my comments.

In any discussion of innovation adoption and diffusion, two fundamental points need to be recognised at the onset. First and foremost, it will not be in the best self-interest of all smallholders to adopt all innovations that they happen to discover. The second subsidiary point is that in a world of imperfect knowledge, actual innovation adoption decisions of necessity must be based on perceived, rather than actual self-interest (i.e. private net benefit). Hence it will be possible for potential adopters to commit either type one or type two errors when making adoption decisions; in other words they may either not adopt when it would be in their own best interest to do so (i.e. private net benefit > 0); or they may adopt when private net benefit is negative. In the latter case, the act of adopting the innovation provides evidence that a mistake has been made, so rational smallholders would learn from this experience and disadopt the innovation. Learning in the former case that a type one error has been committed has to be based on information of a less direct form. Nevertheless, on the basis of empirical findings discussed below, it can be confidently asserted that potential adopters typically adopt eventually if it is in their best self-interest to do so. Hence the old maxim that: 'while it might be possible to fool some of the people some of the time, it is impossible to fool all of the people all of the time', is particularly apposite to the question of innovation adoption and diffusion. It follows that when a smallholder persists in not adopting, even after he has had ample opportunity to learn about innovation productivity, then it almost certainly can be attributed to the fact that private net benefit is negative in the decision-making environment facing the potential adopter.

The proposition that ultimate adoption or non-adoption will depend only on whether private net benefit is positive or negative respectively, is deceptively simple, because the concept of private net benefit, at least as defined by economists, is far from simple. For instance, in a paper on the methodology of design of new technology for small farmers, Anderson and Hardaker (1979: 14) note that: 'small-farm systems are characterised by different patterns of resource endowments, production opportunities, skills, beliefs, and preferences. Generalised solutions for such systems are almost impossible to achieve.'

An important determinant of innovation profitability is the cost of factors of production, and in smallholder agriculture where factor markets are often far from perfect, the opportunity cost can vary widely from farm to farm. This is particularly so for labour markets, as the supply of household labour is far from homogeneous. Other important determinants of innovation profitability are smallholder's highly personal preferences, both for present versus future consumption, and with respect to aversion to risk. Furthermore, as the extensive surveys of empirical evidence by Schutjer and van der Veen (1976), Ruttan (1977), and by Feder, Just and Zilberman (1982) revealed, often there are other significant constraints on the smallholder's capacity to adopt, such as scale bias in relation to size of landholding, unavailability of key inputs, including capital, and tenancy conditions.

Clearly then, the view that ultimate adoption or non-adoption depends on private net benefit is not inconsistent with the thesis that the human factor is an important explanator of individual innovation adoption decisions. However, unless the focus shifts from adoption decisions by individual farmers to that of persistent adoption/non-adoption by populations of potential adopters, as it must in any discussion of technology design and transfer, then the weight of evidence is that factors other than the human one are by far the most important determinant of inter-regional differences. A possible explanation is that those human factors that do influence adoption vary considerably among any given population of potential adopters, but in aggregate do not vary markedly between populations of potential adopters. Conversely, it would seem that those human factors that do vary markedly between potential adopter populations are not significant determinants of adoptive behaviour.

On the other hand, of the many reasons why an innovation that is highly beneficial to only some members of an apparently homogeneous group, need not be so beneficial to other members of the same group, one which is often overlooked, and particularly so by analysts lacking in training in the biological sciences, is that of the location specificity of much agricultural technology. The importance of location specificity is highlighted in the findings of a paper by Perrin and Winkelmann (1976) in which they reviewed and summarised a number of CIMMYT sponsored farm-level studies of the adoption of new wheat and maize varieties, and of fertiliser use, in a number of countries. In order to illustrate the complexity of this apparently unidimensional factor, I quote pages 891–2 of Perrin and Winkelmann, where they conclude that: productivity factors—agroclimatic zone and topography—are the most consistent in explaining why some farmers adopt new varieties, and others do not. . . . we are convinced that much more of farmers' adoption behavior could have been explained by productivity considerations had more accurate measurement of agroclimatic factors as related to productivity been possible. This became clear in retrospect . . . within a small geographic area, we had observed three villages ostensibly similar, with markedly different patterns of adoption: no adopters in one village, nearly all adopters in a second, and a mixed pattern of adoption in a third. Yet with better insight into agroclimatic factors affecting the production of new varieties versus old, this pattern of behavior was understandable apart from considerations of information, prices, and risks . . . These experiences force the recognition that within any farming area, there exists a wide range of expected yield increments from a given new technology. The differences can be the result of gradients in soil depth, texture, or other characteristics, differences in nighttime low or daytime high temperatures in certain seasons, differences in disease incidence related to these factors, and so on.

Rickson cites two further studies in his paper, which apparently argue essentially the same case.

There remains the issue of differential time lags to adoption among the population of potential adopters. This is a secondary issue to that of ultimate adoption levels, but as it can have significant distributive effects, it deserves some comment. Smallholders commonly will be uncertain of the private net benefit to be derived from innovation adoption, and especially so immediately after first learning of the innovation's existence. While they can, and undoubtedly do, learn more about the innovation with the passage of time, not all smallholders have equal learning opportunities or abilities. Consequently, farmer perceptions about innovation productivity at any given point in time are likely to differ, with consequent differences in the time lag to adoption. Such inter-farm differences in adoption time-lags also might be attributed in part to some of the constraints to adoption already referred to above.

While it is tempting to suggest that research should be carried out on smallholder rubber producers to identify means of speeding up this learning process, it is my view that more research of a fundamental nature needs to be carried out before this approach would be likely to produce tangible benefits. In the meantime, applied research on the economic constraints to adoption is likely to be more rewarding.

Conclusion

In summary, ultimate adoption levels are determined primarily by the net benefit that individual smallholders derive from innovation adoption. Although this measure commonly varies widely among the population of potential adopters, the nature of the determinants of private net benefit are such that the crucial problem is one of innovation design. Cultural considerations are only important to the extent that they influence risk and/or intertemporal preferences, constraints to innovation adoption such as tenure arrangements, or the opportunity cost of inputs. Furthermore, as all of the available evidence suggests that the pattern of interfarmer variation in these preferences does not differ markedly from one population of potential adopters to another, there seems to be little point in following the proposal by Cottrell, Ip, and Western that research should focus on 'individual village communities in examining questions of the dynamics of change and continuity and impact of technology'. In my view, it would be much more useful to conduct agroeconomic studies of both past failed innovations, as well as of potential future innovations, in order to learn more about institutional constraints to innovation adoption and likely adoption rates, respectively.

References

Anderson, J.R., and Hardaker, J.B. 1979. Economic analysis in design of new technologies for small farmers. In: Valdes, A., Scobie, G.M., and Dillon, J.L. eds., Economics and the design of small farmer technology. Ames, Iowa, Iowa State University Press.

Davidson, B.R., and Martin, B.R. 1965. The relationship between yield on farms and in experiments. Australian Journal of Agricultural Economics, 9(2), 129–140.

Feder, G., Just, R.E., and Zilberman, D. 1982. Adoption of agricultural innovation in developing countries—A survey. Washington, D.C., World Bank Staff Working Paper No. 542.

Perrin, R., and Winkelmann, D. 1976. Impediments to technical progress on small versus large farms. American Journal of Agricultural Economics, 58(5), 891–892.

Rogers, E.N. 1969. Modernisation among peasants. New York, Holt, Reinhard, and Winston.

Ruttan, V.W. 1977. The green revolution: Seven generalisations. International Development Review, 19(4), 16–23.

Schultz, T.W. 1964. Transforming traditional agriculture. New Haven, Yale University Press.

Schutjer, W., and van der Veen, M. 1976. Economic constraints on agricultural technology adoption in developing countries. Washington, D.C., USAID Occasional Paper No. 5.

Valdes, A., Scobie, G.M., and Dillon, J.L. 1979. Economics and the design of small farmer technology. Ames, Iowa, Iowa State University Press.

Malaysian Structural Change and its Impact on Rubber

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ANY industry will be affected by changes around it. The Malaysian rubber industry grew up in circumstances that differ quite sharply from those that characterise Malaysia today. In a number of ways, the pattern of development over the past one or two decades has been different from earlier decades. Any traditional sector, such as rubber, will face problems of adjustment. The pressures that develop in an economy can be favourable or adverse to some particular sector. We shall argue that, as things have turned out, the changes that have taken place have mainly had adverse consequences for the rubber industry.

Several major changes can be identified. There has been the sudden emergence of the petroleum sector. There has also been the sustained expansion of the manufacturing and services sectors. At a more immediate level, there has been the emergence of competing crops, mainly oil palm. These developments will influence the price that the rubber industry must pay for its inputs, and the prices it receives for its outputs. It appears likely that because of these developments rubber producers are facing a squeeze.

There are various responses that can take place within the industry. Technological progress may take place, and it may be possible to produce rubber profitably even though margins are being reduced. Subsidies may be given to the industry so that uneconomic production can continue. Finally, the industry may contract. Rubber producers might switch to other crops, or they might cease production altogether. A contraction of the rubber industry may be simply part of a process by which an economically developing country can switch out of some industries and into other ones more suited to a new level of development. Other countries have faced this problem, and those that are successful are those that manage the adjustment swiftly. A decline in the Malaysian rubber industry may be a reflection of the success of the Malaysian economy. Other traditional industries, e.g. tin and rice are similarly affected. As such, it may not be undesirable, and it may be counter productive to attempt to arrest the decline.

In the next part of this paper, we sketch out a simple model that we use to examine the effects on rubber of changes in other sectors of the economy. Then we discuss the expansion of the petroleum, manufacturing and services sectors, and how these will affect rubber. We further look at how competing crops will affect rubber production. We examine the empirical evidence on structural change in the following part. Finally, we examine the response by the rubber industry to all these changes.

Influences on the Rubber Industry

There may be many changes taking place in the Malaysian economy, and many key variables may be altering. Rubber industry profitability, however, is determined by two sets of prices; the output prices it faces, and the input prices it must pay. Changes elsewhere in the economy may affect rubber through its effect on these prices. If there is no effect on these prices, there will be no effect on rubber. It is possible that a change, such as a new government revenue source, may enable more government investment in the industry, but this does not necessarily occur.

The possibilities can be summed up in Fig. 1. The cost, or supply, curve of rubber is shown as S_1. Its upward slope suggests that some producers can operate at low cost, but to increase output, it is necessary to obtain output from higher cost producers. Here the world price of rubber in US$ is

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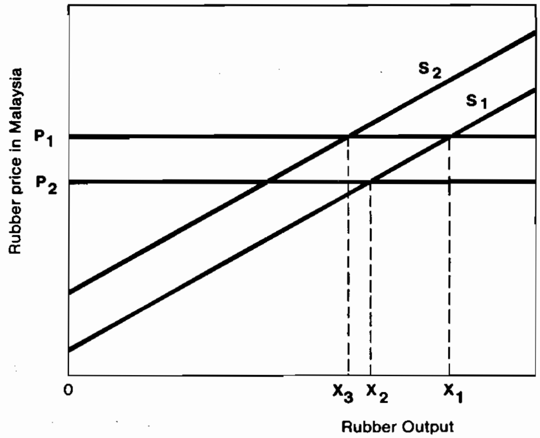

Fig. 1. Rubber supply and demand.

assumed to be unaffected by events in Malaysia. In terms of Malaysian dollars, this price is shown as P_1. Producers then choose OX_1, as the level of output.

The rubber industry can be squeezed in a number of ways. For example, a fall in the price received in terms of Malaysian dollars will lead to the reduction in output. If the price falls to P_2 then producers reduce output to OX_2. Output will also fall if costs increase. For example, a rise in wages, or costs of other inputs such as land, would lead to an upward shift in the supply curve. These prices rise when the value of their use in other applications increases. If the curve rose to S_2 then if the rubber price were P_1, output would fall to OX_3.

These types of changes reduce the incomes of people who are tied for various reasons to the industry (that is, the changes reduce producer surplus). People may be tied because their skills or other physical assets are specific to the industry and cannot be relocated. The income falls in the rubber sector have led to increased concern about rural poverty in Malaysia and some offsetting actions have been initiated. These possibilities can also be illustrated in Fig. 1. For example, subsidies to the industry or investment in the generation and diffusion of new technologies will shift the supply curve to the right.

Figure 1 highlights the role of input and output prices in influencing the size of the industry, and thereby the incomes of people tied to it. We noted above that such price changes will be related to events elsewhere in the economy. In the next section we outline some of these relationships.

Booming and Traditional Sectors

In this part, we make use of the analysis that has been developed to explain the effects of booming sectors on other sectors of the economy. The effects of North Sea Oil and Gas on British or Dutch manufacturing, or of the Australian mining boom on Australian manufacturing or agriculture, are similar to the effects that expanding sectors in Malaysia will have on the rubber industry. (For a review of models of this kind, see Corden (1984), and for a theoretical discussion see Corden and Neary (1982).)

It is possible to identify several key effects that arise from the sudden growth of an industry (these effects will also be present with gradual growth, though it will then be easier for other sectors to adjust). All these effects are likely to be present to some degree, though their relative importance can vary.

The first effect is the 'resource pull' effect. The booming sector requires extra inputs some of which will come from established industries. It will bid up prices paid to the inputs that are in short supply. For example, the price of a sectorally mobile factor like labour could rise, because of this effect.

The second effect is the income, or spending, effect. The booming sector generates new incomes in the economy and these incomes will be spent. Suppose the booming sector produces exportable goods. The boom therefore generates extra export income that will be spent. Some of it will flow out of the economy again in purchasing imports but some will also be spent on non-traded goods, such as construction services or personal services. To the extent some of the income is spent on such goods there will be excess demand for them initially and the Malaysian demand for imports will be less than Malaysia's exports. This will entail a balance of trade surplus, as compared to the position before the boom. Some adjustment is required and it takes the form of the exchange rate effect, in this case, a real appreciation.

The exchange rate effect can occur in a number of ways. Suppose the nominal exchange rate is flexible, then adjustment occurs by an increase in the value of the currency in terms of foreign currencies. This lowers the local currency price of exportables, as illustrated in Fig. 1 by the fall in the price line. Alternatively, the nominal exchange rate may be fixed in which case all the adjustment occurs by a rise in the general level of non-traded goods prices, which has a similar effect on the real incomes of people tied to the rubber industry. The nominal exchange rate in Malaysia varies under a policy of a 'managed float.' In these conditions, both types of adjustment would be observed.

There is a further spending effect, which is not normally discussed, but which is relevant for a developing economy. This may be called the government revenue effect. A booming sector may be an easy sector to tax, in fact, the profits from the sector may go directly to the government. In developing countries, it is often the case that governments find it difficult to raise revenue in a relatively cheap way. They have to rely on inefficient, distorting taxes (such as export taxes). When the new source of revenue becomes available, the government's budgetary constraint is relaxed. It may then be possible to invest in non revenue-generating projects (e.g. education) that are worthwhile (yield benefits greater than costs) yet which were rejected before because of the revenue constraint. This is a real effect, and it may be present in the Malaysian case. It should be noted that this effect does not apply to projects that are self-financing in the long run, since Malaysia has sufficient access to capital markets to undertake those projects that do not require financing out of tax revenues.

It is important to stress that the availability of this revenue to the government is not of any direct benefit to the contracting sectors. It can be directed to them, though there is no necessity that it should be. One may infer that contracting sectors are unlikely to offer many worthwhile investments simply because they are contracting. Governments may not use revenues wisely, however, and they may slow structural adjustment by giving subsidies to the contracting industries.

There are a number of major sectors that we may identify as booming sectors in Malaysia. The first, and more obvious one, is the petroleum sector. The second is the manufacturing sector. This has been growing steadily, and its growth is imposing the need for structural change by other sectors. Other, fast growing, industries can be noted—for example some of the service industries, although it can be argued that the growth is in some part caused by income changes brought about by growth of the petroleum and manufacturing sectors. There are, as well, some smaller industries, which are growing rapidly. Perhaps the one that has most direct relevance to rubber is oil palm.

It should be recognised that there are many other changes taking place in the world economy and the Malaysian economy and these will have some effect on rubber. Changes in world markets will have direct and indirect effects on rubber. A change in the price of rubber in foreign currencies will directly affect the price received by producers in Malaysia. Changes in prices of all Malaysian exports and imports, that is, a change in the terms of trade will affect the domestic rubber price via the balance of trade and then the exchange rate. Protection, of manufacturing and of other crops, may alter. Population, and the size of the workforce, will change, and Malaysian growth may encourage immigration (legal and illegal). We discuss some of these below.

The Impact of Petroleum

In recent years, there has been a substantial increase in the output and export of petroleum. This boom would generate both resource pull and spending effects. However, the petroleum expansion is likely to have no perceptible effect on the real wage. It is a highly capital intensive industry, and its employment consequences will be minimal. It will squeeze the rubber industry but only through the spending effect, via the exchange rate.

The nature of the spending effect will depend on who receives the income. For example, the government could obtain a large part of the extra income through taxation and then use the funds in infrastructure programs or in other forms of investment, such as the heavy industry program (Malaysia 1984). Alternatively, the government could reduce tax raised from other sources so that after-tax incomes of the private sector would rise, thereby generating a spending effect.

The spending effect will have some impact on the labour market, because it will draw labour from traditional sectors into the non-tradable goods sectors. The wage in terms of, say, the price of rubber, will therefore rise.

Current rates of production are unsustainable in the long run. Current production and revenue cannot be used to infer the true long-run value of petroleum. It would be imprudent for a country to spend all of a short-term revenue flow, incur the costs of substantial structural change, and then have to reverse the structural changes when the revenue runs out. Rather, the sensible policy would be to spend on consumption an amount equal to what can be sustained in the long-term and invest the rest.

The simplest way of achieving this, and one that creates least requirement for structural adjustment in the economy is to run a balance of payments surplus when the revenues are high, and build up foreign reserves that can be used when the oil revenues run out. There will still be some adverse impact on the traditional sectors like rubber, but it will be reduced to that level, which will persist in the long-term. Alternatively, a country might invest domestically. This may seem a sensible policy, and a case can be made for it if there are good investments waiting to be undertaken. However, it will mean that the burden of adjustment on the traditional sectors will be greater. As the country invests, resources, e.g. labour, are encouraged to move out of the traditional sectors. To an extent, resources may be used to facilitate or forestall structural change in these sectors. Then, when the revenues fall, investment in these sectors will fall, and the demand for resources will decline. There will then need to be a reversal of the previous change. If the country has adjusted to higher import spending, as well it might, the traditional sectors will be required to expand to make up for the reduction in petroleum exports.

A policy of domestic investment, to the extent that it involves spending on non-tradable goods and services, is one that requires the traditional industry to contract sharply for a period, and then, later, to expand again (probably not to its previous size). The economic and social adjustment costs of such a policy can be high. The problems for industries such as rubber will be made worse if, when the petroleum revenues diminish, the government maintains its investment program by relying on foreign borrowing.

This analysis supposes that petroleum revenues rise because petroleum is discovered. The analysis is somewhat different for the case where a country has a known amount of petroleum, but the petroleum price changes (suppose it rises). There will be an income effect, and an exchange rate effect, but no new resources will be required directly. However, rubber may be in a curious position in this case, since the prices of rubber and petroleum may be related. If synthetic rubber relies heavily on petroleum, when the price of the latter rises, the price of synthetic rubber will rise, and thus will pull up the price of natural rubber. It is possible for the Malaysian rubber industry to even gain from the price of petroleum rising, if the effect on the rubber price outweighs the spending effect. A final point is that the effect of higher petroleum prices on exchange rates and factor prices may not be very great, when it is remembered that Malaysia may not be much more than self-sufficient in oil in the long run.

Impact of Manufacturing

Sources of growth of the size of the manufacturing sector will determine the type of impact it has on other sectors of the economy. There are a couple of explanations of growth in the sector (Garnaut and Anderson 1980).

One explanation is that a country like Malaysia may be relatively small in world markets. It faces world prices for manufactures that are not influenced by its actions. Also it has access to international capital markets and to current technology. Its relatively large endowment of labour implies lower wages compared to other countries. Therefore provided its labour price advantage is not more than offset by low labour productivity, it should be able to compete in world markets.

There are a number of factors that constrain international competitiveness. One might be the availability of certain inputs such as skilled management. Over time, the national endowment of these inputs increases and the volume of manufactured output will increase. Another constraint might be the availability of skilled labour. Labour skills will increase with education and from 'learning by doing.' The accumulation of skills (or human capital) that occurs with growth will therefore tend to accelerate expansion of the manufacturing sector.

A manufacturing boom, created by increased protection and based on import substitution, could occur in a country such as Malaysia. It would adversely affect the rubber industry through its effect on the exchange rate. Such a boom, however, would tend to lower, rather than raise, the real wage, since it would result in the replacement of a labour intensive industry by another less labour intensive, one. It will be seen later that the evidence does not support this interpretation of the manufacturing boom in Malaysia.

A booming manufacturing sector will have both resource pull and spending effects. Resources, especially labour, will be drawn from other sectors of the economy. Real wages paid to labour will be bid up as part of this process. Wages will rise for both skilled and unskilled labour. Labour will be drawn from the rural sector into the manufacturing sectors. This labour movement also occurs in expectation of higher incomes out of rural activities. This is especially the case for younger workers who, even if, initially, they are unemployed in the cities, expect higher earnings over their lifetimes by abandoning the countryside. These resource pull effects will squeeze the rubber industry.

The growth of the manufacturing sector will generate higher incomes. Initially, income growth will be concentrated on the entrepreneurs who have begun projects in the sector but later this income will be spread as higher real wages across the economy.

The increment to manufacturing output will be concentrated in the tradable goods sector, that is, it will lead to import substitution or increased exports. Simultaneously, however, there will be increased demand for tradable goods, because of the income effects of the manufacturing boom. However, the net effect is likely to be an increase in the trade surplus relative to the initial position. The income effects will also generate increased demand for non-tradable goods and set in motion the same adjustment process that is initiated by the petroleum boom. As a result there will tend to be a real appreciation of the exchange rate. However, this exchange rate effect is likely to be relatively small, compared to the implications of a petroleum boom. The major impact of the manufacturing sector growth will be the resource pull effect.

There is a critical difference between the petroleum and manufacturing booms in that the former is temporary, whereas the latter is permanent. Indeed, it is likely that the manufacturing sector will continue to expand strongly. The long-term importance of the petroleum boom is much less than its apparent short-term importance. With manufacturing continuing to expand, it is likely that the real wage will continue to rise. The pressure on traditional sectors will not abate.

Growth in the Service Sector

Part of the growth in the service sector will reflect the income effects created by the expansion of manufacturing and petroleum. The service sector would also be an engine of growth in its own right. For example, the acquisition of skills associated with growth would lead to expansion of that sector as well as manufacturing.

Service sector growth will have a resource pull effect that will squeeze rubber. However, service sector expansion will have the opposite effect on the real exchange rate compared to manufacturing or petroleum booms. The reason is that the service sector can be characterised primarily, although not exclusively, as a non-traded goods sector. The income generated by its growth will be spent on both non-traded and traded goods. This will generate an excess demand for traded goods (that is, a balance of trade deficit) and to a real depreciation of the exchange rate. This change will assist the rubber industry. It can be seen that growth and structural change in the economy is associated with effects in opposite directions on the exchange rate and the net effect is difficult to predict. However, the resource pull effect is consistently in the same direction.

Competing Crops

Traditional crops such as rubber will be adversely affected if new crops become feasible and profitable. In the case of Malaysia, the main alternative crop is oil palm, production of which has been increasing steadily. Oil palm might be regarded as a smaller 'booming sector'—however, unlike petroleum and manufacturing, its impact on rubber is quite direct.

Suppose that it becomes possible to produce oil palm on land where, hitherto, it has not been possible. If this land is currently used for rubber, it will be switched to oil palm if the profits from the latter exceed the profits from rubber. This substitution may not happen immediately; oil palm will gradually replace rubber as a crop on certain lands. The value of these lands, or their rent, will increase. Since it is a gradual process, and changes are taking place in both the rubber and oil palm technologies, it is difficult to determine *a priori* how far or fast the substitutions will take place.

Both rubber and oil palm are affected by changes taking place in other sectors. As noted, expansion of the oil and manufacturing sectors will adversely affect rubber; this does not necessarily mean that they affect oil palm positively. Suppose that the exchange rate appreciates—the price received for both rubber and oil palm falls. The response of a rubber producer might be to abandon production, but not replace it with an alternative crop—no other crop may be viable.

Other changes, however, may affect the relative attractiveness of rubber and oil palm. Suppose that rubber is a labour intensive crop, whereas oil palm is capital intensive. A rise in the real wage will reduce profits in both industries, but it will affect rubber more. While rubber may previously have been the more profitable crop for an area, oil palm may become the profitable crop when wages rise. Thus the general expansion of the manufacturing sector, through increasing real wages, will adversely affect rubber, but also tend to make oil palm a more attractive crop even if it does not render rubber unprofitable. This continued rise in the real wage will be anticipated, and be taken into account by those investing for the long term in rubber or oil palm. Thus rubber production in a particular area may be viable at the current wage rate, but not in the long term, and it is the long-term viability that determines investment.

Evidence of Change

In Tables 1 and 2 we present some summary statistics for the Malaysian economy over the past decade, along with some statistics on rubber. Data are not always easy to obtain for exactly the same time period, however data shown here are sufficiently comparable for a general picture to be evident. Further detail is given in Appendix Tables 1–4.

In 1970 prices, GDP has grown in Malaysia at an annual real rate of 9.2% between 1970 and 1982 and this growth has been shared by most sectors. Manufacturing started with a small base, but expanded rapidly at an annual real rate of 11.6%. Agriculture has fallen as a proportion of GDP, though it has still grown in absolute terms (Table 1, line 5). Services too have grown rapidly at 9.7% a year, and are the largest single sector (line 8). Their share has increased slightly. Many of these trends are also reflected in the employment figures (lines 10–14). It can be seen that agriculture is relatively labour intensive and that labour productivity growth is significant in both manufacturing and services.

The manufacturing sector is the fastest growing major sector, though it is not nearly as large as the service sector. Further detail would show it to be both oriented to import replacement and to export. Overall manufacturing value added has increased rapidly (line 21) and its share of total exports has grown (line 27). Care must be exercised in interpreting this result because of the existence of re-exports of manufactured goods, but growth in real value added nonetheless exceeded 13% over the decade. It is possible to view the manufacturing sector as a major engine of growth. The evidence is that over this decade, protection of manufactured goods did not alter by much.

Petroleum output has boomed (line 20), though it still does not account for a large proportion of GDP or the work force. Much of the change in the mining sector over this period (lines 6 and 11) can be attributed to petroleum. As proportion of exports it has risen substantially (line 26). Its proportion has grown since.

The result was that the trade balance rose to record a very substantial surplus by 1980 (line 15). As exports tailed off in 1981 and 1982, the trade balance became a deficit however. The overall current balance changed little in the decade (line 16) though lately it has fallen into deficit. This reflects a falling off in petroleum revenues, accompanied by government borrowing abroad to finance continued expenditure.

Petroleum revenue is an important source of government revenue (line 17). It has risen from nothing to nearly one-quarter (these figures are underestimates, as they make no allowance for (confidential) government shares of petroleum profits). The government has increased domestic investment—it accounts for a rising share (line 19) of a total investment, which is rising as a proportion of GDP (line 18). These statistics are consistent with the view that the new, and relatively cheap, source of revenue is altering government spending behaviour.

The two key variables are the exchange rate and the real wage rate. We show two measures of the real exchange rate. The first (line 1) is derived from comparing domestic with foreign prices (for different countries weighted by trade shares), and adjusting the nominal exchange rate. The second (line 2) is derived from comparing the prices of non-durable goods in Malaysia (tradable) to the prices of services (non-tradables). Both indicate a depreciation in the exchange rate.

This result does not tell us much. We argued above that the real exchange rate would move in different directions depending on the relative importance of the growth of various sectors in the economy. Also the exchange rate is affected by events in world markets, such as the decline in the Malaysian terms of trade since 1970, which would have had a depreciating effect.

Our model suggests an unambiguous increase in the real wage (see lines 3 and 4). The evidence here is patchy, though consistent with the above proposition. We measure real wages by deflating by the consumer price index. Real wages in rubber and manufacturing have increased, though not spectacularly. This is significant granted the rapid growth in the work force. Real wages do appear to vary from year to year. In addition it is probably misleading to think of Malaysia as possessing a single, integrated labour market. Adjustment lags, especially between sectors, are likely to be large. Nevertheless, the pressure for higher real wages is evident.

In summary, it is difficult to isolate the impact of changing industrial structure on the exchange rate and thereby on the rubber industry because of simultaneous changes on world markets, and the variety of types of structural change in the domestic economy. More obvious and, we believe, significant impacts on rubber have come from the resource pull effect, especially in the labour market and in the use of land, related to the emergence of other crops.

Rubber Sector Responses

The broad response of rubber to these various world market and domestic influences is indicated in Table 2, which denotes a slowing of total output increases in 1970–82 compared to 1960–70, with some decline in absolute labour and land use. Almost all the substantial rise in labour and especially land use in agriculture in these latter years was taken up by oil palm, which also showed a major expansion in output. Within this general trend for rubber, the estate area contracted very greatly, and the individual smallholding area also dropped somewhat after 1970. There was on the other hand a major and more than offsetting increase in the area of rubber under the Federal Land Development Authority (FELDA) and other group smallholdings sponsored by government, where investments were made on wider social and political, rather than economic, grounds. By 1980, individual and group smallholdings together contributed a much bigger share of total output than estates. In contrast, the estate oil palm area had overtaken the estate rubber area by 1980, and there was also a substantial planting of oil palm in group smallholdings, and especially in FELDA schemes. Relatively little oil palm was established on individual smallholdings over these years, however, largely because various economies of scale meant that rubber continued to be more economically attractive under most circumstances.[1] Further details of these responses are given in Appendix Tables 5–7.

Table 2 also denotes the major impact of technical change on rubber cultivation. Average yields per mature planted hectare on both estates and individual smallholdings almost doubled between 1960 and 1982, with relatively more early progress by estates being related to their earlier replanting with higher yielding materials. Output per worker also increased, but the proportion of land and labour used in the rubber sector as a whole barely altered, although there was a slight shift to a lesser labour intensity on estates. Indeed, the value of output/worker actually fell during the 1960s, owing to the decline in real rubber prices over this period. The average yield per mature hectare of palm oil and kernel rose far more than that of rubber over the same period. Oil palm also had a much lower labour intensity, and showed a marked further trend in this direction over time. More information on these aspects is presented in Appendix Table 8.

In terms of changes in production economics of rubber between 1973 and 1981, the average estate situation denotes some reduction in physical labour input per hectare, which can be ascribed largely to higher task sizes (Table 2 and Appendix Table 9). An offsetting rise in the real wage of labour meant that the cost of labour per hectare remained constant, however. The relative share of management and capital increased, reflecting a shift to less labour and more management and capital intensive technologies, especially involving more sophisticated tapping and the use of stimulants. The adverse effect on profitability of increased total production costs was to some extent offset by the rise in yield. It should be noted that the real profitability of oil palm certainly increased over the same period.

The fact that available data only enables the production economics of the 'average' smallholding in 1973 to be compared with the 'progressive' smallholding in 1981 (Table 2) makes the trend of events in this subsector less clear. Compared with the average estate in 1973, the average smallholding used a lower total value of resources in securing a lower yield. Although its output of labour was far greater, it was also much lower priced, reflecting the highly segmented labour market of that period. By 1981, the rubber producing operations on the progressive smallholding, which now had to pay the same price for labour as estates, used only slightly more labour although its operation was more labour intensive with a lower share of other factors. While the overall profitability in net revenue over operating costs was considerably lower under smallholding than those under estate conditions in both years, it may be estimated that this difference was largely offset by the much higher costs of the initial investment in the estate situation.

Thus although estates in 1981 appeared to be facing some decline in real profitability, with some rise in real labour costs, and were accordingly switching to oil palm cultivation where possible, progressive individual smallholdings that could not often change to oil palm also had a far higher opportunity cost of labour, which had much more than doubled since the early 1970s. Yet the fact that the operation of such holdings in 1981 could still easily earn their opportunity cost augured well for the economic survival of this group, especially where it could combine the highly divisible techniques of rubber production with other enterprises (Barlow 1984). There were, on the other hand, also many less progressive rubber farmers whose behaviour had not altered much from the average pattern of 1973. For such people unskilled employment in other industries offered a much more attractive return to labour (Appendix Table 3), and they seemed likely to increasingly abandon their holdings in favour of this alternative (Malaysian Rubber Research and Development Board 1983). Those who

[1] Transport costs in particular were very high for small units, although in certain areas where the great expansion of estate factories offered external economies smallholding production became economic.

did not make this change would certainly feel increasing poverty.

In summary, the rubber sector has adopted a number of responses to pressures from world markets and domestic structural change. Output growth rates have fallen, yields have been increased and some rubber farmers have switched to oil palm (especially in the estate sector). Others have abandoned their holdings. At the same time, the government has intervened to sponsor replanting of old trees and group smallholding schemes. These and other interventions are now discussed in more detail.

Government Action

Any analysis of these major changes in the natural rubber industry must also take account of government policy, which has partly been enabled by the boom in other sectors, and which especially in the case of smallholdings has been very significant. A crucial and all important element of this policy from the mid 1950s has been the replanting grant (Rubber Industry Smallholders' Development Authority 1980a), which in the case of individual smallholdings may be seen as the only practicable means of securing the replanting of old trees with high yielding materials in the virtual absence of a functional long-term capital market.[2] This grant essentially covers the labour and material costs of replanting, and as is appropriate with the rise in labour costs has grown in real value over time. About two-thirds of the grant has been financed by producers themselves, through a tax transfer mechanism involving a 'replanting cess' element in the export tax. The balance has mainly come from central government funds.

Replanting grants had a major impact in achieving the replanting of over 75% of the individual smallholding area by 1980 (Appendix Table 6). Almost all the estate rubber area was also replanted. On the other hand, many less progressive individual smallholders did not replant, owing primarily to social problems (Rubber Industry Smallholders Development Authority 1980b), and are now facing diminishing marginal value products from their rubber trees. In such cases, government is now moving to consolidate the lands involved into 'mini-estates', run largely on an estate basis using hired labour (Mohd. Nor bin Abdullah 1983).

The other major positive element of government rubber policy has been the huge development of group smallholdings, which by 1980 involved 386,000 ha under rubber, together with a further 346,000 ha under oil palm (Table 2). Much of this development was undertaken using central funds, but again with some contributions from the replanting cess. A substantial portion of the new planting involved was organised through the large coordinated FELDA schemes (Appendix Tables 6 and 7), where the provision of central services in credit, information and marketing to settlers based in individual rubber units attempted to overcome the difficulties in those respects of ordinary small farmers (Tunku Shamsul Bahrin and Perera 1977). In the late 1950s and 1960s, the basic rationale in the group smallholding policy was one of providing employment for many landless and underemployed in circumstances of abundant land, which could be profitably developed under rubber and oil palm. In a situation of future price uncertainty, a mix of the two crops seemed best, although the superior performance of oil palm became increasingly apparent. It was not until the early 1980s, however, that government finally decided not to proceed further with group land development under rubber, although the effort to replace old trees upon both existing individual holdings and group development was to be continued (Malaysia 1984). It should also be mentioned here that the central services concept of the group rubber smallholdings has not worked as well as expected, owing to the difficulty of maintaining good working relationships between settlers and central management. This concept was thus being actively reviewed (Malaysian Rubber Research and Development Board 1983).

Government had also supported rubber through its long-term organisation of research, again financed through a tax transfer mechanism. This had produced results of major economic significance over the years, especially in terms of better performing varieties of tree as well as improved cultivation and processing techniques. A smaller advance appears to have been made since the mid 1970s, however, particularly in the important direction of developing less labour-intensive production methods in the context of rising real wages (Rubber Research Institute of Malaysia 1971–1982). It had exercised adverse effects on the crop through the negative protection applied to the industry. This sprung from the combined effects of export taxes, tariffs on manufactures and other imports, and assistance to the food crop sector. Government finally seemed likely to have substantial influence

[2] There were no private credit facilities for much long-term investment by small units, owing basically to high transaction costs and substantial risks of default over many years to maturity. This situation did not of course apply to the estate.

through its acquisition in the late 1970s of a dominant shareholding in the previously private estate rubber sector (Tun Ismail bin Mohd. Ali, 1983), although little result from this was apparent in the early 1980s.

Conclusions

The relative decline of the Malaysian rubber sector results inevitably from various economic pressures arising from the profitable expansions in manufacturing, petroleum, services, and oil palm. In particular, the burgeoning expansion of the economy has provided a wider range of employment accompanied by some increase in the real price of labour, and oil palm has offered better opportunities in the use of land. The specific pressures likely to result from structural change of the Malaysian kind have been reviewed in the initial model of the changing economy, and in the subsequent discussion of the emerging practical situation.

It appears probable that the wider development of the economy, and especially that of manufacturing, will continue quite strongly, and that the upward pressure on real wages will accordingly remain. While the comparative future economics of rubber and oil palm are to some extent conjectural, it seems likely that the latter will remain more profitable and therefore continue to expand at the expense of rubber. Under these circumstances, the relative decline of the rubber sector will continue, unless it is counteracted by technological improvement or assistance to the sector. Technological improvement is desirable, but specific means of assistance to counter the relative decline would, in general, be undesirable.

Yet to the extent that rubber cannot be replaced by oil palm on estates (for soil or climatic reasons) or on smallholdings (for these reasons together with scale problems), rubber is likely to be retained as a substantial agricultural crop. In a situation of rising real wage, the incomes of people tied to rubber are likely to continue to be under pressure. This will sustain concerns about poverty in the rubber smallholder sector. The usual economic approach is to address these concerns about poverty directly, and independently of industry policy. However, there are reasons to be considered for government intervention in the industry to promote a more efficient use of resources. Indirectly, such action will also contribute to social welfare targets.

One rationale for government action relates to the failures of markets to facilitate the adjustment process. One such failure occurs in the market for capital and has justified the provision of replanting grants. Another failure is in the market for information that justifies government funded research and extension. However, the volume and direction of basic research may not be fully appropriate, and its economic desirability should be assessed by cost benefit criteria. The appropriate level need not be linked to the funds made available from the export tax. More research directed toward labour substitution may well be desirable. To complement this redirected research, extension organisations should be improved so that information on increasingly management-intensive technology is made more readily available to smallholders in particular. There are important questions to be answered about the design of extension schemes, as for example, the types of farmers on which they should be focused. Is it worth directing effort to people who do not have the characteristics of progressive farmers?

Another rationale for government action is to correct the errors created by previous intervention. Thus, the constraints on land consolidation imposed by government legislation should be reviewed, and the current methods of operating group smallholding operations should be examined with a view to enhancing their economic efficiency.

Rubber seems likely to endure as a significant albeit reduced contributor to the Malaysian economy, and to rural living standards. However, the economic desirability of the structural change that accompanies and facilitates growth should be borne in mind. In this context, government's responses of the kinds just mentioned need to be carefully evaluated.

Finally, policy towards the rubber sector should be seen in the context of the distortions present elsewhere in the economy. The existence of protection of manufactures and food adds to the costs faced by the sector, and the export tax discourages production. In addition, other sectors that are declining are granted assistance that adds to the pressure on the rubber sector. While there may be sound reasons for some apparent distortions, as would be the case if the export tax increased the price received for rubber exports by the country as a whole, the reduction of other distortions could both improve efficiency overall in the economy and give positive impetus to the rubber sector.

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References

Barlow, C. 1978. The natural rubber industry. Its development, technology and economy in Malaysia. Oxford, Oxford University Press.

Barlow, C. 1984. Institutional and policy implications of economic change: Malaysian rubber, 1950–63. Canberra, Department of Economics, Research School of Pacific Studies, Australian National University.

Corden, W.M. 1984. Booming sector and Dutch disease economics: A survey, and consolidation. In: Oxford Economic Papers, 36, 359–380.

Corden, W.M., and Neary, J.P. 1982. Booming sector and de-industrialisation in a small open economy. Economic Journal, 92, 825–848.

Garnaut, R., and Anderson, K. 1980. ASEAN export specialisation and the evolution of comparative advantage in the Western Pacific Region. In: Garnaut, R. ed., ASEAN in a changing Pacific and world economy. Canberra, ANU Press.

International Monetary Fund. 1984. International Financial Statistics. Washington.

Malaysia. 1973. Mid-term Review of the Second Malaysia Plan, 1971–75. Kuala Lumpur, Government Press.

Malaysia, Department of Statistics. 1965–84. Monthly Statistical Bulletin, Peninsular Malaysia. Kuala Lumpur.

Malaysia, Department of Statistics. 1970–82a. Rubber Statistics Handbook. Kuala Lumpur.

Malaysia, Department of Statistics. 1970–82b. Oil palm, coconut, tea, and cocoa statistics, 1968–80. Kuala Lumpur.

Malaysia, Department of Statistics. 1977. Kuala Lumpur.

Malaysia, Department of Statistics. 1983. General report of the 1980 population census, Khoo, T.H. ed., Kuala Lumpur.

Malaysia, Department of Statistics. 1984. Private communication, Kuala Lumpur.

Malaysia, Treasury. 1970–84. Annual Economic Reports. Kuala Lumpur.

Malaysian Rubber Research and Development Board. 1983. The Malaysian natural rubber industry, 1983–2000. Report of the Task Force of Experts. Kuala Lumpur.

Mohd. Nor bin Abdullah. 1983. The small farmers—progress and problems. In: The state of Malaysian agriculture. Kuala Lumpur, Asian Institute of Management.

Robless, C.M. 1972. Malaysian development alternatives, 1971–80. University of Indiana, Unpublished Ph.D. thesis.

Rubber Industry Smallholders Development Authority. 1980a. Aide-memoire. Kuala Lumpur.

Rubber Industry Smallholders' Development Authority. 1980b. Laporan Akhir Banci Pekebun Kecil Getah Semanajung Malaysia. Analisa Profail Socio-ekonomi Kemiskinan dan Penyertaan Dalam Rancangan RISDA. Kuala Lumpur. (In Malaysian).

Rubber Research Institute of Malaysia. 1971–82. Annual Reports, 1972–82. Kuala Lumpur.

Tun Ismail bin Mohd. Ali. 1983. The Malaysian plantation industry. Structural changes and future challenges. Paper presented to the International Rubber Marketing Conference, Kuala Lumpur.

Tunku Shamsul Bahrin and Perera, P.D.A. 1977. FELDA: 21 years of land development. Kuala Lumpur, Federal Land Development Authority.

World Bank. 1984. Price prospects for major primary commodities, Vol. II and III: Food products and fertilizers, and agricultural raw materials. Washington, Commodities and Export Projection Division, World Bank.

Table 1. Malaysian economy: key statistics.

Indicator	1970	1971	1972	1980	1981	1982
1. Real exchange rate (Trade weighted)	100	99	—	80	79	—
2. Real exchange rate (Non tradables/tradables)	100	—	101	85	85	88
3. Real wage: rubber tappers (1960 = 100)	109	103	109	147	144	122
4. Real wage: manufacturing (1960 = 100)	125	118	136	—	144	—
5. GDP, 1970 M$m (% of total): Agriculture, forestry, fisheries	3.2(32)			6.3(24)		6.7(23)
6. Mining	0.6(6)			1.2(6)		1.2(4)
7. Manufacturing	1.4(14)			4.9(19)		5.2(18)
8. Services	4.5(44)			11.9(45)		13.7(47)
9. Total	10.1(100)			26.2(100)		29.1(100)
10. Labour employed m persons (% of total): Agriculture, forestry, fisheries	1.7(52)			2.0(42)		2.0(38)
11. Mining	0.1(3)			0.1(2)		0.1(2)
12. Manufacturing	0.3(18)			0.8(17)		0.8(15)
13. Services	1.2(38)			1.9(39)		2.4(45)
14. Total	3.3(100)			4.7(100)		5.3(100)
15. Trade balance US$m	349	225	130	2255	-15	-666
16. Current balance US$m	8	-107	-246	-191	-2286	-3445
17. Petroleum revenue as % total government revenue	—	—	—	20	23	23
18. Domestic gross capital formation (as % of GDP)	20	21	21	29	33	35
19. Public sector investment as % of total	40	52	52	66	88	74
20. Petroleum output ('000 tonnes)	859					12200
21. Manufacturing value added M$m	1158				8879	
22. Rubber price (in M$)		100		307		
23. Rubber price (in US$)		100		407		
24. Exports: Rubber (as % of total)	33.4			19.0*		
25. Palm Oil (as % of total)	5.3			11.7*		
26. Petroleum (as % of total)	3.9			17.2*		
27. Manufacturing (as % of total)	11.9			20.0*		

Source: Appendix Tables 1-9.

*1979

Table 2. Features of the Peninsular Malaysian rubber economy, 1960–82[a].

	1960	1970	1982
Rubber output ('000 t)	718	1216	1464
Rubber workers ('000 persons)	614	674	666
Rubber land ('000 ha)	1549	1724	1693
Rubber land ('000 ha)			(1980)
—Estates	783	647	492
—Individual smallholdings	764	837	815
—Group smallholdings	2	240	386
Oil palm land ('000 ha)			
—Estates	55	194	495
—Individual smallholdings	—	15	65
—Group smallholdings	—	65	346
Rubber yield/mature ha (kg)			(1982)
—Estates	738	1140	1428
—Smallholdings	521	787	1103
Rubber output/worker (t)	1.2	1.8	2.2
Rubber planted area/worker (ha)	2.5	2.6	2.5
Palm oil/kernel yields/mature ha (kg)	n.a.	1489	4155
Palm oil/kernel output/worker (t)	8.8	14.8	24.9
Oil palm planted area/worker (ha)	4.2	7.9	6.0

Rubber production economics	Rubber estates, average		Individual rubber smallholdings	
	1973	1981	Average, 1973	Progressive, 1981
Rubber output/ha (kg)	1278 (at $2.26/kg)	1450 (at $2.26/kg)	998 (at $1.81/kg)	1300 (at $1.81/kg)
Labour output/ha (man days)	98 (at $10.73/m.d)	90 (at $11.81/m.d)	172(at $4.36/m.d)	100 (at $11.81/m.d)
Revenue ($/ha)	2888	3277	1809	2353
Costs ($/ha)				
—Labour	1051(70)[b]	1063(52)[b]	750(71)[b]	1181(81)
—Management	175(12)	317(16)	—	—
—Other	275(18)	659(32)	300(29)	284(19)
—Total	1301(100)	2039(100)	1050(100)	1465(100)
Net revenue (farmgate) ($/ha)	1387	1238	759	888

Notes: a. For details, see Appendix Table 9. b Figures in () brackets are percentages of total cost.

Appendix Table 1. Gross domestic product[a] and labour use by industrial origin, Malaysia,[b] 1960–82.

	1960		1970			1982		
	GDP (1965 M$m)	Labour[c] (m persons)	GDP (1970 M$m)	(% growth)[e]	Labour (m persons)	GDP (1970 M$m)	(% growth)[e]	Labour[d] (m persons)
Agriculture, forestry and fishing	1687 (34)[f]	1.245	3241 (32)	5.5	1.714 (52)	6711 (23)	6.2	1.941 (37)
Mining and quarrying	471 (10)	0.059	580 (6)	2.8	0.057 (2)	1175 (4)	6.0	0.065 (1)
Manufacturing	409 (8)	0.135	1354 (13)	10.4	0.276 (8)	5246 (18)	11.9	0.800 (15)
Construction	148 (3)	0.068	384 (4)	8.4	0.071 (2)	1410 (5)	11.5	0.346 (7)
Services	2241 (45)	0.634	4537 (45)	5.0	1.168 (36)	13699 (47)	9.7	2.093 (40)
Finance, insurance, real estate and commerce	1153 (23)	0.195	2074 (21)	3.9	0.304 (9)	6337 (22)	9.7	0.713 (14)
Transport, storage and communication	215 (4)	0.075	440 (4)	4.4	0.111 (4)	2056 (7)	13.5	0.242 (5)
Government services	299 (6)	0.331	655 (6)	5.8	0.566 (17)	3817 (13)	15.7	0.837 (16)
Other services	574 (12)		1339 (13)	6.8		1489 (5)	1.0	0.301 (50)
Industry not adequately described	—	0.033	—	—	0.817 (6)	—	—	—
Correction[g]	—	—	29(—)*	—	—	+890 (3)	—	—
Total	4956(100)	2.141	10096(100)	5.7	3.286(100)	29131(100)		5.245(100)

Notes: a. At factor cost. 1960 figures are at 1965 constant prices, and 1970 and 1982 figures at 1970 constant prices. Using 1965 prices (1960 GDP calculations are not available at 1970 prices) slightly over-emphasises the agricultural component (Appendix Table 3).

b. Figures for 1960 are for Peninsular Malaysia only.

c. Figures refer to 1957.

d. Figures are estimates for 1983.

e. Per annum compound over the previous 10 years. Growth figures for 1960–70 are for Peninsular Malaysia only, using the figures of Robless (1972).

f. Figures in ( ) brackets are percentages of total; * equals < 1%.

g. Plus important duties and less imputed bank service charges. Robless' GDP figures do not indicate how this adjustment was made.

Sources: (of 1960 GDP figures): Robless (1972).
(of 1970 and 1982 GDP figures): Malaysia. Treasury (1970–84).
(of 1957 and 1970 labour figures): Malaysia. Department of Statistics (1977 and 1983).
(of 1982 labour figures): Malaysia (1984).
(of 'services' components of GDP, 1970): Malaysia (1973).

Appendix Table 2. Prices (1982 M$)[a] of major commodity exports, consumer price index, and terms of trade, Malaysia, 1961–82.

	1961	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Rubber, RSSI, 1982 M$/kg fob, K.L.	5.44	3.43	2.59	2.07	1.83	2.10	2.72	1.88	2.80	2.74	2.99	3.45	3.63	2.74	2.01
Palm oil, crude 1982 M$/kg, fob, K.L.	1.39	1.64	1.34	1.37	0.94	1.02	1.75	1.29	1.24	1.66	1.53	1.62	1.33	1.10	.092
Timber sawn, 1982 M$/$m^3$, Malaysian Meranti, cif, France[b]	648	609	558	545	606	682	532	625	601	492	590	917	943	749	740
Tin-in-concentrate, 1982 M$/kg, average export value	14.80	25.79	22.83	21.23	20.29	18.05	24.60	22.44	26.69	34.63	37.41	39.66	41.91	34.20	30.20
Petroleum, crude, 1982 M$/t, average export value	n.a.	n.a.	88	100	102	125	324	325	n.a.	349	318	432	695	726	601
Consumer price index (1980 = 100)[c]	44	45	48	49	51	56	66	69	71	74	77	81	86	94	100
Terms of trade[d] (1970 = 100)	108[e]	114	110	86	79	87	84	68	n.a.	92	96	103	95	66	72
Real exchange rate[f] (1970 = 100)	n.a.	n.a.	100	101	103	110	116	115	120	119	116	125	125	127	n.a.

Notes: a. Current prices deflated by the consumer price index given in the table.
b. Converted before deflation from US to Malaysian dollars, using concurrent exchange rates.
c. Based on 'retail price index' to 1967, and two 'subsequent' consumer price indexes', 1968–82.
d. Change in average (weighted) export price in relation to change in average export price.
e. In 1962.
f. Value of Malaysian dollars in terms of currencies of major trading partners deflated by the Malaysian : trading partners price ratio.

Sources: (of timber prices): World Bank (1984).
(of data to determine real exchange rates): International Monetary Fund, (1984).
(of all other data): Malaysia, Department of Statistics (1965–84); Malaysia, Treasury (1970–84).

Appendix Table 3. Monthly earnings (1982 M$)[a] of important categories of labourers, Malaysia, 1960–82.

	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Rubber tappers[b]	223	222	242	229	243	266	327	204	283	259	n.a.	280	328	322	271
Manufacturing workers															
Overall[c]	305[d]	358	381	361	416	363	392	342	434	458	491	502	n.a.	439	n.a.
Unskilled[e]	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	206	289	212	279	302	342	369	n.a.
Bus labourers[f]	n.a.	n.a.	321	280	269	248	212	214	221	242	n.a.	247	272	305	278
Clerical workers[g]	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	490	758	499	758	849	820	845	n.a.

Notes: a. Current earnings deflated by the consumer price index given in Appendix Table 2. 'Earnings' include values of perquisites, bonuses, overtime, etc.
b. Male.
c. Overall average for the approximately four-fifths of the total manufacturing work force in the sample.
d. In 1962.
e. Directly employed unskilled workers (about one-fifth of the total manufacturing work force).
f. Male general labourers. A minor group of a few thousand persons.
g. Relatively small sampled group, increasing from 14,961 persons (1975) to 24,710 persons (1981).

Sources: (of overall manufacturing workers' earnings): Malaysia, Department of Statistics (1984).
(of other earnings): Malaysia, Department of Statistics (1965–84).

Appendix Table 4. Growth in commodity and manufacturing outputs,[a] Malaysia, 1960–82 (percent per year compound).

	1960–70	1970–82
Rubber	5.1	1.0
Crude palm oil	16.9	18.3
Rice	5.4	1.6
Coconut oil	2.1	-3.2
Cocoa	—	40.0
Sawlogs	12.5	9.2
Tin-in-concentrate	3.3	-3.1
Bauxite	n.a.	-5.6
Iron ore	-2.5	-26.0
Crude petroleum	40.0	24.5
Manufacturing (real value added)	14.9	13.2

Note: a. In terms of physical output, except for manufacturing which is in M$ 1982.

Sources: (of manufacturing data): Department of Statistics (1984).
(of other data): Malaysia, Treasury (1970–84).

Appendix Table 5. Output, labour, and land use, Peninsular Malaysia, 1960–82.

	1960			1970			1982		
	Output ('000 t)	Labour ('000 persons)	Land ('000 ha)	Output ('000 t)	Labour ('000 persons)	Land ('000 ha)	Output ('000 t)	Labour[a] ('000 persons)	Land ('000 ha)
Rubber (dry)	718	614	1549	1216	674	1724	1464	666	1693
Crude palm oil	90	13	55	402	33	273	3253	165	983[b]
Palm kernel	24			87			850		
Rice	645[c]	398	324	929	366	533	1137[d]	366	493
Coconut oil[e]	78	40	210	102	30	213	69	n.a.	249
Cocoa (dry beans)[e]	—	—	—	1	n.a.	3	62	n.a.	190
Total[f]		1065	2138		1103[g]	2746		1197[g]	3608

Notes: a. These labour figures are for 1980.
b. Area in 1981.
c. Output in 1961.
d. Output in 1981.
e. Cocoa and coconut are usually interplanted together.
f. Excluding about 150,000 ha of other crops in all years.
g. Excluding the (very few) cocoa workers in 1970, and cocoa and coconut workers (about 50,000) in 1982.

Sources: (of labour figures): Malaysia, Department of Statistics (1977 and 1983).
(of other figures): Malaysia, Department of Statistics (1965–84).

Appendix Table 6. Rubber on estates and smallholdings, Peninsular Malaysia, 1960–80.

	Estate				Smallholdings					
	Area ('000 ha)				Individual, Area ('000 ha)			Group, Area ('000 ha)		
	Total[a]	Replanted[b]	New planted[b]	Output ('000 t)	Total[c]	Replanted[b]	New planted[b]	FELDA	Other[d]	Total output ('000 t)
1960	783	383(383)	53(53)[e]	420	764	169(169)	6 (6)[e]	2	—	298
1970	647	567(184)	77(24)	621	837	428(259)	33(27)	60	180	595
1980	492	656 (89)	94(17)	587	815	618(190)	51(18)	169	217	877

Notes: a. The net total areas of estates declined largely through the planting of other crops, although there was also some new planting and subdivision into smallholding rubber.
b. Cumulative totals (but the figures in () brackets are areas replanted/new planted over the interval up to the year shown).
c. The net total area of individual holdings increased up to 1970 through new planting and estate subdivision, although there was also limited planting of other crops. The net total area decreased up to 1980 since the planting of other crops offset other trends.
d. Obtained by difference from the total planted area of rubber (Appendix Table 5).
e. New planting is only counted from 1950.

Sources: (of individual smallholding total area): various sources quoted by Barlow (1978).
(of individual smallholding new planting): Mohd. Nor bin Abdullah (1983).
(of other data): Malaysia, Department of Statistics (1970–82a).

Appendix Table 7. Oil palm on estates and smallholdings, Peninsular Malaysia, 1960–80 ('000 ha).

	Estates	Smallholdings		
			Group	
		Individual	FELDA	Other
1960	55	—	—	—
1970	194	15[a]	65	n.a.
1980	495	65[a]	308	38

Note: a. Including a small area of group smallholdings operated under State auspices.

Source: Malaysia, Department of Statistics (1970–82b).

Appendix Table 8. Output:input and land:labour ratios. Rubber, oil palm, and rice, Peninsular Malaysia, 1960–82.

	1960	1970	1982
Rubber[a]:			
Yield/mature ha (kg)			
Estates	738	1140	1428[b]
Individual smallholdings	521	787	1103[b]
Overall			
Output/planted ha (t)	0.5	0.7	0.9
Output/worker (t)	1.2	1.8	2.2
Planted ha/worker	2.5	2.6	2.5
Estates			
Planted ha/worker	2.8	2.9	3.1[b]
Oil palm[c]:			
Yield/mature ha (kg)	n.a.	1489	4155
Overall			
Output/planted ha (t)	2.1	1.8	4.2
Output/worker (t)	8.8	14.8	24.9
Planted ha/worker	4.2	7.9	6.0
Estates			
Planted ha/worker	n.a.	5.1[d]	6.0[b]

Notes: a. Outputs and yields are of dry rubber.
b. In 1980.
c. Outputs and yields are totals of crude palm oil and palm kernel.
d. In 1971.

Sources: (of 'overall' figures): computed from data in Appendix Table 5.
(of smallholding yields): Barlow (1978) and Rubber Industry Smallholders' Development Authority (1980a).
(of other figures): Malaysia, Department of Statistics (1970–82, a and b).

Appendix Table 9. Outputs and inputs in rubber production, Peninsular Malaysia[a], 1973, 1981.

	Rubber estates, average				Individual rubber smallholdings			
	1973		1981		Average 1973		Progressive, 1981[b]	
Outputs:	*kg/ha*		*kg/ha*		*kg/ha*		*kg/ha*	
Yield	1278		1450		998	1300		
	$/ha	*$/kg*[c]	*$/ha*	*$/kg*[c]	*$/ha*	*$/kg*[d]	*$/ha*	*$/m.d*
Revenue (farm gate)	2888	2.26	3277	2.26	1809	1.81	2353	1.81
Inputs:	*person-days/hr*	*$/m.d*						
Labour	98	10.73[e]	90	11.81[e]	172	4.36[f]	100	11.81[f]
Costs	*$/ha*	*$/kg*	*$/ha*	*$/kg*	*$/ha*	*$/kg*	*$/ha*	*$/kg*
Labour	1051	0.82 (70)	1063	0.73 (52)	750	0.75 (71)	1181	0.91 (81)
Management	175	0.14 (12)	317	0.22 (16)	—	—	—	—
Other	275	0.22 (18)	659	0.45 (32)	300	0.30 (29)	284	0.22 (19)
Total	1501	1.17(100)	2039	1.40(100)	1050	1.05(100)	1465	1.13(100)
Profits (farm gate)								
Net revenue[g]	1387	1.09	1238	0.86	759	0.76	888	0.68
Family income[h]	—	—	—	—	1509	1.51	2069	1.59

Notes: a. Values in 1982 $, using the consumer price index of Appendix Table 2 as a weight.
b. Constituting the better 'managers', who form about half the total number of rubber smallholders.
c. Assuming in both 1973 and 1981 that the 'farm gate' estate revenue (constitutes 87.5% of the average 1970–82 RSSI price of 1982 $2.59 per kg (Appendix Table 2).
d. Assuming in both 1973 and 1981 that this 'farm gate' smallholding revenue constitutes 70% of the average 1970–82 RSSI prices of 1982 $2.59 per kg (Appendix Table 2).
e. Valuing estate labour at the average 1972–74 and 1980–82 estate tappers' earnings per person-day (1982 $) in 1973 and 1981, respectively.
f. Valuing smallholder labour at its estimated 'opportunities cost' in 1973 (1982 $) (Barlow 1978), and at 1980–82 average tapper earnings per man-day (1982 $) in 1981.
g. Farm gate revenue less all costs. Export taxes are deducted in getting farm gate revenues, but estates are also subject to income tax.
h. Farm gate revenue less non-labour costs.

Sources: (of basic 1973 data): Barlow (1978).
(of basic 1981 data): Barlow (1984).

Estimating Intersectoral Effects on the Rubber Industry Using a SAM-based General Equilibrium Model

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THE analysis presented in this paper constitutes a preliminary examination of the potential of general equilibrium modeling in the measurement of intersectoral effects of policies affecting the rubber sector. The approach was first suggested by Kym Anderson, Department of Economics, University of Adelaide, and is part of an on-going study of intersectoral effects on the agricultural sectors of a number of East and Southeast Asian countries. The results presented will be subject to change as improvements are made to the model and to the quality of the data on which it is based.

This paper illustrates the use of a simple general equilibrium model to measure the directions and magnitudes of the impacts of economic changes on the rubber sector of Malaysia. Several such changes have been identified and discussed by Barlow et al. (1985). Those on which this paper concentrates are: (1) the petroleum boom of the 1970s, which brought a substantial change in the international terms of trade and accompanied an expansion in Malaysia's endowment of petroleum resources; (2) the rapid growth in Malaysia's manufacturing sector, stimulated in part by changes in comparative advantage as wages have risen in other East Asian countries and accompanying a substantial capital inflow; (3) technological improvements in other export agricultural activities, particularly oil palm; and (4) changes in trade policies affecting both the agricultural and manufacturing sectors.

In this preliminary analysis the impacts of these economic changes are examined using a simple four-factor, six-sector general equilibrium model. The model is a crude abstraction of Malaysia's overall economy that assumes perfectly-competitive, neoclassical factor and product markets and fixed factor endowments. It follows in structure that described by Boadway and Treddenick (1978) and Mendoza et al. (1983). The statistics on which it is based are drawn from the social accounting matrix for Malaysia developed by Pyatt et al. (1984).

The intent of the approach adopted is to decompose the structural changes in the Malaysian economy, particularly those affecting the rubber sector, into components associated with each of the determinants listed above. This would permit the separation of the impacts of determinants such as the terms of trade effects, changes in factor endowments and technology changes, from policy changes affecting levels of effective protection.

To date there has been insufficient time to draw the magnitudes of each of these respective determinants from Malaysian statistics. The results enclosed are therefore based on arbitrary shifts in factor endowments, factor productivity and trade policies, treated separately to illustrate the response of the economy to each.

The Model

A paper giving a detailed description of the model is presently in preparation. The interested reader should refer in the meantime to Boadway and Treddenick (1978) or Mendoza et al. (1983) for mathematical detail. The version described here has, of course, been expanded to four primary factors. Modifications have also been made to the determination of the exchange rate; the rest of the world is, in this version, assumed to have linear excess supply and demand curves for traded merchandise. Most importantly, the model has been converted to draw parameters from and to reproduce internally consistent social accounting matrices. These summarise, at a glance, the changes simulated by counterfactual analysis.

Production

Each sector produces only one good, which is perfectly substitutable for the corresponding good

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Table 1. Aggregate SAM for all Malaysia, 1979 (M$m).

				Expenditures											
				Wants	Factors	Institutions' current			Consol-idated capital	Rest of world		Comm-odities	Activ-ities	Indir-ect taxes	Totals
						House-holds	Comp-anies	Govern-ment		Current	Capital				
				1	2	3	4	5	6	7*	8*	9	10	11	12
INCOMES	Wants		1			7528.2									7528.2
	Factors		2							232.2			10601.1		10833.3
	Inst-itut-ions' Curr-ent	Households	3		8695.7	475.9	108.9	196.2		16.0					9492.7
		Companies	4		1550.9			133.7		15.1					1699.7
		Government	5			388.0	991.6			15.1				1802.0	3196.7
	Consolidated capital		6			1100.6	369.1	855.4			-85.0				2240.1
	Rest of world	Current	7*		586.7		230.1	26.4				4797.6			5640.8
		Capital	8*						-123.8	38.8					-85.0
	Commodities		9	7528.2				1985.0	2363.9	5323.6			9311.1		26511.8
	Activities		10									20402.7			20402.7
	Indirect taxes		11									1311.5	490.5		1802.0
	Totals		12	7528.2	10833.3	9492.7	1699.7	3196.7	2240.1	5640.8	-85.0	26511.8	20402.7	1802.0	

Source: Pyatt et al. (1984).

produced abroad. Every firm combines intermediate inputs with four primary factors, i.e. capital, labour, land, and mineral resources. The production technology is represented by Cobb-Douglas functions and inputs are used in fixed proportions relative to the level of output. Thus, while primary factors are substitutable, with unit elasticities of substitution, intermediate inputs are not (Boadway and Treddenick point out a simple modification to avoid this rather restrictive assumption).

Consumption

Every institution—households and government are combined in the model into the aggregate of institutions—sells its factor endowment to firms and thereby derives income. Overall primary factor endowments are fixed. Expenditure decisions maximise utility for a given level of income, assuming Cobb-Douglas utility functions. Income and price elasticities of demand are therefore assumed to hold unit values.

Foreign Trade

Average import tariffs and export tariffs are recognised explicitly in the model. Excess demand for Malaysia's exports in the rest of the world and the corresponding excess supply in the rest of the world of Malaysia's imports are linear functions of the border prices, expressed in foreign currency. Services are assumed to be non-traded and the current account is assumed to balance exactly—there are no capital accounts in the model. In each solution, the exchange rate adjusts endogenously so as to achieve current account balance.

Solution Technique

An iterative technique is used in which a general equilibrium is sought through Walrasian adjustment in the factor markets. Provided the reference SAM is internally consistent, a general equilibrium follows immediately. In counterfactual experiments, the model proceeds from the reference solution (for 1970) to a new equilibrium and therefore to a new internally consistent SAM.

Results

A summary of the original SAM, drawn from Pyatt et al., is given in Table 1. Taking account of the many restrictive assumptions inherent in the model—most importantly, the absence of capital accounts and the substitutability of domestic with foreign goods—a simplified aggregate SAM was first developed. This SAM is listed in Table 2. Then, drawing upon the detail provided in the Pyatt SAM, this abstraction was disaggregated to form the working SAM on which the model is based. This SAM is listed in Table 3.

The results of experiments using the model are then presented in Tables 4 through 11. They are expressed as proportional changes to individual entries in the SAM of Table 3. Corresponding changes in the exchange rate are listed, where relevant, at the foot of each table, expressed as changes in the domestic price of foreign exchange. It should be borne in mind that the version of the model on which these results are based does not evaluate the relative prices of products, factors and foreign exchange in terms of any predetermined numeraire. Nevertheless, the set of these prices at which equilibrium is attained are meaningfully interpreted only in relative terms. The changes in factor prices are not listed explicitly on Tables 4 through 11 but, where factor endowments remain fixed, the proportional changes in their prices are equivalent to the corresponding changes in factor incomes.

External Adverse Changes

The first three experiments, presented in Tables 4 through 6, examine the intersectoral effects of external changes that have reduced rubber profitability, i.e. the mineral boom, the manufacturing boom, and productivity increases in the non-rubber agricultural export sector. For simplicity, the mineral boom is simulated only as an increase in Malaysia's endowment of mineral (say petroleum) resources. The result is clearly adverse from the point of view of the competing export sectors, including and especially rubber, but it is also adverse from the point of view of the manufacturing sector, with which the mineral industry competes for capital.

In the case of the manufacturing boom, an expansion in Malaysia's capital endowment of 10% is assumed. Such a change might occur in response to the mobilisation of domestic and foreign savings for investment in low comparative-cost areas within the relatively capital-intensive sectors, including minerals and other export agriculture (particularly oil palm) but especially manufacturing. These sectors are stimulated and draw labour away from the more labour-intensive sectors, particularly rubber. As a consequence, total output in the rubber sector declines.

Table 2. Aggregate Social Accounting Matrix for Malaysia, 1970.

	Expenditures of			
Incomes to	Factors	Institutions	Production	Rest of world
Factors			10601	
Institutions	10601	897		200
Production		7335	13000	3266
Rest of world		3466		

Table 3. Malaysian social accounting matrix, (M$ millions), 1970.

Incomes to		Expenditures by: Factors: Capital	Labour	Land	Resrcs	Institutions	Production/sectors: Rubber	OAgX	Food	Minrls	Mfg	Srvcs	Rest of world	Totals
Factors:	Capital						154	614	233	433	1280	360		3074
	Labour						1081	602	1633	432	853	1363		5964
	Land						309	608	466	10	20	30		1443
	Resources									120				120
Institutions:		3074	5964	1443	120	897							200	11698
Production sectors:	Rubber					75	406	3		3	47	49	1688	2271
	O Ag X					672	3	154	175	11	182	118	995	2310
	Food					2765		1	627		7	204		3604
	Minerals					246	20	77	71	1352	193	334	583	2876
	Manuftng					1505	131	159	180	120	882	969		3946
	Services					2072	167	92	219	395	482	5167		8594
Rest of world:	Food					510								
	Manuftng					2956								3466

Note: Cost of foreign exchange, e = 1.0.

Table 4. Malaysian social accounting matrix, (% changes due to mineral boom).

Incomes to		Expenditures by: Factors: Capital	Labour	Land	Resrcs	Institutions	Production/sectors: Rubber	OAgX	Food	Minrls	Mfg	Srvcs	Rest of world	Totals
Factors:	Capital						-3.2	-.7	.6	20.3	-6.2	3.4		.4
	Labour						-3.2	-.7	.6	20.3	-6.2	3.4		.9
	Land						-3.2	-.7	.6	20.3	-6.2	3.4		-.7
	Resources									20.3				20.3
Institutions:		.4	.9	-.7	20.4	9.3							34.4	2.0
Production sectors:	Rubber					2.0	-3.2	-.5		25.0	-6.4	3.1	-3.6	-3.2
	O Ag X					2.0	-3.5	-.8	.2	24.6	-6.7	2.8	-2.4	-.8
	Food					.3		-.5	.5		-6.4	3.1		.5
	Minerals					2.0	-5.6	-2.9	-2.0	21.9	-8.7	.6	59.8	21.9
	Manuftng					-16.8	-3.3	-.6	.4	24.9	-6.5	3.0		-6.5
	Services					2.0	-3.4	-.6	.4	24.9	-6.5	3.0		3.0
Rest of world:	Food					11.1								
	Manuftng					9.3								9.6

Note: Resource endowment increased by 2/3. Δ e = 0.06%.

Table 5. Malaysian social accounting matrix, (% changes due to manufacturing boom).

Incomes to		Expenditures by: Factors: Capital	Labour	Land	Resrcs	Institutions	Production/sectors: Rubber	OAgX	Food	Minrls	Mfg	Srvcs	Rest of world	Totals
Factors:	Capital						-7.1	3.3	-2.1	1.1	15.1	3.6		7.0
	Labour						-7.1	3.3	-2.1	1.1	15.1	3.6		1.5
	Land						-7.1	3.3	-2.1	1.1	15.1	3.6		-.5
	Resources									1.1				1.1
Institutions:		7.0	1.5	-.5	1.1	-9.6							-.6	1.7
Production sectors:	Rubber					1.7	-7.3	4.4		2.0	16.8	3.5	-8.7	-7.3
	O Ag X					1.7	-8.2	3.3	-3.3	1.0	15.6	2.4	3.5	3.3
	Food					-2.8		4.3	-2.3		16.8	3.5		-2.3
	Minerals					1.7	-8.0	3.6	-3.0	1.2	15.9	2.7	-4.1	1.2
	Manuftng					30.7	-8.4	3.1	-3.5	.8	15.4	2.3		15.4
	Services					1.7	-7.6	4.0	-2.7	1.6	16.3	3.1		3.1
Rest of world:	Food					26.4								
	Manuftng					-9.6								-4.3

Note: Capital endowment increased by 10%. Δ e = -.36%.

Table 6. Malaysian social accounting matrix, (% changes due to O.Ag.X productivity increase).

Incomes to		Expenditures by: Factors: Capital	Labour	Land	Resrcs	Institutions	Production/sectors: Rubber	OAgX	Food	Minrls	Mfg	Srvcs	Rest of world	Totals
Factors:	Capital						-16.1	43.0	-5.9	-3.7	-14.8	-2.5		.4
	Labour						-16.1	43.0	-5.9	-3.7	-14.8	-2.5		-3.1
	Land						-16.1	43.0	-5.9	-3.7	-14.8	-2.5		12.5
	Resources									-3.7				-3.7
Institutions:		.4	-3.1	12.5	-3.7	13.9							-12.6	.9
Production sectors:	Rubber					.9	-16.3	52.5		-2.3	-14.2	-.5	-17.8	-16.3
	O Ag X					.9	-20.9	44.2	-11.3	-7.7	-18.9	-5.9	101.4	44.2
	Food					-6.9		52.0	-6.5		-14.5	-.8		-6.5
	Minerals					.9	-17.6	50.2	-7.6	-3.8	-15.5	-1.9	-9.1	-3.8
	Manuftng					-32.6	-17.4	50.6	-7.3	-3.5	-15.2	-1.7		-15.2
	Services					.9	-17.8	49.8	-7.8	-4.0	-15.7	-2.2		-2.2
Rest of world:	Food					42.8								
	Manuftng					13.9								18.2

Note: 10% across the board increase in O.Ag.X. factor productivity. Δ e = -1.89%.

Table 7. Malaysian social accounting matrix, (% changes due to rubber productivity increase).

Incomes to		Capital	Labour	Land	Resrcs	Institutions	Rubber	OAgX	Food	Minrls	Mfg	Srvcs	Rest of world	Totals
		Expenditures by												
		Factors					Production/sectors							
Factors:	Capital						37.5	-11.6	-10.2	-5.8	-4.7	1.7		-3.8
	Labour						37.5	-11.6	-10.2	-5.8	-4.7	1.7		2.1
	Land						37.5	-11.6	-10.2	-5.8	-4.7	1.7		-.2
	Resources									-5.8				-5.8
Institutions:		-3.8	2.1	-.2	-5.8	4.6							10.8	.5
Production sectors:	Rubber					.5	39.5	-17.1		-10.9	-9.9	-6.0	44.1	39.5
	O Ag X					.5	48.6	-11.7	-11.8	-5.0	-4.0	.1	-22.9	-11.7
	Food					-11.5		-10.4	-10.6		-2.6	1.5		-10.6
	Minerals					.5	48.0	-12.0	-12.2	-5.4	-4.3	-.3	-11.4	-5.4
	Manuftng					-9.8	47.8	-12.1	-12.3	-5.5	-4.5	-.4		-4.5
	Services					.5	49.5	-11.1	-11.3	-4.5	-3.4	.7		.7
Rest of world:	Food					65.8								
	Manuftng					4.6								13.6

Note: 10% increase in total productivity of factors in rubber production. Δ e = -1.45%.

Table 8. Malaysian social accounting matrix, (% changes due to reduced rubber export tax).

Incomes to		Capital	Labour	Land	Resrcs	Institutions	Rubber	OAgX	Food	Minrls	Mfg	Srvcs	Rest of world	Totals
		Expenditures by												
		Factors					Production/sectors							
Factors:	Capital						28.8	-8.0	-8.0	-3.7	-3.6	.1		-2.8
	Labour						28.8	-8.0	-8.0	-3.7	-3.6	.1		1.5
	Land						28.8	-8.0	-8.0	-3.7	-3.6	.1		.2
	Resources									-3.7				-3.7
Institutions:		-2.8	1.5	.2	-3.7	1.5							-43.3	-.6
Production sectors:	Rubber					-.6	28.6	-7.1		-2.1	-2.0	.1	31.7	28.6
	O Ag X					-.6	27.3	-8.0	-9.1	-3.1	-3.0	-.9	-14.8	-8.0
	Food					-8.8		-7.1	-8.2		-2.0	.1		-8.2
	Minerals					-.6	26.9	-8.3	-9.4	-3.4	-3.3	-1.2	-5.6	-3.4
	Manuftng					-6.0	26.8	-8.4	-9.4	-3.5	-3.3	-1.3		-3.3
	Services					-.6	27.8	-7.6	-8.7	-2.7	-2.5	-.4		-.4
Rest of world:	Food					44.0								
	Manuftng					1.5								-7.7

Note: Export tax reduced from 5% to zero. Δ e = -.90%.

Table 9. Malaysian social accounting matrix, (% changes due to O.Ag.X. productivity increase + export tax).

Incomes to		Factors: Capital	Factors: Labour	Factors: Land	Factors: Resrcs	Institutions	Production/sectors: Rubber	Production/sectors: OAgX	Production/sectors: Food	Production/sectors: Minrls	Production/sectors: Mfg	Production/sectors: Srvcs	Rest of world	Totals
Factors:	Capital						1.0	-14.5	3.9	-1.1	6.4	1.8		.2
	Labour						1.0	-14.5	3.9	-1.1	6.4	1.8		1.0
	Land						1.0	-14.5	3.9	-1.1	6.4	1.8		-4.5
	Resources									-1.1				-1.1
Institutions:		.2	1.0	-4.5	-1.1	-4.0							33.6	-.6
Production sectors:	Rubber					.3	1.0	-5.0	-1.5		5.7	.8	.9	1.0
	O Ag X					.3	-7.5	-13.0	-4.8	-9.8	-3.2	-7.6	-25.9	-13.0
	Food					3.7		-5.5	3.4		5.2	.4		3.4
	Minerals					.3	1.3	-4.7	4.3	-1.2	6.0	1.2	-6.0	-1.2
	Manuftng					11.2	1.0	-5.0	3.9	-1.6	5.7	.8		5.7
	Services					.3	1.2	-4.8	4.1	-1.4	5.9	1.0		1.0
Rest of world:	Food					-18.1								
	Manuftng					-4.0								-6.1

Note: 10% factor productivity increase + 10% export tax. $\Delta e = -.06\%$.

Table 10. Malaysian social accounting matrix, (% changes due to mineral boom + mineral export tax).

Incomes to		Factors: Capital	Factors: Labour	Factors: Land	Factors: Resrcs	Institutions	Production/sectors: Rubber	Production/sectors: OAgX	Production/sectors: Food	Production/sectors: Minrls	Production/sectors: Mfg	Production/sectors: Srvcs	Rest of world	Totals
Factors:	Capital						-.8	.2	.8	1.0	1.1	2.0		.9
	Labour						-.8	.2	.8	1.0	1.1	2.0		.8
	Land						-.8	.2	.8	1.0	1.1	2.0		.3
	Resources									1.0				1.0
Institutions:		.9	.8	.3	1.0	1.7							18.9	1.1
Production sectors:	Rubber					1.1	-.9	.2		7.2	.8	1.8	-1.1	-.9
	O Ag X					1.1	-1.0	.1	.6	7.0	.7	1.7	-1.1	.1
	Food					.6		.1	.7		.8	1.8		.7
	Minerals					1.1	-4.7	-3.7	-3.1	3.1	-3.0	-2.1	10.7	3.1
	Manuftng					-.2	-1.0	.1	.6	7.0	.7	1.7		.7
	Services					1.1	-1.2	-.1	.4	6.8	.5	1.5		1.5
Rest of world:	Food					4.1								
	Manuftng					1.7								2.0

Note: Resource endowment increased by 2/3 and 5% added to mineral export tax. $\Delta e = .44\%$.

Table 11. Malaysian social accounting matrix, (% changes due to manufacturing boom + reduced tariff).

Incomes to		Expenditures by: Factors: Capital	Labour	Land	Resrcs	Institutions	Production/sectors: Rubber	OAgX	Food	Minrls	Mfg	Srvcs	Rest of world	Totals
Factors:	Capital						-1.9	14.9	2.0	17.9	-8.5	4.1		2.5
	Labour						-1.9	14.9	2.0	17.9	-8.5	4.1		2.7
	Land						-1.9	14.9	2.0	17.9	-8.5	4.1		6.6
	Resources									17.9				17.9
Institutions:		2.5	2.7	6.7	17.9	-3.1							24.7	3.2
Production sectors:	Rubber					3.2	-2.5	16.3		19.9	-3.9	5.3	-3.0	-2.5
	O Ag X					3.2	-3.9	14.6		18.2	-5.3	3.8	29.8	14.6
	Food					1.1		16.2	1.4		-4.0	5.3		1.4
	Minerals					3.2	-4.3	14.1	-.5	17.6	-5.8	3.3	43.1	17.6
	Manuftng					-18.0	-6.2	11.8	-2.4	15.3	-7.6	1.3		-7.6
	Services					3.2	-4.3	14.1	-.5	17.7	-5.8	3.3		3.3
Rest of world:	Food					14.7								
	Manuftng					16.0								15.8

Note: Capital endowment increased by 10%, tariff reduced from 30 to 25%. Δ e = 1.5%.

The third experiment measures the impacts of a 10% increase in total factor productivity in the non-rubber agricultural export sector, such as might result from technology improvements in the sector. Again, such a change draws factors from other sectors, e.g. land from the rubber and food sectors and capital from the mineral and manufacturing sectors. It is the rubber sector, however, that suffers the largest proportional decline.

It is worth noting that, despite the adverse impacts of these changes on the rubber sector, each results in increased national income (see the row/column total for institutions). Also, in the cases of the mineral and manufacturing booms, average wages are increased. In the case of productivity improvement in the non-rubber agricultural export sector, average wages decline but land rents (incomes to rural landholders) increase. It is difficult, therefore, to see these changes as being other than beneficial from the viewpoint of the economy as a whole.

Potentially Beneficial Changes

Three experiments illustrate changes of potential benefit to the rubber sector, i.e. technology improvement in the sector, reduced taxation of rubber exports and the imposition of taxes on sectors that compete with rubber for primary factors. The results from these experiments are listed in Tables 7-9. In the former two cases, the profitability of the domestic rubber industry is increased and labour is attracted away from other sectors, the average wage increases, and national income increases, at least in terms of purchasing power abroad.

The third experiment adds to the case of the productivity increase in the non-rubber export agricultural sector, considered above, a tax on exports by this sector. Comparing Tables 6 and 9, it can be seen that the combination of these changes retains some of the net gain in national income from the technology improvement while negating the decline in rubber output and in average wages that accompany it. Total output in the non-rubber agricultural export sector declines, however.

Mitigating Effects of Booms

The intersectoral effects of the mineral boom in Malaysia have been mitigated somewhat by taxation of mineral (mainly petroleum) exports. The impact of such taxation can be gauged from a comparison of Tables 4 and 10. Although some of the increase in national income from the boom is foregone, the adverse impact on the rubber sector is substantially reduced and that on the manufacturing sector is eliminated.

The manufacturing sector in Malaysia has traditionally received substantial tariff protection. The intersectoral effects or rapid expansion in some industries within this sector can therefore be mitigated by reducing the level of this protection. The impact of such a tariff reduction can be gauged from a comparison of Tables 5 and 11. In this case the decline in total rubber output is substantially reduced while the gain in national income stemming from the increased capital endowment is retained. The manufacturing sector declines, however, as capital is drawn into the more profitable, and relatively capital-intensive, non-rubber agricultural export and mineral sectors.

Conclusions

The experiments presented in the previous section illustrate the application of general equilibrium modeling to the analysis of intersectoral effects on the rubber sector of Malaysia. Although the data upon which the model is based and the economic changes presumed to be the origins of these effects are as yet only crudely measured, the potential of this approach is clearly demonstrated. It might usefully be applied to the measurement of the extent to which the decline in profitability of the Malaysian rubber sector in the past decade has been due to the taxation of rubber exports and to the intersectoral effects of policies directed primarily at other sectors of the economy.

Should the net effects of the Malaysian government's interventions be to distort the economy in a direction adverse to the rubber industry, a case can be made on efficiency grounds for changes of policy that might reduce pressure on the industry. Nevertheless, as national income and real wages continue to grow, Malaysia's comparative advantage can be expected to move away from very labour-intensive sectors, such as rubber, toward industries relatively intensive in natural resources and human capital. Malaysia might then be expected to export more rubber research and management services and, possibly, more rubber products, with lightly-processed rubber making up an ever-decreasing share of total exports.

The ultimate survival of a healthy rubber production industry in Malaysia depends primarily upon the capacity of research to shift the industry's factor shares of value added in a direction consistent with the shift occurring in Malaysia's overall factor endowments. The industry must become less labour-intensive. The analysis of the potential impacts of labour-saving technical change in rubber production is another possible application of general equilibrium modeling. Such an approach would usefully complement research on technology transfer in the rubber industry by making explicit the likely intersectoral consequences of technological change.

References

Barlow, C., Findlay, C.C., Forsyth, P.J., and Jayasuriya, S. 1985. These Proceedings.

Boadway, R., and Treddenick, J. 1978. A general equilibrium computation of the effects of the Canadian tariff structure. Canadian Journal of Economics, 11, 424.

Mendoza, M.N., Roumasset, J., and Clarete, R. 1983. Planning policy with general equilibrium models: Effects of tariffs in the Philippines. Working Paper WP-83-19. Honolulu, East West Resource Systems Institute.

Pyatt, G., Round, J.I., and Denes, J. 1984. Improving the macroeconomic data base—A SAM for Malaysia, 1970. World Bank Staff Working Paper No. 646, May.

Agricultural Research and Innovations with Special Relevance to Malaysian Rubber Smallholders

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OF the 4.28 million ha of cultivated land in Malaysia in 1980, about 46.8% or just over 2 million ha was under rubber. Individual independent smallholdings accounted for 54.7% while small farms organised under schemes, e.g. the Federal Land Development Authority (FELDA), and the Federal Land Consolidation and Rehabilitation Authority (FELCRA), accounted for about 20% of the total area under rubber. Thus almost 75% of rubber or 1.5 million ha are cultivated by smallholders, the majority of the small farms being less than 3 to 4 ha. The remaining area (about 0.5 million ha) is managed as organised estates.

The total area of rubber under the estate sector has been declining. In 1960, this sector accounted for 0.89 million ha or 45% of the rubber areas. On the other hand, the total area in the smallholder sector has increased from 1.08 million ha in 1960 to 1.49 million ha in 1980.

At the same time, the productivity in the smallholder sector is low compared to that in the estate sector. In 1960, the average yield per planted hectare was only 436 kg/ha in the smallholders sector, while that in the estate sector was 758 kg. By 1970, the average yield in the two sectors was 752 and 1189 kg/ha, respectively. These large differences were ascribed to many factors, the main one being that by 1970, about 90% of the rubber in the estate sector had been replanted with the then modern clones while such replacement in the smallholders sector was less than 70%. Another factor considered as a contributor to this was that almost all research on rubber was conducted in the estate sector. The realisation of this disadvantageous position of the smallholdings resulted in research also being directed to selected problems in the smallholders sector from the mid-1960s (Pushparajah et al. 1973a). Till the mid-sixties as indicated earlier, all research investigations were conducted in the commercial estates. It cannot be denied that the smallholders benefited from this research though the results of the investigations were directly applied to these holdings often without adjustments for their conditions. From the mid-sixties, results of such investigations were tested in and adapted for smallholding situations. The main areas of agricultural research aimed at smallholders were on:

1. Choice of planting materials.
2. Density of planting and methods of establishment.
3. Fertiliser use, cover and interrow management.
4. Exploitation.

Further, in a large number of instances, the smallholders would have no alternative income during the first six years of replanting. Investigations on cultivation of intercrops and/or small ruminants to provide alternative sources of income were initiated and still continue.

This paper discusses the results and progress of such continuing investigations.

Agricultural Innovations

Planting Materials

Till the late 1960s, clonal seedlings used to be the main planting material supplied to smallholdings. On the other hand, in the estate sector, buddings of selected clones were often used. The former were not only variable, but generally had lower potential than buddings of more modern clones. Further, even when buddings were used in the smallholder sector, these were confined to choice from one to two clones for the whole country.

On the other hand, the estate sector had the choice of a large number of clones. They were categorised into:

1. Class One clones for planting on a large scale, with a choice from about 5 to 7 clones.

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2. Class Two clones for moderate scale planting up to one-third of planting on an aggregate, with a choice from 10 or more clones.
3. Class Three clones for experimental plantings in 2-10 ha with a choice from often more than 10 recent clones.

At the same time, the Malaysia Peninsula was divided into 17 planting regions. The regions were based on susceptibility to wind and the incidence of leaf, stem, and panel diseases. Thus, in any one area, the clone to be used would have to have a resistance for the limiting factor prevalent in the planting region. At the same time, for the estate sector, clonal seedlings were also included as a material suitable for large scale planting.

On the other hand, investigations had shown that for the smallholders sector, the use of clonal seedlings was not practicable for a number of reasons. Among these was the fact that they could not be identified and thus the seedlings used in plantings may not be the genuine materials. Further, clonal seedlings could not withstand intensive tapping as often practised in the smallholders sector. In view of these findings, clonal seedlings were removed from the planting recommendations for smallholdings in 1973 (RRIM 1973).

In the absence of any direct experimental work in the smallholders sector, based on extrapolation of the Institute's trials, planting recommendations for smallholdings were revised according to the 17 regions as for the estates (Pushparajah et al. 1973a). The choice of clones was confined to only the Class One clones. However, in any one district, the smallholder was given a choice of at least three clones. The recommendations also indicated that in order to get the maximum benefit, a mixture of 2 or more clones was to be used.

Subsequent to this recommendation, investigations on the smallholder sector have also involved establishment of Class Two and Class Three clones on an experimental scale on block planting. These continue to be monitored with the view to enable better selection of newer materials more adapted to smallholder situations. At the same time, the planting recommendations for the different sectors have recently been revised (RRIM 1983) and six clones have been incorporated under the Class One category to be used in the individual smallholder sector.

This recommendation incorporates for holdings < 1 ha, only one clone and for holdings > 1 ha but < 2 ha, any one clone should not account for > 50% of the planting.

For block plantings, some Class Two clones are also provided. However, the area planted with any one of these Class Two clones should not exceed 10% of the total planting in the block.

The objective of the recommendation is to ensure maximum choice at minimal risks.

The choice of a clone to be used still rests, however, on the environment of the area.

Density of Planting

Experimental and survey results (Westgarth and Buttery 1965) have shown that yield per unit area increased with higher density up to a point. However, based on the experiences of the estate sector, the commonly recommended density for buddings in both estate and smallholder sectors continued to be 370-400 trees/ha at the commencement of tapping. Barlow and Lim (1967) however, based on economic evaluations of results of earlier trials, pointed out that the economic density varied with the management practice. The density at commencement of tapping considered optimum for the smallholders sector ranged from 370-420 trees/ha where hired tappers were used. On the other hand, where the owner himself tapped the holding, a stand of up to 500 trees in tapping was considered desirable. Based on this evaluation, the planting recommendations on density were appropriately modified for the smallholder sector with the recommended initial stand being a minimum of 500 trees/ha. To evaluate further the performance under actual smallholder situations, such different densities have been implemented in selected smallholdings.

Abdullah (1979) evaluated the performance of smallholdings with different densities. His evaluation and economic analysis clearly indicated that for independent smallholdings, an average of 400-500 trees/ha in tapping is optimal. To achieve this, an initial stand of 550-700 trees/ha may be desired. In better managed FELDA schemes, a stand of 350-400 trees in tapping was considered optimal. This would entail an initial stand of 500-600 trees. The initial high stand was to allow for losses due to root diseases, etc., and for thinning out runts thus giving the optimal stand desired at tapping.

Methods of Establishment

In the field establishment of rubber for a considerable period of time and even up to late 1960s, the practice was to plant clonal seedlings or unselected seed at stake in the field and to do the budding in the field. Such a practice not only led to an unproductive phase of 6–12 months until budding, but also resulted in large variability in the stands in the field. Subsequently, this was superseded by the use of bare-rooted budded stumps. However, even the use of such materials resulted in variability and failures with the need for a large number of supplies. Investigations in the estate sector had shown that the use of buddings raised in polybags up to a stage of 2 whorls not only gave greater uniformity but could reduce the unproductive phase by 12–18 months. This finding was then investigated in the smallholder sector and was found to be applicable to this sector. Thus more and more of the replantings in the smallholder sector is utilising such plants raised in polybags.

Fertiliser Use

In so far as fertiliser use for immature rubber is concerned, the requirements range according to soil and cover conditions. Thus the results of investigations in the estate sector were equally applicable to the smallholder sector. On the other hand, this did not appear to be so for mature rubber, particularly because the smallholder sector generally did not use fertilisers once the fertiliser subsidy was discontinued after the initial 5–6 years of establishment of the rubber. In addition, the over-exploitation and the poor vigour of the trees imply that the fertiliser requirements for the smallholder sector should be different from that of the estate sector.

Early experiments had shown that there were different patterns of responses to fertilisers according to the major groups of soils under rubber. Such experimental results interpolated with soil and leaf nutrient analysis and agronomic management history have been used as a base for diagnosing the specific fertiliser needs of different planting materials for rubber in estates. A similar approach is also in use for smallholdings in schemes that are in organised groups, e.g. FELDA, FELCRA.

In a survey, Chan et al. (1972) showed that in the individual smallholder sector, the nutrient status, particularly of nitrogen, phosphorus, and potassium, was low and was considered suboptimal according to the criteria indicated by Pushparajah and Tan (1979).

Thus investigations were initiated in the smallholder sector to assess the fertiliser requirements of replanted smallholdings with rubber in tapping. The smallholdings were selected with the view to giving sufficient coverage of the major soils. The fertiliser regimes were then based on interpolation of soil and foliar data (Chan et al. 1972). The results of the investigation clearly showed increase in yield to fertiliser application (Pushparajah et al. 1973b). In addition, they showed that such increases gave a large increase in economic returns to the smallholders. Based on such findings, 14 different formulations of fertilisers have been forwarded for the smallholders sector. This enables catering for major soil groups and 2 clonal groups (Chan et al. 1972). At the same time, broad reconnaissance soil maps for ease of identification of the major soil types have been cartographed. More detailed mapping on a scale of 1:25,000 has been continuing from the mid-1970s in order to provide more accurate soil maps for such use.

Interrow Management

INTERCROPS

The smallholders generally had not been establishing any selected covers but had more or less been allowing natural covers to generate. Further, during the unproductive period of 5–6 years, little to no income was derived. With the view to ensuring returns during this stage, various investigations were carried out. Guha and Soong (1970) based on the Storie (1984) index, assessed that about 30% of the area under rubber would be very suitable for intercropping with annual crops. Pushparajah and Wong (1970) based on their investigations, determined the appropriate fertiliser regimes for intercrops of groundnuts and maize in different smallholdings and showed that such intercrops were profitable. That such returns from groundnut intercropping was profitable was also confirmed by Tan and Templeton (1970). Detailed investigation by Cheng (1970) resulted in selection of appropriate groundnut and soybean varieties. Further, Pushparajah (1973 unpublished information) showed that intercrops such as groundnuts and maize in rotation, did not adversely affect the growth of rubber, and that the growth obtained in intercrop areas was similar to that obtained where rubber was grown with legume covers.

Pushparajah and Tan (1970) also considered the use of tapioca as an intercrop. Though the returns from the tapioca intercrop were very satisfactory, it was found that generally, tapioca could compete with the rubber in the initial stages. However, they showed that where crop rotation sequence was used, e.g. groundnut followed by groundnut or maize and subsequently tapioca was established, the returns were not only high but the adverse effect on rubber was not evident, provided the tapioca was planted at least 1 to 1.5 m away from the rubber, which was by then about 1.5-2 m tall. Investigations on intercropping with groundnuts, maize, soybeans, and bananas were further evaluated in smallholdings.

The findings (Wan Mohamed and Chee 1976) further confirmed economic returns to the smallholders.

COVERS

Pushparajah and Tan (1979) showed that the use of legume covers not only gave nitrogen returns equivalent to over 700 kg of N during a period of over 10 years of establishment, but also resulted in higher yields of rubber. To obtain such returns from covers, the need for 'starter dose of fertilisers', phosphatic fertilisers, and appropriate inoculation with *Rhizobium* was essential. In addition, Tajuddin et al. (1979) showed that maximum benefit of N returns from legumes could be obtained only by adequate weed control by use of both pre- and postemergent herbicides. Attempts to introduce the establishment of legumes in rubber smallholdings, however, often failed.

Chee et al. (1979) identified that the poor quality of legume seeds was one of the factors for this failure. This therefore necessitates the need for seed testing. Subsequent investigations indicated that the smallholders sector found it difficult to try and obtain the necessary inputs from various sources. Chee (1984), from investigations in individual smallholdings, concluded that for successful implementation of legume covers in smallholdings, a 'package deal' must be provided. The package included a 'planting kit' with viable seeds, *Rhizobium*, herbicides (pre- and postemergent), and a simple technical leaflet. Rock phosphate and a compound NPK fertiliser for 'starter' application formed the other package. While this approach is now being implemented, further efforts to refine the techniques of establishment are in hand.

ANIMALS

After about 2.5–3 years of growth of rubber, the amount of light reaching the interrow area is restricted and intercropping may not be feasible. Wan Mohamed (1977) in a survey of the vegetation in the interrow found the following vegetative types in smallholdings:

1. Grasses (*Axonopus compressus, Paspalum conjugatum, Ottochloa nodosa,* and *Imperata cylindrica*) with a crude protein content of 9.4%, fat content 1.5% and fibre content 33.3%.
2. Dicotyledons—*Mimosa pudica, Mikania cordata, Melastoma* and residual legume covers with a crude protein content of 13.2%, fat content 1.9% and fibre content 32.9%.
3. Ferns mainly *Nephrolepis, Lygodium, Gleichenia linearis* with a crude protein content of 11.4%, fat content 1.8% and fibre content 31.9%.

The total dry matter at a given time ranged from 500 to 1000 kg/ha. About 70% of the vegetation was considered suitable for grazing by the sheep. At the same time, there is often the necessity to control this growth under rubber using chemical herbicides and this is often not practiced in smallholdings. To evaluate the performance of sheep under such vegetation, investigations were conducted. The findings (Tan and Abraham 1981) showed that the local sheep (believed to be a mixture of the Yunnan earless and breeds imported by early Portugese and Arab breeders (Lowe 1968)) performed satisfactorily, giving a mean weight gain of about 46 g/day.

Further, it was found that sheep effectively grazed on the vegetation, resulting in a control of excessive growth of the vegetation, which could have competed with the rubber. In addition, the preliminary findings indicated that the growth of the rubber where sheep were grazed was better than where no weed control was practiced. Tan and Abraham (1981) ascribed this improved growth as being due both to the control of the vegetation as well as the return of organic manure by the sheep.

Later, Wan Mohamed and Hamidy (1983) considered the performance of local sheep and crosses to Dorset Horn. The sheep were herded for grazing under rubber between 7.30 a.m. and 1.30 p.m. and kept in the shade during the rest of the day. In addition to preventive measures against pests and diseases, salt licks were provided.

The results clearly showed that the 50% Dorset Horn performed very much better, giving a liveweight nearly double that of local sheep at the end of 12 months.

This and other studies have shown compatibility of sheep farming with rubber production. In addition, in the smallholders sector where weed control is seldom practiced, sheep would be an agent of biological control and at the same time, provide extra income to the smallholders. More recently, it has been observed (Ani Arope, RRIM, pers. comm., 1984) that where sheep are allowed to graze in an area mixed with legume creeping covers, *Mikania*, and grasses, they would first graze on the grass and *Mikania*. Thus if the intention is to keep a pure legume cover to be of benefit to the rubber, the sheep could be moved to different grazing areas once they have grazed on the non-legumes. The initial findings indicate that by this method, the cost of weeding in legume areas could be minimal.

More work is being concentrated particularly on breeding and selection aspects and on pest and disease control coupled with other management studies including vegetative management, stocking rates, rotation frequencies, etc.

Exploitation

In the late 1960s, Abraham et al. (1968) found that the chemical, 2-chloro-ethano-phosphonic acid (Ethephon) increased the flow rate of latex and thus the yield. The results of this investigation were then extended to smallholdings (Abraham and Manikam 1973). They found that in the smallholders sector, response or increase in yield to the use of Ethephon even in seedling rubber was economical if the tapping system was done on an alternate daily basis. There was however no appreciable benefit if the tapping system was on an intensive basis, i.e. on a daily tapping. Meanwhile, Pushparajah et al. (1972) demonstrated that there would be no response to Ethephon in the absence of an adequate nutritional status of trees. Hence as the smallholder sector did not use fertilisers once the trees came into tapping, the need to apply fertilisers before Ethephon stimulation became a prerequisite.

Subsequent investigations in the smallholders sector confirmed that where tapping was done on a daily basis, the tapping cut should be reduced from the half spiral cut to a quarter spiral cut. Manikam and Abraham (1976) indicated that where such quarter spiral cuts were used and Ethephon was applied, there were appreciable increases in yield and hence extra income. Further, as on each tapping, only a quarter cut was made, the rate of bark consumption was also reduced.

Another problem faced by the smallholders particularly in the east coast of Peninsular Malaysia is the inability to tap or exploit the rubber during those 2–3 months of the year when excessive heavy rain makes tapping impossible. This clearly had resulted in lower yields being obtained by the smallholders in the east coast States. In other States, the smallholders may abandon their holdings during the fruit season, for example, for periods of 1 to 2 months. Thus, non-exploitation of the rubber during this period has often resulted in lower yields. An investigation by Yahaya et al. (1983) showed that a more frequent periodic tapping with a panel-changing short-cut system with mild stimulation with tappings being done in 10 months per year, gave yields as much if not more than the alternate daily system of tapping practiced elsewhere. In this periodic tapping system, tapping cuts were on a quarter cut and though daily tapping was to be done, often on days of rest in the week and on days due to rain interference, tapping was not implemented. This system therefore enables the smallholder to recover losses due to the monsoon season or to recover losses due to his being away from the holding during the fruit or padi planting season, for example.

Implementation

The various findings listed above have been tested in selected smallholdings on a project basis. However, there is an urgent need to look into socioeconomic and other constraints and overcome them in order to ensure these innovations can be implemented in the smallholder sector to realise the maximum possible benefits.

Future Research

In some of these areas, the Institute is still actively pursuing investigations. Such areas include:

- Selection of broader varieties of intercrops (in collaboration with other agencies).
- Selection of appropriate *Rhizobium* for intercrops such as groundnuts, soybeans, and legume covers.
- Breeding and selection of *Hevea* not only for increased yields but to cater for the wide range of environmental conditions and management practices.
- Evaluation of adaptability of newer cultivars to the various environmental conditions in the smallholders sector.
- Improved efficiency in the use of fertilisers in smallholdings.
- Improvement of seed production of legume covers to reduce cost of cover seeds, which are currently imported.
- Further refinements in exploitation techniques and the development of appropriate tapping tools, such as the mechanised tapping knife, which would entail use even by unskilled workers.
- Improving the breeding, selection and management practices of small ruminants, e.g. sheep, to be reared under smallholder rubber.

In these investigations, interaction with other agencies that have specialised skills is of paramount importance and such interactions are actively pursued.

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References

Abdullah Sepien. 1979. Economics of high planting density in rubber smallholdings: Revisited. Proceedings of the Rubber Research Institute of Malaysia Planters Conference, Kuala Lumpur, 1979, 82–96.

Abraham, P.D., and Manikam, B. 1973. RRIM ethrel trials on smallholdings: Progress report. Proceedings of the Rubber Research Institute of Malaya Planters Conference, Kuala Lumpur, 1973, 59–73.

Abraham, P.D., Wycherley, P.R., and Pakianathan, S.W. 1968. Stimulation of latex flow in *Hevea brasiliensis* by 4-amino-3,5,6-trichloropicolinic acid and 2-chloro ethano phosphonic acid. Journal of the Rubber Research Institute of Malaya, 20(5), 291–305.

Barlow, C., and Lim, S.C. 1967. Effect of density of planting on growth, yield and economic exploitation of *Hevea brasiliensis*, Part II. The effect on profit. Journal of the Rubber Research Institute of Malaya, 20(1), 44–64.

Chan, H.Y., Soong, N.K., Woo, Y.K., and Tan, K.H. 1972. Manuring in relation to soil series in West Malaysian mature rubber growing plantations. Proceedings of the Rubber Research Institute of Malaya Planters Conference, Kuala Lumpur, 1972, 97–126.

Chee, Y.K. 1984. A report on development projects on legume cover crops. International Report of the Rubber Research Institute of Malaysia, Kuala Lumpur, 1984, 9 p.

Chee, Y.K., Chin, T.V., and Rashid Bin Shariff. 1979. Legume seeds in rubber cultivation. Proceedings of the Rubber Research Institute of Malaysia Planters Conference, Kuala Lumpur, 1979, 241–251.

Cheng Yu-Wei. 1970. Improving the performance of catch crops in Malaysia. In: Crop diversification in Malaysia. Blencowe, J.W., and Blencowe, E.K. eds. Kuala Lumpur, Incorporated Society of Planters, 66–77.

Guha, M.M., and Soong Ngin Kwi. 1970. Suitability and prospects of rubber growing soils for intercropping. In: Crop diversification in Malaysia. Blencowe, J.W., and Blencowe, E.K. eds. Kuala Lumpur, Incorporated Society of Planters, 15–24.

Lowe, J.S. 1968. Sheep under rubber. Rubber Research Institute of Malaya Planters Bulletin No. 98, 141–145.

Manikam, B., and Abraham, P.D. 1976. Stimulation procedures for rubber smallholders. Proceedings of the Rubber Research Institute of Malaysia Planters Conference, Kuala Lumpur, 1976, 208–223.

Pushparajah, E., and Tan See Yeok. 1970. Tapioca as an intercrop in rubber. In: Crop diversification in Malaysia. Blencowe, J.W., and Blencowe, E.K. eds. Kuala Lumpur, Incorporated Society of Planters, 128–138.

Pushparajah, E., and Wong Phui Weng. 1970. Cultivation of groundnuts and maize as intercrops in rubber. In: Crop diversification in Malaysia. Blencowe, J.W., and Blencowe, E.K. eds. Kuala Lumpur, Incorporated Society of Planters, 53–65.

Pushparajah, E., Sivanadyan, K., Png, T.C., and Ng, E.K. 1972. Nutritional requirements of *Hevea brasiliensis* in relation to stimulation. Proceedings of the Rubber Research Institute of Malaya Planters Conference, Kuala Lumpur, 1972, 140–154.

Pushparajah, E., Mohd. Johar Bin Mohd. Rashid, Subramaniam, S., Ti, T.C., and Yoon, P.K. 1973a. Towards modernisation of smallholders. Proceedings of the Rubber Research Institute of Malaya Planters Conference, Kuala Lumpur, 1973, 35–49.

Pushparajah, E., Mohd. Noor Bin Wahab, and Samuel, J.G. 1973b. Response to fertilisers in replanted smallholdings. Proceedings of the Rubber Research Institute of Malaya Planters Conference, Kuala Lumpur, 1973, 258–266.

Pushparajah, E., and Tan Keh Huat. 1979. Legumes in the nitrogen economy of rubber cultivation. In: Proceedings, Symposium on soil microbiology and plant nutrition, Broughton, W.L. et al. eds. Kuala Lumpur, 1976, 413–434.

RRIM (Rubber Research Institute of Malaya). 1973. Planting recommendations, 1973–1974. Rubber Research Institute of Malaya Planters Bulletin No. 125, 33–56.

RRIM (Rubber Research Institute of Malaysia). 1983. RRIM planting recommendations, 1983–1985. Rubber Research Institute of Malaysia Planters Bulletin No. 175, 37–55.

Storie, R.C. 1984. Revision of soil rating chart. Berkeley, University of California Agricultural Experiment Station.

Tajuddin Ismail, Chin Siew Lock, and Pushparajah, E. 1979. Improving efficiency of legume covers for increased nitrogen returns. Proceedings, Symposium on legumes in the tropics, Universiti Pertanian, Serdang, 1979, 403–414.

Tan, K.H., and Abraham, P.D. 1981. Sheep rearing in rubber plantations. Proceedings of the Rubber Research Institute of Malaysia Planters Conference, Kuala Lumpur, 1981, 163–173.

Tan See Yeok, and Templeton, J.K. 1970. Returns from a catch crop of groundnut and some aspects of spacing. In: Crop diversification in Malaysia. Blencowe, J.W., and Blencowe, E.K. eds. Kuala Lumpur, Incorporated Society of Planters, 46–52.

Wan Mohamed Bin Wan Embong. 1977. Utilisation of ground vegetation in rubber plantation for animal rearing. Proceedings of the Rubber Research Institute of Malaysia Planters Conference, Kuala Lumpur, 1977, 265–281.

Wan Mohamed Bin Wan Embong, and Chee Yan Kuan. 1976. Maximising returns in immature rubber smallholdings. Proceedings of the Rubber Research Institute of Malaysia Planters Conference, Kuala Lumpur, 1976, 34–43.

Wan Mohamed, W.E., and Ahmad Hamidy, M.Z. 1983. Performance of dorset horn crossbreds under rubber. In: Proceedings of the Rubber Research Institute of Malaysia Planters Conference, 1981, 235–.

Westgarth, D.R., and Buttery, B.R. 1965. The effect of density of planting on the growth, yield and economic exploitation of *Hevea brasiliensis*. Part 1. The effect on growth and yield. Journal of the Rubber Research Institute of Malaya, 1965, 18(2), 62–73.

Yahaya Hashim, Sakibun Husin, Ismail Hashim, and Abraham, P.D. 1983. Tapping systems for East Coast rubber. In: Proceedings of the Rubber Research Institute of Malaysia Planters Conference, Kuala Lumpur, 1983, 213–234.

Malaysian Smallholder Rubber: Issues and Approaches in Further Processing and Manufacturing

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ALMOST all natural rubber, which is processed into industrial raw material for use in a very wide range of manufactured articles, comes from a perennial tree known as *Hevea brasiliensis*. The world produced just over four million tonnes of this crop in 1983, some 94% of which came from the Asian countries. About 84% of this rubber is exported, whilst the remainder, predominantly in China and India, is used locally in rubber products manufacturing. Rubber growing is characterised by large numbers of widely-scattered small farmers who together contribute nearly two-thirds of the global production.

Malaysia is the leading producer of natural rubber, accounting for 39.2% of the world's output and 45.7% of the world's net export in 1983. Its importance to the Malaysian economy is reflected by the fact that it contributes about 14% of total export earnings and 10% of the gross domestic product of the country. The rubber industry is divided into two parts: estates largely controlled by limited companies with sophisticated management, and smallholdings mostly below 4 ha apiece. The latter now account for more than three-quarters of the total planted area of 2 million ha and involve about half a million rural families, indicating their enormous socioeconomic importance to the country. There has been a rapid change in production pattern since the early 1960s. In particular, the estate planted area has shrunk, whilst that of smallholdings as well as their production have improved considerably (Table 1). A major feature has been the expansion of group smallholdings in land development schemes, and the consequent rise in productivity and farm income. Another important change is the introduction of improved processing and central marketing as a means to assist smallholders to augment their earnings. This approach has made it possible to process smallholders' rubber using new technologies that have become available since 1965. Of particular significance is the feasibility of extending this approach to further processing and rubber products manufacturing, especially the latter, which is now envisaged to play an increasingly important role in

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Table 1. Total planted area, output and yield of rubber in Malaysian estates and smallholdings, 1960–83[a].

	Estates[b]			Smallholdings[b]		
Year	Planted area ('000 ha)	Output ('000 t)	Yield[c] (kg/ha)	Planted area ('000 ha)	Output ('000 t)	Yield[c] (kg/ha)
1960	889.4(45.2)	438.0(56.4)	758	1076.4(54.8)	339.2(43.6)	436
1965	788.6(38.6)	514.6(55.7)	952	1256.0(61.4)	409.1(44.3)	590
1970	677.1(32.9)	631.0(49.7)	1189	1382.3(67.1)	638.3(50.3)	752
1975	583.4(29.3)	592.1(40.6)	1272	1408.3(70.7)	867.4(59.4)	962
1980	510.7(25.5)	595.2(38.9)	1428	1493.9(74.5)	934.8(61.1)	964
1983	469.2(23.5)	565.3(36.2)	1485	1526.8(76.5)	996.7(63.8)	1031

a. Figures refer to Malaysia as a whole, i.e. Peninsula Malaysia, Sabah, and Sarawak, except as noted under c below.
b. Figures in brackets denote proportion of planted area and output in estates and smallholdings.
c. Refers to output per tapped hectare in Peninsular Malaysia only.

Sources: (a) Rubber Statistics Handbook (various issues). Department of Statistics, Kuala Lumpur.
(b) Malaysian Rubber Research and Development Board, Kuala Lumpur.

the development of resource-based industries. At the same time, as part of the overall effort to boost industrialisation, technologies are being developed to integrate the production of raw rubber production with manufacture. At the macro-level, the government has announced the national agricultural policy under which the strategy for the rubber industry is to raise production efficiency on the existing area and to increase efforts towards greater usage of rubber (Malaysia 1984a). The policy implications are therefore to (1) raise productivity, and (2) to add value to rubber before export. These views, and the need for Malaysia to produce rubber of topmost quality to meet consumers' changing requirements, are also emphasised by a specially-appointed rubber task force of experts (Malaysian Rubber Research and Development Board 1983).

These developments have raised issues impinging on the traditional economy of smallholdings. There is now increased stress on industrial growth, apart from the continued thrust in production, aimed at not only providing job opportunities for the rural youths but also at encouraging value-added exports. Processing of smallholders' rubber logically forms part of rural industrialisation. The extension of this to rubber products manufacturing, absorbing new technologies, is also being pursued. The approaches taken are reviewed here, and more appropriate strategies suggested in the light of government policies influencing such industrial activities and of changes occurring in the rural economy.

The issues and approaches in further processing and manufacturing based on the use of smallholders' rubber are of interest, especially as industrial policies are being formulated to encourage vertical diversification in the context of achieving wider industrialisation. Smallholders' involvement in industrial activities hitherto has been minimal, and yet this is so important towards improving and developing the rural areas. The study hopes to identify problems on which collaborative work can be undertaken with a view to assist in the design of appropriate development strategies. It may also have lessons elsewhere for rural programs aimed at setting up small-scale industries based on agricultural resources.

The General Setting

Malaysia has achieved an average annual growth of 7-8% in its gross domestic product throughout the seventies, and a respectable rate of 5.6% during 1982–83 in spite of the world-wide recession. Rubber and other agricultural commodities have contributed substantially to this growth in the nation's economy. However, the relative importance of agriculture is diminishing, in terms of its contribution to gross domestic product and employment, due to great expansion in the manufacturing and services sectors. A major feature of this economic change is accelerating rural-urban migration, resulting in labour shortages in agriculture. In part, this has pushed up the wages of rural labour, whilst the real price of rubber has declined over the years. Within the agricultural sector itself there has been rapid structural change, principally as a result of widespread interest to replace old rubber with oil palm on estates and new plantings of oil palm on land development schemes; thus the share of rubber dropped from 69% of total cultivated area in 1960 to about 47% in 1980, whilst that of oil palm rose from 2.4% to 25% over the same period (Lim 1983a). Despite this, the total planted area of rubber has increased by about 10% to around 2 million ha since 1960 (Table 1), and the crop has retained its pre-eminent position in Malaysian agriculture. The industry, however, has transformed from one dominated by estate interests to that of small growers. In the process, a third institutional unit of production in the form of group holdings in land development schemes has emerged, in addition to the traditional estates and individual smallholdings.

In the face of economic change, the rubber industry has made considerable adjustments, involving long-term investment decisions and new technologies. The preference for the more profitable and less labour-intensive oil palm growing has been mentioned in the estate subsector, which by government regulation has no access to new land. This shift in investment policy is also evident amongst progressive individual smallholders, particularly in areas where processing facilities are available. In rubber growing significant technical adjustments have been made, and these include the adoption of high-yielding rubber trees, planting techniques to shorten the immature period, improved agro-management measures, and new processing and packaging methods. These adjustments and their policy implications were analysed by Barlow (1983).

As the area planted under rubber is not expected to increase very much under the national agricultural policy, innovations in production and processing, and the industry's adjustments to these, assume even greater importance in the future. In respect of processing, there is a definite need to make more out of rubber through further processing and manufacturing as a means to assist producers and to generate additional foreign exchange earnings. Towards this end, the government is designing an integrated industrial strategy to attain a diversified manufacturing sector, and to augment its share of gross national product to 30% by 1990. One major element of this strategy is the promotion of resource-based industries, in which rubber products manufacturing has been singled out to play a leading role (Malaysia 1984b; Lim 1984). The small percentage of rubber currently being processed locally into manufactured items is a matter of concern, but is also seen as a potential for great expansion. The government is, therefore, anxious to see downstream manufacturing operations adopted as a strategy to hasten rural growth (Razaleigh Hamzah 1984), and this policy is bound to be reflected in the industrial master plan now in the process of being finalised.

The natural desire to enhance value-added exports is also prompted by innovations and developments in raw rubber processing, which are directed to convert natural rubber from an agricultural commodity to a technically classified, industrial performance material to match the synthetic rubber. A major innovation that has revolutionised the processing and marketing of rubber was the Standard Malaysian Rubber Scheme (SMR) launched in 1965. Under this scheme the traditional visual grading system was replaced by technical specifications and guaranteeing conformance to specification standards. It departed from the traditional method of converting rubber into sheet form to crumb or comminuted material, which allows easy processing and savings in energy cost at the consumer level. It has also led to the development of physically or chemically modified specialty rubbers, all of which are value-added materials while some of which can be considered as semi-finished items similar to rubber compounds and master batches. Parallel to this development are efforts directed to establishing the technical and commercial viability of integrating raw rubber production with product manufacturing (Sekhar 1984). There are not only enormous cost advantages of such operations close to the rubber growing areas, but also important economic and social implications.

The rubber industry is now beginning to respond to the government's industrial policy, just as it had successfully made the adjustments in production to economic changes occurring over the last three decades. There is, however, a major difference this time. While previous adjustments were achieved largely through horizontal or crop diversification and raising production efficiency, the present situation calls for vertical diversification involving further processing and manufacturing. It is much harder to make this kind of adjustment, downstream manufacturing operations are more capital intensive and involve new production and marketing skills, which are not ordinarily found within the rubber planting industry. At least two government intervention policies are seen to have significant impact on this issue. One is the initiative taken largely by the Malaysian Rubber Development Corporation (MARDEC) to upgrade the quality of smallholders' rubber, and to participate in foreign joint-ventures in manufacturing rubber products and related items. The success of MARDEC has generated interest in other agencies concerned with smallholding development. The other is the substantial restructure of the corporate estate subsector, through the intervention of the National Equity Corporation (PNB), by buying out the dominant foreign interests. Some rationalisation of activities was undertaken after this transfer of control. There is no doubt that as Malaysian companies, 'they are expected to re-orientate their policies in accordance with national aspirations' (Ismail bin Mohamed Ali 1983). To some extent, the trade sector has also taken up manufacturing, particularly in terms of further processing. This vertical adjustment will accelerate following the government's encouragement of value-added activities and as new processing technologies become commercially available.

Further Processing and Smoking

Problems and Issues

Natural rubber is obtained by tapping, an action of making a regulated incision in the trunk of the tree. The milky liquid that flows into a cup is collected as latex a few hours after tapping, whilst further late drippings are collected, after natural coagulation, as cuplump and tree lace just before the next tapping. The latter is referred to as 'scrap' and is of lower grade because of extraneous materials gathered during exposure and handling. The relative yields of latex and scrap vary with a host of factors, but are generally in a 4:1 ratio. Both latex and scrap can readily be sold after collection from the trees without any further treatment. However, most smallholders prefer to process their latex, using traditional methods, and sell it in the form of sheet. This type of rubber, as well as scrap, has to undergo further processing and treatment before export.

The mode of processing, and hence the method of marketing, of smallholders' rubber is very much dependent on the type, and sometimes also the size, of operating units. As indicated earlier, there are broadly two types of operating units; the individual or unorganised units, which account for about four-fifths of the 1.53 million ha under smallholdings, and group or organised units, which make up the balance. In terms of holding size, a recent national survey (Rubber Industry Smallholders' Development Authority, pers. comm. 1983) reveals that about 52% of these units are each less than 2 ha. By and large, processing and marketing of rubber from the organised subsector has been satisfactory. This refers largely to rubber from the land schemes under the control of the Federal Land Development Authority (FELDA) and the Federal Land Consolidation and Rehabilitation Authority (FELCRA), which together contribute about 120,000 t annually. More than half of this output is sold directly to MARDEC, and the balance, practically all FELDA's latex, is processed into Standard Malaysian Rubber (SMR) grades and concentrated latex for direct export. While other land schemes, such as those managed by the Rubber Industry Smallholders Development Authority (RISDA) and state agencies, are less organised in terms of processing, their rubber is also handled through established channels. The core problems of processing and marketing, therefore, lie in the unorganised subsector, especially amongst the large number of small individual units. A great majority of these are much smaller than the national holding size of 2.4 ha, and are believed to fall within the poverty group (Rubber Industry Smallholders' Development Authority, pers. comm. 1983), the improvement of whose welfare and standard of living is the principal objective of RISDA and MARDEC. Modern, progressive smallholders are in the minority in this unorganised subsector, but they usually own larger holdings and can cope with changing conditions. They usually process their rubber satisfactorily, and can exploit the intensified competition in marketing to advantage by selling their crop in the form of good quality sheet to bigger dealers, or simply by disposing of it as latex to MARDEC if the price is satisfactorily competitive. These are technically and allocatively efficient smallholders capable of adjusting effectively to any external changes (Barlow 1983).

Malaysia produced about 1.525 million t of rubber in 1983, of which some 63% came from smallholdings. This rubber is exported in various types and grades (Table 2), which are quite different from the original forms in which rubber is sold at the farm-gate level. The bulk of smallholders' rubber has been further processed or treated in one way or another before final export. Although detailed information is not available, it is believed that around two-thirds of smallholders' latex is processed by them into unsmoked sheet (USS), which is sold to first-level village dealers. This rubber is then cleaned and smoked, either at this level or after being passed to the middle dealers, before it is clipped, graded and baled by the packers for export largely as ribbed smoked sheet (RSS); the bulk is finally graded as RSS 3 and RSS 4. A further one-quarter of the latex is also processed into sheet, but it is cleaned and smoked by the smallholders before sale, mostly as RSS 2, thus fetching a premium over USS. The remainder is sold straight as liquid latex to MARDEC and other commercial factories, where it is processed into quality SMR (i.e. CV and L) or latex concentrate for direct export. All scrap rubber from smallholdings is sold as coagulated lumps to dealers, mostly at the first marketing level, and the bulk is eventually assembled by remillers who convert almost all this material into SMR grades (mostly SMR 20). Prior to the introduction of SMR this material was processed into thick brown crepe, which now forms a negligible part of Malaysian export. Economic aspects of processing and marketing of smallholders' rubber were extensively analysed by Lim (1968), Cheam (1971), and Abdullah Sepien (1975).

Accordingly, more than four-fifths of smallholders' rubber passes through the traditional marketing chain, and a large proportion of this requires further processing and treatment before export. This has been considered a major issue in programs aimed at raising smallholders' standard of living. Smallholders are widely believed to be caught in the producer-middleman syndrome: they are compelled to sell their primitively-processed rubber at a very low price because of indebtedness, need for cash or social obligation, and are not able or encouraged to upgrade their rubber through improved processing. As is the case with other agricultural produce, rubber dealers have been criticised for their monopolistic-monopsonistic control over the trade, although no firm evidence has been provided to support this belief. Studies mentioned above suggested that low quality USS and scrap containing varying degrees of moisture and dirt could be subject to manipulation by dealers. However, the domestic market for smallholders' RSS was found to be reasonably competitive and efficient, and the use of quality-improving techniques was a good way to assist smallholders to get a better return. This thinking was in fact reflected in early intervention policies concerning smallholders' rubber processing and marketing. Thus, in the early

Table 2. Gross exports of different types and grades of natural rubber from Malaysia, 1970-1983.

Type and grade	1970 Volume ('000 t)	1970 Proportion (%)	1980 Volume ('000 t)	1980 Proportion (%)	1983 Volume ('000 t)	1983 Proportion (%)
RSS[a]:						
1	350.4	26.04	144.7	9.26	201.8	13.23
2	200.3	14.88	86.2	5.51	180.0	11.80
3	163.0	12.11	250.0	16.00	186.3	12.21
4	51.2	3.81	61.8	3.95	67.4	4.42
5	14.9	1.11	11.7	0.75	12.6	0.82
Others	27.1	2.02	34.2	2.19	48.4	3.17
Subtotal	806.9	59.97	588.6	37.66	696.5	45.65
SMR[b]:						
CV	—	—	77.2	4.94	72.8	4.77
L	24.5	1.82	64.8	4.14	47.5	3.11
5	25.6	1.90	33.1	2.12	33.7	2.21
10	5.3	0.39	140.8	9.01	93.6	6.14
20	65.9	4.90	370.6	23.71	294.4	19.29
50	3.5	0.26	3.4	0.22	3.9	0.26
Others	44.8	3.34	18.9	1.21	18.9	1.24
Subtotal	169.6	12.61	708.8	45.35	564.8	37.02
Crepe:						
Latex crepe	21.7	1.61	5.9	0.38	7.2	0.47
Sole crepe	17.1	1.28	3.7	0.24	9.1	0.60
Thin brown crepe	33.9	2.52	0.2	0.01	0.7	0.05
Thick brown crepe	104.3	7.75	15.9	1.02	10.6	0.69
Subtotal	177.0	13.16	25.7	1.65	27.6	1.81
Latex:						
Centrifuge concentrate	152.3	11.32	172.4	11.03	196.3	12.86
Other latex	20.3	2.51	30.5	1.95	3.7	0.25
Subtotal	172.6	12.83	202.9	12.98	200.0	13.11
Others	19.3	1.43	36.9	2.36	36.8	2.41
Total	1345.4	100	1562.9	100	1525.7	100

a. RSS: Ribbed smoked sheet.
b. SMR: Standard Malaysian rubber.

Source: Quarterly Natural Rubber Statistical Bulletin (various issues). Association of Natural Rubber Producing Countries, Kuala Lumpur.

1960s, an advisory service was organised to transfer appropriate processing and smoking techniques to groups of smallholders in specially built processing centres (Barlow and Lim 1965). The provision of these centres has succeeded in upgrading the quality of users' rubber and thus securing a higher price for it. But most users still did not smoke their USS, and many left the centres after awhile because of alleged inconvenience and disagreement amongst users. Owing to financial and manpower constraints, the number of centres that could be constructed was small, covering only a few thousand smallholders. Although more such centres have been built recently by RISDA, the total amount of rubber processed using these group facilities is still low, accounting for less than 4% of smallholders' output. The bulk is still sold as USS to local dealers who convert it into RSS.

Major initiative was not taken until much later when large central factories with modern management and equipment were established by MARDEC to process smallholders' rubber into top-quality SMR and latex concentrate for direct export. This massive intervention has been successful in achieving the dual object of raising smallholders' income and improving the quality of their rubber product (Barlow et al. 1968). In the meantime RISDA has expanded its activity of purchasing USS, largely from group processing centres, and curing it in central smokehouses for sale locally or to consumers overseas. At present, MARDEC handles some 150,000 t, or about 16% of smallholders' rubber, and RISDA another 45-50,000 t or an additional 5%. This simply means that a huge quantity of smallholders' rubber is still processed in the traditional manner and is marketed largely as USS.

Much of this rubber, and the scrap, are produced by those smallholders who are classified in the poverty group and who are in greatest need of help but have so far been barred from MARDEC's and RISDA's facilities because of difficulty of access. To some extent MARDEC is unable to extend its services owing to financial, managerial, and operational constraints; most of these smallholders are scattered and located in remote areas, and it is not in MARDEC's economic interest to organise latex collection.

The need to upgrade product quality, and MARDEC's inadequate coverage, have prompted RISDA to operate central smoking of USS collected from widely scattered group processing centres. It has also started direct sales of RSS to consumers overseas. In the meantime, the National Association of Smallholders (NASH) has persistently voiced its dissatisfaction, and exerted pressure on the authorities concerned to ensure more efficient processing and marketing, including direct trading. It has organised cooperatives to handle bulk selling, and has planned to undertake direct marketing as well. In the event, there is a certain degree of overlapping of activities at the farm level and of unhealthy competition, particularly between MARDEC and RISDA. This has resulted in a considerable waste of human and financial resources at the expense of uneconomic-sized smallholders in the remote areas. To make matters worse, the involvement of RISDA has in part affected its main responsibilities of replanting and providing extension services.

The government's intervention policies through MARDEC and RISDA have certainly benefited smallholders as well as the nation as a whole. The chief tangible benefit to the affected smallholders is improved return as a result of higher prices paid by MARDEC and RISDA as compared with those of the dealers (Table 3). It is important to note here that dealers' prices have also been raised in the face of intensified market competition, thus indirectly benefiting those smallholders who are not selling to MARDEC and RISDA. However, the major weakness of this direct intervention policy is that it still covers about one-fifth of total smallholders' rubber, and that there are financial, organisational, and practical constraints to further expansion. Most smallholders, therefore, continue to process their latex into low-value USS. Moreover, dealers' prices in these remote areas have generally tended to be

Table 3. Index numbers of average monthly prices paid to smallholders by dealers, MARDEC and RISDA (dealers' price = 100) and farm gate price as a proportion of f.o.b. price, 1983–1984.

	Price indices (%)			Proportion of f.o.b. price[a] (%)	
Month	Dealers[b]	MARDEC[c]	RISDA[d]	With duty and cesses	Without duty and cesses
1983:					
January	100(127.0)	101.3	102.1	70.2	76.9
February	100(132.2)	100.6	101.0	64.7	70.7
March	100(148.2)	101.9	102.3	64.7	73.1
April	100(164.0)	110.7	102.6	70.5	82.5
May	100(157.2)	106.5	105.0	69.8	82.9
June	100(165.1)	106.0	102.9	70.1	81.9
July	100(170.9)	105.3	101.4	68.5	81.3
August	100(172.6)	106.9	103.0	67.9	83.5
September	100(165.4)	102.8	103.7	65.4	81.0
October	100(164.6)	102.1	101.4	67.5	80.1
November	100(170.0)	98.5	102.9	67.8	79.1
December	100(174.4)	100.0	101.6	69.0	81.5
1984:					
January	100(174.4)	104.9	101.2	70.5	83.2
February	100(175.2)	106.5	102.3	70.8	83.5
March	100(175.2)	108.2	102.1	72.4	85.9
April	100(167.7)	105.7	103.0	71.5	84.1
May	100(153.5)	105.3	104.4	72.3	83.7
June	100(145.2)	106.7	103.4	75.4	85.0

a. Average of farm gate prices expressed as percentages of f.o.b. RSS prices.
b. Figures in brackets denote prices paid by dealers for smallholders' unsmoked sheet rubber.
c. Refers to latex.
d. Refers to unsmoked sheet rubber.

Source: Malaysian Rubber Exchange and Licensing Board, Kuala Lumpur.

low, owing to a lack of competition and to higher transport cost. Another weakness is that, even after allowing for export tax, i.e. duty and cesses, farm-gate prices are still lower than the appropriate f.o.b. prices by as much as 15–20% (Table 3). The differential is much greater if smallholders' latex is assumed to be finally exported as higher value types and grades, indicating considerable potential for the agencies concerned to raise farm-gate prices through improved processing and marketing efficiency.

These are issues of great concern to policy makers and bodies interested in smallholders' welfare. There have been extensive discussions, but most have centred on operational problems of MARDEC and RISDA and have little or no relevance to those smallholders who are really in need of help. No doubt, it is a complicated problem; many of these smallholders continue to prefer making USS, as opposed to selling latex, for reasons which are not entirely economic, whilst it is not in MARDEC's commercial interest to operate in areas where the supply of latex is low. RISDA, too, is finding it difficult to maintain group interest in many of its specially built processing centres, let alone organising smoking facilities. Is the technology inappropriate to this large group of individual smallholders, or are the advisory and extension techniques ineffective? These are issues of interest and under constant review by the agencies concerned, especially by the technology transfer committee comprising specialists from RISDA, NASH and the Rubber Research Institute of Malaysia (RRIM). While remedial effort is certainly necessary, there is evidently an urgent need to better the situation.

An Integrated Approach

It, therefore, appears sensible and imperative to devise a strategy aimed at further processing the rubber collected from smallholders currently not served by MARDEC. This will not only contribute to value-added exports but will also enable technical adjustments to meet changing consumers' requirements. There is now increasing demand for technically standardised rubber that possesses consistent and predictable qualities in compounding and end-product performance (Malaysian Rubber Research and Development Board 1983); the change is accelerated by manufacturing plants becoming increasingly automated and computer-controlled. These exacting demands can only be met if smallholders' rubber is processed in large centralised factories where strict quality control can be exercised. As already explained, the volume of USS is very large and is assembled through a network of dealers who clean and smoke it, whilst the scrap is further processed or remilled mostly into SMR grades. It appears that most smallholders will continue this practice of making USS, and that the only practical way to involve them in centralised operations is to adopt a cannot-beat-them-join-them strategy. MARDEC, given its expertise and infrastructure, should assume the dealers' role by assembling USS and further processing it into appropriate SMR grades (e.g. SMR GP, which requires a mixture of latex, USS and scrap), or simply curing it into RSS if the market for it is good. The proportion of SMR and RSS exports varies over the years (Table 2), which seems to indicate that it is commercially prudent to develop production flexibility as regards types of rubber to meet changing demand. A proper combination of products, as dictated by relative prices, should contribute to marketing efficiency and improved earnings.

To maintain socioeconomic viability, and because of wasteful competition indicated earlier, it is considered that MARDEC and RISDA should rationalise and consolidate their resources. The idea is to evolve an integrated functional system whereby activities relating to purchasing, processing and marketing of smallholders' rubber in the unorganised subsector are separately undertaken. The approach suggested entails the formation of or, more correctly, the restructure of existing facilities into three distinct units. These are envisaged as centralised entities: one should be made responsible solely for the collection and purchase of USS and scrap, another for further processing and smoking, and the third for marketing, particularly international trading activities. As a logical first step, RISDA should not involve itself directly in processing and marketing. Instead, it should deploy its wide network of extension staff to complement the effort of MARDEC by advising smallholders to produce cleaner and better USS (so that less cleaning is needed prior to smoking and higher RSS grades can be obtained), and then by organising the USS in strategic locations for collection. These operations should gradually develop into a centralised purchasing unit to form the first part of the integrated functional system. It should be noted that certain efforts expended in organising scattered smallholders' rubber are necessarily advisory in nature and should legitimately be viewed as part of the overall rural development program. Put another way, an element of social cost is involved, and this should be appropriately allowed for in costing the operation and in calculating the farm-gate price.

Naturally, in respect of further processing and smoking, MARDEC is the ideal agency to assume the role. As noted earlier, it already has a group of central factories equipped with modern processing facilities and staffed by commercially competent people. To cope with the new requirements, these factories can be expanded, or additional units can be set up, including the provision of smoking facilities. The latter should, of course, incorporate the existing central smokehouses operated by RISDA, so that sufficiently large capacities are available throughout the country. This is of economic interest, since there are substantial economies of scale in processing and smoking sheet rubber (Planters' Bulletin 1984). Unlike the purchasing operation, the massive investment that is required in processing and smoking should be based purely on commercial considerations.

Marketing is the third component of the integrated approach suggested here. There is already a full-fledged unit within MARDEC, which has considerable expertise and experience in the international rubber trade. This should be the base for building up a more diversified and sophisticated network of marketing; RISDA's much simpler and smaller set-up for RSS marketing should merge with the proposed unit. The emerging situation is one of direct trade arrangement with consumers arising from bulk processing, penetration into non-traditional markets, and the need for technical dialogue. An important element in the rubber trade today is the flow of technical knowledge; producers want to learn as much as possible about the specific requirements of manufacturing consumers, and the latter in turn want to ascertain from the source the availability of the kind of rubber needed at competitive prices. There is, therefore, need to make appropriate adjustments to cope with this commercial change, and MARDEC with its international marketing expertise is well-placed to meet the challenge.

The integrated system comprising the three distinct units outlined should adequately serve the interests of individual smallholders in the unorganised subsector. In particular, the approach would benefit, through further processing and smoking, a large number of USS-making smallholders who hitherto have not been involved in any government-sponsored centralised operations. This is especially so if organised facilities are made available for them to upgrade their USS. Of course, extra benefits can be expected to the country as a whole, chiefly in terms of value added over and above the amount accrued to the existing types and grades, largely RSS 3 and RSS 4, produced by smallholders. Given the same latex from the rubber tree, there is no reason why sufficient care should not be exercised to maximise returns by producing rubber of highest quality (Table 4). Indeed, this has always been the industry's policy, as is evidenced by the fact that Malaysia has always been able to generate a substantially higher unit export value for its rubber than that received by other natural rubber producing countries (Table 5). As a result, compared with Indonesia and Thailand, the Malaysian export in 1983 easily had contributed an additional US$150 million in foreign exchange earnings. These benefits will be further enhanced as the integrated strategy begins to engender an increasingly greater volume of high-value rubber from the unorganised smallholder subsector.

Need for Competition

Competition among buyers for smallholders' rubber at the farm level is necessary to achieving marketing efficiency. There is evidence that smallholders have secured more favourable prices in

Table 4. Index numbers of average f.o.b. prices for selected types and grades of rubber (Average RSS 3 and 4 prices = 100), 1975–83.

	Price indices				
Year	RSS 3/4	RSS 1	RSS 3	SMR CV	SMR L
1975	100(129.0)	105.0	102.5	111.2	109.0
1976	100(187.7)	105.9	102.3	114.8	111.3
1977	100(195.6)	103.5	102.3	111.9	108.9
1978	100(221.0)	104.1	102.0	107.2	105.9
1979	100(269.6)	103.6	101.6	109.2	108.9
1980	100(296.5)	105.3	102.0	110.0	107.7
1981	100(227.4)	113.4	104.8	115.2	112.6
1982	100(177.6)	113.3	106.9	110.8	110.9
1983	100(234.9)	105.2	102.8	118.0	116.1

Source: Quarterly Natural Rubber Statistical Bulletin, 9 (2), July 1984. Association of Natural Rubber Producing Countries, Kuala Lumpur.

Table 5. Index numbers of average rubber export prices in ANRPC countries, 1970–1983.

	Price indices[a]		
Country	1970	1980	1983
Malaysia	100 (416.0)[b]	100 (1394.9)	100 (1010.4)
Indonesia	79.5	85.6	89.0
Thailand	91.7	95.4	92.3
Sri Lanka	110.4	93.5	95.8
Singapore	97.8	97.5	99.6

a. All currencies converted to US dollars using prevailing average exchange rates.

b. Figures in brackets denote, in US dollars, the export value per tonne of Malaysian rubber.

Source: Quarterly Natural Rubber Statistical Bulletin. 9(2), July 1984, Association of Natural Rubber Producing Countries, Kuala Lumpur.

areas where keen competition exists, irrespective of whether this occurs amongst dealers, or between dealers and MARDEC and RISDA (Lim 1968; Malaysian Rubber Research and Development Board 1983). This competitive element is certainly beneficial to smallholders and is desirable in the free enterprise system. It should be noted that monopsony has never been an object of MARDEC's and RISDA's involvement in processing and marketing, and that competition of private enterprise is seen necessary to ensure their efficiency. In any case, in view of the size and spread of smallholdings, the integrated units outlined above cannot be expected to cope with all smallholder rubber; the financial and managerial resources are too enormous for such extensive undertaking by the public sector alone. Also, it runs counter to the privatisation policy declared recently by the government, under which a wide range of public sector activities and services will progressively be taken over by the private sector.

What, then, is the desirable or feasible extent of participation by the government sponsored agencies in smallholder processing? Lim (1983b), in attempting to set a target for this commercial venture, has considered that it should not exceed 40% of total smallholding output, leaving the balance to business competition from the rubber trade. A significant proportion of the latter is produced by progressive smallholders owning relatively big farms, who can adjust successfully to any changes in the commercial economy and whose continued practice should contribute to competitiveness of government's involvement in further processing and smoking. In the meantime, attempts should be made to establish joint ventures between dealers and government-sponsored units. If organised commercially, this joint effort should be effective in passing maximum benefits to a larger number of smallholders and in ensuring a ready outlet for their rubber at all times.

Product Manufacturing

Government Policy

Being the undisputed top producer of natural rubber, Malaysia is certainly not satisfied merely with exporting this commodity in its raw form, be it of the finest quality or of specially processed high-value type. It is logical that Malaysia extend its interest to manufacturing by converting, as much as possible, raw rubber into finished products or at least semi-finished items before exporting it. This is seen as a leading role in the development of industries based on the use of agricultural resources. To reflect this aspiration, the rubber-based industry has been included in the industrial master plan currently being formulated for the country. In 1983, the rubber product manufacturing industry accounted for about 14% of the gross domestic product generated by the manufacturing sector. While the industry is still small, it already produces a very wide range of articles for export, after having achieved an impressive average growth rate of over 15% during 1970–83 (Table 6). This is the result of the government's promotional policy, which led to the establishment of export-oriented joint-venture companies to exploit the comparative cost advantages, particularly of latex-based operations. A target has now been set to utilise some 300,000 t of rubber annually by the year 2000. This is more than four times the present consumption, but analysis by Lim (1984) indicates that the industry is well on course to meet this target.

Unlike processing of raw rubber, smallholders are not until now affected by developments taking place in the rubber manufacturing sector. If any, their involvement has been indirect, and this is only because of MARDEC's interest in several joint-venture companies manufacturing rubber products. The socioeconomic change occurring in the rural areas and rapid growth in the industrial sector have begun to alter the situation and arouse the interest of smallholders. There is growing concern about relying too much on a 'raw material economy'; to counter this the government wishes to promote resource-based activities as part of the new strategy to hasten rural growth. It is believed that industrialisation is a necessary ingredient to developing a viable rural community, including the stoppage of labour migration to the urban centres. The latter

Table 6. Peninsular Malaysian output of rubber products and average growth rates, 1970–83.

Product group	Output (M$ million)[a] 1970	Output (M$ million)[a] 1983	Average growth 1970–83 (%)
Tyres	48.6 (40.7)	323.6 (40.4)	15.7
Inner tubes	6.0 (5.0)	29.7 (3.7)	13.1
Footwear	26.7 (22.3)	153.0 (19.1)	14.4
Foam products	13.0 (10.9)	39.6 (4.9)	8.9
Rubber compounds	7.6 (6.4)	39.0 (4.9)	13.4
Sheeting and matting	9.3 (7.8)	23.2 (2.9)	7.3
Hoses and piping	1.6 (1.3)	1.9 (0.2)	1.6
Latex products[b] and general rubber goods	6.7 (5.6)	191.8 (23.9)	28.8
Total	119.5 (100)	801.8 (100)	15.8

a. Figures in brackets denote proportion for each product group.
b. Latex products easily account for 80% of values in this class.

Source: Lim Sow Ching. 1984. Industrialisation: Role and prospects of the Malaysian rubber-based industry. Presented to the Symposium on issues and prospects towards an industrialised nation organised by the Malaysian Economic Association. July 1984, Kuala Lumpur.

phenomenon has resulted in few young people entering agriculture, whilst those remaining are becoming older and generally risk-averse and innovation-shy. As far as rubber smallholders are concerned they are now ready, through NASH, to take a more active part in trade and manufacturing activities. They have accordingly urged the government to allow them to take over some of MARDEC's operations, and to restructure MARDEC so that it is permitted to handle the processing and marketing of palm oil, cocoa, and coconuts as well (Mohd. Rashid 1984).

It is in this background that downstream manufacturing operations based on smallholders' rubber should be examined. There is no doubt that they are beneficial, especially in terms of value-added exports, employment and possible economic linkages. But their impact is difficult to assess on smallholders in particular, and on the rural areas in general, since smallholders are not directly involved. Clearly, this is influenced by the extent, location and manner in which the manufacturing activities are undertaken.

Smallholder Involvement

The rubber-based industry comprised about 140 manufacturing units in 1983, excluding the tyre-retreading activity. Companies with foreign interests formed about one-third of this number and accounted for nearly two-thirds of the total capital investment. They have brought into the country modern technology, special skills and market know-how, and thus have played an important role in the export-oriented expansion in recent years. Most factories are located in major urban centres and close to the ports on the west coast of Peninsular Malaysia where good facilities, particularly electricity, water and telecommunications, are readily available. For rubber product manufacturing, ready access to quality natural rubber at advantageous prices is not enough. There must also be sufficient supply of other ingredients like rubber chemicals, carbon black, fabrics and, in certain articles, synthetic rubber, some of which have to be imported. Owing to these factors special tax incentives provided by the government have hitherto not been very successful in attracting industrial activities to less developed areas. These are reviewed in the industrial master plan with the aim of (1) designing more effective strategies to disperse industries, and (2) encouraging selective manufacturing activities in rural centres.

As noted earlier, smallholders have already been indirectly involved in downstream operations through several joint-venture companies. MARDEC, and more recently NASH, are constantly on the lookout for more opportunities to achieve their wider participation. There are at least three ways in which this object can be realised. The first approach, of course, is to continue seeking out suitable partners to set up viable projects for rubber product manufacturing. The partners may be foreign investors or local entrepreneurs, but usually the former because they possess both technical and market know-how for export-oriented products. The next approach is to organise the sale of more and more smallholders' rubber directly to local manufacturers. The third way is to involve smallholders preferentially in the adoption of technological developments that have bearing on aspects of rubber product manufacturing as and when they become commercially available. This development strategy was employed with success in the mid-sixties when block rubber processing under the SMR scheme was introduced on a commercial scale to smallholders by the predecessor of MARDEC.

In respect of involvement through further joint ventures, MARDEC, or the restructured processing unit of the integrated system suggested in this paper, is considered the best vehicle for attaining the goal. This agency has gained the necessary knowledge in various aspects of partnering, management and operation of joint ventures. The vertical growth in the sense described should strengthen the overall integrated system, thereby passing on the benefits accrued to the smallholders. While other interested bodies (e.g. NASH) are not precluded from taking part in manufacturing, the importance of industrial experience in ensuring success should certainly not be overlooked. Partnership may be based on the commonest arrangement in terms of direct capital contribution, but if necessary, separate marketing and technology transfer agreements should be entered into to ensure the long-term interest of local shareholders. The choice of products is purely a commercial consideration, depending largely on the export market and on the special skills of the foreign partners. However, as far as possible, attention should be concentrated on growth areas that have been identified, e.g. heavy-duty tyres, latex-based items, and selected general rubber goods that have a high content of natural rubber and high value added. What is needed is to ensure greater and more meaningful smallholders' involvement, in the sense of direction that can be provided by a properly conceived and designed strategy with visible benefits to the smallholders' community. The transfer of existing MARDEC's interests in manufacturing joint ventures to other bodies (e.g. NASH and PNB) will have to be considered carefully. To the extent that MARDEC is already charged with the socioeconomic responsibility of uplifting smallholders' welfare, it is difficult to see the merits of any change in control. For in the final analysis, smallholders' standards of living must be raised, irrespective of the vehicle with which the intervention policy is carried out. It is neither realistic nor fair to neglect the welfare of the smallholders.

On the approach of increasing rubber usage, smallholders have already made a substantial contribution. Here again the smallholders' role is performed by MARDEC, which supplies rubber to companies in which it has a definite interest and to other local manufacturers. It is estimated that at least 35% of the rubber used locally is purchased directly from MARDEC. Unlike the imported synthetic rubber, this raw material is readily available to the users at advantageous prices, especially in the case of concentrated latex, resulting in considerable savings in input costs. The major reason is that rubber consumed locally does not bear any export duty and cesses, since these levies are only collected at the port. Export duty on rubber is a contentious issue; producers, particularly smallholders, have always been unhappy about this levy and have persistently urged the government to abolish it because of inequity (Lim and Tay 1977) and the rising cost of production. The government has responded over the years by progressively lowering the rates and raising the threshold price level. This fiscal action, however, has aroused serious concern in the rubber manufacturing sector, owing to its opposite effect: lowering export duty means increasing the relative cost of using rubber locally and eroding competitive advantage in the export market.

In view of the above, and as part of the general incentives, the government has announced in the 1985 budget a specific provision for rubber manufacturers to buy natural rubber at discounted prices from three authorised agencies, namely FELDA, MARDEC and RISDA (Malaysia 1984c). This budgetary measure, which was to become effective in early 1985, will not only encourage the growth of rubber-based industry but will also enhance the involvement of smallholders in this industrial activity. It can be expected that with this special price incentive, over and above the amount deducted for export duty and cesses, local manufacturers will find it to their economic interest to obtain all their rubber from the specified sources. It is now up to the agencies concerned to ensure greater efficiency so that maximum benefits are passed on to the smallholders.

The final approach considered relevant to greater smallholders' involvement in rubber product manufacture concerns current developments in processing technology. As widely known, the Malaysian Rubber Research and Development Board (MRRDB) has been providing technical back-up to the manufacturers through its research institutes and technical advisory units. In addition, concerted efforts have been directed to developing technologies that could strengthen the competitive advantage of the Malaysian rubber product manufacturing industry. Two developments that will be successfully completed in the near future are of special interest, and it is considered that agencies dealing with smallholders should be preferentially involved in their commercial adoption.

The first is the application of a special and novel technology in which the production of raw rubber is integrated directly with product manufacture. Technically, it involves custom compounding of rubber at the latex stage and using the coagulated crumb thereupon as a semi-finished material for the manufacture of industrial products. This process is preferably carried out near the source of latex supply, so that attendant large savings in mixing, baling and transportation costs can be realised. This unique Malaysian technology is ideal for application near MARDEC-type centralised factories processing smallholders' latex, and in land schemes managed by FELDA and FELCRA. It is essential that, as soon as this technology is proven, facilities should be created to encourage its application on a commercial scale.

Another research development at a similar stage is the conversion of latex by a simple chemical reaction into a modified material with specific new tailor-made properties. These properties are designed to enable it to meet the requirements of markets for which it was hitherto unsuitable. The present contender is expoxidised natural rubber (ENR), which possesses both oil resistance and air impermeability equivalent to special purpose synthetic rubbers (e.g. nitrile rubber). These modified natural rubbers, which will command a high premium, can replace special purpose synthetic rubbers and should be available at advantageous prices to local rubber product manufacturers. Here again smallholders should be involved from the very beginning to produce the material for domestic consumption as well as for the export market.

While there is little economic linkage just now, it is considered that smallholders' involvement in downstream rubber manufacturing operations can be greatly enhanced. The centralised units envisaged under the integrated system for purchasing, processing, and marketing smallholders' rubber are well-placed to take advantage of the industrial opportunities and to generate benefits for the smallholder community. This industrial role can also be effectively played by central organisations like FELDA and FELCRA by setting up activities on the periphery of their land schemes. Establishing manufacturing processes close to the rubber growing areas, and the attendant spillover effects, should discourage rural-urban migration, thereby reducing labour shortage in the rural areas.

Conclusions and Further Studies

This review of Malaysian smallholders' rubber highlights the enormous possibility for obtaining more from the crop, both in terms of higher farm income to the individuals involved and additional foreign exchange earnings to the nation. The way is to ensure that most smallholders' rubber is processed and finally exported as high-value materials, and to encourage the local manufacture of rubber-based products. Although there are positive effects of organised interventions by government-owned bodies in processing and marketing, notably through the efforts of MARDEC and FELDA, a greater part of smallholders' output remains unaffected. While some individual smallholders have made adequate adjustments to technical and economic change, either by selling their latex or processing it into top RSS grades, most continue to produce USS of poor quality on tiny holdings in relatively remote areas. The latter practice is unlikely to change, and no adjustment to new processing technologies and emerging opportunities can be expected without some kind of official measures.

It thus seems practical to suggest that an integrated approach involving specialised units be designed on a national scale to engage separately in the purchasing, processing, and marketing of smallholders' rubber. As a means of overcoming the persistent preference of smallholders to produce USS, it is suggested that central facilities be created as part of the integrated approach for further processing and smoking. This integrated system, particularly the unit developed for further processing, should lead to vertical growth by diversifying into rubber product manufacturing and related operations. Smallholders' involvement in industrial activities is seen as direct participation in joint venture companies, increased sale of their rubber to local manufacturers and adoption of new technological developments relevant to downstream operations. The latter, in particular, are promising areas for which manufacturing facilities can be created close to centres of raw rubber processing and organised land settlement schemes to maximise comparative cost advantages. This could well have an important bearing on efforts to develop agro-based industries and to reduce the negative effects of socioeconomic changes occurring in the rural economy.

The success of the integrated approach will hinge on the ability of the organisations concerned to assemble smallholders' rubber efficiently, and to pass on the benefits accrued from further processing and smoking and product manufacturing. This is a complex task, and is seen as a single major obstacle to the centralised schemes outlined here. To a considerable extent, policy formulation is constrained by a lack of knowledge on the mode, location, and distribution of rubber supplies and on smallholders' response to technical change in general, and to governmental programs in processing and marketing, in particular. It also needs to take account of the policy implications of program costs that can be legitimately 'socialised' from the broader view of rural development, as well as economic linkages involved. These are important and fruitful areas that need to be investigated rigorously. The most interesting and testable hypotheses that could be derived from the particular example of the rubber smallholder subsector are that intervention policies in processing and marketing are beneficial both from the smallholders' and national viewpoints, and that greatest benefits are more likely to occur where: (1) the area is remote and isolated, (2) the smallholders are progressive and can readily make adjustments to economic change, or where extension efforts are intensified, and (3) the market is rendered competitive by the presence of private sector dealers. The information needed to support these hypotheses can be secured and evaluated, but sufficient evidence is subject to external observation and verification.

There is yet another useful area of research, and this concerns the impact of industrial activities on agriculture. There is much talk about out-migration of young farming people and its impact on labour costs, output and productivity. The extent and future trend of this rural phenomenon need to be ascertained. For apart from the wider policy considerations, it has direct relevance to the promotion of further processing and manufacturing based on rubber and other agricultural resources.

The problems outlined are of great interest and importance in the context of further processing and manufacturing based on smallholders' rubber. It is useful to work out a conceptual and theoretical framework relevant to these, and to suggest testable hypotheses suitable for empirical research. It is felt that this exercise can form a part of the cooperative programs where Australian assistance is valuable.

References

Abdullah Sepien. 1975. An analysis of the smallholders' rubber marketing in the east coast of Peninsular Malaya. Master's degree in Agricultural Development Economics thesis, Canberra, Australian National University.

Barlow, C., and Lim Sow Ching. 1965. A report on the survey of Malay group processing centres, 1964. Economic report No. 1, Rubber Research Institute of Malaya.

Barlow, C., Lim Poh Loh, and Ong Yong. 1968. An assessment of smallholders' central processing and marketing schemes. Journal of the Rubber Research Institute of Malaya, 21, 592–603.

Barlow, C. 1983. Institutional and policy implications of economic change in agriculture: The case of Malaysian rubber. Canberra, Department of Economics, Research School of Pacific Studies, Australian National University.

Cheam Soon Tee. 1971. A study of the marketing of smallholders' lower grade rubber. Economics and Planning Division, Report No. 8. Kuala Lumpur, Rubber Research Institute of Malaysia.

Ismail bin Mohamed Ali. 1983. The Malaysian plantation industry. Structural changes and future challenges. Presented to the International Rubber Marketing Conference. October 1983, Kuala Lumpur.

Lim Sow Ching. 1968. A study of marketing of smallholders' rubber at the first trade level in Selangor. Economics and Planning Division, Report No. 4. Kuala Lumpur, Rubber Research Institute of Malaysia.

Lim Sow Ching, and Tay Thiam Hock. 1977. A note on the re-structured export duty on rubber. Malaysian Rubber Review, 3, 21–31.

Lim Sow Ching. 1983a. Plantation agriculture: Some factors impinging on the future of the industry. Presented to the Seventh Convention of the Malaysian Economic Association. January 1983, Kuala Lumpur.

Lim Sow Ching. 1983b. Marketing Malaysian rubber: An approach by sector. Presented to the International Rubber Marketing Conference 1983. October 1983, Kuala Lumpur.

Lim Sow Ching. 1984. Industrialisation: Role and prospects of the Malaysian rubber-based industry. Presented to the Symposium on issues and prospects towards an industrialised nation. Organised by the Malaysian Economic Association. July 1984, Kuala Lumpur.

Malaysian Rubber Research and Development Board. 1983. The Malaysian natural rubber industry 1983–2000. Report of the Task Force of Experts, Kuala Lumpur.

Malaysia. 1984a. National Agricultural Policy, Kuala Lumpur.

Malaysia. 1984b. Mid-term Review of the Fourth Malaysia Plan 1981–85, Kuala Lumpur.

Malaysia. 1984c. The Budget 85, Kuala Lumpur.

Mohd. Rashid Ahmad. 1984. Press statement by NASH. New Straits Times, 16 October 1984, Kuala Lumpur.

Planters' Bulletin. 1984. No. 179, June 1984, 39–51. Kuala Lumpur, Rubber Research Institute of Malaysia.

Razaleigh Hamzah. 1984. Opening speech (in Bahasa Malaysia) by the Minister of Trade and Industry at the symposium Towards improving and developing rural society with trade and industry—challenges and approaches. April 1984, Kuala Lumpur, Bank Pembangunan Malaysia.

Sekhar, B.C. 1984. Natural rubber research and developments. Past, present and future. Presented to the International Rubber Conference and Exhibition, September 1984. Colombo.

Approaches to Agricultural Extension and Development in the Rubber Smallholdings Sector in Malaysia

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THE rubber industry in Malaysia consists of the estate (plantation) sector and the smallholding sector. A smallholding is defined as an area of less than 40 ha (100 acres). Smallholdings in Malaysia in 1983 occupied about 76% of land under rubber, or about two-thirds of the land under agricultural crops, and produced about 63% of the total rubber output. The smallholdings can be categorised as individual (independent) smallholdings and organised smallholdings. Individual smallholdings are those that come under the agencies of the Rubber Industry Smallholders Development Authority (RISDA), whilst the organised smallholdings are those in the regional development agencies such as Federal Land Development Authority (FELDA) and Federal Land Consolidation And Rehabilitation Authority (FELCRA).

In terms of hectarage and production, the rubber smallholder sector in Peninsular Malaysia has made a marked expansion, especially the smallholdings under RISDA (Table 1).

Table 2 shows the rate of replanting in smallholdings. The area replanted since 1975 is given in Table 3, which also indicates substantially greater hectarages since 1980. The expected achievable targets in replanting from 1983 to 1985 are stated in Table 4. By the end of the Fourth Malaysia Plan a total of 152,000 ha should have been planted by 1985.

Smallholders

The data presented below are based on the census report of rubber smallholders in Peninsular Malaysia carried out by RISDA in 1977.

Of the estimated 490,560 active rubber smallholders in the country, including those on land schemes, about 74.6% were Bumiputra, 23.4% Chinese, and 2% Indian and other ethnic groups. Bumiputra smallholders owned 63.1% of the rubber land, the Chinese smallholders about 34.6%, whilst the Indians and others owned a very small proportion.

About 70% of smallholders were male and they owned almost three-quarters of the smallholder rubber land; the remaining 25% was owned by female smallholders (30%).

The average age of smallholders was 48.2 years and the median age was 48.3. Just over 21% were 60 years or older.

Some 73.5% of the smallholders claimed to operate all the rubber land they owned while 23.8% had others operating their land, and 2.7% operated part and had others operating part. In terms of ownership, 81.4% of smallholdings were said to have only one owner, and the other 11.2% two owners.

About 39% were solely dependent on their smallholdings for income, 23.1% depended on their rubber plus other agriculture, and 31.1% had access to some employment outside of agriculture.

On the whole, the average size household was 6.4 persons, which is large compared with the average size of 5.2 for Peninsular Malaysia as a whole in 1980. Among the different ethnic groups Chinese had a large average household size (8.1 persons); and Indian households averaged 7.7 persons.

Tenure here refers to the holdings rather than to the operators or the owners, i.e. it pertains to the land rather than the person. The study showed that owner operator is the dominant one in terms of both numbers (69%) and area (64%) of the smallholdings overall and within each ethnic group. Wage labour (*upah*) is the second most common form of tenure of smallholder rubber land, accounting for 15%. It is more common among Chinese (25%) and Indian (23%) smallholders, and least among the Bumiputra (10%). Share cropping is the third most common form of tenure, accounting for 10% of all smallholder rubber land. Share cropping is more common among Bumiputra (11%)

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Table 1. Planted hectarage ('000 ha), production and yield on smallholdings in Peninsular Malaysia, (1970–1980).

Year	FELDA	RISDA	FELCRA	Others[a]	Total production (t)	Estimated Av. yield[b] (kg/ha)
1970	59.8	436.0	5.7	575.8	594757	753
1971	67.6	459.2	8.3	551.4	608865	735
1972	76.2	482.6	15.0	518.2	598815	703
1973	88.8	511.2	21.5	483.1	791519	927
1974	94.3	534.8	23.6	464.9	800972	1039
1975	105.1	555.9	26.1	444.5	817505	1068
1976	114.7	570.2	26.2	419.6	884542	1093
1977	124.6	583.0	28.5	409.2	883919	1102
1978	145.2	596.3	31.2	403.0	888047	1104
1979	156.8	610.6	35.1	392.6	890053	1105
1980	168.9	626.3	41.8	368.7	877090	1104

a. Includes independent smallholdings (and those assisted by RISDA) and organised smallholdings other than those in FELDA and FELCRA schemes.
b. Source. Malaysian Rubber Research and Development Board; Department of Statistics, West Malaysia Rubber Statistics Handbook.

Table 2. Percentage under replanting, 1970–82.

Year	Estate %	Smallholding %
1970	90	46
1971	92	49
1972	93	52
1973	95	56
1974	95	59
1975	97	62
1976	98	64
1977	98	66
1978	98	68
1979	99	70
1980	99	72
1981	—	75
1982	—	78[a]

a. An estimated 791 696 ha were replanted to rubber on smallholdings up to 1982.

and other ethnic group smallholders (8%). There is another category known as untended rubber land (*tanah terbiar*), which accounts for about 6% of total rubber land.

Persistent poverty among rubber smallholders has been attributed to holdings that are uneconomic in size and to the concentration of ownership in the hands of a few smallholders. Nearly 52% of the holdings in Peninsular Malaysia are below 2 ha. Bumiputra have the most holdings below 2 ha (59%), whereas only about 29% of the Chinese smallholdings belong to this category. In terms of area, about 25% of the total area is in holdings below 2 ha.

The Chinese smallholders have the highest average total production at about 172 kg/month. The

Table 3. Hectarage replanted since 1975 and estimated replanting up to 1985.

Year	Hectarage replanted (rubber only)	Hectarage replanted (other crops)	Total hectarage replanted (all crops)	Estimated replanting (all crops)
1975	20709	12470	33179	—
1976	14250	5485	19735	—
1977	12789	5419	18208	—
1978	13255	5943	19198	—
1979	14186	8205	22391	—
1980	15300	7685	22985	—
1981	22624	6827	29451	26710
1982	23699	7484	31183	30271
1983	—	—	—	33355
1984	—	—	—	36422[a]
1985	—	—	—	38446[a]

a. Includes replanting on FELDA schemes. 1984 = ± 3643 ha.
1985 = ± 4048 ha.

Source. Rubber Industry Smallholders Development Authority (RISDA).

Table 4. Expected achievement in the replanting program in Peninsular Malaysia, 1981-1985.

Year	Area (ha)	Cost (M$ mill.)
1981[a]	29550	81.62
1982	30467	96.72
1983	33355	121.91
1984	28651	76.57
1985	29697	80.08

a. Actual achievement.

Source: RISDA.

Bumiputra smallholders have the lowest average total production with 105 kg/month. On a per hectare per month basis, Chinese smallholders are still the more productive at 80 kg with Bumiputra smallholders the least at 70 kg.

Problem Areas

Though smallholdings rubber increased over the years vis-a-vis the estate sector, its productivity still lags behind that of the latter. The average annual yield of the smallholdings is relatively lower at 1104 kg/ha (Table 1) compared with the estates' yield at 1507 kg/ha. Socioeconomic inadequacies and technological factors, e.g. uneconomic size holdings, ageing labour, insufficient production and management techniques together with the vagaries of the market on smallholder produce account for the low productivity and the high incidence of poverty among the smallholders at 41.3% in 1980. They still form the single largest poverty group in the country numbering about 175,900 poor households. Their percentage among the total poor was the highest in the country at about 26.4% in 1980. In terms of average family income individual smallholders were earning about M$240/month. However, rubber smallholders in land development schemes in 1983 enjoyed a much higher level of net income of M$450/month, owing to their larger farm size. Those with land holdings of 12 acres earned a net average income of M$1044/month during the same period.

In view of these structural problems, which resulted in low productivity and income particularly among the individual smallholders, government agencies such as RISDA, FELDA, and FELCRA have developed and implemented their programs in a more comprehensive manner, with the main objective being to increase the productivity and income of smallholders.

Smallholder Assistance

There are four major development agencies that have been entrusted with the development of the smallholder sector, namely RISDA, FELDA, FELCRA, and MARDEC. These agencies in general carry out extension and development work covering some or all aspects of rubberplanting, production, processing, and marketing as well as the socioeconomic development of the smallholders and their families.

RISDA, established in 1973, was given the responsibility for all aspects of development and modernisation of the smallholder sector of the rubber industry. Its overall objective is to improve the socioeconomic well-being of the rubber smallholders. This is being pursued through vigorous programs of replanting of old rubber and ensuring that up-to-date technology that emanates from research is being implemented in all their development programs. Supporting services such as extension and much needed agricultural inputs, e.g. planting materials, fertilisers, and chemicals subsidy, are being channeled by RISDA to smallholders in an integrated and organised manner.

FELDA, established in 1957, is presently the largest government agency for land development and settlement in the country. It has been entrusted with developing jungle land for planting rubber or oil palm and settling thousands of landless people from the rural areas into these lands. A typical FELDA scheme involves a land area of about 2000 ha and each scheme could settle about 400-500 settler families. At the end of 1980, FELDA had developed about 168,200 ha of land planted with rubber.

The Federal Land Consolidation and Rehabilitation Authority (FELCRA), which was formed in 1966, was entrusted with the responsibility to rehabilitate land development schemes that had not been successfully developed, as well as idle agricultural lands and to consolidate these lands into viable production units. Basically, FELCRA undertakes to develop and manage four types of schemes, viz. Rehabilitation, Fringe, Youth and In-situtіon. Other than rubber, oil palm, padi pepper, and cocoa are also planted in some of the FELCRA schemes. By the end of 1983, FELCRA had developed 57,088 ha of rubber land and settled more than 12,500 families.

MARDEC, established in 1967, was entrusted with the processing and marketing of smallholders' rubber. Through this approach smallholders' rubber can be processed into high quality rubber, which can be exported direct to consumers all over the world. To date MARDEC has about 20 processing factories, which process about 200,000 t (20%) of smallholders' rubber annually.

The Rubber Research Institute of Malaysia (RRIM) established in 1925 is primarily concerned with research into all aspects of natural rubber (NR) cultivation and latex production, the development of new forms of rubber and consumption, as well as technological and end-use research in the processing and manufacture of NR products. Its responsibilities also include advisory and information services to extend the benefit of research and development to all sectors of the industry. As far as the smallholders are concerned, the Research and Development efforts by the RRIM have been geared to fulfilling their needs and problems. The present approach is to have adaptive trials and model holdings in smallholdings. The Institute has also established the Smallholders Extension and Development Department, which will be responsible for research and specialised extension work for the smallholder sector.

Extension and Development

Each of RISDA, FELDA, and FELCRA have been given specific functions and responsibilities—RISDA for replanting/socioeconomic development, FELDA—new planting and resettlement of smallholders, and FELCRA—rehabilitation and consolidation with emphasis on untended lands. These development agencies over the years have evolved different strategies to development that affect their clientele system.

RISDA

Its main thrust has been in the replanting of old rubber holdings and planting modern high-yielding clones. In implementing the replanting programs RISDA provides all the necessary agronomic and financial inputs and an in-house extension service to the participating smallholders. One of the latest strategies in the replanting programs has been the concept of the mini estate in which individual holdings to be implemented are grouped together into an integrated unit of between 40-200 ha, with RISDA developing the land to ensure its success. Labour is provided by a hired contractor who may involve the smallholders in developing the land. This approach to land development through a replanting program of old rubber on a group basis is an innovative approach that is aimed to ensure success. This means that in a mini estate there will be an optimum stand of rubber trees per unit area and proper agronomic inputs and recommended agricultural practices will be implemented in such areas. There is also proper management of such replantings by RISDA; each scheme has a supervisor or field assistant.

Mini estates enable the uneconomic sized holdings and those of smallholders, who are unable to replant their old rubber themselves because of old age and other reasons, to be converted into economic units where proper management practices and new technologies can be implemented in the smallholding sector. The only disadvantage in this approach, if any, is the fact that smallholders tend to depend on RISDA since their involvement is minimal in the development of the scheme. Technology transfer is effected to the holdings and the contractors but not necessarily to the smallholders. To date RISDA has successfully developed about 256 mini estates totalling 30,000 ha. Measured in terms of stand per acre, maintenance and tree growth they are comparable to any plantation (estate).

FELDA

FELDA's approach to land development is by opening up jungle lands and planting them with rubber or oil palm on a large scale using the services of contractors. The contractor is responsible for planting and maintenance up to 2 years after planting. Subsequently the settlers will be responsible for the maintenance of the scheme until maturity. Each settler is given 10–12 acres of land, a house and one-quarter acre for an orchard. Each FELDA scheme usually has complete infrastructure with amenities such as roads, schools, clinics, and the like.

Settler development programs are planned and implemented in all FELDA schemes in a coordinated manner in which relevant outside agencies are involved. Through their trained management personnel, appropriate technologies on rubber planting production and processing are conveyed by the RRIM and ultimately implemented in their schemes. FELDA does its own processing and marketing of rubber. Through efficient management FELDA settlers earn about M$500-$1000 per month, which is substantial when compared with the average monthly earnings of individual smallholders (M$240).

One problem faced by FELDA is the question of land ownership, in which under the present agreement, settlers are given the titles to their land after the development cost is fully repaid. With growing age and the tendency for their children to find alternative employment, there is a great likelihood for the land to be sold or subdivided and this relegates them back to the status of individual uneconomic smallholdings. There are also growing difficulties in enforcing good management practices during the mature phase of rubber, especially in tapping and selling operations. Some of the older schemes have older settlers (35 years and above) and by the time the loan is repaid (15 years) these settlers will be 50 years or older. Settlers in the new schemes are on average about 25 years old and will be about 40 when the loan is repaid. A strategy adopted by FELDA is the introduction of a share system to all their schemes and not allowing individual participants their land and land titles.

FELCRA

FELCRA adopted three approaches to land consolidation and rehabilitation:

1. Firstly consolidation through management, which does not involve physical consolidation of land. It is a system of management of individual lots that have been rehabilitated into one integrated unit where each land owner becomes a shareholder and each share is based on the acreage of the land they own.

2. The second is by consolidating the alienated lands in the villages with new lands developed by FELCRA that are available near the vicinity of the village. Management of such schemes is through a 'share' system.

3. The third approach is through the resettlement of smallholders in the village into new lands developed by FELCRA. The smallholders affected will have to give up their old lands and homes, which will also be developed and realloted to others. Lands that are uneconomic in size will be consolidated into economic size, which for the time being is 2.5 ha.

FELCRA's priority now is to develop idle lands that have been alienated to individuals and consolidate them into economic size units. Smallholders who are owners of such lands become shareholders in the scheme. Under the Fifth Malaysia plan, FELCRA is expected to develop and consolidate 107,600 ha of such lands.

The share system of management of land developed by FELCRA has in its Board of Directors representatives of settlers who determine the policy of programs to be implemented in each scheme. The scheme management (FELCRA) has full control of the operations of each scheme.

Each scheme is treated as a profit centre and any profit accrued from the scheme will be given to the settlers in the form of a bonus; dividend is paid once in every 6 months. The share system of managing FELCRA schemes has been found to be effective and beneficial to the settlers and is ensuring the future of such schemes run by FELCRA.

Each scheme has been able to adopt and implement modern technology and agricultural practices, while ensuring a remunerative income to the settler participants. It also managed to involve and motivate participants in the operations of their lands, while giving a certain amount of flexibility to the scheme managers. According to FELCRA, the development cost/ha of rubber is around M$6000 (M$2500/acre). Total income accrued to participants is about M$450/month, which is again comparable to the income of FELDA settlers (M$400-$500/month). Under the 'share system' of FELCRA, there are other advantages such as economy of scale, risk sharing and more equitable profit sharing, ability for adoption of new technologies, participant involvement, and more importantly the money for development goes back to the settlers and is thus retained within the local economy.

RRIM, which is the source of new technology on rubber, not only carries out research and generates new technologies but also involves itself in transferring these technologies to the smallholder sector in a structured manner. This has been more so since 1982 when a committee on Transfer of Technology was estabished between RRIM and agencies like RISDA, FELDA, and FELCRA at the national and state levels. The rationale for this approach was to ensure a constant flow of available and up-to-date technologies to the smallholder sector from RRIM and also for RRIM to obtain feedback from the smallholder sector on the technologies that have been recommended and implemented. Basically, through meetings and consultations these organisations determine what technologies are required; RRIM works with them on the appropriate technologies that can be implemented in smallholdings in 'package form'.

RRIM gives all technical support and provides advisory/consultancy services to the organisation concerned, especially to its management and extension personnel. The organisation so involved provides all the necessary inputs and is responsible for implementation of all programs.

The Transfer of Technology program emphasises those technologies that are proven and appropriate for the smallholding sector and those that would enhance productivity. In the implementation of programs, the group approach (such as mini estates) and group replantings rather than individual holdings in order to maximise the effects/impact of such programs are also emphasised.

Integrated Projects Approach

The IDP approach in group replanting aims to consolidate the scattered 1-2 ha individual rubber smallholdings into a larger more or less contiguous block or area of 10–20 ha. This consolidation, which is more often under multiple ownership, creates an economic farm size for efficient adoption of various modern, appropriately developed and adapted technologies at the immature and mature phases of rubber growth. The planning, implementation and coordination of the IDP are done by the sponsoring authority, which in this case is the RRIM, with assistance forthcoming from RISDA and other related development agencies. The actual project implementation is done by a project manager from the RRIM who is assisted by the smallholders or the participants' development committee. Project financing comes from the RISDA replanting grant for rubber and production credits (or subsidies from RISDA and other development authorities) from the sponsoring authority for other agricultural projects. The project cycle lasts through the immaturity and maturity period of rubber with the recommended technologies dovetailing each other in the proper time sequence.

The rationale for the selection of this farm size group for the IDP is based on the fact that in Peninsular Malaysia more than 70% of the smallholdings are owner-operated and are particularly small in size. RISDA's smallholders registration showed that 90% of its replanting applications are from the group less than 4 ha in size, 5.5% between 4 and 5 ha, 3% between 6 and 12 ha, and only 1.3% exceed the 12 ha size group. Of those with less than 4 ha, the majority have holdings of 1.2 ha and less, comprising mainly uneconomic holdings with very low productivity. These small and scattered entities are often excluded from the mini estate development concept and enjoy only peripheral effects or benefits from new technologies developed through research and development.

The objectives of this multi-enterprise integrated development concept of technology transfer to smallholders are to:

1. Further enhance smallholders' development through 'package-deal' technologies in order that they might realise short- and long-term benefits from their limited plots of land by applying these new technologies available from the research and development in RRIM.
2. Raise general farm productivity by increasing farm production, profits and family income in more continuous, consistent, diverse and efficient ways.
3. Narrow the rubber yield gap between the smallholdings and estates sectors.
4. Serve as demonstration plots to other surrounding smallholders to show the benefits obtainable from adopting new technologies on an organised group basis.

Progress of IDP

RRIM initiated the IDP concept in 1982 on 22 ha at Sg. Taling, Negeri Sembilan. The area was replanted with rubber in late 1982 using the RISDA replanting grants; the rubber interrows were intercropped with short- and long-term cash crops covering a total of 6.3 ha. Five poultry sheds were constructed for the rearing of 500 broilers per batch per shed on a rotational system. An interrow nursery was also established for the production of planting materials for sale. These activities were conducted on a credit system to supplement smallholders' income during the immaturity period of rubber.

The intercrop projects showed a total net profit of M$3107 over 1.5 years. Produce from the long-term cash crops, e.g. banana and papaya, will continue to be harvested for the next 3 or 4 years thus ensuring further realisable income streams.

The broiler project commenced in December 1982. Until September 1984, 34 batches were produced. From the total 16,980 day-old chicks reared, 15,920 broilers were eventually sold; mortality was 6.2%. A net profit of M$2028, representing total accrued income to smallholders between December 1982 and September 1984 was obtained. This did not take into account the fixed cost on sheds and equipment, which is given out as soft loans repayable when participants make above-nominal profits.

The interrow nursery project producing 100,000 budded stumps on a 2 ha site has realised until now a profit of M$7268, with a further 30% of material still for sale.

The performance of the 22.04 ha rubber area planted in December 1982 shows that the replanting project is a success. An average of 445 trees/ha at 22 feet x 11 feet layout pattern were planted with seedling materials and budded with clones RRIM 600, RRIM 712, PB 217, and PB 235 in July 1983. The rubber trees, including the trial clones (new clones) are growing well and no serious incidence of pest or disease attack has been observed. Regular maintenance, fertiliser application, and controlled pruning with branch induction were conducted as recommended. To date (i.e 12 months after budding) the trees have reached an average height of 3 m and have a girth measurement of 10 cm. They show healthy and vigorous growth.

The total establishment cost of the rubber replanting project from July 1982 to September 1984 was M$66,583. The amount spent so far is 56% of the total disbursement, which is in line with the third instalment from the replanting grant payable by RISDA.

Regarding credit recovery, the intercropping project has recovered 88% of the credits given to smallholders. The broiler project also recovered 34% of the credits given for the construction of the chicken sheds and purchases of other fixed cost items. Until September 1984, about 47% of the total credits given were recovered from the smallholders, indicating that a workable credit system is a project-financing procedure for the IDP. Thus, the overall progress of the Integrated Development Project is satisfactory and on schedule.

Conclusion

In view of the structural problems of small-farm size coupled with institutional constraints on technology transfer and management, shortage of productive labour force, the absence of economies of scale in production and so forth, which in turn resulted in low productivity and income among the individual smallholders, the Government through its development agencies is embarking on a more comprehensive agricultural development approach by way of Integrated Development Projects that are organised on a group basis. Such programs cover all those agricultural activities that have the potential for development on an economic and commercial scale through land-augmenting technologies with the objective function of raising the total farm productivity and income. Projects undertaken by FELDA, FELCRA, RISDA, MARDEC and pilot projects undertaken by RRIM have demonstrated the viability of the approaches undertaken by these agencies in alleviating poverty and raising productivity in the rubber smallholding sector in Malaysia.

References

FELCRA (Federal Land Consolidation and Rehabilitation Authority). 1984. Usha Meningkatkan Pemulihan Dan Penyatuan Tanah oleh FELCRA. (In Malaysian).

FELDA (Federal Land Development Authority). 1983. Annual Report.

Kadir Mahmood 1984. Strategy Pemprosesan dan Pemasaran Getah Pekebun Kecil. Presented at the Persidangan Kebangsaan Pekebun Kecil. (In Malaysian).

Malaysia, Department of Statistics, West Malaysia Rubber Statistics Handbook.

MRRDB (Malaysian Rubber Research and Development Board). 1983. Annual Report.

RISDA. 1977. Draft Final Report. RISDA census of rubber smallholders, Peninsular Malaysia. Socioeconomic profile, poverty and participation in RISDA's Program.

RISDA. 1983a. Annual Report, Replanting Division.

RISDA (Rubber Industry Smallholders Development Authority). 1983a. Annual Report Unit Mini Estate.

RRIM (Rubber Research Institute of Malaysia). 1983. Annual Report.

RISDA's Extension Program for the Development of Smallholders in the Rubber Industry

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THE purpose of this paper is to show the role of the Rubber Industry Smallholder Development Authority (RISDA) and the approach adopted by it in implementing extension programs aimed at promoting a balanced socioeconomic development for all non-organised smallholders within the rubber industry.

When RISDA was established by an Act of Parliament in 1973, it took over the responsibilities from its predecessor, the Rubber Industry (Replanting) Board. The responsibility of RISDA is wider than that of its predecessor. RISDA's focus is the development of the rubber smallholder, which is different from the role of the Rubber Industry (Replanting) Board, which was only to assist smallholders to replant their uneconomic rubber holdings. The changing of the word 'Replanting' to the words 'Smallholder Development' within the agency's title confirms this mandate.

Smallholder Sector

The rubber smallholder sector comprises about 0.5 million families with an estimated population of 2.5 million people. These smallholders are scattered throughout the country on small non-contiguous farms. (< 2 ha, 254 835 smallholders; 2–4 ha, 173 364; > 4 ha, 62 261).

The total area covered by smallholdings is over 1 million ha. This averages out as 2 ha per family and 0.4 ha/person. The important question is the feasibility of ensuring productivity from this limited area to support the smallholder family. Can productivity be optimised from 0.4 ha to generate a constant flow of income sufficient to support one person in a reasonable standard of living? In financial terms, is this area able to generate an income of not less than M$6000/year or M$500/month net, for each family. This appears to be the crux of the matter. There is a growing school of thought as to the hopelessness of the situation. Many in fact appear to have abandoned any attempt to even try to think about the possibility of using mixed farming concepts as a strategy to boost family incomes though many talk about it. The general call is towards the integration and consolidation of land with a view to group development approaches.

Resulting from the apparent belief that it is not possible to generate required income from such small farms or parcels of land, many smallholders migrate to areas of intensive industrial development or to city centres to look for alternative employment. Inevitably, it is the young who migrate—those within the 20–40 age group—leaving the very young and the very old to tend the smallholdings. The average age of the smallholders who tend these holdings is about 49.9 years. These smallholders lack the educational standards and the decision-making capabilities required to optimise productivity from limited land areas. Thus any attempt to introduce technology and other farm management practices will inevitably be met with lukewarm interest and perhaps even a certain amount of scepticism.

The above situation creates a plethora of issues and problems for RISDA. A dwindling labour force leads to an increase in neglected holdings and diminished productivity. What can be done to reinstate confidence in small farm development as a means of ensuring livelihood? What income generating activities should be introduced that would optimise farm output? What size of farm labour work force should be encouraged to remain within the rural sector? What kind of support services would be necessary to boost farm productivity?

In considering these problems, RISDA appears to have no alternative but to forge ahead and make whatever attempts it can to enhance productivity

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from the smallholdings through the introduction of the 'farm systems approach' and the injection of technology into the sector. Wherever possible, development would be carried out on an integrated basis using what is commonly referred to as 'mini estates.' These have in fact already been implemented wherein smallholders caveat their lands to RISDA to be managed by RISDA personnel with the help of hired labour. The hired labour may be the smallholder himself.

However there are also many smallholders, a rough estimate would be about 200,000 families, who own lands that are non-contiguous and thus cannot be developed on an integrated basis. In this particular instance, and short of the introduction of extensive land reforms, RISDA would have no alternative but to conduct in-situ development using whatever resources are available. In attempting to achieve this RISDA has crystallised the following implementation strategies.

1. Define specific socioeconomic goals that need to be achieved, which when taken as a whole, would reflect smallholder development in more tangible terms.

2. Identify smallholders within a specific geographical area and develop a socioeconomic profile of the individual family and the community within the area.

3. Identify potentials and prospective projects that could be implemented within specific geographical areas based on needs and resources available.

4. Develop a communication strategy to ensure effective extension.

5. Develop an effective management information system to ensure proper data collection, recording, evaluation and feedback at all levels of the organisation hierarchy.

6. Consolidate items 1–5, institutionalise them and promote staff capability to utilise the system.

7. Monitor and evaluate continuously using defined indicators to measure effectiveness.

Specific Goals

Specificity of goals is a critical factor in promoting successful implementation. The goals would have to be expressed in visualisable terms so that they would be understood by all, regardless of their level within the organisational hierarchy. These goals should be in a form that could be readily operational without any degree of ambiguity. This is really basic, but it is mentioned because it is often overlooked.

What therefore, in RISDA's context, would be the goals for smallholder development? RISDA has drawn up a Seven Point Development Plan, which stipulates the following goals to be achieved:

1. Replant all uneconomic rubber with high-yielding varieties.

2. Ensure that all replanted rubber would come into tapping within 5.5 years.

3. Ensure maximum utilisation of land to generate a steady monthly income of not less than M$500/family starting from the time of replanting. This would have to be achieved through the use of mixed farming concepts.

4. Ensure that the annual yield of rubber from replanted areas is no less than 1700 kg/ha.

5. Ensure that the quality of rubber is not less than equal to grade two at the worst, and that smallholders obtain fair prices for their produce.

6. Consolidate smallholder resources through cooperatives and promote the development of small-scale industries.

7. Promote the assimilation of the correct attitudes, knowledge, and skills through education and vocational training.

For each of these seven goals, RISDA has identified specific projects that should be implemented. These 'clusters of projects' would have to be introduced to specific target groups of smallholders who would be identified according to their socioeconomic profile and their implicit needs. Within every village each RISDA field extension worker would have to identify his own target groups, determine their priority needs, design a communication strategy and also monitor, evaluate and report progress with respect to each and every smallholder within his jurisdiction. The extension worker will have to 'manage' extension and not just go through the motions of conducting extension activities.

Tridelta System

In order to promote a unified approach, RISDA has created this system, which could possibly be described as a data-based systems approach to extension with potentials for computerisation (Appendices 1, 2 and 3). The system is still in its infancy but has already shown promise of greater potentials.

The Tridelta system derives its name from the combination of the two words 'Tri' and 'Delta', which was intended to connote the three changes of attitude, knowledge, and skills, which become the objective of any extension activity. There is however no other significance in the word Tridelta. The system however would permit any extension operative to plan, organise, monitor, and evaluate extension programs for smallholders within his/her area of operation.

Every field extension worker would have to conduct a household survey of smallholders within his area of operation and record the following data:- name of household head, type of crops he is operating, age of rubber owned, tapping status of the rubber, total monthly family income, family membership, family employment status, family interest and experience, and house ownership status.

The above data, once collected and collated, would permit the categorisation of target groups based on the age of rubber owned, interests, income, and crops owned. Each category would indicate a specific need for a particular type of activity, technology or project, or clusters of projects. One could design extension programs to cater for technology transfer, poverty redress, or even for social projects.

By using the various categories of smallholders as an indicator of community needs within the area, the field extension worker can now determine his total workload. Subsequently it would be possible for him to identify possible projects consistent with resources available. He would then design and schedule extension communication programs for a specific period with a view to ensuring the successful participation of smallholders in projects consistent with their identified needs.

The extension worker maintains a record of each and every smallholder with whom he is dealing. Records are maintained on type of project, name of smallholder, dates of discussions attended, applications forwarded, application approved, demonstrations attended, inputs supplied, and project started.

These items are recorded as and when they occur and are then reported upwards on a regular basis.

As the data are accumulated upwards, an ever growing perspective evolves regarding the scenario on extension activity that culminates at the central point in headquarters, which is able to examine the following aspects:

1. What potentials exist for extension work in the smallholder sector?
2. What effort has been carried out to encourage participation?
3. What effect has this effort brought about in terms of the number of smallholders participating in each project.
4. What impact has been achieved in terms of income and other non-tangible benefits resulting from the projects?

Conclusion

RISDA has been given the very difficult task of coordinating and ensuring the development of about 500,000 smallholders under various types of constraints. With the hindsight benefit derived from over 30 years of accumulated experience, it has evolved an approach progressively alternating between identifying and solving problems.

RISDA's approach to introduce development and modernisation to the non-organised smallholders within the rubber industry may perhaps be described as the total development approach. In ensuring successful development, there appear to be two critical factors, namely:

1. Do we know what exactly is it that we want to achieve? In other words do we know exactly what tangibly represents the profile of a 'developed smallholder'?
2. Do we have a specific system that allows a unified approach to enable us to 'manage' our efforts?

RISDA's Seven Point Development Plan and the Tridelta System provide an affirmative response to both the above questions. They have only recently been introduced and doubtless require further refining; however it is felt that a major step has been achieved in the field of rural development extension programming and management. RISDA is happy in being able to pioneer its own in-house system which will hopefully bear positive results in the near future.

FELDA's Role in Solving the Problems of the Rubber Smallholders

Abdul Ghafar Wahab*

AGRICULTURE'S share of the Malaysian Gross Domestic Product in 1982 was 23.4%. The annual growth rates of this sector for 1981 and 1982 were 5.3% and 6.3% respectively, an improvement compared to the average growth rate of 4.3% over the 10 year period from 1971 to 1980. For the current 5 year plan covering the period 1981-85, the agricultural sector takes up 37% of the Government's expected development spending. In terms of employment, agriculture accounted for 38% of the total jobs in 1982 as against 51% in 1970.

The total land area of main crop cultivation, the annual production figures, and their share of world production figures are summarised in Table 1.

Table 1. Crop area and production, 1982.

Crops	Area ('000 ha)	Production ('000 t)	World production (%)
Rubber	2008	1516	40.4
Oil palm (Palm oil)	1226	3511	59.4
Rice	758	1339	Negligible
Coconut (Copra)	320	257	Negligible
Cocoa	133	65	3.0
Pepper	11	25	22.7

Source: Economic Report 1983-84. Ministry of Finance. Kuala Lumpur, Malaysia.

Rubber is the most important cash crop in Malaysia, and in 1982 it covered 45% of the estimated 4.456 million ha under major crops. Even after considerable achievements in the nation's diversification program, rubber contributed some 9.4% of total export earnings in 1982. In 1980, about 45% of the work force in the agricultural sector of some 18% of the total work force of the country was employed in the rubber plantation industry.

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Smallholder Sector

The Malaysian rubber planting industry is divided distinctly into two sectors, viz. the estate sector comprising production units of 40 or more ha and the smallholding sector with holdings less than 40 ha.

In 1982, the smallholding sector covered some 1.5 million ha or 75% of the total area under rubber cultivation, and contributed some 902,300 t or 62% of total rubber production. Some 3 million people or about 25% of the total population of the country are dependent directly or indirectly on rubber smallholdings for their livelihood and welfare.

Until 1960, almost all the rubber smallholdings were individually owned and operated holdings of 1-5 ha, of which 90% were less than 4 ha in size, with a median ranging from 1.2 to 3.2 ha in extent. Meanwhile, the rubber estates were almost entirely owned by the private sector, characterised by its well organised and commercially oriented concerns.

The investment in new land development for agriculture, until the late fifties, was almost entirely undertaken by the private sector. However, the growth of private investment in rubber planting started to decline in the early sixties. The percentage of planted area of rubber estates in Peninsular Malaysia started to decline as early as the fifties as shown in Table 2.

Table 2. Total planted area under rubber in Peninsular Malaysia.

Year	Estate ('000 ha)	Estate (%)	Smallholdings ('000 ha)	Smallholdings (%)
1930	308	61	197	39
1950	793	53	700	47
1960	785	48	854	52
1970	643	37	1081	63
1980	510	25	1494	75

Sources: Lim Sow Ching, land development schemes in Peninsular Malaysia: A study of benefits and costs, 1976. Department of Statistics. Kuala Lumpur, Malaysia.

The downward drift in the estate sector rubber was due to several factors, among which were:

1. The fragmentation of estates into smallholdings as a result of the sale of European-owned estates.

2. New private investment in rubber has been discouraged by the fall in rubber prices since 1960; old rubber has been replaced instead by oil palm.

3. Restriction by the State Governments on the alienation of fresh land for new planting by the private sector due to socioeconomic and political pressures for large-scale land development for the landless poor and those with uneconomic holdings.

Regarding the third factor, a Working Party on Land Settlement was established by the government in August 1955 to assess the need for a planned and coordinated development of land. The Working Party recommended the setting up of the Federal Land Development Authority. This statutory body, more popularly known as FELDA was established in July 1956. The same Working Party also recommended that new land settlement schemes should be based on perennial crops like rubber, and not on the traditional Malay farmer's preference for paddy.

The active implementation of the government's new land development schemes beginning in the late fifties, led to the emergence of a new subsector within the rubber smallholdings sector, i.e. the Land Development Schemes (LDS) each consisting of separate holdings of 2–4 ha in size and being centrally managed on an estate basis. Ho vever, until 1981, individual smallholdings still med the biggest subsector with a total area o million ha or 52.8% of the total area planted with rubber (LDS, 471,000, and Estate 542,000).

Today, Malaysian rubber smallholders are no longer a homogeneous group. Two distinct subsectors are easily identifiable with a smaller and less significant third subsector comprising mainly city dwellers who joined the ranks of the smallholders through the acquisition of the fragmented European-owned estates. The two main subsectors are the traditional individual smallholders, the largest group, and the participants of the government's LDS.

Problem Areas

The smallholder sector consists of an individual farmer with an uneconomic holding of 0.8 ha of rubber land and another 0.8 ha of mixed farmland (mainly paddy and/or orchard), or a LDS settler enjoying the advantages of an estate-type environment, or an absentee landlord residing in the city. By virtue of their characteristics, the individual smallholders are faced with numerous and complex problems. These smallholders constitute the largest poverty group in the country.

The major problems confronting the individual smallholders are:

1. Remoteness and scatteredness of holdings.
2. Small and uneconomical farm size.
3. Lack of infrastructure.
4. Low yields and income, coupled to uncertain and unstable prices for rubber and other produce.
5. Hard-core replanting problems:
   (1) Old age of smallholder.
   (2) Lack of family and hired labour.
   (3) Inability to bear the interim loss in income consequent upon replanting.
   (4) Too many co-owners, and their inability to agree on any required action.
6. Low level of education and training, particularly in more lucrative skills.
7. Limited scope of on-farm activities, and lack of employment opportunities elsewhere.
8. Lack of alternative and more efficient marketing systems for inputs and outputs.
9. Lack of finance and credit facilities.
10. Increasing population pressures on the limited land and other resources.
12. Little equipment.

Improvement Schemes

Efforts towards improving the well-being of the individual rubber smallholders were first initiated in the early 1950s when attempts to resuscitate the industry were made to assist all the rubber producers to replant their low-yielding material (Mudie 1954). A number of replanting schemes were then implemented by the Rubber Industry Replanting Board (RIRB).

Efforts to upgrade the individual smallholders were intensified with the establishment of the Rubber Industry Smallholders Development Authority (RISDA) in 1973 to take over and expand the RIRB's smallholders function. By virtue of its financial resources, RISDA now undertakes a wider range of advisory services and is able to afford a much closer level of supervision for the benefits of smallholders. However, by and large its role continues to be advisory in nature with the provision of technical inputs and the introduction of newer technology. RISDA also organises a large number of programs to look after the welfare of smallholders.

The total target to which RISDA addresses itself in the context of smallholdings is about half a million families spread over 1,071 million ha.

In the field of rubber processing, individual smallholders had confined themselves to the production of unsmoked sheets. The Rubber Research Institute of Malaysia's (RRIM) smallholders Advisory Division during the period of its existence, established and implemented the concept of Group Processing Centres to produce mainly smoked sheets. With the development of technically specified rubber, the smallholders were unable to gain access to this facility. Their volume of produce was low and the location of factories was distant. In 1969, a government agency named the Malaysian Rubber Development Corporation (MARDEC) was established principally to buy smallholder's produce and channel it towards the production of technically specified rubber. However, with the 15 factories under its operation today, MARDEC is able to cater for only approximately 12% of the total smallholder's produce.

In respect of the development of new rubber areas, the Land (Group Settlement Areas) Act 1960 made it possible for bodies sponsored by the Federal Government to undertake land development schemes directly. Backed by this legislation, which was necessary because the States own all land rights under the Federal Constitution, FELDA has been able to develop land and recruit settlers as an effort to solve the problems of the landless poor and those with uneconomic holdings.

Until 1982, in a total of approximately 465,511 ha of rubber developed under LDS, FELDA's share was 181,344 ha, i.e. 39%. The other government agencies involved in new planting of rubber are the Federal Land Consolidation and Rehabilitation Authority (FELCRA) (51,740 ha), RISDA (40,500 ha), State Economic Development Corporations (SEDCs), and State Agricultural Development Corporations (SADCs) (48,500 ha) and others (143,380 ha).

FELDA Strategies

FELDA is now one of the biggest land development agencies of the Malaysian Government. FELDA's objective is to improve the standard of living of the landless poor through land development and settlement. This objective is in line with the Malaysian Government's overall objectives of poverty eradication and restructuring of society. These objectives were spelled out officially first in The Second Malaysia Plan, 1971-75.

FELDA's participation in the development of the rubber industry started as early as 1957. By the end of 1982, 122 rubber schemes had been developed with a total plantable area of 181,344 ha. Some 82,992 ha, i.e. 45.7% of this area, came into production by the end of 1982. To date, 32,188 settler families have been placed in 91 rubber schemes.

Table 3. Development of the rubber industry by FELDA, pre 1960-1982.

Year	Number of new projects	Area (ha)
1960 and earlier	14	5908
1961-65	37	35353
1966-70	5	18561
1971-75	20	45319
1976-80	36	62984
1981	5	10197
1982	5	3022

Table 3 shows the progress of rubber development by FELDA over the years.

Based on a fully integrated 'package-deal' approach, FELDA's operations include jungle clearing, planting of the main crops, development of villages and urban centres, selection and placement of settlers, management of projects, provision of credit, processing and marketing services, and the provision of extension services for social and community development. Funds required for the implementation of the above-mentioned activities are being provided by the Federal Government in the form of grants and loans. The cost of agricultural development, settler houses, and subsistence credit is financed through loans recoverable over a 15-year period while the grants meet the administrative and management costs.

A typical FELDA land development project consists of an area of about 2000 ha capable of settling 400 families. Each settler family is allocated 4 ha of agricultural land and 0.10 ha for a house-lot. The size of agricultural holding is determined by labour and income generation considerations. Size of holdings has changed over the years with the earlier schemes having 2.5, 2.8, and 3.2 ha. A few FELDA schemes have holdings of 5.5 ha per settler family. Each FELDA LDS is self-sufficient, being provided with the basic infrastructures and amenities such as roads, water supply, school, health clinic, community hall, mosque, shop houses, transportation, and communication services.

The felling of virgin jungle and the clearance of economic minerals and timber, typifies the beginning of a FELDA land development project. The jungle clearing and planting works are carried out by contractors who have been successful in making competitive bids to undertake the project's initial development tasks. Planting proceeds according to a clockwork schedule, utilising the high-yielding class-one clones recommended by RRIM. In 1982, the total production of rubber from FELDA's 82,992 ha of matured rubber area was 96,792 t. This gives an annual average of 1162 kg/ha as compared to about 800 kg/ha per year obtained by the individual smallholders. While agricultural development work proceeds, a central portion of the newly developed area is carved out for the settlement/residential area. Staff quarters and settler houses are constructed, roads and water pipes laid, and other public and social amenities are provided. The new settlers arrive to find the agricultural area planted and maintained, their houses ready for occupation, which enables them to have a 'head-on' start for an exciting and challenging new life ahead. Applicants to become settlers must be married and between the ages of 18 and 40 years. Selection is by an interview based on a weighted point-system of 'need' and 'suitability' criteria. One of the basic criteria for 'suitability' is that the would-be settlers should not own more than 0.8 ha of farmland prior to joining the FELDA LDS. Those with farming experience have an added advantage.

FELDA's model of land development can be rationalised. The initial development undertaken by FELDA up to the point of the entry of settlers, is part of a development strategy meant to provide them with an opportunity for progress that is not available to most of the individual smallholders. The merits of this approach to development as compared with other 'self-help' land development projects are a faster rate of tightly scheduled development, and a more efficient and effective exploitation and utilisation of land resources. This ready-made initial development provides the settlers with a 'launching pad', as it were, for an economical and social 'take-off'.

Upon entry into a land scheme, settlers take over and continue the maintenance and development of the agricultural area through to its maturity. While tending to the immature crops, they are provided with a monthly subsistence allowance based on actual work done. (Each settler is guaranteed a minimum monthly income of M$200 provided he fulfils a 25-day monthly work obligation.) On-the-job training is provided as the settlers orientate and discipline themselves to a new system of work and a new way of living. The staff associated with the scheme guide and advise the settlers through their elected leaders. Upon maturity of the main agricultural crop, the settlers begin to make payments towards the development cost of the scheme and the subsistence credit. Their produce is brought to a central collecting and processing centre where it is valued. Deductions are made from their monthly income towards their loan repayment over a 15-year period, with the prospect of their being issued with land titles granting them rightful ownership of the land.

Based on the current-year estimates, the development and some maintenance costs of 1 ha of rubber up to maturity are M$7400. Some M$2800, i.e. 38% of this, is the estimate for the provision of major works such as jungle clearing, planting, and farm road construction while the balance is for maintenance. A settler's house, which is a one-room timber house with a floor area of approximately $42m^2$, is estimated to cost M$4500. The loan to a settler family with about 4 ha of rubber and 0.10 ha of house-lot and house is estimated to be M$37 100 by the time the rubber area comes into maturity.

The monthly loan repayment repayable by a settler family over a period of 15 years at zero interest (with effect from 1981, the Government of Malaysia extended interest-free loans for FELDA's agricultural development; prior to this, interest was charged at the rate of 5½%) when based on the above estimates is M$206. The average monthly net income of a settler family is estimated to be M$480 (based on M$2.95/kg f.o.b. price of rubber).

The actual average monthly net income of settlers in FELDA rubber schemes for 1979 was $M474; 1980, $472; 1981, $492; 1982, $402; and 1983, $482.

Prior to joining FELDA LDS, the majority of the settlers had been earning a monthly income of M$100-200. RISDA's estimate of overall average monthly total household income for smallholders in 1983 was M$240. From the above it can be seen that a FELDA family has been earning well above the subsistence level and the objective of giving the rural population a higher living standard is being met.

Conclusion

FELDA's approach to land settlement has been to provide the settlers with a 'package deal.' Their interests are looked after from the felling of the first tree to the sale of their produce. As part of this deal, FELDA has established subsidiary corporations that provide services in processing, marketing, transportation, and storage of settler's farm produce as a means to ensure that they receive a fair return. In areas where technical know-how is lacking, FELDA has gone into joint ventures with the private sector. One such joint venture is the construction of a fertiliser plant that since early 1983 has been producing granulated fertilisers for supply to FELDA and other users.

FELDA's agricultural development and the supporting credit, processing, and marketing facilities are specifically geared to give settlers a better income. The more important input in FELDA's 'package-deal' aims at the development of the settlers themselves. While adopting and practicing a commercial approach in its agricultural development activities, FELDA also emphasises the social content of its development program, and thus fulfills its role and obligation towards the total development of settlers. Agricultural development provides the economic base upon which total development can have its foundation. Right at the root of FELDA's development program, is the development of human resources—those of the settler, his family, and the community in the scheme.

FELDA's social development program initiated in 1967 is aimed at instilling the spirit of willingness to work, self-help, and the betterment of themselves and their families through their own efforts. Besides emphasising the high standard of farm maintenance and operations, settlers are encouraged to participate in off-farm commercial activities. Training courses are being conducted and credit facilities are made available to those who are interested to participate in business enterprises.

Today, some 3000 business ventures are being undertaken by FELDA settlers and their dependents covering various fields such as retail provision shops, restaurants, tailoring, barber shops, motor repair shops, and furniture manufacturing. At the end of 1983, there were 173 cooperative societies in FELDA LDS, 108 of which were engaged in the transportation of oil palm fresh fruit bunches with a turnover of M$37 million. Thirty five of the cooperatives were operating provision shops, 5 were operating school buses, 3 in public bus services while the remainder were engaged in various other activities such as transportation of scrap rubber.

References

Economic Report. 1983-84. Ministry of Finance, Kuala Lumpur, Malaysia.

Lim Sow Ching. 1976. Land development schemes in Peninsular Malaysia: A study of benefits and costs. Kuala Lumpur, Malaysia.

Mudie, R.F. 1954. Report of the Mission of Enquiry into the Rubber Industry in Malaysia, Kuala Lumpur.

Rubber Statistics. 1982. Department of Statistics, Kuala Lumpur, Malaysia.

The Malaysian Natural Rubber Industry. 1983-2000. Report of the Task Force Of Experts.

Some Aspects of Technological Developments in the Malaysian Rubber Industry

Yee Yuen-Loh*

NATURAL rubber remains the major source of cheap elastomer material for the wheels of the world. Malaysia produces and exports more rubber than any other country. Since the inception of the Malaysian rubber industry in 1876, rubber production has played a vital role in the economic development of the country. In 1981, Malaysia accounted for about 42% of total world natural rubber production. The area planted with rubber trees in Malaysia increased from less than 2000 ha in 1900 to about 2 million ha in 1983. The national average annual yield of mature rubber trees in the estate sector increased from 385 kg/ha during the pre-World War II period (average of years 1929–40) to about 1205 kg/ha in the 1970s (average of years 1970–80). Various authors quote different data. National and consistent average yield figures for the smallholding sector are difficult to obtain. However, the increase in productivity, while significant, is undoubtedly not nearly as great as in the estate sector.

Research has produced major technological changes in rubber growing and production in Malaysia over the last half century (Pee 1977; Yee 1981). The dramatic yield increases have been primarily due to advances in agro-botanical and chemical technologies. Adoption of new high-yielding cultivars and the associated package of improved techniques, especially in the estate sector, has been widespread. The potential for greater rubber output has improved the prospects for sustained growth of the industry in the face of both fluctuating world rubber prices and increasing costs of inputs.

Despite the success of past research strategies, the wisdom of continuing rubber growing research along traditional lines has been increasingly questioned in recent years. Two major and related criticisms of past research are firstly, that it has been biased towards improving productivity of capital rather than the productivity of labour and, secondly, that it has developed technologies more suitable for larger-scale than for smaller-scale rubber growing operations (Barlow and Peries 1977). On the first point, Malaysia has recently experienced a major change in relative factor prices in the rural sector (Harun 1979). Labour is no longer readily available and cheap relative to capital, as was the case in the past. Regarding the second point, the proportion of rubber land under smallholdings is over 73% and accounts for about 63% of the total output in Malaysia. The increasing importance of the smallholding sector is a significant factor in the research policy of the rubber industry. Thus, for both economic and political reasons, future research must be seen to be relevant to the smallholding sector.

The major challenge currently facing policy makers and planners is that of devising policies that will continue to encourage productivity increase and at the same time enable the technologically poor smallholders to reap the benefits of technological developments. Towards this, a detailed understanding of past research and technological developments are essential for formulating appropriate policies that are in line with present resource endowments and the growing importance of the smallholding sector. This paper sets out to review and examine some of the work done in Malaysian technological developments with respect to estate rubber production, and not including processing and marketing, and determines their relative impact on the rubber production operation.

Rubber Research

The technological advances in rubber growing that have occurred and are continuing to be developed are consequences of the intensive research

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effort by both private research stations and the Government statutory research organisation, i.e. the Rubber Research Institute of Malaysia (RRIM). Funding of research in the private sector is by individual plantation groups, which in turn derive their funds from member estates. During the early period of rubber research, RRIM was supported by a special research cess of 0.1653c per kg of rubber exported. The research cess underwent numerous revisions and producers are currently paying a rate of 3.85c per kg of rubber exported. Table 1 shows the research expenditure incurred by both private research stations and RRIM. RRIM, with an average annual research expenditure of more than M$20 million during the 1970s, now carries out the bulk of the research. Biological research in RRIM constitutes about two-thirds of the total expenditure while chemical research accounts for the remainder.

Table 1. Total expenditure on rubber research in RRIM and private stations (Malaysian dollars).

	RRIM		Private		
Period	($'000)	(%)	($'000)	(%)	Total ($'000)
1920	NIL	0	136	100	136
1920–29	1060	57	801	43	1861
1930–39	4949	87	765	13	5714
1940–49	8051	92	690	8	8741
1950–59	38821	96	1455	4	40276
1960–69	103439	98	2325	2	105764
1970–79	222877	99	2260	1	225137

Source: Pee (1977; 39–40 and 42–43). RRIM Annual Reports (1978, 1979).

Benefits from rubber research, both private and RRIM, have been quantified in a study by Pee (1977). The concept of 'economic surplus' was used to estimate the gross research benefits of Malaysian rubber research for the period 1932–73. The overall returns to producers and consumers from investments in rubber research, as estimated by Pee, are high, with an annual internal rate of return in the region of 24–25%. Even when the secondary benefits were excluded from the study, the returns to rubber producers were still high enough to warrant investment by rubber producers in rubber research.

While rubber research represented a worthwhile project in the past, Pee has also pointed out that the estate sector had been the major beneficiary of rubber research. This conclusion is consistent with the views put forward by Bauer (1948), and Barlow and Peries (1977). However, there is no substantial evidence to support the notion that technological developments in the past are not appropriate for adoption in the smallholding sector (Lim 1978).

While current research in RRIM emphasises fundamental and product development research (RRIM 1983), the urgent need for social-economic research, particularly on methodological aspects of solving problems like constraints to adoption and constant monitoring of diffusion of technology in the smallholding sector, should not be taken lightly.

Technological Developments

Technological developments in the Malaysian rubber industry have all been due virtually to systematic research since the 1920s. Increase in yield has been largely brought about by the development and adoption of several high-yielding clones or clonal seedlings. Extension replanting and new planting of these new rubber cultivars have been the major factors in this rapid increase in productivity. In the field of applied science, the technique of bud-grafting has been developed, which enables unlimited vegetative reproduction of a desirable cultivar. This permits the use of high-yielding materials that would have been otherwise discarded because of some defective crown characteristics of the cultivar. The whole principle of this technique is to obtain an ideal cultivar, which has a good rooting system, a high-yielding trunk, and possesses desirable crown characteristics. This technique also enables the selection and development of cultivars that are resistant to diseases, wind damage, and other environmental constraints.

The development of high-yielding cultivars and bud-grafting techniques have been complemented by developments in improved horticultural and agronomic practices, which can substantially reduce the immaturity period of rubber trees. Research on exploitation techniques (tapping) has also been continued since the continuous excision method of tapping was discovered (devised) by Ridley in the 1890s (Wycherley 1959). As a consequence, a number of tapping systems have been devised for different rubber cultivars based on their yield responses, girthing rates, and varying susceptibility to dryness of the trees. Agronomic practices introduced in the rubber sector have been numerous and include appropriate fertiliser usage, soil conservation measures, weeding and maintenance, and the most important of all being the development of yield stimulants.

The successful use of yield stimulants to increase production has been an important technological development. Stimulation experiments conducted by RRIM during 1929–30 used a mixture of cattle manure, wood ash, and other minor ingredients such as sulphate of iron, and permanganate of potash. The yield stimulant now used in the rubber sector is essentially an ethylene inducer and consists of 2 chloro-ethano-phosphonic acid and palm oil. It is commonly known as ethephon. Using data from Yee (1981), the extent to which yield stimulants have resulted in yield increases under commercial estate conditions is shown in Table 2.

Table 2. Mean yield response to stimulation for all cultivars in 1976.

Tapping panel	Stimulation	Number of fields	Mean annual yield (kg/ha)	Yield increase (%)
A	No	93	1294 (336)[a]	27
	Yes	23	1641 (486)	
B	No	131	1542 (322)	22
	Yes	54	1878 (514)	
C	No	20	1642 (214)	31
	Yes	93	2146 (314)	
D	No	9	1436 (392)	38
	Yes	73	1983 (174)	
E[b]	No	16	1211 (241)	39
	Yes	51	1688 (301)	
F[c]	No	8	984 (134)	57
	Yes	48	1544 (288)	
All	No	277	1493 (387)	32
	Yes	342	1977 (276)	

Figures within parentheses are standard deviations.

a. Refers to 100% stimulation, i.e. all trees were stimulated.
b. and c. Panels E and F, which showed the most yield response, represent second renewal bark.

Economic Impact of Technological Developments

Comparison of economic variables (three sets of cross-sectional data were collected for the analysis, one each for the production years 1964, 1970, and 1976; the nature and the sources of data collected are reported in Yee (1981) over time, was conducted for estates possessing different 'vintages' of capital (rubber trees) or 'technological strata'. In the course of technological evolution of the rubber industry, four time periods are differentiated. Appendix Table 2 sets out to specify in detail each of these technological strata. Although each vintage exhibited differences in the associated package of inputs, the single most important technological feature of each vintage of technological stratum was the class of cultivars involved.

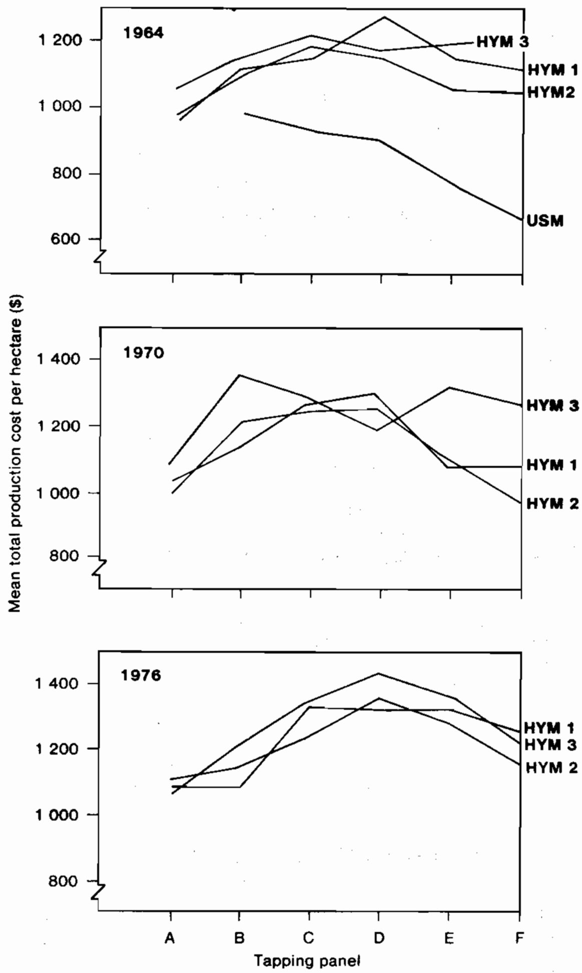

Fig. 1. Variation in mean total production costs per hectare in 1964, 1970, and 1976.

Figure 1 shows the variation in mean total production costs per hectare of rubber production in 1964, 1970, and 1976. Total production costs consist of overhead costs, tapping and collection, manuring, weeding, stimulation, processing, and other maintenance costs. Constant 1976 prices are used in all three production years. A common feature noted was that the adoption of more advanced planting materials and the associated technologies was usually linked with higher production costs per hectare, especially in 1964. The differences in the mean total production costs per hectare between the USM technology and the other HYM technologies were very wide for all tapping panels. However, variation between HYM1, HYM2 and HYM3 technologies fluctuated with different tapping panels. In 1976, HYM3 incurred higher production costs for most tapping panels thereby indicating increased unit-production costs as rubber producers adopted more recent advanced technology.

The effect of implicit technological factors on the mean operating profit per hectare for 1964, 1970, and 1976 is shown in Fig. 2. There is a significant difference in profits between USM and other HYM technological strata. This large difference indicates the realisation of financial incentives, which the estate sector envisaged at the time it embarked on large-scale replanting programs during the periods prior to and after World War II.

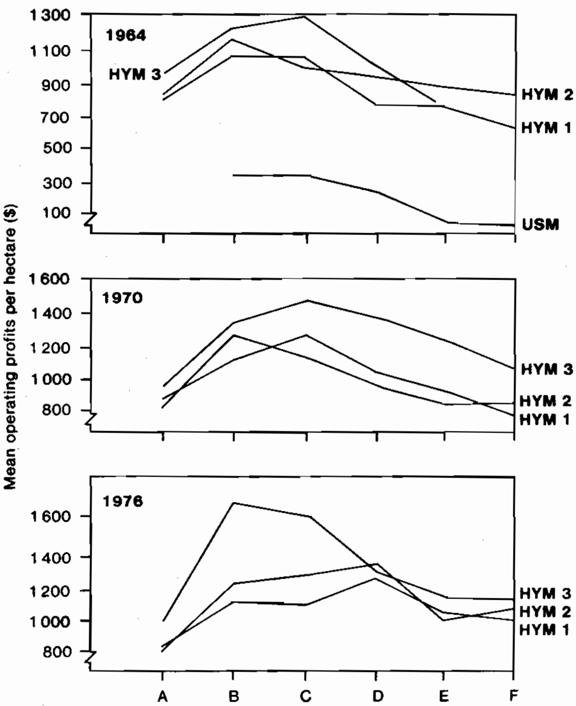

Fig. 2. Variation in mean operating profits per hectare in 1964, 1970, and 1976.

Performance among the HYM technological strata also indicated the superiority of the HYM3 technological stratum. This is especially evident for the results shown in the 1970 and 1976 data.

Using time series data from each technological stratum, the combined impact of explicit factors like better tapping systems, improved tree maintenance, discriminatory fertiliser application, more efficient management, and the application of yield stimulants is shown in Fig. 3. For each technological stratum, an overview of the effect of new technology over time is demonstrated. Virtually all tapping panels indicated an increase in profit using the most recent technology. This increase is entirely due to the improved productivity made possible by the adoption of the new technological developments.

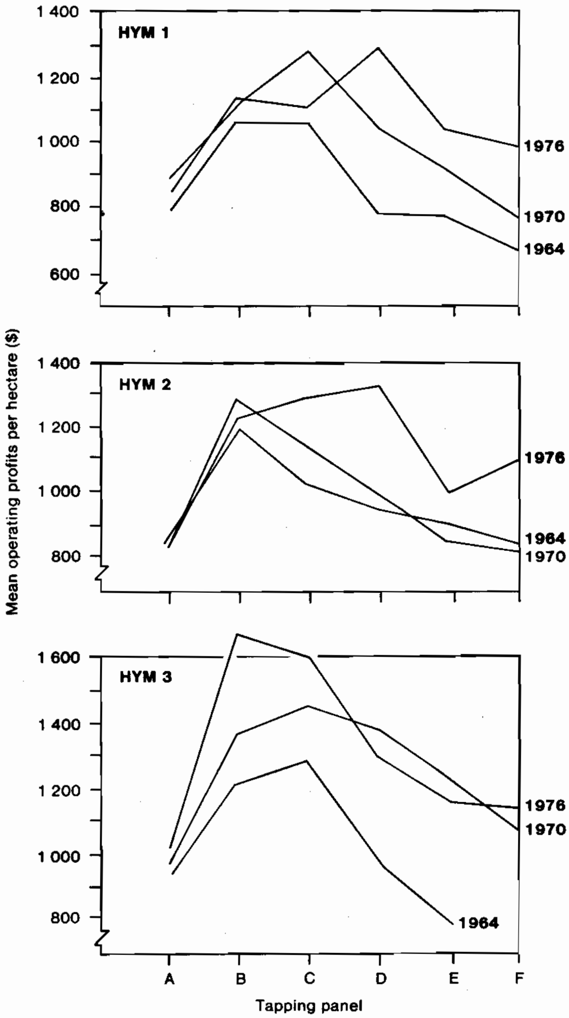

Fig. 3. Variation in mean operating profits for high-yielding materials in 1964, 1970, and 1976.

Bias in Technological Developments

As discussed at the beginning of the paper, technological change has been criticised as being biased towards the productivity of capital rather than the productivity of labour. These critics argue for a major re-ordering of research priorities to eliminate the alleged bias inherent in past research strategies.

In an attempt to quantify the impact of technological progress and to investigate the claim that past research has been biased in nature, Yee and Longworth (in press) used the production-function approach to derive some results on the nature and magnitude of embodied and disembodied technological change in the Malaysian rubber industries. The production hypersurface for each technological stratum (see later section) was estimated at different points in time. It was found in all cases that the upward shift in the hypersurface from one technological stratum to another is neutral with respect to all input factors. Input factors used in the production function study are (a) harvesting labour measured in total number of tappings, (b) total index value for tappable trees per field, (c) total kilogram of fertiliser applied per field per year, (d) other input expenditures measured in Malaysian dollars, (e) and management proxy in terms of the ratio of gross profit to total expenditure for a particular field. (See Yee (1981) for discussion of the selection of input variables and functional forms.) The result indicated that until 1976, rubber research leading to new embodied technology has not been biased since it raised the productivity of all input factors at about the same rate over time. Embodied technological factors include (a) cultivar, (b) planting density, (c) propagating and planting techniques, (d) land quality or soil type, and (e) other factors applied during the immature phase, e.g. disease and weed control, fertiliser application, use of cover crops, and general maintenance.

Whilst the embodied technological change is neutral in nature, results of the estimate of disembodied technological change in the Malaysian rubber industry revealed that technological advances did not shift the hypersurfaces in an unambiguously neutral fashion. Disembodied technological factors are those that are applied during the productive phase, e.g. tapping systems, fertiliser application, disease and weed control, yield stimulants, and other maintenance inputs. The general feature is that disembodied technological changes improved the overall productivity of all HYM technological strata. The study also suggests that there has been a tendency towards the development of technology that raises the productivity of 'management' and 'fertilisers' with less emphasis being given to improving the technical productivity of either labour or capital. Another important feature reported in this study is that all of the cross-section production functions estimated exhibit constant returns to scale. This implies that productivity gains achieved by research are equally applicable whether the rubber fields are large, as in the estate sector, or small, as in the smallholding sector. Of course, among other things, this study assumes the underlying production functions are the same in both sectors.

Conclusion

Agricultural research may easily lead to new technology that is biased in its impact. This problem is potentially more serious in perennial than annual crops. This paper has reviewed the rubber research and the impact of technological developments on rubber profitability in the estate sector. There is no evidence that past developments have been potentially biased towards the productivity of 'capital' or 'labour' in Malaysian rubber research. Technological developments have resulted in higher production costs and the benefits derived from their application have resulted in substantially higher profits in the estate sector.

Until the 1970s, technological developments in the Malaysian rubber industry have been appropriate to both the estate and smallholding sectors. Because of different resource endowments and other subtle differences in the smallholding sector in the past, criticisms of inappropriate technological developments may be justified. For example, the two sectors have traditionally used different tapping systems in the past. As a result, rubber cultivars selected under tapping systems commonly used in the estate sector, may not have been the most productive cultivars in the smallholding sector. On the other hand, recent technical and economic changes in the smallholding sector have narrowed the gap between the sectors in many aspects. In particular, both the rural labour shortages and the commercialisation of agriculture, which resulted from rapid economic growth during the 1970s, have moved factor price ratios faced by smallholders into line with those encountered by the estate sector. As a result, smallholders have been rapidly adopting the production methods of the estates.

Therefore, in future, research which is appropriate for the estates, will also be appropriate for the smallholders. There is a need for the research sector in Malaysia to move along the lines adopted in the 1970s and the call for re-ordering research priorities in the 1980s need not be taken too seriously.

Classification of Technological Strata

In the course of the technological evolution of the industry, four time periods can be differentiated. These are the periods associated with:

1. Planting of unselected seedlings (before 1930).
2. Planting of the first group of HYM (1930–42).

3. Planting of the second group of HYM (1945–59).
4. Planting of the recent group of HYM (since 1960).

Preliminary enquiries in 1977 from 27 estate managers and field assistants attending an estate management and planning course conducted by RRIM indicated that it was not possible to obtain detailed input-output data for individual production fields for years prior to 1960. A field is a block of land planted with rubber trees within an estate. An estate consists of a number of fields each planted with rubber trees of different ages. The majority of the managers indicated that they did not retain records of field production after the fields had been replanted. Thus long-term time-series data are not available from fields using technologies associated with the earlier periods. The level of technology available during these earlier periods must be examined indirectly.

The procedure adopted in the study by Yee and Longworth (in press) was to classify different technological strata news based on detailed information derived from cross-sectional surveys about the types of cultivars and their associated package of inputs introduced during various time periods. Due to the perennial nature of rubber trees, it is possible to obtain data from cross-sectional surveys that cover cultivars recommended and planted in a range of time periods. The present study, therefore, employed cross-sectional data on cultivars and their associated package of inputs that were introduced during the various time periods.

Work on breeding and selection of cultivars produced new HYM materials in the early 1900s. These high-yielding cultivars were introduced to the industry by RRIM as Class 1, Class 2, and Class 3 materials. Class 1 materials are recommended for planting on a large scale (i.e., up to 80% of the planted area). Class 2 materials are recommended for planting on a moderate scale (i.e., usually up to 20% of the total planted area). Class 3 materials are recommended for planting in experimental plots only. New plantings and replantings in the estate sector generally follow RRIM recommendations for large-scale planting and hence fields are mostly planted with Class 1 materials. This study grouped the Class 1 materials into different technological strata. Table 3 summarises the various new Class 1 materials that were recommended to the industry at different time periods.

It must be noted that Class 1 materials that continue to be recommended are not included in the list for subsequent periods in Table 3. This is because when the cultivars (and hence their associated package of input factors during the planting time) were first recommended to the rubber industry, they embodied the state of technology at the time of their recommendations, i.e. they were vintage specific. Their continued recommendations as Class 1 materials in the subsequent period do not embody any new technology.

Table 3. Class 1 planting materials recommended by RRIM at different periods.

Period	Clone	Seedling family
Before 1930		Unselected seedlings[a]
1930s	Tjir 1 Tjir 16 PB 86 Pil B84 PB 25	
1940s	Gl 1	
1950s	RRIM 501 RRIM 513 PR 107	PBIG/C PBIG/D PBIG/E PBIG/F PBIG/G PBFB/A PBFB/B Ch IG/B Ch IG/E Tjir 1M Tjir 1 illegitimate
Since 1960	RRIM 600 RRIM 605 RRIM 623 PB 5/51 GT 1	PBIG/GG1 PBIG/GG2

a. Not a recommended material but indicated here as the original material used in the industry.

Based on the information in Table 3, Class 1 cultivars are classified into four technological strata each representing one state of technology for the four time periods discussed above. The four technological strata representing the above time periods are, respectively, USM, HYM 1, HYM 2, HYM 3. USM represents the original planting materials and their associated package of input factors. It must be noted that USM represents the oldest technology and the cultivar, i.e. unselected seedling material, is not a Class 1 material as listed in Table 3. HYM 1 represents the technology embodied in those Class 1 cultivars and their associated package of input factors introduced during the period 1930–42. HYM 2 represents the technology embodied in the next group of Class 1 cultivars and their associated package of input factors introduced during the period 1945–59. This is the immediate period after

World War II. HYM 3 represents the technology embodied in the most recent group of Class 1 cultivars recommended since 1960. The grouping of rubber cultivars into different technological strata is summarised in Table 4.

Table 4. Classification of cultivars into different technological strata.

Techno-logical stratum	Cultivar	Characteristics
USM	Unselected seedlings	Original technology introduced to the industry
HYM 1	Tjir 1, Tjir 16, PB 86, Pil B84, PB 25	Pre-World War II high-yielding technology (1930–42)
HYM 2	RRIM 501, RRIM 513, PR 107, Gl 1, PBIG/C, PBIG/D, PBIG/E, PBIG/F, PBIG/G, PBFB/A, PBFB/B, Ch IG/B, Ch IG/E, Tjir 1M, Tjir 1 illegitimate	Immediate post-war high-yielding technology (1945–59)
HYM 3	PB 5/51, GT 1, RRIM 600, RRIM 623, RRIM 605, PBIG/GG1, PBIG/GG2	Recent high-yielding technology (since 1960)

References

Barlow, C., and Peries, O.S. 1977. On some biases in the generation of technologies by rubber research institutes. Journal of the Rubber Research Institute of Sri Lanka, 54, 445–459.

Bauer, P.T. 1948. The rubber industry: A study in competition and monopoly. London, Longmans.

Harun, A. 1979. Overcoming labour shortage through labour mobilisation. Presented at seminar on labour shortage and agricultural production, 1979. Kuala Lumpur, Agricultural Institute of Malaysia.

Pee, T.Y. 1977. Social returns from rubber research in Peninsular Malaysia. Ph.D. Thesis (unpublished), Michigan State University.

RRIM (Rubber Research Institute of Malaysia). 1978, 1979, 1980, 1981, 1982, 1983. Annual Reports. Kuala Lumpur, Malaysia.

Wycherley, P.R. 1959. The Singapore Botanic Gardens and rubber in Malaya. The Gardens Bulletin, 17(2).

Yee, Y.L. 1981. Technological change in the Malaysian rubber growing industry. Ph.D. Thesis, (unpublished). University of Queensland, Australia.

Yee, Y.L., and Longworth, J.L. Biases in research: The case of rubber growing in Malaysia. Journal of Agricultural Economics, (In press).

Improvement of Smallholder Rubber Farming Productivity in Indonesia

Suryatna Effendi*

RUBBER is the third largest foreign exchange earner for Indonesia and is also the principal source of cash income for at least 8 million people. Rubber is grown primarily in 13 provinces in Sumatera, Kalimantan, and Java. North Sumatera alone accounts for 34% of Indonesia's rubber exports. Smallholders predominate in South Sumatera and Kalimantan.

The planted area in 1983 was about 2.4 million ha, consisting of 89% smallholdings, about 8% government estates, about 3% foreign estates, and the remainder locally owned private estates. The hectarages of rubber plantations in the Indonesian Provinces in 1983 are shown in Table 1.

Table 1. Location and area of rubber plantations in Indonesia, 1983.

Province	Area (ha)
South Sumatera	472573
Jambi	355103
West Kalimantan	321536
North Sumatera	268176
Riau	265380
Central Kalimantan	107364
South Kalimantan	66383
West Sumatera	54825
D.I. Aceh	27541
West Java	22726
Bengkulu	24027
Lampung	19468
East Kalimantan	10402
Irian Jaya	1641
D.I. Yogyakarta	1071
Central Java	625

Most smallholdings range from 0.5 to 10 ha with the average being 1.5 ha.

Rubber production is estimated to be about 980 000 t of which 81% is produced by smallholders, 14% by government estates, 5% by foreign estates, and the remainder by local private estates. Comparative annual yields have been estimated at 400 kg/ha for smallholdings, 740 kg/ha for private estates, and 1100 kg/ha for government estates.

The low productivity of smallholders is attributed to the high proportion of old rubber in their holdings. Smallholders are generally living at a subsistence level and rubber production for some of them is a secondary source of cash income. Often it is planted under a shifting cultivation system with food crops and left without any maintenance after the farmer moves, the farmer only returning later to the area to tap the trees. The resulting rubber produces very low yields and a short production life that is made worse by bad and indiscriminate tapping.

The main problem in the development of smallholders is the small farm size and scattered locations, which makes transfer of technology to farmers difficult. There is a need to integrate them into an economic unit, which the government has commenced to do by setting up integrated schemes for smallholders like Nucleus Estates, Smallholder Development Projects, and Project Management Units (PMUs). Credit facilities are made available to smallholders in these schemes.

The technologies that are appropriate for the development of smallholders in order to increase their productivity and their quality of life must be made available rapidly.

Problems and Potential

Most smallholder rubber production in Indonesia is part of a shifting cultivation cycle. Fields (*ladang*) cleared from jungle, shrub, old rubber stands are planted with seedling rubber trees, and also with upland rice and other short-term food crops. Such intercrops may be established at intervals for three successive years, and are an important

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justification for the initial clearing. They play a major economic role in providing subsistence, and sometimes cash, to the farmers concerned (Table 2).

Table 2. Average area of rubber smallholders in rubber producing areas in Indonesia.

Province	Farmer's family (ha)	Food crop (ha)
West Kalimantan	1.95	2.52
North Sumatera	1.71	0.82
Jambi	1.63	0.49
Riau	1.42	1.72
South Sumatera	1.39	0.48
West Java	1.15	0.80
West Sumatera	0.92	0.30
South Kalimantan	0.65	0.36

Yields of upland rice and other intercrops from such clearings are generally low, as they are grown from local unimproved seed and without fertilisers or other material inputs, which farmers cannot afford. The sole cash expenditure by most smallholders in any phase of cultivation is for simple hand tools.

The rubber seedlings are often planted haphazardly, and at quite high densities compared to those on estates. They are generally unselected, and derived from seeds gathered beneath mature unimproved trees close to the new planting.

After years of short-term intercrop cultivation, soil nutrients are exhausted and the growing rubber trees begin to exclude light from ground level. Further intercrops cannot be grown. The *ladang* is virtually abandoned as farmers move away to income-earning activities in other parcels, either in cultivation of annual crops or tapping mature rubber trees. A typical farmer has 2–3 separate parcels of rubber, comprising at least one mature and one immature area. He may also have additional areas of rainfed rice, and other annual or perennial crops.

The *ladang* is abandoned for many years and the area becomes invaded by *alang-alang* (*Imperata cylindrica*) and shrubby growths. The growth of young rubber trees is badly retarded, and it is usually 10 years or so before they are large enough to commence tapping.

Rubber, which is well suited to tropical rain forest land, requires from 1500 to 2000 mm of well-distributed rainfall, without pronounced dry seasons. Early morning rain interferes with tapping.

The optimum daily mean temperature is 28°C; big changes in temperature are unfavourable. The western part of Indonesia covers at least 20 million ha of land with these climatic conditions. In this type of climate red yellow podzolic soils occur.

Higher risks are incurred if these podzols are devoted only to food crop production, because they are fragile and sensitive to erosion. Red yellow podzols have a very good potential for perennial crops, especially rubber.

The compounded changes in morphological, physical, and chemical soil characteristics during cropping for food production are reflected in changing soil productivity. Figure 1 shows the yields of upland rice after 7 years of cropping (Driessen et al. 1976).

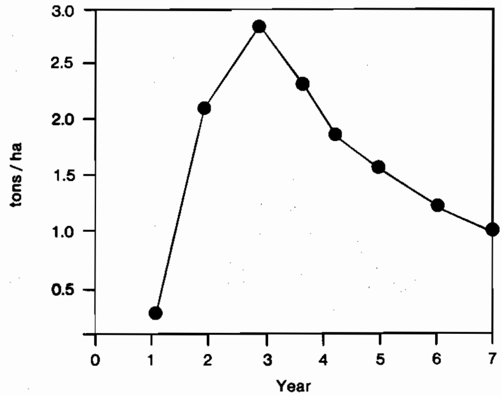

Fig. 1. Upland rice yield on podzolic soil during 7 cropping years.

The curve shows the yields were still low in the first year after reclamation, peaked in the third year, then decreased at a roughly exponential rate.

Directly after felling/burning of the forest the total amounts of soil surface nutrients are high. However, at that stage there is no crop to benefit from the liberated nutrients, which will to some extent be leached from the surface soil.

The remaining nutrients are partly tied up in stable organic structures and become available to the plant only after some time when decay of organic material by microbial action has accelerated. This explains why crop yields are commonly lower in the first year of cultivation than in the second and third year, particularly if the soil has been under forest and has a high proportion of relatively resistant organic matter.

After the easily decomposable organic matter has mineralised in the first few years of cultivation, the rate of organic matter decomposition, which is thought to be exponential, and consequently likewise the supply of nutrient, slows down resulting in decreasing yields.

The most serious consequence of prolonged food crop production is steadily accelerating soil erosion, which causes the loss of humus surface-soil material, which commonly contains some 80% or more of all nutrients in the profile, and so leaves the soil in an extremely impoverished state. In addition, removal of humus surface soil exposes the very unstable and erosion-sensitive subsoil to the direct impact of rain and wind.

Red yellow podzolic soils are a part of the broad category of Red Soils in Indonesia (Soepraptohardjo and Ismangun 1980). Collectively, they cover much of the land area of Indonesia that is not swampy, alluvial, nor of recent volcanic origin. They are distinctly different from the Latosols and Mediterranean soils that are also part of the Red Soil group. These general classifications have been adequate in the past since these soils are not widely used for food crop production. Physical characteristics and topography were most important for planning large perennial crop estates. There was little need for more detailed classification because the land was not considered suitable for sustained agriculture involving food crops.

The Red Soils cover about 30% of Indonesia. A little more than 50% of this area (32 million ha) consists of red yellow podzolic soils. Within the Soil Taxonomy Classification System most of these soils would be Udults and would be described as fine loamy to clayey, kaolinitic and isohyperthermic. In the level areas (< 2% slope) where there is poor surface drainage, plinthite is usually present in the soils. Well drained soils on rolling land usually contain no plinthite and exhibit the characteristics of Paleudults.

Crops in these soils respond dramatically to phosphatic and nitrogen fertilisers. Without the use of fertiliser and incorporation of crop residues (directly, or as animal manure) production from continuous cropping declines rapidly.

These soils must be considered fragile compared to Latosol soils found on Java. In comparison they are poorly aggregated, shallow to the impervious horizons, and susceptible to erosion and sloughing on all but level land. Continuous cover by cropping, mulching, and terracing are management practices that must be followed to protect soil and maintain its productivity.

In these undulating areas prone to erosion, farming strategies must be designed to provide food but only enough for subsistence; the main commodity should be perennial crops, mainly rubber and possibly coconut, coffee, cacao, and pepper.

Areas with well-drained soils are the most suitable for planting rubber. Such land may be replanted, or jungle cleared and planted. Relatively good soils that are now covered by *alang-alang* are suitable for planting rubber, providing labour or machinery is available to eradicate this serious grass pest. In order to prevent the invasion of new rubber sites by *alang-alang*, intensive cultivation of the areas with a suitable crop rotation is necessary. Also permanent cover crops should be established to retard the growth of grass and weeds and to control soil erosion.

In these higher well-drained regions, budded clonal stumps and also possibly clonal seedlings will make satisfactory planting material. However, the type of planting material selected for use in the different areas will depend upon the state of development of the area, the planting material available, and the preference of the smallholders.

Short-Term Improvement

Improvements may be approached by either short or long-term methods. The first objective is to increase the amount and quality of rubber produced. Emphasis should be placed on the production of good quality slab rubber, air dried sheets, and good quality smoked sheets. Sufficient incentive must be provided so that better grades of rubber are produced and the amount of bad quality slab rubber reduced to a minimum.

It is highly desirable that an alternative marketing system be established by means of cooperative processing facilities. This will minimise the influence that middlemen now have on the processing and marketing of smallholder rubber. A few tentative steps have been taken in this direction but they are merely preliminary trials. It is important that adequate supplies of tapping equipment and other materials be made available to the smallholders.

Cooperative processing and marketing facilities would stimulate an interest in the production of an improved product by the individual. An intensive educational program would be necessary.

Long-Term Improvement

The only real long-term solution to the smallholder rubber problem is increasing the efficiency of production through the planting of new high-yielding rubber plant material. However due to the time lag between planting and age of tappability, new plantings do not prevent in the interim a continuing decline in Indonesia's smallholder rubber production.

The Indonesian Government would need to provide adequate technical supervision for any large smallholder-planting program, if optimum results are to be obtained. A suitable training program, accompanied by simple bulletins and circulars, should cover planting operations, maintenance, proper tapping, and correct procedures for processing the latex into the desired end-product.

Research Approaches

These include planting materials, agronomic practices, intercropping, agricultural tools, and the establishment of technical standards.

Planting Materials

CLONES AND STOCKS

Replanting with local seedlings is not recommended because of the difficulty in identifying seedlings and the greater variability in characters between trees of the same population.

Identified polyclonal seedlings should be tested in the field (in order to get good seed sources) for obtaining high-yielding polyclonal seedlings (3-4 times greater yield than the average yield level of smallholder rubber plantations). This will not only provide better planting materials but also reduce the cost of producing planting materials.

The yield produced from different clonal seedlings in the field in respect of economic return should be evaluated.

Forward planning is necessary to ensure a ready supply of recommended clones and stocks of clones for large planting in smallholdings. The choice of clones will be based on the main environmental constraints prevailing in the area concerned. Details of soil surveys and various terrain information on the major soil types for each rubber producing area or possible new planting area should be acquired. Windiness, rainfall intensity and distribution, and disease constraints in a locality can be obtained from a study of conditions in adjacent rubber growing areas. This intimate knowledge will enable accurate characterisation of the environments concerned, which in turn improves the choice of clone(s) following the environmax approach.

An environmax planting recommendation should be developed for Indonesia. It is devised on the principle of maximising the yield potential of a particular locality (environ) subject to the inhibitory influence of the environmental factors.

The environmax method of selection involves (a) characterisation of rubber growing areas, (b) characterisation of clones according to their susceptibility to environmental constraints, and (c) ranking of these clones according to yield performance on the broad groups of soil types and terrain.

Clones selected for smallholdings on this basis should have a high average yield over their economic life, be high yielding during the early years of tapping, have a good response to yield stimulation and low intensity tapping, and show good vigour.

Clones recommended for smallholder and estate plantations are listed in Table 3.

Another study is on the use of planting material of ministump and regular budded stump, planting material establishment, and a distribution scheme to farmers.

Table 3. Recommended rubber clones for smallholder and estate plantations.

Clones	Yield (kg/ha)
GT 1	1085
PR 107	1052
PR 255	1552
PR 261	1417
PR 300	1770
PR 303	1690
PR 228	1238
BPM 1	1220
AVROS 2037	n.a.
RRIM 600	1301
PR 302	1329
PR 311	1434
IAN 710	1637
IAN 717	1834
IAN 873	1983
PR 249	1561

NURSERIES

The long unproductive period of immaturity can be reduced by planting green or brown budded stumps or budded polybag plants. For implementing this on a large scale it will be necessary to decentralise nurseries and have forward planning. This will be a researchable issue for getting information on the most appropriate planting materials that should be produced for smallholder rubber and nursery management.

Agronomic Practices

Methods of land clearing from secondary forest and clearing *alang-alang* grass land are very important. Because the critical period of rubber growing is from planting to the third or fourth year, it is vital that soil preparation for planting and field maintenance including noxious weed control should be of a high standard. As a general practice, weeding rounds should be carried out simultaneously for the interrow and the rubber strip.

Proper manuring will promote more rapid growth, shorten the maturity period, and enable a better recovery from attacks by pests and diseases, all of which will be reflected in a better yield performance. Dosage, time, method, and type of fertiliser used are being studied, especially on red yellow podzolic soils in order to obtain the optimum fertiliser response.

Intensification of the tapping system is an agronomic requirement. The major portion of smallholder rubber plantations are old rubber plants. To encourage replanting activities it is necessary to determine methods to increase tapping intensity for improving the production per work day and so maximise income and encourage replanting schemes.

Intercropping

Whenever possible intercropping and mixed farming should be introduced in order to provide an alternative source of income to smallholders during the immaturity phase. In the first two to three years, short-term crops such as upland rice, corn, groundnut, soybean, etc. can be grown on rotation in flat and gently undulating land. In hilly terrain, crops such as banana or pineapple should be considered. An animal component should be included in their farming systems.

Whenever feasible, smallholders should be encouraged to grow crops and rear livestock at the same time and treat them as one farming system. Suitable varieties of upland rice and grain legumes, and good crop rotations should be researched to obtain appropriate cropping technology. The main objectives for such intercropping are to (a) produce food crops to at least meet the needs of the farmers and (b) reduce weed growth and obtain good rubber tree performance.

Where intercropping is not practiced, legume covers should be established to prevent soil erosion, maintain organic matter, establish biological nitrogen fixation, and suppress weed generation. Maintenance of legume covers should commence immediately after sowing the cover-crop seeds.

Agricultural Tools

Research is needed on better agricultural tools for land preparation, planting (intercropping), weeding, tapping and other activities to increase the efficiency of the labour input.

Establishing Technical Standards

Research teams will have to use existing agroeconomic profiles as a basis for achieving improvements. It will be necessary to keep records of farmer practices and experimental results, monitor local conditions and changes, sample yields, analyse experimental results from weed control trials, plant protection, manuring, intercropping and planting material trials in order to develop technical standards. The evaluation will be based on technical feasibility, economic profitability, and socioeconomic acceptability analysis. The technical standard establishment will be focused on obtaining an appropriate technology for a smallholder rubber development scheme in the near future.

It will include providing information and guidance in:

1. Cultural practices using high-yielding clones, fertiliser management, weed management, intercropping, tapping systems, plant protection and the like.
2. Processing and marketing. Smallholders will have to process their latex into good quality sheets, as well as slab, and sell it to centralised factories that make standard Indonesian rubber. They may have to be organised into Group Processing Centers and a Group Marketing Organisation and be supplied with all the facilities for processing and transportation.
3. Transfer of technology (Research Result Dissemination). Training of the right personnel at different levels to provide adequate extension advice is still the intrinsic tool that is basic to the overall concept of transfer of technology. To date, the transfer of technological innovation to the smallholder sector has been slow. Regular visits must be made to smallholdings by the extension staff. Frequent demonstrations, group discussions, and short courses have to be organised, possibly at PMU level to improve existing production and processing methods.

There must also be good training programs with the following objectives:

1. To equip smallholders with up-to-date knowledge on all aspects of rubber cultivation, production, and processing.
2. To train extension staff in all aspects of rubber cultivation, production, processing, and marketing.
3. To train youths of smallholders in all aspects of rubber production and processing so that there will be an abundant supply of skilled manpower available.

The effectiveness of any training program will be judged by the number of staff trained, the knowledge and skills absorbed, the amount of extension work diffused in terms of the types of projects introduced and the number of smallholders adopting the practice, and the achievements by smallholders consequent to adoption.

References

Driessen, P.M., Buurman, P., and Permadhy. 1976. The influence of shifting cultivation on a podzolic soil from Central Kalimantan. Peat and podzolic soils and their potential for agricultural expansion in Indonesia. Proceedings of the ATA 106 Midterm Seminar Tugu, October 1976. (Also Bulletin 3, Soil Research Institute, Bogor).

Soepraptohardjo, M., and Ismangun. 1980. Classification of red soils in Indonesia by the Soil Research Institute. In: Buurman, P. ed., Red soils of Indonesia. (Also Agricultural Research Reports 889. Bogor, Indonesia, Soil Research Institute).

Invited Comments on the Paper 'Improvement of Smallholder Rubber Farming Productivity in Indonesia'

R. Hassan*

SURYATNA Effendi's paper succinctly described the nature of the problem of low productivity of rubber smallholdings and its impact on rubber production as well as on the Indonesian economy. That rubber is a principal source of income for 8 million Indonesians and the third largest source of foreign exchange for the country are sufficient reasons to warrant a systematic study by agricultural and social scientists of the factors influencing its production. But what makes the discussion and the analysis of the problems of this important subsector of Indonesian agriculture even more urgent are the statistical facts provided by the author in the paper. These facts show that 71% of Indonesian rubber is produced by smallholders with only 40–50% of the yields from the government and private estates. Any significant improvement in yields achieved by smallholders can produce salutary effects for the Indonesian economy as well as for the well-being of the smallholders.

The reasons identified by Effendi for low productivity of the rubber smallholder sector are: firstly, the small size of holdings, which makes it difficult for smallholders to seek and benefit from new and better technology. The small size has also resulted in the evolution of agricultural practices that are not conducive to high-level productivity. Secondly, the mixed-farming practices of smallholders with their reliance on food crops for subsistence and on rubber for cash income tend to result in the neglect of rubber trees. The problem of neglect is further compounded by the fact that most of the land cultivated by the smallholders is made up of podzolic soil, which is fragile and deteriorates rapidly under conditions of continuous intercropping and becomes less productive. But at the same time, podzolic soils respond dramatically to fertiliser treatments with phosphorus and nitrogen. Thirdly, the low productivity is attributable to a lack of research on soil classification, rubber seedlings suitable for smallholdings, and agricultural tools. It is suggested that research in these areas would enable the smallholders to match the condition of their respective soils with appropriate rubber seedlings with the use of appropriate agricultural tools for better production.

The existing government-sponsored schemes and strategies such as Nucleus Estates, Smallholder Development Project and Project Management Units, Effendi suggests, are all aimed at overcoming the aforementioned problems by providing financial and technical facilities to the smallholders. But it is not clear whether these schemes and strategies have succeeded or will succeed in overcoming the problem. Further work on the relative merits of these schemes and their impact on productivity would be useful.

After identifying and discussing the problem in the first half of his paper, Effendi proceeds to outline the short-term and long-term solutions to improve productivity of the smallholders in the second half of his paper. The short-term strategy, presumably aimed at millions of existing smallholders, seeks to improve rubber processing to produce good quality slab rubber, which would bring higher economic returns to the producers. It also stipulates a direct marketing strategy through producers' cooperatives, which would eliminate the middleman's exploitation of the smallholders—resulting in high economic returns on their produce. This would involve establishment of cooperatives for processing and marketing under government or semi-government sponsorship. Such a solution would now be regarded as a fairly conventional and practical one to increase economic returns for the small community producers. It would not increase productivity of the smallholders per se. In further work, it would be useful to know whether such

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facilities are already available and what kind of lessons they have to offer for the success or lack of it. Indeed, it would be equally instructive to know if such facilities do not exist or why they have not evolved so far.

The second strategy (solution) directly deals with the problem of low productivity of smallholdings. This strategy is comprehensive and long-term in its orientation and scope. It would involve the planting of new high-yielding rubber plants under qualified technical supervision. The main emphasis of this strategy is on publicly funded research programs on rubber clones and stocks, and soil classification in order to find most suitable rubber stocks for various types of soils. It would also involve substantive research on agronomic practices, intercropping, agricultural tools, and technical standards.

The long-term strategy proposed by Effendi is comprehensive, appropriate, scientifically feasible and in my opinion achievable. My main concern is about its administrative and organisational setup. It seems to me that the organisational setup of agricultural research and extension stations that spearheaded the green revolution can serve as an organisational model for rubber research and extension centres. It may well be that such bodies already exist and if they do it would be useful to assess and evaluate their effectiveness in improving the productivity of rubber smallholders.

If the organisational structure of an agricultural research and extension station is appropriate for carrying out the activities proposed by Effendi then the sociological consequences of such organisational structure would require a closer examination. In general, bureaucratic structures raise problems of accessibility to them. Existing sociological evidence suggests that bureaucratic structures, such as the agricultural research and extension centres, encounter major difficulties in coping with problems of lower social-status groups. The client-centred public service bureaucracies in general often avoid lower-class clients who are likely to handicap the organisation in attaining its goals, which are necessary to demonstrate success. This happens mainly due to the fact that poor clients for services tend to challenge organisational effectiveness as measured by quantitative criteria by presenting problems that cannot easily be resolved. More time and effort is needed to resolve problems of the poorer groups and even then, their success cannot be predicted with confidence. Since efficiency and rationality are the normal measures of effectiveness, this prompts bureaucratic organisations to select for processing those whom it perceives as most amenable to fulfilment of formally defined objectives and to exclude those whose needs represent greatest threats.

The research findings from the distribution of benefits of the green revolution tend to suggest that technological innovations and inputs tend to benefit the well-to-do farmers more than the poor, which further accentuates the existing social inequalities. By mentioning these problems I am not arguing against the establishment of research stations to conduct research activities as suggested by Effendi. My purpose here is to emphasise that from the very onset special attention should be paid to the fact that the organisational setup of the research stations, if and when they are established, and their personnel, are particularly sensitive and responsive to the needs and problems of the rubber smallholders in order to avoid problems of differential accessibility to their services and also to avoid the development of new social inequalities. The main issue here is that technology transfer both at macro and micro levels is mediated by the social structure, and the bureaucratic organisation acts as a conduit in this mediation.

To conclude, I think Effendi's paper describes the nature of the problems succinctly and clearly. It addresses itself to the need for technology appropriate for overcoming the problems of low productivity of rubber smallholders in Sumatra. It proposes a comprehensive program of research aimed at overcoming technological, administrative, financial, social, and cultural impediments to technology transfer. Such a research program, I have suggested, can be carried out through the establishment and funding of rubber research and extension stations for rubber smallholders. The solutions, both the short-term and the long-term, proposed by Effendi merit very serious discussion. Perhaps the next step should be to discuss the research priorities and organisational forms of the research stations. It will also be appropriate to discuss why such research organisations have not yet emerged. And if they already exist, are they carrying out the type of research program proposed by Effendi in his paper.

Development of Rubber Smallholders in North Sumatra

H.S. Dillon*

NOTWITHSTANDING the fact that the largest breakthroughs in rubber technology during the pre-Second World War era were made in Indonesia, its rubber smallholders do not appear to have benefited from all these research benefits. The smallholders, who had managed to successfully integrate *Hevea brasiliensis* into their swidden agriculture, remained tied down to their initial level of technology.

The availability of abundant land at the turn of the century had allowed them to allocate their household labour in such a way as to continue growing their subsistence crop, i.e. rice, while simultaneously benefiting from the additional revenue generated by their rubber stands. Capital was not required in any significant amount, nor did the cultivation, processing and marketing demand any sophisticated skills.

The inherent price instability, coupled with increasing relative land scarcity over the decades, on top of the fact that most of the research was geared towards solving problems faced by the plantations was responsible for the smallholders' plight. The state had not intervened in their behalf, despite the fact that it enjoyed large foreign exchange earnings from their rubber exports. Very little effort had been put into helping the smallholders escape from the vicious circle of meagre returns from their holdings, no accumulation of capital, no investment in new high-yielding technology, and decreasing returns as their stands aged further amidst continuing depressed rubber prices.

The development of the natural rubber sector was strongly influenced by the inherent sociological and technological dualisms between the plantations and the smallholders. The sociological dualism was one between the Western planters, with their agency houses and hierarchic plantation structure (with Javanese labourers as the base), and the indigenous smallholders, to whom rubber provided cash in an otherwise largely subsistence economy. The technological dualism was between different factor endowments and different production functions. The plantation was characterised by relatively plentiful capital, relatively scarce labour, and access to advanced cultivational and processing technology. The situation of the smallholder was one of very scarce capital, inadequate household labour, and little knowledge of advanced technologies (Barlow 1975: 4).

The colonial government further strengthened this dualism by providing the plantations with land and credit, and building road networks for them. State discrimination against the smallholders was brought to the fore during the Depression: a very high levy—at one time ranging as high as 83% of the current international price—was imposed on smallholder rubber in an attempt to help the plantations by curtailing supply and thereby shoring up rubber prices (van Gelderen 1939: 72).

The Depression also demonstrated the flexibility of the smallholders' horticultural system in adjusting their household labour allocation from rubber to rice and back, in tune with the changing environment during and after the Depression. The regional commodity statistics reveal that smallholder exports from the east coast of Sumatra dropped from 21 600 t in 1919 to a low of 9200 t in 1923. During the same period, production of rice expanded from 75 000 to 96 000 t. When rubber prices recovered in 1933, smallholder rubber exports rose again to 20 656 t, while rubber production fell to 84 000 t (Thee Kian-wie 1977: 26).

The political turbulence and the economic instability of the fifties did not prove conducive to Indonesian smallholder rubber development. After one brief respite during the high prices caused by the Korean War, the smallholders found themselves in a most untenable position. Smallholders provided 75% of national rubber production, and their falling yields brought on a secular decline in Indonesia's share of the world rubber market. While world production grew at an annual rate of 2.3% between 1960 and 1975, Indonesia's annual production only grew 1.5%. In contrast, the two other major producers of natural rubber, i.e. Malaysia and Thailand, experienced growth rates of 4.2 and 4.9%, respectively. As a consequence, Indonesia's market share shrank from 30.5% of trade in 1960 to 24% in 1976.

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It becomes evident, then, that from the Indonesian government, the rejuvenation of the rubber smallholder sector was a *conditio sine qua non* for protecting its share in an expanding market. Those in policymaking circles also felt that something had to be done to arrest the deterioration in the welfare of rubber smallholders. The Directorate General of Estates' decision to plan and implement a pilot smallholder development project in Labuhan Batu was thus based on both growth and equity considerations.

Project Outline

The North Sumatra Smallholder Development Project (NSSDP) was intended to provide land, high-yielding rubber clones, credit, and extension to its participants. The US$10 million pilot project's stated objective was to raise the living standards of 18 000 rural households (90 000 people in all) then living at near subsistence levels. It was further stated that if successful, the project would be adopted as a model for similar activities in other parts of the country (IBRD 1973: 73).

Circumstances surrounding the development of this project, especially the search for good rubber land, led to the incorporation of two almost-defunct government plantations covering 7000 ha into the project area. The labourers working on these plantations had to be included as project participants, along with the rubber smallholders in the area. The plantations were partitioned into 3 ha plots distributed to 774 labourer households, while 4418 ha of other government land were parcelled into 2 ha holdings given to 2209 smallholders. Another 334 hectares were allocated to 167 households comprised of former plantation staff, pensioners, and youth groups. On top of this, all 2700 rubber smallholders were provided with grants to replant 1 ha each of their old stands.

Multi-Level Project Analysis

The objectives of the study were to:

1. Gain a better understanding of the manner in which rubber smallholder and plantation labourer households respond to new technology and productive resources.

2. Conduct an evaluation of the project in a way that would help identify its strengths and weaknesses in order to improve future project development.

3. Formulate a smallholder rubber development policy based upon project and other related experiences.

The objectives indicate that the analysis should be carried out at three levels:

1. The level of the national economy, which would help provide an understanding of the historical, economic, social, and political conditions leading to the project development, thus placing it within its proper context.

2. The project level, where its economic performance and its regional impact could be evaluated.

3. The level of the household, which would reveal how the participating households adapted and responded to the project.

The decision-making behaviour of rubber producing households is closely related to the existing ecological, social, economic, and political constraints. The project is viewed as an outside initiative impacting upon these households for a limited amount of time, after which the households would face a different institutional environment. The rapid change in their environment requires a dynamic view of the processes by which these households adapt and respond to changes in their constraint set. All historical changes in these constraints, such as extreme fluctuations in rubber prices and the nature of relationships with the middlemen, local officials, plantations, and the government also enter into the decision-making calculus of these households. Thus, comprehension of the 'rationality' of their observed behaviour requires explicit recognition of the political economy of natural rubber. Herein, the commercialisation of agriculture under colonial rule, and the integration of natural rubber in the international economy are studied. The inherent dualism in the plantation and smallholder modes of rubber production, and the articulation of the State with the plantation labourers and rubber smallholders, during both the colonial and postcolonial periods, also fall within the realm of political economy.

The political economy approach adopted in the study was not a class analysis, and not meant to address specifically the circular flow of capital or the conflict between contending classes involved in the production and distribution of natural rubber. It was, rather, an attempt to analyse the various actors taking part in the above production and distribution processes, and to understand their decision-making behaviour in light of their social, economic, ecological, and political environments. The elements of political economy analysed were the manner in which natural rubber was introduced into Indonesia, its dualistic growth pattern, its integration into the international economy, and the articulation of plantation labourers and rubber smallholders with the State. Discussion of all these elements was encapsulated with history, economics, technology, and politics of natural rubber.

Household labour allocation research analyses the manner in which households adapt and respond to changes in their environment. The basic assumption is that the decision-making regarding the time allocation of different household members across separate sets of activities, whether income-generating, household maintenance, or a host of other activities, reflects the survival strategy of the particular household.

There are two theoretical approaches to studying household labour allocation: the new household economics based on neoclassical economics, and the theory of peasant economy grounded upon Chayanov's investigation into rural household decision-making. Neither theory gives adequate attention to the economic, social and political environments under which the household operates. The conceptual model of rubber producing households developed for this study differed substantially from that of rice cultivation, due to rubber's long gestation period and to the very rapid returns to labour once the rubber trees are in production.

The new household economic theory postulates that all households have a household production function, and that they maximise household utility subject to their full income constraints. The basic departure from the conventional Hicksian model of utility maximisation is the explicit inclusion of time as a resource (cost) constraint in the production and consumption of goods and services, whether within or outside the household (Encarnacion 1976: 103).

In describing the labour allocation of peasant households, Chayanov postulates that the total amount of labour allocated is determined by 'the state of basic equilibrium between the measure of demand satisfaction and the drudgery of labour'. He further states that 'the household would continue to allocate its labour to work activities until the basic equilibrium is met' (Chayanov 1966: 78).

The computation of project costs and benefits, the cornerstone of conventional project evaluation, is grounded in welfare economics. The application of this theory to the evaluation of projects in developing countries requires a knowledge of their specific economic and institutional constraints.

Three criteria can be applied in the estimation of project worth:

1. The benefit-cost ratio, which is the ratio obtained when the present value of the benefit stream is divided by the present value of the cost stream.

2. The present value of net benefits, which comprises the present value of the incremental net benefit.

3. The internal rate of return, (IRR), i.e., the discount rate which makes the net present worth of the incremental net benefit stream equal zero.

The World Bank and most other international financing agencies use the IRR for practically all economic and financial analyses of projects.

As the study's major purpose was to study a specific government policy down to the household level, the research design had to provide a baseline against which to compare the welfare of the direct beneficiaries of the project who, prior to joining the project, had either been rubber plantation labourers or smallholders.

As there were no baseline data on the socioeconomic conditions of both participating groups prior to joining-up, the only remaining avenue was to conduct a with-and-without project evaluation. Its major advantage over a before-and-after analysis was the ability to take other intervening factors into account. The sharp increase in world rubber prices shortly after the inception of the project is a good illustration of such a factor.

The design called for the selection of households outside the project which were comparable to the project participants. Thus, the control group of the smallholders was rubber smallholders independent of the project; labourers working on a neighbouring rubber plantation served as a control for the former labourers.

Data were initially collected on 360 households equally distributed over the four groups. These data covered household composition, all resources owned or operated (e.g. farm assets by size and type), the various crops planted, the technology employed in the cultivation of these crops, household assets, returns to the household, and household consumption.

In the intensive labour allocation study, which spanned eight months, all activities of household members above the age of eight years were recorded on a monthly basis. The number of hours per day and days per month were enumerated without any *a priori* restrictions (i.e. the work categories were open-ended). The actual timing of each activity and travel time were also recorded. Returns to various activities, wherever available, were also measured.

Problems in Implementation

The project came into being due to the appointment of a North Sumatran army officer to the position of Director General of Estates (DGE) in the late sixties. Coming from a smallholder rubber-producing village in South Tapanuli, he was very aware of the conditions of the rubber smallholders. He commissioned a study to identify areas suitable for development, and to formulate a project for the reorganisation of the production, marketing, and processing of smallholder rubber.

Upon approval of World Bank financing, the DGE appointed a one-time student leader, Rahman Rangkuty, who had intensively studied rubber smallholders during his university days, to manage the project. The Project Management Unit (PMU) with a strong degree of managerial and financial autonomy, headed by Rangkuty, was made responsible for project implementation. Rangkuty was made directly responsible to the DGE, and not to the head of the Regional Tree Crops Extension Service. However, to foster better cooperation between the various agencies having jurisdiction over different aspects of smallholder development, a Project Management Board with representatives from several ministries was made responsible for overall policy, and similar bodies comprised of representatives from these ministries were set up at the regional and district levels.

One of the reasons behind the poor performance of the Regional Extension Services responsible for smallholder tree crop development was the low pay received by their personnel. In order not to recreate a similar situation, the project staff were paid according to the higher government plantation pay-scale.

From the discussion on the rationale and project design agreed upon by the DGE and the World Bank, it is apparent that both parties acknowledged the fact that the general constraints were too intractable to allow the launching of a country-wide rubber smallholder development program. They were, in Hirschman's terms (1967), both trait-takers and trait-makers. His description of the circumstances surrounding the decision to formulate an autonomous agency similar to the NSSDP fits this particular situation very well: '(The planners) . . . are willing to be trait-takers inasmuch as they give up as unrealistic any expectation that the traits which are incompatible with the successful implementation of the project could be eradicated in time in the society at large. On the other hand, (they are trait-makers in the sense that) . . . they are unwilling to forego or delay the project, so that they attempt to set it up with all the required modern traits as an enclave protected by suitable safeguards against contamination by a hostile environment' (Hirschman 1967: 153).

As it turned out, the major problems besetting project implementation were of a financial nature, which caused severe delays during start-up. The Project Management Board did not provide any operational guidance, nor did it ever manage to elicit satisfactory cooperation from the other government agencies. The PMU had literally been left to solve its own problems, most of which originated and could be solved only in Jakarta. Had it not been for the World Bank Resident Mission in Jakarta, the project might never have lifted off the ground.

From the very onset, it became evident that coordinating the various agencies concerned was going to be nigh impossible. This would have been expected by Hirschman, as he notes that: 'The establishment (of the autonomous agency) meets with far fewer difficulties than its successful operation' (Hirschman 1967: 155). The disbursement of government funds was never on time and the project senior staff had to spend a great deal of their time in Jakarta in the attempt to expedite such matters. The expatriate consultants played a crucial role by going straight to the World Bank Resident Staff with their predicaments.

On the physical implementation side, the major problem was one of dealing with squatters on the government land earmarked for the project. The PMU managed to reach a compromise whereby the squatters would be allowed to retain their land, provided that they divided it into two-hectare holdings and signed them to their children and next-of-kin.

The selection of project participants was another problem having a large impact on subsequent project performance. The PMU had initially laid down explicit selection criteria: 1. All participating households should have at least two adults to devote all their working time to their project plots; and that 2. The smallholders signing up should already own between 1and 2 ha of mature rubber.

Many of the labourers on the estates to be parcelled out had left their families to seek employment elsewhere, with the virtual collapse of these estates a few years earlier, while those remaining were somehow hesitant in signing up. Such hesitancy can be easily understood in light of their traumatic experience during the aftermath of the communist upheaval during the mid-sixties. On the other hand, as the project was also designed to benefit households that had lost their major source of income with project inception, all labourers wishing to join had to be accepted, irrespective of whether or not they had sufficient household labour.

Due to the compromise reached with the squatters, a number of new households were formed, when nuclear families split off in order to be closer to their rubber holdings. The study revealed that some of these new households owned neither the minimum amount of mature acreage, nor the amount of household labour required to establish and maintain project stands.

The establishment of 800 Group Coagulating Centres called for by the appraisal to serve as activity centres encompassing the selection of project participants, extension, processing of smallholder rubber, and its marketing under PMU supervision, never materialised. To begin with, the initial figure was unrealistic and was based on an erroneous estimate of the number of existing smallholders in the area. It was also based on the assumption that a large number of them were collecting daily and selling clean latex. In actuality, at project inception, most of the smallholders were producing cuplump and selling it on a weekly basis. All of the rubber processing factories in the area were geared toward the manufacturing of block and crepe rubber from cuplump, and, consequently, the rubber traders were not paying any substantial premium on smoked sheet. Studies in 1976 revealed that, within the prevailing prices for cuplump and smoked sheet, the smallholder stands to lose by producing the latter, when the cost of his own labour is entered into the calculus (Hutagalung et al. 1977; Burhanisyah et al. 1979).

On the other hand, intercrop rice yields proved to be critical to successful stand establishment, especially in the case of participants without any off-project land. They provided such households with a means of subsistence, and lent further credence to the project. On the one hand, such high dry land rice yields were *prima facie* evidence of the benefits to be obtained from adopting high-yielding cultivational technology, and on the other, the fact that they were allowed to retain their harvest in full proved that the project was sincere in promoting their welfare.

Lessons of Development

Project Performance

In the present analysis, all data on costs already incurred have been accepted at face value. Data on non-rubber costs and benefits have also been borrowed in toto from the evaluation report prepared by IBRD, and although it is recognised that developments in the international economy affecting world rubber prices would also influence prices of palm oil and other oil palm products, the present calculations are limited to variations in rubber yields and prices.

Two separate profiles are added to the evaluation report profile: one obtained from the Rubber Research Station at Bogor, and the other specifically assembled for this study. Besides the price projections used in the evaluation report, the highest and lowest prices actually obtained since project inception were also employed. Thus, three yield profiles were run in combination with three sets of rubber prices to produce nine internal rate of return figures.

Employing the Bank yield profile, the IRR dropped from a high of 18.7% to a low of 10.73% with a decline in prices. Correspondingly, using the Bogor and Dillon profiles, the IRR estimates fell from highs of 18.04 and 19.14% to lows of 9.7 and 10.91%. One of the important revelations of this exercise is the extent to which the economic performance of the project ultimately depends on world rubber prices.

The analyses prove that the project has successfully met most of its objectives. The high initial rubber yields obtained by participants demonstrate that the Indonesian smallholder is capable of adopting high-yielding technology provided that he is given the necessary inputs and extension. The high internal rate of return proves the economic efficiency of investment in this project. This high rate was achieved despite uncertainty about world rubber prices and project yields. The training of badly needed managers and extension agents, which was not valued in the IRR, shows that the above rates of return are underestimations of the project's real worth to society. The adoption of the new technology by rubber smallholders in the vicinity serves as evidence of the project's favourable regional impact.

The household labour allocation analysis revealed that the participating households responded positively to the demands placed upon their labour during the establishment of new rubber stands. Although intercropping with rice and vegetables provided a means of subsistence during the first three years, the critical period between the end of intercropping and the commencement of tapping 18 months later places a heavy burden upon the participating households. In this transition period, considerable labour must be used to control weeds and implement other cultivational practices that ensure that the young rubber trees will grow rapidly to reach tappable girth as quickly as possible. At the same time, these families had to work off the farm in order to obtain adequate funds to procure food and other subsistence needs. The strategy they followed was economically rational. The male household-heads hired themselves out as wage labourers, because the plantations—the largest source of employment—paid men much higher wages than either women or children. The stand maintenance was taken over by the spouses and older children; similarly, younger children helped their older siblings by performing a large proportion of the household chores. An illustrative example of the increased work load is that women in these households expended 78% more of their labour time on rubber production than did women in the smallholder control group where stands were already producing and there was a steady flow of income from sales of rubber. By adopting such a labour allocation strategy, these households sacrificed, or at least delayed, the education of their children. It is also possible that some normal household tasks were slighted and clearly all project family members had less leisure than their counterparts.

The labour allocation strategies of all rubber producing households were found to be optimal, in the sense that each subgroup made the best possible use of the productive resources at its disposal. The wealthier households obtained higher hourly earnings, due more to the amount of capital utilised in their off-farm work than to a more favourable position in the labour market. In the poorer families, children played an important role in the household's survival strategies. One of the most direct consequences of the lack of productive resources was the low educational attainment of these children.

The main reason for this success, aside from the basic viability of its design, was the project's dynamic leadership and the strong support by the lending agency. The dedicated staff had considerable autonomy, which allowed them to pursue their charted course towards project objectives.

In accordance with the initial plans, the World Bank and the PMU prepared an appraisal for the project's second phase in 1976, calling for a further new planting/replanting program covering 20,000 hectares in the project vicinity.

The new Director General of Estates rejected it out of hand, giving the following reasons to the World Bank that:

1. North Sumatra had already received considerable assistance for agricultural development.
2. The cost of the PMU was too high.
3. The government-owned estate groups, rather than PMU, should be used for future smallholder development.

These arguments merit a discussion:

1. North Sumatra had been the largest revenue-earning region for decades. The project costs were a minor fraction of what the government had earned from the rubber smallholders of North Sumatra. Furthermore, millions of dollars were being poured into fertiliser subsidies and big irrigation projects, benefiting the Javanese.

2. The purported high PMU costs were due to its pilot nature. Furthermore, there was no basis for cost comparison, as the DGE had never developed a rubber smallholder development project of such proportions. In any case, this should have been an argument in favour of launching the second phase, as the utilisation of extant project facilities (such as headquarters, vehicles, and trained staff) would have considerably lowered per-unit costs.

3. This argument reveals the power of the government estate lobby. The project's early success had alerted them to the possibility of more government estates being carved out to their labourers. Capitalising upon the Central Government's predisposition towards favouring rural households on Java and benefiting from the high commodity prices, the government estate lobby threw its support behind the Nucleus Estate and Smallholders concept. This integrates the government's political position with the above lobby's desire for self-preservation by transmigrating Javanese households onto the Outer Islands within projects using government estate groups as nuclei in expanding tree crop production.

The DGE was able to resist World Bank pressure because Indonesia was enjoying the windfall income from the OPEC price hike and was no longer entirely dependent upon World Bank financing. Such developments had also been observed by Hirschman (1967: 158) in other projects, and he notes that: 'One must expect such battles between the modern agency asserting its rights and the central authorities who are basically unreconciled to the formula to which they have consented in a moment of weakness, passing enthusiasm, or overwhelming desire to get hold of World Bank funds.'

Developing a Policy

The search for an effective policy to develop Indonesia's rubber smallholders renders it imperative that policy proposals made by earlier researches and the evaluation results of the NSSDP be critically examined.

One of the most important debates in smallholder rubber development strategies has been the high cost versus low cost schemes. Both Bauer (1948) and Thomas (1957) all called for the early and wide dispersal of high-yielding planting material to the smallholders. Bauer had a very good grasp of the political economy of natural rubber, and recommended that smallholders be allowed to participate in policy-making concerning the future directions of smallholder rubber research and development (Bauer 1948: 378). Thomas had a keen insight into the bureaucratic infighting, and therefore recommended that officials from all concerned agencies be represented on the boards of smallholder rubber policy-making bodies. He further emphasised the importance of studying the smallholders' own preferences before formulating a rubber planting strategy (Thomas 1957: 61).

Lim's study (1976) proved that the intensive-management high-input projects were more efficient than the low-cost projects. Recognising the need for a wider dispersal of high-yielding technology, he proposed a two-prong strategy that would continue the high-input projects while increasing the management intensity and input levels of the low-cost projects. He expected the additional costs to be justified by the better performance of the erstwhile low-cost projects (Lim 1976: 282).

I subscribe to the arguments of Barlow and Muharminto (1982) regarding the discrimination against rubber smallholders, and to the observation that there has been very little change, if any, in the plantation-bias of rubber-research institutes. However, I disagree with them on a number of issues. The PMU at Aek Nabara was not allowed to expand due to its relative autonomy, and it has proven to be economically efficient. Furthermore, the larger off-project smallholders have utilised the high-quality budgrafts made available by both project participants and staff operating private nurseries. Also the PMU trained a large number of staff who now manage other smallholder development projects. A more balanced focus on both small and large rubber smallholders would incorporate the crucial rice-rubber relationship into the decision-matrix. It would further reveal that the lack of technological adoption is due more to the sets of constraints binding the smallholders than to any behavioural attitudes.

The review of policy proposals has revealed that recommendations arising from actual evaluation studies of smallholder development projects invariably favour the intensive-management high-input projects, while more global studies seem to call for a wider dispersal of development funds.

The preceding analyses have shown that Indonesia still stands in need of a viable rubber smallholder development policy. It is imperative that such a policy would recognise the resource constraints at different levels. To be feasible, this development policy should not place the rubber smallholders in a more vulnerable position, i.e. provision has to be made to enable them to survive under adverse circumstances by cultivating food crops of their own. This particular approach to the development of the rubber smallholder is based on the assumptions that the current general situation continues undisturbed into the near future, in that there exists a core of dedicated and honest officials, and that institutions like the World Bank continue to play an important role in development of the Indonesian economy.

It is proposed that high input, high management projects be developed in all rubber-producing regions, with the highest priority for participation being accorded to landless households. The lessons learned from the Aek Nabara experience should be incorporated into the design of these projects. Once the core plantings have been successfully established, the project nurseries (which should have themselves been established one year prior to project implementation) should be used to supply the high-yielding planting material at cost to the surrounding smallholders. These nurseries would be operated by project staff, preferably those who have taken up the option of staying on as smallholders after project phase-out.

At the same time, project staff would be selected to manage similar but more distant nurseries. Again, these staff should be provided holdings of their own, and kept on the project payroll until their stands come into production. Their duties would include management of the nurseries, sale of the planting materials, and extension to the surrounding smallholders. Ideally, the managers should be provided with incentive payments based on the number of trees successfully established on independent holdings. They should be encouraged to set up stores selling fertiliser and agrocides, which could be greatly facilitated by the PMU's underwriting the first few shipments supplied by companies that have done business with the project. The PMU, even when only a few staff remain after project phase-out, should control these nurseries for budgraft quality, and also the quality and prices of the chemical inputs.

Similarly, as rice is intercropped and other food crops cultivated on land provided by the project, the surrounding smallholders should be encouraged to diversify their rubber holdings. High-yielding rice seeds should be provided at no charge; in areas where yields of dryland rice are too low, other crops should be introduced, and adequate provision made for the marketing of these crops. This particular facet is of even greater importance in regions with very high rubber-rice land ratios, which have suffered extreme food shortages during falls in rubber prices.

It is hoped that a cadre of dedicated and qualified staff will be formed within 10 years of adopting the above policy, and that improvements in the general environment would have further favourable repercussions on this subsector.

In essence, the policy outlined above incorporates most of the elements contained in the Barlow-Muharminto proposal. The NSSDP type projects in all rubber-producing regions would become centres for the regional development of smallholders. The larger smallholders, favoured by the Barlow-Muharminto policy, would also be able to benefit from the project's supply of high-yielding planting material, as the Aek Nabara experience has proven. Thus, both the relatively poor and the rich rubber-producing households would be able to benefit from the new technologies.

Conclusions

Almost two years have elapsed since the study was completed. A number of important changes have since occurred; most notably the appointment of a Junior Minister to Enhance Production of Estate Crops in an attempt to derive higher export earnings to compensate for the slump in oil prices.

The institutional arrangement still leaves much to be desired, with responsibility being diffused over a host of agencies. Decision-making still mostly takes place in the central bureaucracy, and the low-cost Projek Rehabilitasi and Perluasan Tanaman Ekspor (PRPTE) projects, i.e. Projects for the Rehabilitation and Extension of Export Crops, have shown a high failure rate.

The SRDP schemes have shown good results, and are being expanded. Their processing and marketing arrangements with private entities seem to be working quite well, but it is too early to determine whether sufficient premium on quality will continue to be placed in times of depressed prices.

In the Nucleus Estate and Smallholder (NES) schemes, the processing, marketing and credit recovery system still requires fine tuning in order to develop procedures and mechanisms whereby the smallholders are convinced that they are obtaining the best possible prices for their produce and the nucleus estate receives a fair return on its investments.

Nevertheless, most of the recommendations made by independent researchers have yet to be implemented. Manpower has emerged as a full-fledged problem, and recommendations have been made to establish a unit at the DGE level to handle manpower development and training for the subsector.

Further Research

As yet, no comprehensive research strategy seems to have evolved. A number of institutes are continuing to conduct research on various aspects of rubber with a direct and indirect bearing on smallholder development. Universities are still doing specific research on contract, and an estates training institute also seems to be studying the NES schemes. Nowhere has there been any systematic effort to conduct an in-depth study into understanding the sets of constraints binding rubber smallholders with differential control over resources, or to develop cultivational and processing technology specifically for the smallholders.

Thus, there is room for collaborative effort in conducting a longitudinal study on rubber smallholders with differences in size of holdings, rubber: non-rubber ratios, stand composition, and household characteristics.

Another research avenue worth exploring would be comparing and contrasting the differential rates of technological diffusion through the various smallholder development projects, along with smallholders still virtually untouched by such schemes.

The institutional setup of the tree crops subsector, with authority and responsibility shared among a number of agencies, is another interesting research topic, as is the whole processing, marketing and credit recovery complex.

References

Barlow, C. 1975. Development and equality in the natural rubber industry. Presented at a Work-in-Progress Seminar, Canberra, Department of Economics, Research School of Pacific Studies, Australian National University.

Barlow, C. 1978. The natural rubber industry: Its development and technology in Malaysia. Kuala Lumpur, Oxford University Press.

Barlow, C., and Muharminto. 1982. The rubber smallholder economy. Bulletin of Indonesian Studies, 17(2), 86–119.

Bauer, P.T. 1948. The rubber industry—a study in competition and monopoly. Cambridge, Harvard University Press.

Burhamisyah et al. 1979. Beberapa faktor yang mempengaruhi perkembangan karet rakyat di Sumatera utara: kabupaten labuhan batu. Medan, RISPA. 1966. (In Indonesian).

Chayanov, A.V. 1966. The theory of peasant economy. Thomas, D., Kerblay, B., and Smith, R.E.I. eds. Homewood, American Economic Association Translation Series, (original 1925).

Encarnacion, J. 1976. Comment. Journal of Agricultural Economics and Development, 6(1), 103-107.

Hirschman, A.O. 1967. Development projects observed. Washington, The Brookings Institution.

Hutagalung, O. et al. 1979. Beberapa faktor yang mempengaruhi perkembangan karet rakyat di Sumatera utara: kabupaten tapanuli selatan. Medan, RISPA. (In Indonesian).

IBRD (The International Bank for Reconstruction and Development). 1973. Appraisal of smallholder development project, North Sumatra, Indonesia. Report No. PA-1042.

Lim Sow Ching. 1976. Land development schemes in Peninsular Malaysia, a study of benefits and costs. Kuala Lumpur, Rubber Research Institute of Malaysia.

Thee Kian-wie. 1977. Plantation agriculture and export growth: An economic history of East Sumatra 1863-1942. Jakarta, National Institute of Economic and Social Research.

Thomas, K. 1957. Smallholders rubber in Indonesia. Jakarta, Institute for Economic and Sociai Research, University of Indonesia.

van Gelderen. 1939. The recent development of foreign policy in the Netherland East Indies. London, Longmans, Green & Co.

Invited Comments on the paper 'Development of Rubber Smallholders in North Sumatra'

R. Hassan*

IN this paper Dr Dillon provides a candid account of the development of one project aimed at improving the social and economic conditions of rubber smallholders in North Sumatra. Its intellectual orientation, empirical and analytical insights, and frank appraisal of the bureaucratic red tape all merit careful reading and close discussion.

The historical overview of the process of gradual impoverishment of the rubber smallholders in Indonesia in the last 100 years or so is useful and instructive. It is suggested, and in my opinion correctly, that their economic impoverishment was strongly influenced by sociological and technological dualisms between the plantations and indigenous smallholders. The policies of colonial government and its successor in the post-independent period have continued to favour the plantation sector through various concessions and more or less left the smallholders to evolve their own socioeconomic strategies for survival until very recently.

In retrospect it appears that the smallholders have responded to their problems very rationally and developed strategies to cope with the vagaries of national and international rubber markets. Now the economic reality of their role in rubber production with the support of a national and international lobby of politicians, public servants, social scientists, and international organisations has resulted in the development of public policies aimed at improving their socioeconomic conditions and the productivity of their smallholdings for the national good.

The sociological background of the inception, evolution, and development of the North Sumatra Smallholders Development Project (NSSDP) is very instructive. It demonstrates that given the personal concern and commitment to improving the lot of the less privileged, 'evolution from the top' can work and overcome an enormous amount of bureaucratic infighting and technical and related problems.

The evaluation of the NSSDP carried out by the author shows that the project was successful and the Indonesian smallholders are capable of adapting high-yielding technology, provided they are given the necessary inputs and extension services. The analysis of Dillon also points out the need for monitoring the unexpected adverse effects of successful technology transfer process at the micro level with long-term macro-sociological implications. For example, he points out that adoption of the household labour strategy implicit in the development plan of the Aek Nabara project resulted in the low educational attainment of their children. There may be other similar unexpected consequences that need to be first recognised and then monitored carefully to assess their long-term impact for the well-being of the members of rubber smallholders.

Dillon attributes the success of the project primarily to (a) the basic viability of the project design, (b) the project's dynamic leadership, (c) the strong support of the international organisation involved in the project, and (d) the dedicated staff of the project whose economic needs were well recognised from the very outset and were paid higher public service salaries.

The success of the project, however, did not lead to the expansion that was envisaged, nor did it lead to the adoption of its organisational setup by other projects created by the government for improving the conditions of rubber smallholders. The reasons for this are clearly identified by Dillon and by no means are either unique to the project or to Indonesia. These include a lack of commitment of the new personnel at the top to the lessons of the project, administrative infightings, bureaucratic jealousies, and interregional antipathies. Unfortunately these

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are the types of problems that are unlikely to be resolved by extensive, expensive, and competent research alone. They require administrative vision, political will and social commitment, which unfortunately research and scholarship alone cannot impart. These are qualities that the collective will of the society must demand and encourage its leaders to cultivate.

The contents and the lessons of this paper reminded me of a question asked some 15 years ago by an eminent student of Indonesian society in particular, and developing societies in general, namely Professor W.F. Wertheim. After analysing and discussing the problems faced by rural poor in Asia he posed the question *Resistance to Change—From Whom?* He answered this question by pointing out the bias of most scholars (especially Western and Western educated), who tend to see the Westernised elites of developing countries as the major modernising focus whereas the rural poor are regarded as passive, traditional, fatalistic, apathetic, and resistant to change. It is true that the rural poor in most developing countries tend to be slow in accepting innovation but they do so because of the overall social situation and not due to some immutable personal traits. Attempts by the less privileged to improve their conditions through their own initiative and on rare occasions through a project like NSSDP led by committed local leaders (such as Rahman Rangkuty) are often thwarted by the more privileged, powerful public servants with vested interests and other members of the modern elite. It also reminded me of the observations made by Vernon Ruttan about differential distribution of the benefits of the green revolution: 'a technology that is essentially neutral with respect to scale has been introduced into environments in which the economic, social and political institutions have varied widely with respect to their neutrality'. These observations I believe, are also applicable in the case of NSSDP.

I would like to conclude my comments by more or less echoing Dillon's suggestions for further discussions, namely the search for an effective policy to develop Indonesia's rubber smallholders. In such a discussion the results and the lessons of NSSDP should be critically examined. His observations about the merits of intensive management and high-input projects needs close examination. And I completely agree with him about the need to pay special attention in research to the needs of smallholders rather than plantations.

More specifically I agree with the research priorities suggested by Dillon. The highest research priority should be given firstly to systematic and in-depth longitudinal studies that investigate the sets of constraints binding rubber smallholders with differential control over resources. And secondly to studies comparing and contrasting differential rates of technological diffusion through various types of smallholder development projects. This, hopefully, will be done in the case of NES schemes by research, which Professor Selo Soemardjan is conducting. He is extending his earlier work on coconut and sugar to rubber smallholders. He has initiated a project entitled 'Research Plan on Rubber Nucleus Estate and Smallholder Projects', which he reported to the Workshop.

Prospects for Group Processing and Marketing for Rubber Smallholders in Thailand

Chalong Maneekul*

RUBBER is one of the most important economic crops of Thailand. At present, the total land area under rubber is about 1.6 million ha. Most of the rubber is grown in 14 provinces in southern Thailand and in three eastern provinces. There are approximately 600 000 farm holdings engaged in rubber production of which 95% are smallholders, who own about 3.2 ha per holding, and the remaining 5% own 40 ha or more. In 1982, Thailand produced about 570,000 tonnes of rubber of which 10% was used within the country whereas the remaining 90% was exported to Japan, Singapore, some European and other countries. The rubber produced consisted of 74% smoked rubber sheets, 17% block rubber, 8% crepe rubber, and 1% other rubber, e.g. latex concentrate.

Rubber production in Thailand is hindered by low productivity due to the use of native varieties, over-aged trees, lack of field upkeep, and improper tapping and rubber processing. At present, more than 50% of the total rubber area is planted to native clones. Native rubber trees annually yield about 300 kg/ha whereas the new clones of the Rubber Replanting Program annually yield about 1500 kg/ha.

Generally speaking, the rubber from native trees is low in quality. In 1982, 10% of the rubber sheets were first and second grade, 64% were third grade, and remainder were fourth and fifth grades.

In the past there was a slow rubber development and slow rate of farmers adopting new technology. In 1962, the government initiated a Rubber Replanting Program to accelerate rubber production in the country. At present, new high-yielding clones are highly accepted by the rubber farmers and the government plans to replant about 50,000 ha/year.

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To promote rubber sales and production, the government has also set a policy for rubber sheet improvement and group marketing for rubber smallholders under the name of Group Processing and Marketing (GPM) to be implemented by the government agencies concerned.

Rubber Agencies

The government agencies involved in rubber development in Thailand are departmental agencies under the Ministry of Agriculture and Cooperatives, viz. (a) the Rubber Research Institute (RRIT), Department of Agriculture (DOA); (b) Office of Rubber Replanting Aid Fund (ORRAF), (c) Nabon Rubber Estate Organisation (NREO), and (d) Department of Agricultural Extension (DOAE).

RRIT has three major rubber research centres (RRC) and many rubber experiment stations. The main functions of these centres and stations are to conduct research on rubber production and technology. RRC will send its staff members to train the officers of other agencies working with rubber development. RRC staff also train many farmers arranged by ORRAF and DOAE. ORRAF is responsible for the replanting programs and some related extension work. NREO concentrates on rubber production and the preparations of planting materials for farmers and replanting programs. The DOAE plays an important role in transferring technology to farmers in crop production, including rubber. In addition, DOAE is responsible for new rubber planters and those completed replanters released from the responsibility of ORRAF. In fact, only three organisations (RRC, ORRAF, DOAE) are closely and actively involved in the transfer of rubber production technology. The coordination among these three agencies is illustrated in Fig. 1.

In this system, DOAE, by RRI and RRC, concentrates on rubber research work and some training functions. The new technology will be

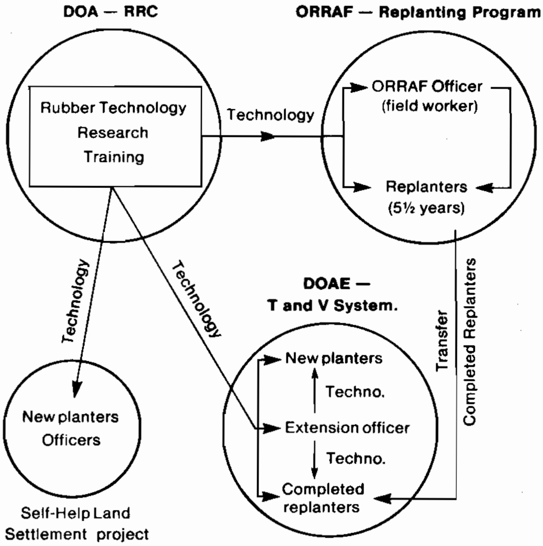

Fig. 1. System of rubber technology transfer in Thailand.

transferred to ORRAF, DOAE and some special projects. ORRAF and DOAE officers will be trained by RRC staff. The training programs for on-going replanters are jointly organised by RRC and ORRAF. The government has set up many training programs for rubber smallholders and officers in the fields of rubber growing, field maintenance, rubber tapping, rubber propagation, rubber processing and marketing. Since 1982, the training programs for completed replanters have been organised by DOAE with the trainers supported by RRC. In practice some RRC staff and the trainers of DOAE will take care of training programs for new planters and all completed replanters. Training for completed replanters concentrates on four major areas, viz. opening for tapping, tapping systems, good rubber sheet making, and rubber marketing and field maintenance, which includes disease and weed control and fertiliser application.

After the start of replanting programs, rubber yield increased considerably. However, these various organisations were concerned with rubber quality, rubber marketing, and bargaining power. Many informal groups were formed by various agencies to improve rubber quality and marketing.

Group Processing and Marketing

Before 1958, most rubber smallholders in Thailand processed their latex in their own homes using primitive facilities such as straw filter, unidentified acid, unclean water, dirty floors, and kerosene cans as trays. The rubber sheets were thick, dirty and difficult to dry. Most rubber sheets were third and fourth grade, and the farmers received low prices for their rubber. It is estimated that during 1970–79, Thailand lost about US$40 million for not producing and exporting good quality rubber sheets.

During 1958–67, the Department of Agriculture tried to tackle this problem by organising group processing to improve rubber quality. Even though rubber quality was improved, the farmers did not get a good price because they sold their rubber sheets separately without any bargaining power. The travelling buyers and village and district buyers were not serious about rubber grades and the price difference between grades was not attractive. Usually the rubber produced by smallholders has to pass through three to four buyers before reaching the exporter. The prevailing rubber marketing system is shown in Figure 2. The rubber smallholders sell their unsmoked sheets to travelling buyers and these buyers sell rubber to village or district buyers. Therefore, the price received by smallholders is much lower than the actual market price.

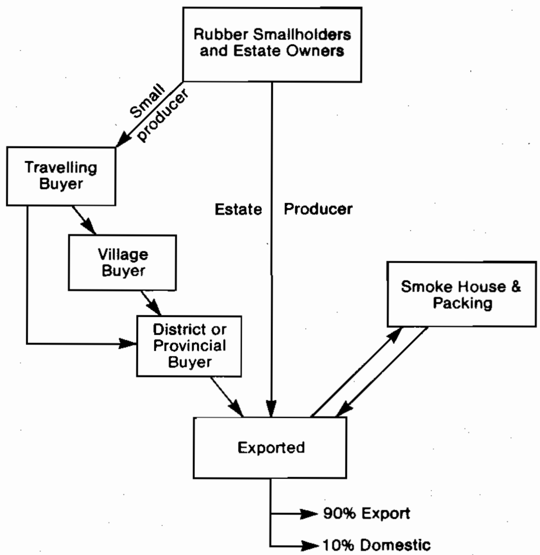

Fig. 2. Rubber sheet marketing channels. (Source: Thai Farmers Bank, 1982).

During 1968–76, 60 rubber processing and marketing groups were organised independently by RRC, ORRAF, and DOAE. The main objectives of these groups were to produce good rubber sheets, to have better bargaining power and receive higher prices, and to be the contact point for receiving new technology from extension officers. This effort was successful to some extent because these groups received advice and technical assistance from those organisations. The main problems encountered by these groups were the lack of experience, management skills, revolving funds, equipment, support, and guidance. RRC and ORRAF had insufficient officers to supervise their groups. Sometimes, the members of the groups could not wait for the designated selling date because of lack of money. Therefore, they sold their rubber sheets to the forementioned buyers ahead of the due date, thus reducing the amount of rubber for group sale. The bidders did not like to come and buy small amounts of rubber sheet.

In late 1976, the Thai Government recommended that the activities concerning group processing and marketing be the responsibility of the DOAE. All rubber processing and marketing groups formed by various organisations were transferred to be under DOAE responsibility. However, the RRC is still responsible for technical support, especially in supplying new technology to agricultural extension officers. At present, DOAE has launched a new intensive extension program called the National Agricultural Extension Improvement Program (NAEP) in which the training and visiting system (T & V) is used as an important means of modern extension work.

Role of T & V

DOAE was established in 1967 with limited human resources and facilities. At that time, the agent/farmer ratio was about 1:4000 farm households and DOAE was working hard to recruit more personnel. In 1977 the government received a bank loan and technical assistance from the International Bank for Reconstruction and Development (IBRD) and the United States Agency for International Development (USAID) to improve the agricultural extension system in Thailand and the T & V system was extensively begun. This system calls for a continuous training of extension agents and a regular visit to farmers every fortnight. The NAEP project provides the following facilities for the T & V system:

1. An increase in extension personnel to bring the ratio of extension agents to farmers down to 1:1000.
2. Allocation of extension agents to work at the village level with some housing facilities provided.
3. Training facilities are provided for project implementation and fortnightly training for extension agents.
4. Relevant technology in crop or rubber production is transferred from RRC, ORRAF, or universities to local extension workers and finally to farmers.
5. Fortnightly farm visits are scheduled and the transportation means are provided for all extension workers.
6. In each village, a number of contact farmers will be selected (1 out of 10 farmers) to serve as liaison between farmers and the extension agent.

As the extension personnel increase throughout the villages, the implementation of group rubber processing and marketing is more effective. In 1977, there were 72 groups and in 1983 there were 553 groups with 11 060 farm households as members. Most of the groups are fairly successful in their operation whereas 29 groups need more support and improvement. The prospects, activities, and obstacles of running group processing and marketing are discussed in the following paragraphs.

Group Processing and Marketing

It is evident that rubber smallholders in Thailand have insufficient knowledge of making good rubber sheet and are short of equipment and supplies, and they lack bargaining power. Therefore, they produce low quality rubber sheets and receive unfair prices from their rubber sale. One means of solving these problems is to establish Group Processing and Marketing (GPM) at the village and/or district level.

Benefits of GPM

1. Smallholders have a common place to make good rubber sheets and sell their rubber.
2. It is more convenient for the officers to advise on rubber production and sheet making.
3. It is convenient for the buyer/bidder to come and buy a large quantity of rubber sheets from the group.
4. Farmers obtain correct weight and a good price from their rubber sale.
5. The margins of sale or transaction change money will be pooled as group income.
6. GPM produces good rubber sheets, which are necessary for export and the building of confidence by foreign markets.

Objectives of GPM

1. To improve rubber quality and produce good rubber sheets of grades 1, 2, or 3.
2. To encourage group sales at village level with a view to implementing district groupings and rubber cooperatives to obtain more bargaining power.
3. To encourage more formation of GPM in all rubber producing areas.

Procedures of GPM

1. Extension officers visit rubber smallholders to identify problem areas that produce low-quality rubber sheets.

2. The officers encourage farmers to form groups of 15–30 members and choose one household or a central place to set up a GPM.

3. The officers offer training and visits to the groups, 1–2 times a month.

4. The group will elect a committee to run the GPM.

5. DOAE lends GPM equipment for 3 years and suggests that groups buy their own equipment and supplies thereafter.

6. The officers advise on good rubber-sheet making and the process of group marketing.

7. The officers advise on weighing, rubber grading, record keeping, and rubber storage.

8. Rubber sales are conducted weekly or every two weeks. The officers assist in contacting buyers or bidders to come to the GPM centre. Rubber sales must be in cash received from the highest bidding or the best negotiation.

9. Payment to farmers is made on the same day as the sale. Minor expenses may be deducted and margins of sale or transaction change money will be pooled as group income.

10. Pooled income will be used to buy equipment and supplies and for the welfare of GPM members.

11. District agricultural officers submit GPM reports to the provinces every month and the provinces send the reports to DOAE every 4 months.

Problems of GPM

1. Members are accustomed to old methods of sheet making and may not be really interested in GPM.

2. GPM lacks housing, necessary equipment, and transportation means.

3. GPM lacks revolving funds and smallholders do not have enough money to raise such a fund.

4. Some members are not devoted and there is no pay when working for GPM.

5. The committee lacks leadership and managerial skills about rubber business.

6. To sell rubber through GPM takes much time in weighing, grading, storing, selling, and money giving. The farmers get bored from waiting because they have other farm work to attend.

7. Rubber grading is not very serious causing insignificant differences in rubber pricing.

8. Some members bring wet or dirty rubber sheets to GPM.

9. Some farmers who have less rubber cannot wait until the selling date and they often sell their rubber ahead of the appointed date causing a decrease in the amount of rubber sheets at GPM.

10. Some farmers owe rubber buyers and they have to sell their rubber to those people to pay back the debt.

11. Some extension officers lack supervisory experiences for GPM.

12. Some buyers/traders do not like GPM because they have to pay more when buying rubber sheets.

13. The buyers do not understand the objectives of GPM. Therefore, not many buyers will go to the biddings. Sometimes, they secretly agree to submit a fake or unreasonable price.

14. Some GPM centres are distant from town and the amount of rubber is too small to attract many buyers.

15. Prices of nonsmoked rubber between different grades are not significantly different, so farmers do not pay much attention to GPM.

16. When GPM receives a lot of money from a rubber sale, the committee feels insecure about keeping the money. It is difficult to get a treasurer for such a risky, unpaid job.

GPM Improvement

1. GPM should be provided with some revolving funds to pay needy farmers in advance.

2. The government should have provision to sell equipment and supplies on an instalment basis to GPM.

3. The officers should know about the rubber business and understand the basic problems of GPM.

4. Small GPM groupings are recommended at the beginning with expansion to large GPM afterwards.

5. The officers must fully participate in all activities at the beginning and gradually withdraw at a later stage.

6. Members must be encouraged and shown to realise the importance of GPM. It must not be a matter of an officer pushing GPM onto farmers.

7. Buyers/traders must be fully informed and encouraged to come to GPM.

8. Committee members and farmers must have regular meetings to solve GPM problems. When the GPM has some reserve funds, some presents should be given to the GPM committee.

9. A rubber field-day should be organised to enable farmers and GPM to meet with buyers, officers, etc.

10. All other provincial related officers should pay attention to GPM and develop good coordination among the officers concerned.

11. Organise rubber sales at the district level by inviting village GPMs to pool rubber sheets together (say 50-100 tonnes/sale). At present, there are two districts trying this method and the result is very satisfactory.

12. Modify some large GPMs as a savings place for the members. A few GPMs are adding this savings/lending activity to their regular service.

13. A central rubber market may be developed in the village or district so that the GPM and buyers can meet. Finally, the rubber association should be established to perform large-scale processing and export activity.

Impact of Technology

Since the government launched the Rubber Replanting Programs, established more rubber stations and the Rubber Research Institute, organised farmer and officer training programs, and improved DOAE and the T&V system, rubber production and rubber quality in Thailand are increasing. The quality of rubber smoked sheet (RSS) has improved since 1981 from 70 to 75% for RSS 1, 2, 3, and decreased from 30 to 25% for RSS 4, 5.

It was reported in 1983, that the GPMs in 12 provinces could obtain more money from the sale of good-quality rubber sheets. The extra income for those GPMs was an additional US$400 000. At the present time, smallholders are very interested in applying for rubber replanting, therefore new technology and the extension package as previously described have a direct impact on rubber smallholders' development. However, rubber development needs to have three to four components simultaneously active, viz. knowledge, technology, motivation, and a permanent and continuous improvement policy of the government.

Conclusions

There are 553 GPM centres in Thailand with 11 060 farm households as members.

The GPM centres comprise 15-30 rubber smallholders and some of them act as a committee of GPM.

DOAE officers give advice and work cooperatively with the GPM on rubber production, good rubber sheet-making and rubber marketing.

The government should provide some revolving funds to GPM to assist rubber smallholders when they join the GPM. The government financial institution should have provisions to sell rubber equipment and supplies on an instalment basis to GPM.

Suggested research programs are: (a) factors affecting the success and failure of group processing and marketing, (b) effects of government programs on the income of rubber smallholders, (c) an analysis of the response of smallholders towards government programs, and (d) socioeconomic factors affecting the development of rubber smallholders.

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References

ASEAN (Association of South East Asian Nations) ADPC. 1983. Study on production and marketing of rubber in the ASEAN region. Workshop on the ASEAN ADPC Research Studies. July 1983. Hat Yai, Thailand

Department of Agricultural Extension, Rubber Section. 1983. Report on the situation of Group Processing and Marketing in Thailand. (In Thai).

Ministry of Agriculture and Cooperatives, Office of Agricultural Economics. 1982. Current situation and outlook on the production and trade of selected agricultural products in Thailand.

Searmlarp Wasuwat. 1984. Natural rubber development in South Thailand. Presented at first workshop for rubber smallholders development. July 1984, Southern Thailand. (In Thai).

Surasak Sutiwong. 1980. Thai rubber: Quality to be improved. Rubber Research Center, Hat Yai, Thailand. (In Thai).

Somporn Krisanasap. 1982. A study on the situation of Processing and Marketing in Thailand. Rubber Research Centre, Hat Yai, Thailand. (In Thai).

Vorasak Pakdee. 1980. Agricultural extension in Thailand. Presented at the International Seminar on agricultural extension and communication. June 1980. Bangkok, Thailand.

Rubber Replanting Scheme in Thailand

Narong Suchare*

AGRICULTURE in Thailand accounts for 25% of total GDP, 60% of all exports, and 70% of employment. This sector has achieved more than 3.5% rubber replanting annually from 1975. Expansion of the cultivated area was mainly responsible for the earlier growth rate but as good plantable land soon became scarce, marginal land had to be used making rubber growing less productive and less profitable. Growth improvement will have to come from better use of modern technologies, materials, and diversification into higher value crops.

Thailand is self-sufficient in food. Therefore, the Royal Thai Government's main agricultural development objective is concerned with growth and equity. Tree crops, which account for about 15% of the planted area, allow this possibility. Except for oil palm, all other tree crop planters are smallholders. This makes the re-establishment and the replanting of tree crops difficult because of their long immature period and high establishment costs. Rubber and coconut are the two major tree crops; they are grown on relatively poor soils under rainfed conditions but play an important role in the growth of rural people's income.

Rubber is grown mainly in the fourteen southern provinces (90%) and in the four eastern provinces (10%) of Thailand. Its plantings are now encouraged in the east and northeast of Thailand to replace cassava. The total area under rubber is estimated at 1.6 million ha of which about 30% is senile. Another 30% of the rubber is old, low-yielding and annually produces no more than 300 kg/ha. The number of rubber holdings is estimated at over 500 000 with an average size of 3.2 ha. The majority of the holdings are between 2.4 ha and 9.6 ha. The Royal Thai Government in the late fifties realised the need to provide assistance to replant these old rubber trees with high-yielding varieties as a means of increasing productivity.

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Replanting Scheme

An Act was passed in 1960 to obtain funds for rubber replanting, under which rubber exporters are required to pay a cess levied on rubber exports following the regulations and procedures prescribed, and according to a rate specified periodically by the Minister in the Government Gazette. The cess is collected and paid directly to the Board of the Office of the Rubber Replanting Aid Fund (ORRAF) for use in the following manner:

1. Five percent to be given to the Department of Agriculture for research and experiments on rubber production.
2. Up to 5% to be used as the administrative cost of ORRAF. If the amount is insufficient, the Royal Thai Government provides a fund through its annual budget to cover the difference.
3. An amount equal to 90% goes back to the rubber plantation owners for replanting; it cannot be used for any other purposes.

ORRAF is a statutory body under the management of a Board. Until about a year ago, the Minister of Agriculture and Cooperatives was the Chairman of the Board. At present, the Permanent Secretary of the Ministry of Agriculture and Cooperatives (MOAC) serves as the Chairman. The Board is represented by five members from the MOAC, one member each from the Ministries of Finance, Interior, Commerce, Industry and the National Economic and Social Development Board, two farmers, and the Director of ORRAF. The Board Members are appointed by the Council of Ministers for a period of two years which term can be extended by re-appointment. The quorum and decisions of Board meetings, which are held once a month, are reached with one-half attendance and by a simple vote majority of the members, respectively.

The Board has an overall control to administer the fund and execute the rubber replanting activities. With the approval of the Minister of the MOAC, it sets rules and regulations for the administration, finance and operation of ORRAF. Its responsibilities include (a) policy matters, (b) annual programs and budget, (c) grant rates and terms and conditions for grant payment, (d) administrative matters concerning staff, (e) fund's activities, and (f) structural and procedural changes as and when found necessary.

The Board may delegate some of its power and duties to the Director of ORRAF for speedy execution of the fund and replanting activities.

The head office of ORRAF is located in Bangkok. It has 12 provincial offices and 35 suboffices at the district level to administer grant payments and supervise the replantings.

The executive head of ORRAF is the director who is appointed by the Council of Ministers. Under him are two deputy directors, one assistant director and four divisional heads forming the executive groups of the organisation. The total number of staff as at September 1984 was 2224.

To be eligible for the rubber replanting grant, which is given in cash and kind in seven instalments over a period of five and a half years, the rubber plantation owners must have the following:

1. A rubber holding of not less than 0.32 ha.
2. The rubber trees in it should be over 25 years old or damaged and low yielding.
3. The average minimum density of 25 trees/0.16 ha in the applied plot or 10 trees/0.16 ha in any given area.
4. Suitable soils, topography, and climatic conditions for rubber growing.
5. A clear land title or certificate of ownership for the rubber holding.

The participants must decide at the time of application to replant one of the three types of plantings allowed for by ORRAF. The first type, commonly known as Type I Replanting, is to replant with budded stumps or polybagged buddings. Type II Replanting is to plant seed-at-stake for subsequent budding in the field. Type III Replanting is to plant with tree crops other than rubber. The grant rate is US$1115/ha [26.90 Thailand baht (THB) = US$1] for Type I and II plantings, and US$813/ha for Type III planting.

The procedures for application to replant and to qualify for receiving the grant are in the following order:

1. ORRAF field staff visit the would-be replanters. After ascertaining that they are eligible for participation, they assist them to complete the application forms. The ORRAF survey teams then visit the rubber holdings and make detailed reports, including a preliminary plotting of the areas to be replanted. The reports, which contain also the surveyor's recommendations, are forwarded by the Provincial Replanting Officers to the Replanting Consideration Section of the Replanting Division in Bangkok. They are subsequently submitted to the ORRAF Board for approval before returning to the Replanting Division for further processing by the EDP Unit and recording in the Management Section.

2. Next, Headquarters notifies the Provincial Offices of the approvals of applications with details of the areas for each surveyed plot. On receipt of these, the Provincial Replanting Officers inform the applicants accordingly by calling them to a meeting for a briefing on (a) the rights and responsibilities of the replanters; (b) the distribution of individual replanting booklets, which contain the schedules of input applications, supervision of ORRAF staff and grant in cash and kind instalments; and (c) vouchers for receiving the first lot of material inputs (mainly fertilisers and herbicides) from the village stockists according to the application schedules. Cash payments are made to the replanters through a local bank at 10-day intervals for part of the labour input.

3. ORRAF field staff carry out visits to each replanted holding at the completion of land clearing, planting, and cover crop establishment. Thereafter, field visits are made regularly at 3–4 monthly intervals throughout the 6-year immaturity period. The approval of field inspectors is required for each stage in order to qualify for disbursement of the grant for the replanting schedule. If the field upkeep is not up to the required standards, replanters are given the necessary advice and help to improve within a specified time prior to a second inspection. On average, a field inspector makes about three inspections a day and he is responsible for about 450 rubber holdings. The field staff are provided with motorcycles. With the good trunk and feeder roads available in the rubber growing provinces, surveys and inspections are conveniently carried out according to the schedule.

The sources of finance for ORRAF come from cess income on rubber exports, Government subvention through loans from the World Bank (WB) and the Commonwealth Development Corporation

(CDC) and its regular budget. From 1960 to 1983, ORRAF's aggregate income was equal to US$411.3 million.

Rubber replanting in the period 1960–68 was carried out using only the cess income. As expected the replanting rate was slow during that period because at the beginning, the farmers took more time to respond and appreciate the value of the scheme. From 1969 to 1977, the Royal Thai Government provided budget finance to accelerate the replanting program. With external loans commencing in 1978, acceleration was further stepped up. The external loans came in two phases. The first loan amounted to US$50 million from the WB and £3.4 million from CDC for 1978–81. The second loan was US$142 million and £15 million from the two respective sources for 1982 to 1985. The annual loans disbursement rose from US$3.29 million in 1978 to US$38.83 million in 1983. Expenditures exceeded income in 1981 and 1982 because of the large increase in replanting areas since 1978 and the sharp decline in rubber prices in the two years causing a severe reduction in cess income.

To improve the management and technical capabilities of the staff of ORRAF and the Rubber Research Institute of Thailand (RRIT), the United Nations Development Programme (UNDP) gave technical assistance for 1981 and 1982. The Food and Agriculture Organization of the United Nations (FAO) was the executing agency. The assistance was for foreign expertise, fellowships, study tours, and equipment amounting to US$1.76 million for 1976–80 and US$1.09 million for 1982–86.

Table 1. Actual replanting area and plots, 1962–83.

	Rubber		Other tree crops		
Year	No. of plots	Area (ha)	No. of plots	Area (ha)	Remarks
1962–68	23101	39222	1841	1491	a.
1969–73	53765	75747	4372	4427	b.
1974–77	70264	90697	3946	3669	b.
1978	29182	34880	526	420	c.
1979	36935	45062	432	338	c.
1980	34846	41905	66	47	c.
1981	35114	42299	12	12	c.
1982	45821	55874	23	23	c.
1983	39389	49059	1	1	c.

a. No Royal Thai Government subvention.
b. With Royal Thai Government subvention to accelerate replanting.
c. With Royal Thai Government budget and external loan.

Table 2. Rubber replanted areas, 1962–83.

	No. replanted plots	Area (ha)	Plot average size (ha)
1962–68 using cess income alone	24942	40713	1.6
1969–77 with additional income through Government regular budget	132347	174540	1.3
1978–1981 with external loans (Phase I)	137113	164963	1.2
1982–1985 with external loans (Part Phase II)	85234	104957	1.2
(Total estimated in 1984–85[a]	73110	95043	1.3)

a. To complete Phase II Target of 200 000 ha replantings.

Results

The average size of a rubber-replanted plot is about 1.28 ha. Between 1962 and 1983, about 380 000 plots covering about 485 000 ha were replanted. Since the acceleration of the rubber replanting program was instituted in 1978, the rate steadily increased each year until it exceeded the target of 50 000 ha a year in 1982. The number of farm plots currently replanted annually ranged from 35 000 to 40 000. This target allows a complete replacement of the old rubber holdings with the high-yielding rubber varieties within 33 years, which is the normal life-cycle of the rubber tree under good care, proper exploitation, and management (Table 1).

After the initial slow start in the sixties, the response from farmers for replanting gained momentum. Table 2 shows the areas replanted during 1962–1983.

In the two loan project-periods, the replanting rate was greatly accelerated. It rose from 24 857 ha in 1977 to 54 000 ha in 1982, which passed the annual target of 50 000 ha by 8%. During the last two years of the Phase II Replanting Project in 1984 and 1985, the replanting rate will average about 47 500 ha/annum to complete the project target of 200 000 ha for the four years (1982–85). In addition to the replanting of new stands, ORRAF provided grants and technical assistance for about 200 000 ha of immature replantings planted prior to and during the phase I period (1978–82).

The number of actual replanters would be expected to be smaller than the total number of replanted plots because some replanters have more than one plot of replantings. Although the number of actual replanters for each period is not available, the data collected by ORRAF for the 1976–80 plantings showed that the 125 000 replanted plots were carried out by 114 000 farmers (91%). This figure will decline in the Phase II project and for periods beyond because more replanters would have participated in the replanting scheme earlier. However, assuming that the total 379 636 plots between 1962 and 1983 were made by about 75% of the replanters (284 727 actual participants), ORRAF-supported activities have benefited about 1.7 million people (estimating six members/replanting household).

In the early replanting years, the types of rubber planting materials used were Tjir 1 clonal seeds. From 1984 onwards, buddings of proven high-yielding clones were introduced. This involved the establishment and control of budwood and budded stump nurseries. Smallholders responded well to the planting of clonal materials using initially the old clones such as Tjir 1, PR 107, GL 1, and PB 86. The selection was eventually changed to more modern clones of RRIM 600, GT 1, PB 5/51 and some PR and PB clones. RRIT reviews and makes clone recommendations for use by ORRAF at intervals of four to five years.

Originally, large central rubber nurseries were established by the Department of Agriculture and the Government Estates Organization. This system was gradually changed in later years to that of establishing more nurseries in the rubber-producing provinces to reduce handling and transportation costs. The present policy of ORRAF is to have 50% of the planting material requirements produced by the replanters themselves, 25% by private nursery operators, and 25% by ORRAF nurseries.

To replant 50 000 ha/year, ORRAF needs about 37 million green budsticks and 32.5 million buddings annually, which is equivalent to 740 green budsticks/ha and 650 buddings/ha. All budwood nurseries have to be registered with RRIT to ensure purity of materials. The minimum nursery size allowed is 0.32 ha. The budwood nurseries and budded stump/polybagged budding nurseries were expanded from 117 to 166 ha and from 250 to 415 ha, respectively.

Fifty percent of the materials used were green-budded stumps, 40% seed-at-stake planting for subsequent budding in the field, and about 10% polybagged buddings. Encouragement is given to plant more polybagged buddings as they will help to reduce the immaturity period of the rubber trees. Innovations to improve planting results and growth of the trees are constantly considered by the researchers for application by the replanters.

The recent survey of rubber farmers conducted by ORRAF and the National Institute of Development Administration (NIDA) shows that the majority of ORRAF beneficiaries, i.e. 47% of ongoing and 53% completed, belong to the small farmers whose rubber holding sizes range from 0.32 to 2.38 ha. It indicates that most of the rubber farmers, both participants and non-participants of the ORRAF scheme, own between 2 to 4 ha and 4 to 8 ha. The median farm size for all rubber farms is about 4 ha with an average area of 5.6 ha. Rubber farmers are therefore better off than the average Thai farmer for whom the median farm area is about 2.4 ha with an average of 3.68 ha. The survey also shows that the income of the completed rubber replanters increases by 45% of total family income and 73% of farm income.

Yield and Production

The average annual yield of old unselected seedling rubber is about 350 kg/ha while that of the high-yielding clonal rubber is about 1500 kg/ha. Based on the current farm-gate price of US$0.56/kg for a farmer with a 3 ha rubber holding, his average annual earning is US$588 and US$2520 respectively (US$1 = 26.90 Baht). Replanting with high-yielding rubber has resulted in an increase of over 400% making the rubberholders in Thailand the best paid, and usually most progressive, farmers.

As a result of the success in the rubber replanting scheme, production increased significantly. In 1960 Thailand exported 169 848 t of rubber. It rose to 279 163 t in 1970 and 456 802 t in 1980. In 1984 Thailand exported 552 486 t out of a total production of 587 000 t. This year it is likely to reach 600 000 t.

Training and Technology Transfer

ORRAF's training programs were designed to meet the requirements of the accelerated rubber replanting scheme. Proper selection of subjects and trainees was carried out. UNDP/FAO financed and supported many training activities. Courses were organised for staff as well as rubber replanters in budgrafting, nursery establishments, planting techniques, field maintenance, tapping, processing, and marketing.

Staff were trained in management, planning, auditing, extension methods, audiovisual, and communication. During the two phases of the project period 1978–83 over 2000 ORRAF staff and 80 000 rubber farmers benefited from the various training courses. In addition, many ORRAF and RRIT staff of different categories were sent overseas for postgraduate studies, short-course training, and study tours.

Technological Changes

Over the last two decades, the change to using better rubber clones was necessary and desirable. Replanters have readily responded to this to such an extent that some progressive ones have demanded the use of unproven clones thereby causing difficulty to the organisation. However, clone RRIM 600, which is an all-round high-yielding tree, continues to remain popular.

The planting of polybagged buddings is gaining popularity. This type of material shortens the immaturity period of the rubber trees and gives a more uniform stand.

Magnesium has been removed from the four fertiliser formulations. RRIT's experiments confirmed that there is adequate magnesium in the soils in Thailand to support good growth of the rubber trees. This has resulted in a considerable savings in fertiliser costs.

The usage of higher fertiliser concentrations to reduce handling and transportation charges is a worthwhile technical input.

The planting density/ha of rubber trees was raised from 420 to 500 trees. Consideration is now being given to further increase it to 600 trees/ha for rubber holdings of 2.4 ha and below. This change will provide more rubber trees for smallholders to tap their trees less intensively and at the same time, give them more yield.

The introduction of high-level upward tapping with the application of a tree stimulant to exploit the old rubber trees more efficiently prior to replanting, is another technological change.

Constraints and Problems

The unexpected fall in world rubber prices in 1981 and 1982 caused a reduction in cess revenues. This resulted in an unsatisfactory financial position for ORRAF, which had to draw substantially on its reserves and also request an increase of disbursement percentages from the WB and CDC under the second loan. An additional loan of £5 million was further arranged with CDC to overcome the unbalanced financial situation.

The present cess rate, which is dependent on the quantity of rubber exports and world rubber prices will always result in constant fluctuations in ORRAF's funding. It will probably not enable ORRAF to be self-sufficient in funding its annual replanting of 50 000 ha, until about 1995. The Royal Thai Government is considering a flat rate for the cess in order to stabilise ORRAF's income and ensure that the current replanting program will continue without affecting the foreign exchange earnings and welfare of the rubber smallholders.

Under the present ORRAF Act, only 5% of the cess revenues can be used for the administrative costs of ORRAF. This sum is grossly inadequate. The actual costs of administration are between 15 and 18%. Re-examination of this clause has become necessary to either raise the level or make ORRAF administrative costs a part of the overall expenditure in the operations as a long-term solution to the problems.

ORRAF's assistance to rubber smallholders is now restricted to a five and a half year period from planting. At the time of termination, the rubber trees are not of tappable size. Some 50% of the released replanters, particularly the small ones, usually open their trees for tapping. This practice of opening undersized trees will seriously reduce the economic life of the rubber trees. Another attempt will be made to obtain the agreement of the government to extend ORRAF's involvement in replanting from 5.5 to 7.5 years. During the extended period, replanters will be prevented from opening their rubber trees until they have attained a girth of 50 cm at a height of 150 cm from the ground. At the same time, replanters will receive a supply of fertiliser for one more application in the sixth year, which is an active-growing time for the trees to reach maturity. Current tapping systems, good field maintenance, processing, and group marketing can also be introduced and maintained by ORRAF and related agencies in the two years.

At least 70% of the released replanters prefer the daily tapping one-third spiral-cut system. This will result in excessive bark consumption, higher incidence of dry trees, and a shorter economic life of the tree. The one-half spiral-cut alternate daily system recommended by RRIT is adopted by no more than 20% but it is a practice that the smallholders find hard to adopt because of small-sized farms. This is a serious situation. Strong efforts by researchers to find a more appropriate tapping system and by extension officers to educate and persuade farmers to exploit their trees correctly should be given top consideration.

Research, training and extension support to the replanting program should be strengthened and improved. Although much of this support was given since the establishment of the replanting scheme, the demand for such support outpaced the supplies. Technological developments, e.g. the recommendation of clones according to environmental suitability, better cultural practices, fertilising, use of advanced-planting material to shorten the immaturity of rubber trees, appropriate exploitation systems for the old and young mature rubber, and provision of efficient extension services to the farmers who have completed their replanting programs are some of the areas that will further improve the rubber production of Thailand.

The Future

Thailand will continue to maintain its annual rubber replanting rate of 50 000 ha. The ORRAF system of operation through the provision of grants has proven to be the most effective means of enforcing discipline to achieve good replanting results; it is also a suitable way of transferring new technologies to rubber smallholders to ensure their adoption during the immaturity period of rubber trees.

ORRAF will need further external financing assistance for the third phase of the accelerated replanting program. This will be for a 4-year period from 1986 to 1989. The estimated cost for this phase will be about US$350 million of which the loan requirement will likely be from about US$90 to US$140 million.

Because of the anticipated change in the Rubber Act to allow either a higher or fixed cess, and with a substantial increase in rubber production by 1990 and beyond, together with better prices, ORRAF hopes to be self-sufficient after the third phase project.

Current Situation and Outlook for the Smallholder Rubber Industry in Thailand

Sanit Samosorn*

At present, Thailand is the third largest supplier of natural rubber to the world market. Although over 95% of production comes from smallholders' rubber, production is increasing and could reach 1.2 million tonnes by the year 2000. Increased production is expected not only from the active replanting of holdings but also from new planting areas of about 6 million ha that could be exploited.

Much effort has so far been made by government agencies and the private sector to increase production, thereby increasing the national income and improving living standards for Thai smallholders. Both research and transfer of new technology are of primary importance in smallholding development.

Background Information

Rubber-Growing Areas

The main i.e. traditional, rubber-growing areas are located in two regions in Thailand. The first rubber introduction to be grown in Thailand, as the primary base of production today, is in the south. It started from the Malaysian border and moved to the upper southern provinces. This area comprises 14 provinces where the climatic conditions and soils are the most suitable for growing rubber. The other site of rubber growing is in three provinces in the east and southeast of Bangkok. The yield and growth of rubber is comparable with that in the south, and production is one to two months earlier than the southern provinces. These two rubber-growing areas cover 1.5 million ha.

Rubber and Yield

Although Thailand produces about 14.8% of the rubber in the world market, there is still a big production gap to be bridged. Thailand started growing rubber in 1901. The yield from this material is much lower than that from recently impro-

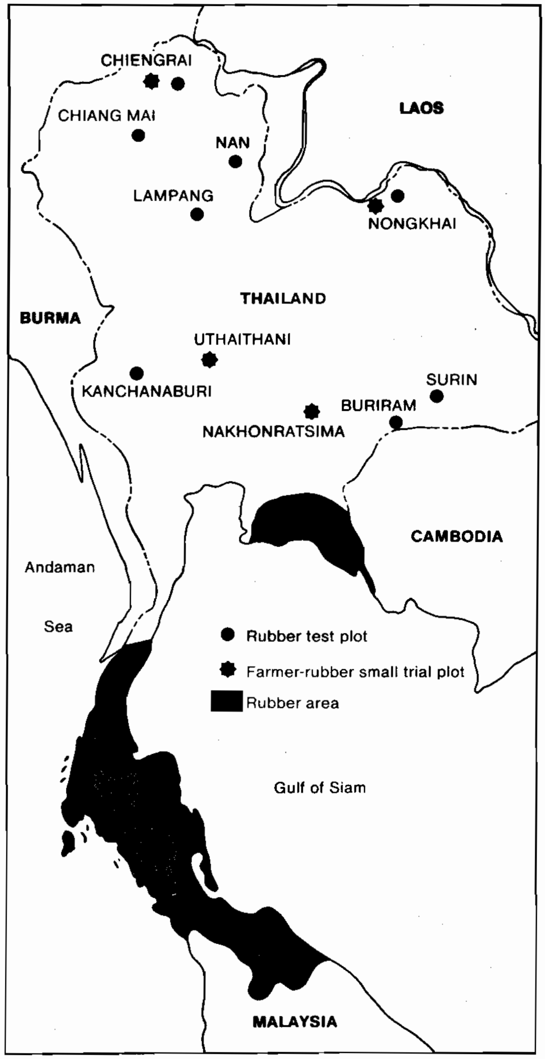

Fig. 1. The major rubber production areas, rubber test plots, and farmer-rubber small trial plots in Thailand.

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ved planting material, and gives a very low return to farmers:

	Yield in kg/ha	Area in '000 ha
Immature	—	320
Young mature	1350	560
Old seedlings	250	656

Immature rubber trees are not yet tappable, and consist of high-yielding clones that are expected to give a high return to the smallholders when they are mature. Most rubber in this category has been derived from replanting programs; some have been planted by themselves, either as new plantings or as replantings where smallholders did not qualify for the grant.

Young mature rubber now plays a major role in production; most of the trees are high-yielding clones. Various problems associated with this category need to be solved, however. Because of over-exploitation by wrongful tapping, the lifespan of trees has been shortened necessitating earlier replanting.

Illegitimate rubber trees are very old, being over 25 years and these are in need of replanting. The current low price of rubber in the world market places Thai smallholders growing this type of rubber in a difficult position. Government agencies relating to rubber activities have encouraged farmers to increase yields by various means, especially the application of stimulants to the virgin bark above the ordinary tapping panel on old rubber trees. This technique, viz. high-level tapping, has been adopted in old rubber smallholdings where the lower panels have already been destroyed by years of tapping. The high-level tapping campaign has been funded by a grant from the European Economic Community with the objective of improving the rubber yield in smallholdings. If the correct technique is followed, yield is expected to increase between 50 and 100% in old trees prior to felling in replanting programs.

Processing and Marketing

The Thai rubber smallholder sector comprises about 800 000 families, with an estimated population of 4 million people being involved with rubber, excluding the trading and manufacturing people. The average size of holdings is 2.5 ha/ family; most of them maintain their holdings by using family labour. Occasionally during the planting season hired labour may be required because the owner may have been engaged in some other activity of his own. Thai farmers normally rely on more than one crop, with rice being the most popular alternate. This is perhaps the main reason why Thai farmers have never starved even though the rubber price is at a critical level.

Dry rubber is first obtained in the form of latex from rubber trees by tapping, and is then processed into different rubber products. Unsmoked sheet is a very common preparation at the smallholding level because most smallholders cannot afford to do their own smoking. Thus unsmoked sheet will be sold to the traders or directly to the factory. There are 1740 local dealers, 130 exporters, 18 TTR (Thai-tested rubber) factories, and 162 smokehouses and other facilities.

Unsmoked sheets produced by smallholders are still of poor quality and vary from grade 1 to 5. Rubber-related government agencies have realised this problem and as a result, Group Marketing Organisations (GMO) have been established to help smallholders improve quality and make group sales to obtain better prices. Over 500 GMOs have been established by the Rubber Research Institute of Thailand (RRIT) and the Department of Agricultural Extension. This has resulted in rubber quality being upgraded to grade 1 and sold at a higher price to give better incomes to smallholders.

Besides unsmoked sheet, various other forms of rubber are produced by factories, e.g. block rubber, crepes, concentrated latex, airdried sheets etc. (Table 1).

Table 1. Rubber exports by type and grade in 1983.

Type and grade	%	
RSS[a] 1	1.17	
RSS 2	7.41	
RSS 3	52.87	
RSS 4	16.03	
RSS 5	3.06	80.5
TTR[b] 5 L	0.27	
TTR 5	0.11	
TTR 10	—	
TTR 20	12.99	
TTR 50	0.01	13.4
Crepes	5.47	
Concentrate latex	0.10	
Air dried sheet	0.33	
Other	0.18	6.1

a. Ribbed smoked sheet.
b. Thai tested rubber (= block rubber).

Most of the natural rubber, especially RRS 3, is exported to Japan in the form of ribbed smoked sheet. Thai rubber of different types has been exported to over 20 countries throughout the world, (e.g. in 1983, 58% to Japan, 13% to USA, 9% to Singapore, 7% to China, 4% to Malaysia, 3% to Soviet bloc, 2% to EEC, 0.5% to Europe, and 4% to other countries).

Research and Development Activities

A Rubber Research Centre was established in 1965 for home-based research and development on various rubber activities. Promising technologies have been released that have subsequently benefited smallholders in developing their own rubber holdings. About 200 research and development activities are carried out annually. The Centre has been able to recommend suitable planting material and rubber clones for smallholder planting. Fertiliser formulations and correct application schedules have been established. Maintenance procedures both during the immature and mature periods were recognised as being most important for tree growth. Production, processing, and marketing have been successfully resolved.

Research findings and experiences have been conveyed to smallholders by various forms of technology transfer. Training, which is one of the major direct approaches to transfer of new technology, is usually performed at the training school located on the rubber station. If smallholders do not attend the course at a particular time, a mobile training unit can be arranged to meet them at the site. Training activities are organised by coordination among three major government agencies, viz. the Rubber Research Centre, the Office of Replanting Aid Fund, and the Department of Agricultural Extension. Close to 90 000 smallholders were trained as follows between 1969 and 1984: completed replanter—37 563, tapping—8 307, budgrafting—26 517, training for trainers—3959, and others—13 498.

Table 2. Projection of rubber production and exports (in millions of tonnes).

Year	Production	Domestic consumption	Export
1980	0.485	0.028	0.457
1985	0.650	0.035	0.615
1990	0.903	0.046	0.857
1995	1.145	0.056	1.089
2000	1.242	0.060	1.182

Outlook for the Industry

Present Justification

Problems associated with natural rubber production (NR) are placing both producers and consumers in a very difficult position. A long-term stable supply of NR to the world market is obviously needed and demanded. Development in the natural rubber industry of Thailand places strong emphasis on the social welfare of smallholders. A Thai farmer's income is consistently low with little possibility of saving. The previous projections on rubber production as shown in Table 2 of 1.2 million tonnes in the year 2000 should be reconsidered.

Potential Rubber-Growing Areas

The national goal of 48 000 ha has been replanted annually; this means that new rubber plantings in traditional areas have been operated consecutively. Those farmers who own land themselves and are not qualified to be covered by the Replanting Program have started planting rubber in new areas ahead of time. RRIT has launched a suitable planting survey program of the existing agroecological zones as is shown in Table 3.

It is evident that the northeast is now a poor area that needs to be developed as soon as possible. Most farmers there are struggling with difficult climatic conditions where a vast area has been cleared for growing cassava and other shifting cultivation. RRIT has developed a few rubber test plots and the rubber yield after tapping has been found to be comparable with the traditional rubber area; however more emphasis is required on researching soils suitable for growing rubber and more test plots should be installed.

Research Program

The Department of Agriculture where RRIT is located has re-oriented the structure of the Institute. The objectives are now aimed at the direct transfer of new technology to farmers in each specific region. Three new rubber research centres, viz. Songkla, Suratthani, and Chacherngsao have recently been formed to represent wet, extremely wet, and semi-dry rubber growing areas.

The rubber experiment stations are located at Yala, Kokpremeng, Tarntoh, Klongtom, Kaochong,

Table 3. Existing and potential rubber areas (millions of hectares).

	South	West	East	Central	North -east	North	Total
Existing area	1.44	0.17	—	—	—	—	1.61
Potential area	—	0.16	1.27	0.16	2	1	4.59

Kokpo, Bajorh, Reusorh, Naichong, Kraburi, Talang, Bangpor, Koontalae, Wangtang, Chandi, Pongrat, Toongpel. Each rubber research centre has its own satellite research stations to carry out field research and development and training activities. The Chacherngsao Rubber Research Centre represents semi-dry and wet areas where there is a new planting program. It is located in the heart of the cassava growing area in the east. It is only a few hundred kilometres from Bangkok. In order to strengthen a new planting program in this region, an additional rubber station is being considered.

The research approaches likely to be implemented for developing the new plantings are:

VARIETAL IMPROVEMENT

Most of the rubber clones used for planting are widely adapted to meet the suitability of the traditional environment. A long-term breeding program is aimed at producing high yielding, vigorous material with the emphasis on stress tolerance, and wind resistance.

PLANTING MATERIAL

Using the correct planting material in a suitable place results in a higher growth rate. In areas where there is a pronounced dry spell during the planting season, both type and method of planting seem to be important factors.

Polybag material with at least one whorl of hard leaves is recommended in dry planting situations. Field budding onto seedling stock planted in the planting hole while the stem is green is another method, which is considerably cheaper than polybag planting but its slows down maturity by 6–12 months.

PLANTING AND UPKEEP

Semi-dry areas contain a low soil moisture content and have a high rate of evaporation from the surface of the ground. In order to conserve soil moisture for young rubber during the early developing stage, deep planting is recommended so that the rubber roots are in close contact with the underground water.

In semi-dry areas soil moisture is easily depleted if the soil surface is bared. A leguminous cover is usually practiced on most smallholdings to prevent moisture depletion and to add fertility to the soil. A prominent legume cover, viz. *Calopogonium caeruleum* is strongly recommended for planting as a soil cover. Mulching with grass or rice straw also conserves moisture and prevents weed growth as well.

Soil fertility in most areas of the northeast is usually depleted by successive cropping with cassava. Organic fertilisers improve fertility and the physical properties of soil.

INTERCROPPING

A major problem in the establishment of rubber plantations, especially at the smallholders level, is the family-earning situation during the immaturity period. National new planting programs have long considered how and whether the government should subsidise the farmers and if so, how much money should be paid per hectare. During the first 3–4 years, when farmers cannot earn to support their families, some short-term crops could be introduced to grow between rubber rows, as intercrops (e.g. banana and pineapple). Banana is a multipurpose crop; it provides edible fruit, soil moisture can be conserved by the stand, and the leaf-sheath is usable for mulching. Pineapple tolerates drought and can grow under rubber shade until the fourth year after planting rubber.

TAPPING SYSTEM

Latex can be extracted from the bark by different methods, Correct tapping by a skilled tapper gives a high latex yield. The alternate daily tapping system

Table 4. Summary of research and development activities in traditional and non-traditional rubber growing areas.

Future research and development activities	Area	
	Traditional	Non-traditional
Clone improvement	high yield	high yield
	vigorous	vigorous
	—	wind prone
	disease free	—
	—	tolerant to stress
	—	no wintering
Planting material	budded stump	—
	field budding	field budding
	large stump	—
	—	polybag
Planting & upkeep	normal	deep planting
	—	mulching
	normal cover	*C. caeruleum* cover
	chemical fertiliser	organic fertiliser
	row weeding	circle weeding
	—	branch induction
	—	wind break
Intercropping	—	banana
	pineapple	pineapple
	upland rice	legume
Tapping	conventional	low tapping intensity
		earlier tapping
Processing & marketing	latex	conc.latex
	air-dried sheet	polybag collection
	unsmoked sheet	cuplump

has been recommended to smallholders, at present. The tapping system likely to be introduced to new plantings where rainfall is lower is the low-tapping intensity system. The northeast region is a semi-dry area. Because temperature and humidity are correlated with sunshine, earlier tapping before dawn is another useful way to increase yield.

PROCESSING AND MARKETING

The activities of both processing and marketing are still premature. They are the final stages of rubber production at the smallholders level. Where the water supply is scarce, rubber sheet making is difficult and the processing method has to be modified. The polybag collection or cuplump of rubber in the field could be considered as another choice.

Future research and development activities in comparison between traditional and non-traditional rubber growing areas are summarised in Table 4.

TRAINING FOR NEW PLANTERS

New planters unfamiliar with rubber are a major problem in developing the improvement program. Various training courses are essential and could perhaps be organised in cooperation with other departments that are concerned with the program.

Concluding Comments

Rubber production in Thailand is increasing rapidly, and production has been forecast by RRIT to reach 1.2 million tonnes in the year 2000. A recent feasibility survey found that about 6 million ha of rubber-growing land are still available for new plantings. Further detailed surveys on the macro and micro environments need to be investigated. Preliminary results on yield, growth from various rubber test plots, and socioeconomic attitudes of farmers in the northeast show positive responses. The success of the program to strengthen the Thai smallholder rubber industry will require more inputs.

References

Krisanasap, S., and Kasem Intrasakul. 1984. Thai smallholder rubber industry, with special emphasis on cost and price. Presented at the International Rubber Study Group Meeting. June 1984, London.

Rubber Research Institute of Thailand. 1984. Thailand Rubber Statistics. Rubber Research Institute of Thailand, 13(2), 1–40.

Wasuwat, S. 1984. Rubber information of Thailand up to 1984. Presented to the Cabinet Committee on Agriculture and Cooperatives. October 1984, Bangkok, Thailand.

Rubber Research Priorities for Papua New Guinea

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THE rubber industry in Papua New Guinea (PNG) has been in existence well over 50 years. Considerable stimulus was given to it after World War II. It is currently estimated that there are about 8500 ha of plantation rubber, the major part of which is in the Central Province. The government commenced settling smallholder rubber blocks around 1960 and about 1900 ha have since been planted under such smallholder rubber schemes. These schemes are in Cape Rodney and Bailebo in the Central Province, Gavien in the East Sepik Province, Murua/Epo in the Gulf Province, a much lesser extent at Suki in the Western Province, and Kaiam in the Gulf Province (Fig. 1).

However, village rubber schemes account for about 60% of the total smallholder plantings and are widely spread over the whole country, with the largest proportion being in the Western Province. Total smallholder plantings (i.e. settlement schemes and villages) as of July 1984, are estimated at almost 6000 ha. This area is established on over 4500 smallholdings and spread through nine lowland provinces.

The rubber plantation sector has been generally unresponsive to the social changes and technological innovations that have been occurring in other producing countries, especially in the last 10 years. This is exemplified by the continued use of the contract system of labour employment, with its inherent practice of accommodation of labour under unsatisfactory conditions, by the absence of an organised, planned, and coordinated replanting scheme, and by the widespread use of clonal seedlings for replanting as opposed to budgrafted material. There is effectively no research and there is a lack of dynamism in the industry. As a result, PNG's net return per hectare with yields ranging from 0.3–1.5 t/ha is poor when compared with Malaysia, Indonesia, etc.

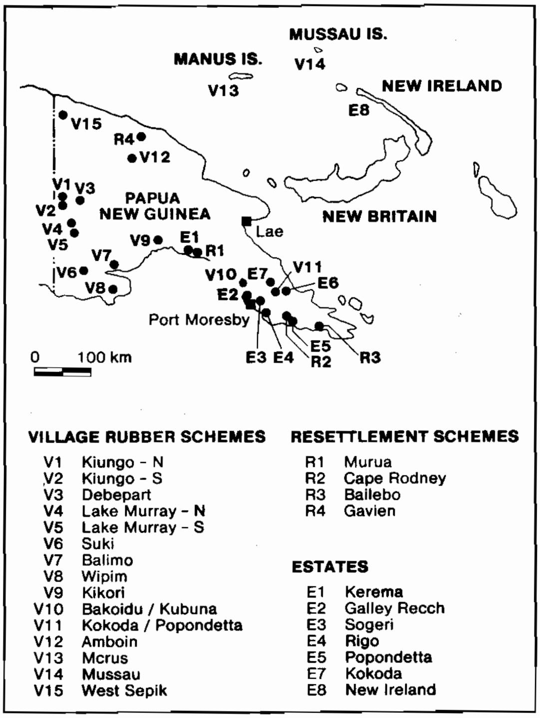

Fig. 1. Location of village rubber schemes, resettlement schemes and estates

This reluctance to change on the part of the plantation sector has resulted from political uncertainty from a basically inactive public sector policy stance, and the fact that the country's rubber has not been sold on a purely commercial international market, a 'captive market' for PNG's rubber having been created in 1958. This has been achieved by the annual renewal of an Australian customs bylaw (at the request of PNG) allowing natural rubber imports into Australia from other countries free of duty, in consideration of all of PNG's rubber being consumed in Australia.

Since independence, the Australian Government, through the Papua New Guinea Australian

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Trade and Commercial Relations Agreement (PATCRA), has undertaken to continue with the practice and purchase all of PNG's production of natural rubber. (Three of the leading tyre manufacturing companies in Australia take about 50% of PNG's rubber by mutual agreement). This marketing arrangement has enabled the growers in PNG to obtain the world price, without due consideration to quality.

Industry Structure

The present structure of the industry can be described as follows: The estate sector continues to account for the major portion of PNG's exports (greater then 80% in 1983). While the total area under rubber exceeds 8500 ha, about 50% of this is comprised of old 'retired' seedling rubber. Only at Galley Reach is any attempt being made to exploit this material. The largest group of estates, at Galley Reach, has recently come under the control of the Belgium Company, SA Sipef NV, and a K10 million redevelopment of 3500 ha commenced in 1984. This same company has expressed interest in a 4000 ha development at Cape Rodney to commence in 1986. The Sogeri Rubber Development Corporation has almost completed the first stage (300 ha) of their redevelopment program and in 1985 will commence a 600 ha second stage. By 1990 a total of 1200 ha will be replanted. A study has been completed by the Commonwealth Development Corporation recommending a possible 2000 ha redevelopment of Mamba by Higaturu Oil Palm Pty Ltd. Proposals to redevelop estates in the New Ireland and Gulf Provinces are at too early a stage to quantify any potential development. Doa, Sama and Mamba plantations operate their own technically specified rubber (TSR) factories and export their production as PNG Classified Rubber (PNGCR) grade 20 (predominantly). A number of smaller plantations, such as Sogeri, Mamai, Epo etc. are in various stages of disrepair and the subject of specific redevelopment proposals.

The extent of the rundown of the estate sector can be judged by the events of 1981 and 1982 when prices fell. As long as the prices received had been above the short-term costs of production, ageing trees were tapped, but in steadily reducing numbers. Rubber exports declined but earnings were sustained by rising prices until 1981. When, in 1982, prices fell, tapping ceased on uneconomic fields, or even on whole estates. This obviously demonstrates a strong price response on the part of these producers but in a very negative sense and as a result of the inherent inefficiency of the industry. Volumes, values and average prices for PNG rubber exports are shown in Fig. 2.

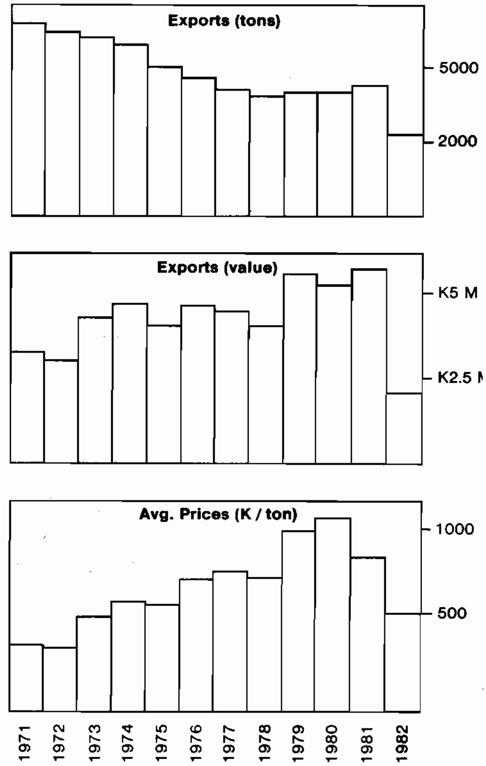

Fig. 2. Volumes, values and average prices of PNG rubber exports, 1971–82.

As much of the smallholder rubber was planted in the late 1960s most of this rubber could now be tapped. The Department of Primary Industry is now placing very high priority on bringing into production some 3000 ha of rubber. However, of an estimated 6000 ha of smallholder rubber probably less than 1000 ha is currently being tapped. The Asian Development Bank's (ADB) funded development of Gavien in the East Sepik has virtually been completed, with some 700 ha now established. A K25 million redevelopment and expansion of the Cape Rodney scheme, which will result in approximately 4000 ha being planted by 1990, began in 1984. Over the last five years considerable village plantings have been undertaken in the West Sepik, East Sepik, and New Ireland Provinces. The Government has established two TSR factories, at Cape Rodney and Gavien, which are capable of handling cuplump from both the schemes and adjacent village production. Delays in commissioning the Cape Rodney factory have resulted in little emphasis upon stimulating Central Province village production. At Bakoiudu/Kubuna 'Kunico' have commenced producing ribbed smoked sheet (RSS) from 300 ha of village blocks plus old plantations in the area. Northern Province has a well-established but very underutilised area of village and scheme plantings that are dependent upon the Mamba TSR factory for processing and marketing facilities. Redevelopment proposals for Bailebo and Epo/Murua schemes have, even after a considerable planning input by the Department of Primary Industry, not materialised.

The largest area of village plantings is established in Western Province where almost 1900 ha of rubber have been planted by over 1700 growers during the 1960s and 70s. However, it is estimated that less than 20% of this is being tapped at present. This is an area of great concern to the future development of this subsector of the industry. In a region relatively disadvantaged by problems of poor soils and accessibility, rubber offers an actual and potential source of cash income for smallholder/village level cultivators, which other crops cannot match. As a result of the difficult local conditions, plantings of rubber are fragmented and producers face considerable difficulties in marketing their crops. On grounds of equity alone, and within the context of PNG's overall development, attention needs to be given to producers in this area.

In general terms, therefore, the rubber industry in PNG is highly undeveloped compared with other countries in the Southeast Asia/Pacific Region. The estate sector has failed to respond to the technological improvements from overseas in the face of local difficulties of both political and economic dimensions, i.e uncertainties around the time of Independence, continuing land tenure problems, and the undeniably relatively high costs of establishment and maintenance of estates within the country in the face of what at the time seemed a long run decline in demand and, therefore, price for natural rubber. Estates are also small and mostly uneconomic; their past 'management' has been indifferent to technical change and owners often live overseas. Smallholder production has been constrained by the absence of an efficient and dynamic estate sector to lead the way in technology adoption by the absence of an adequate and appropriate extension effort and by marketing difficulties as a result of operating in difficult infrastructural conditions.

However, recent developments in the industry have led to a resurgence of interest in rubber within PNG and largely explain the recent developments described earlier. In particular, the worldwide switch to radial car tyres in the 1970s gave a new lease of life to natural rubber, which had long been losing its share of the elastomer market to synthetic rubber. Global consumption of natural rubber is now expected to rise by some 50% to 6 million tonnes a year by the end of the century, and consequently price projections are far more favourable to producers. As well as this the relatively recent (at least for PNG) developments with respect to the production of cuplump (instead of latex) and TSR rubber have made potential returns, especially at the smallholder level more attractive (although difficulties still exist in PNG about distances to processing facilities). The conversion to production of cuplump has also changed significantly the economics of tapping the old abandoned areas of plantation rubber. Some upwards or high level tapping is also proving profitable and hence extending the life of these trees. Investment in rubber production can now seem more attractive for all types of producers, and great scope would seem to exist for the expansion of the industry in PNG.

There is, however, a great shortage of reliable information about the actual state of the industry in PNG, and the lack of a mechanism to regularly gather it. In particular, there is a serious absence of data on estimated costs of production for different types of producers in different areas. This has a number of implications for appraising proposed new developments as well as for understanding and monitoring the current situation. There is also very little understanding of the potential for technology transfer to smallholders from the newly established estates, as well as the whole farm situation of smallholder producers, i.e. how rubber production may conflict with food crop production. Low-output volumes and low-importance ratings to the industry have also discouraged an analysis of price response for smallholders, and there is consequently little knowledge about the need for, or desirability of, a stabilisation scheme for rubber producers. Work also needs to be done on designing an appropriate and equitable marketing system for rubber, if the difficulties associated with producing in inaccessible areas are to be addressed. Issues also arise from the present pricing and sale arrangements of rubber in Australia.

Research Needs

It is therefore apparent that great scope exists for research work in all of the above areas. Of prime importance though must be the need to take stock of the industry at present, especially with respect to defining costs of production and the present technological practices of smallholders. This type of data could most likely be collected in the course of an agroeconomic survey of the type to be undertaken in PNG for coffee, copra and cocoa (funded by ACIAR) over the next few years. It would hopefully serve as a benchmark to monitor future constraints to production. The Papua New Guinea Export Tree Crops Study is a collaborative research project (Queensland Department of Primary Industries) funded by ACIAR with the objective of collecting data for the major export tree crops of PNG to provide a national baseline data source and to set up a suitable survey methodology, which would be replicable over time. In the course of the survey estimates of numbers and types of producers by area, yield distributions, agronomic practices, levels of technology used, costs of production, ways of cash cropping interacting with food production, marketing arrangements etc, could potentially all be obtained. Equally important, however, is that an appropriate methodology be identified for the monitoring of changes in these variables over time.

A major feature of current and historical agronomic information within PNG is that available data are 'patchy' in the sense that a nationally comparable time series for even the major crops and producers does not exist: what information there is, is usually of an 'ad hoc' nature and has been collected for a specific purpose. This applies as much, if not more so, for the rubber industry. Indeed the collection of agronomic information for rubber poses special problems in view of the geographical dispersion of the industry over a very wide and often inaccessible area, with smallholder village plantings especially being both scattered and small in size. The design of an appropriate sampling method in view of these conditions is therefore obviously apparent, within the need to collect basic agronomic data on a national basis.

The second major area of concern regarding knowledge of rubber producers is to measure costs of production for different types of producers and to explain differentials both between different types of producers and amongst apparently similar producers. Such information may be a subject of data collected in the course of a major agroeconomic survey, but is more likely to require more detailed work at particular geographical locations. Identifying and explaining differentials in costs of production should help extension efforts to raise the productivity of those producers who are currently well below some production possibility frontier (i.e improvements made at the intensive margin) by the recommending of improved practices. The identifying of optimum sizes of producing and processing units to realise the benefits of economies of scale should also be possible. Lack of understanding about industry costs of production is obviously a result of variability in estimates of those major parameters that determine costs per unit of output, viz. yields, establishment costs and input costs, prices received etc. Yield estimates in particular are highly variable. Whilst it is realised that the use of budwood stock and budgrafting skills can result in yields of over 2000 kg/ha, actual yields are usually far lower. The best estate yields are currently thought to be around 1200–1300 kg/ha, with poorly managed estates at around half this level. Smallholder resettlement schemes probably average about 500–600 kg/ha at present, although yields of almost double this size can be consistently maintained by good smallholdings. Village plantings of rubber have largely unknown yields, but would likely be in a range of 200–600 kg/ha.

The paucity of reliable information about the parameters that determine unit costs of production and the factors that influence them is not confined to yield estimates alone. In particular, estimates of establishment costs vary greatly: the World Bank estimated K1,600/ha for the Mamba project whilst Cape Rodney has budgeted around K2,500/ha for a similar situation. The differences in these estimates of basic technical parameters makes it especially hard to assess project appraisals. On the basis of their data, for example, the Commonwealth Development Corporation (CDC) indicated to PNG Government that in their opinion, returns on investment in rubber at Cape Rodney were inadequate to justify investment. Two other studies of rubber investment proposals at Galley Reach (by Sipef) and Mamba (by the World Bank/FAO Cooperative Program) have indicated viable projects. Sipef in fact indicated considerable interest in the land at Cape Rodney that CDC had said would not justify investment. The result of differences in estimates of yields, costs, etc. is naturally a great difference in the rate of return estimates to projects. Again, CDC estimate returns to be 16% below the Malaysian average, whilst Sipef estimate 8% below and the World Bank 4% below. The situation is further not helped by differences in assumptions about the economic life of rubber trees in projects. There is therefore a great need within PNG to develop a data base of technical relationships for a range of conditions and situations against which proposals for rubber investments can be assessed.

The next major requirement is to document current technological practices used by both smallholders and estates in relation to practices used internationally, especially with respect to tapping systems and tapping technology. Gouge tapping knives are still often used on estates despite heavy bark consumption and panel wounds. There has been no widespread experimentation or adoption of more modern techniques such as micro or puncture tapping. On smallholdings, widespread damage to trees has resulted from poor tapping practices. (Village producers typically adopt a full spiral every fourth day rather than various half spirals, as this fits in more with traditional lifestyles). A major extension effort must be to improve tapping practices and particularly to reduce the level of skill required in tapping. Options for the introduction of relatively new tapping arrangements for smallholder and village blocks could also be investigated. An example of this could be the 'share tapping' system as used in Malaysia (where school leavers and others stay on village blocks, and proceeds are split between workers and owners).

The same 'technology gap' between PNG and major Southeast Asian producing countries applies with respect to other factors of rubber production and it is a high priority to glean information about them. The majority of rubber planted in PNG for example is still clonal seedling material and the transition to budgrafted stock, whilst it is occurring could be faster. Similarly there is a need to document the extent of adoption of high-level tapping and stimulation practices, as well as the measures used to reduce the immaturity phase of rubber trees. Knowledge of current practices within the industry on a national basis is a prerequisite for formulating plans for industry development, and for understanding why rates of adoption of new technology have not been higher. Within this area of identifying current technological constraints to expansion and the state of the art in PNG is the need to develop appropriate and fruitful links with institutions overseas that are conducting agroeconomic research. The rubber industry in PNG at present cannot support a large research program and so it is important that PNG takes advantage of research results from institutes such as the Malaysian Rubber Research and Development Board and the Rubber Research Institute of Malaysia, adapted where necessary for local conditions.In general terms, therefore, there is a need to identify the extent of relative underdevelopment of the rubber industry in PNG with respect to technological practices and to devise suitable strategies for long-term improvement.

Another main area of concern with respect to technological practices needs is the extent of 'flow down' from estates to smallholders regarding technological innovation. PNG does not have a history of nucleus estate type developments in relatively high population density areas with which to compare its experience with SE Asia. Until recently, the development of estate and village rubber was relatively separate: there is therefore a need to define what is appropriate as regards future strategies for resettlement schemes, nucleus estates etc. so as to extract the maximum benefits from technology transfer. Given PNG's attempted development path, and expecially in view of the need to 'create productive employment opportunities' as part of the Medium Term Development Strategy the design of a rubber development strategy in this context is critical.

Recent studies (Blencowe, undated) advocate for PNG some form of nucleus estate type developments with the private sector being encouraged to not only achieve high rates of planting and replanting and hence output, but also to play a major training role: desired targets could only be achieved if private enterprise were to be encouraged to participate, inject additional funds, and concurrently—as a vital part of the nucleus estate concept—assist parallel development in the smallholder sector. Well-staffed and well-financed estate companies could achieve the rate of planting or replanting envisaged, but major training programs would be required to create the pool of skilled tappers that would be needed when the new trees reached maturity . . . modern processing methods (i.e the production of TSR) not only require very high capital input, but also require large, very stable throughput in order to reduce unit costs . . . it is for this reason that dependence for throughput entirely on smallholders is not economically feasible and hence the need for nucleus estates.

While this is fairly apparent from experiences in other countries as well as PNG, and it is in fact government policy to encourage the establishment of a series of nucleus estates throughout the country, particular problems remain for PNG. Figure 1 shows the distribution of rubber throughout PNG and highlights the fact that most village rubber is in the highly inaccessible Western Province whilst most estate rubber is on the Papuan coast and New Ireland. There is little likelihood that estate development could be encouraged on an entirely commercial basis in the remote area of the Western Province: there is therefore a need to develop appropriate extension inputs into the region if the substantial areas of village plantings are not to deteriorate, either relatively or absolutely. Possibilities for some kinds of subsidised private/government estate developments could also be investigated (perhaps some small-scale estates with peripheral village extension/training components?). It is also the case that the optimum sizes of processing facilities are too large to serve individual development areas of smallholder village planting: the likely medium-run situation is that rubber would continue to be best transported to the TSR factory at Cape Rodney for processing. Issues surrounding prices offered to smallholders and to what extent actual or implied subsidies are given to encourage production therefore exist, and are discussed below. Issues surrounding technology transfer therefore exist in two contexts for PNG: firstly, and as in other countries, as regards how to design new settlement/nucleus estates to realise the full economic and socioeconomic benefits from having a mix of producers at the same location; and secondly, how to develop strategies to raise the productivity of village rubber producers in situations where they will typically be without the type of technical and logistical support that estate/settlement schemes can provide.

As well as understanding the current level of technology used by smallholders, there is also a great need in PNG to develop an understanding of the 'whole farm' situation of smallholders. Rubber is usually promoted as an ideal smallholder crop in that its establishment and exploitation are extremely labour intensive, it requires low inputs of fertilisers and pesticides (and hence low cash outlays), and it can be harvested irregularly as and when cash needs/traditional obligations dictate etc. However, problems exist in this area, which make PNG unique, and which result in very low tapping rates of trees when compared to SE Asian countries (probably only around one-third of tappable trees on smallholdings are exploited in PNG). Amongst the Association of Natural Rubber Producing Countries (ANRPC), PNG is unique in the level of monetary orientation of its smallholder producers. Basically subsistence lifestyles predominate in virtually all regions, including the rubber growing areas (which are some of the least developed parts of the country). Provinces such as Western, Gulf, East Sepik, and West Sepik and rubber growing areas in general are areas of low natural resource endowment and, as such, have been slow to develop a modern economy, resulting in high outmigration and extremely low per capita incomes as well as poor levels of nutrition and high child morbidity and mortality rates. Effects of this are a low volume of trade in consumer items, very limited outlets for expenditure and a low cash crop output. Indicative of limited cash needs and of other preferences for labour times therefore is the low level of mature tree exploitation on smallholdings. Smallholder rubber producers thus face a situation where not only is disposal of their produce hampered by geographical and infrastructural conditions but also their demands for cash to spend on consumer items are severely limited by the absence of modern goods. Obviously the initiatives to development in such areas must involve more than just rubber extension work. Not only must marketing arrangements be substantially improved (as discussed below) but the supply of consumer goods/spending opportunities must be increased. Work can be done on the best way to achieve this.

The difficulties that preclude the establishment of viable commercial rubber developments in areas where smallholders currently produce rubber have also precluded the establishment and development of a private marketing system. As a result the Department of Primary Industry has acted as a 'buyer of last resort' for smallholder producers. This is obviously an unsatisfactory situation with regard to the speedy transmission to the smallholder of correct market signals. The system in the past has proved cumbersome and considerable problems have arisen as to prices offered and exactly what degree of costs of transport and processing have been borne by smallholders and what degree by government. The situation in recent years has improved with private buyers beginning to operate in Western and Northern Provinces but elsewhere government continues to control the marketing services. The situation is now entrenched in many ways but options for the complete hand-over of marketing to private operators need to be investigated. Data on costs of transport of produce from particular areas as well as processing costs need to be collected as a way of ensuring relatively fair pricing. Government's role should ultimately be one of monitoring the system rather than running it.

Another major area of economic research on rubber production and disposal in PNG relates to the mechanisms of pricing of the produce. Within this area, there are the questions of the appropriateness of the present pricing policy, smallholder supply response to price and the need (or otherwise) for a price stabilisation scheme (as presently exists in PNG for coffee, copra, oil palm, and cocoa). At present all of PNG's rubber goes to Australia (under PATCRA) and is sold at a price fixed in relation to those prevailing on the first trading day of each month in Kuala Lumpur and remains in force for the whole month. Whilst from PNG's point of view it may be desirable to have preferential access to the Australian market, this pricing policy is disadvantageous in inflationary periods and is compounded by delays in payments. Alternatives for more frequent pricing arrangements need to be studied, as well as the mechanism by which these prices are passed on to growers at the farm gate or factory door. More important, however, are the questions of supply response and the related need for a rubber stabilisation scheme. No work in PNG has been done on measuring or explaining the degree of supply response to price changes of rubber on the part of smallholders. However, it is felt (certainly by the Rubber Industry Section of the Department of Primary Industry) that smallholders are highly price-responsive and that quantities offered at factory door directly relate to prices offered. Indeed there is current concern that the December 1984 selling price of K77 per tonne is much lower than the previous months' prices, which allowed a factory door price of K450/t to be paid. In a situation in which active development of the industry is being encouraged, the need for a scheme to stabilise, in the long term, prices paid to producers should be addressed. This is especially so in a situation where long-term prices are regarded as being essentially favourable and where low-prices are temporary but can have substantial effects on production. Whilst the question of the establishment of a rubber stabilisation scheme has been rejected in the past because of the small size of the industry, and is unlikely to be popular with large commercial producers, the fact that government desires to expand the industry, and particularly smallholder involvement, suggests that the question does merit attention. It is presently proposed that a joint PNG Department of Primary Industry and Australian Bureau of Agricultural Economics study be conducted on the history and effectiveness of operations of the coffee, cocoa, and copra stabilisation schemes: the same methodology and intention can be applied to rubber.

Conclusions

The foregoing paragraphs have detailed the state of the rubber industry in PNG. There is a need to design strategies for the future development of the industry, and especially for increasing smallholder involvement, in view of the fact that it is unlikely that a dynamic commercial estate sector will provide the type of overall lead that it apparently has in other countries, and has in other industries in PNG. In particular, there is a need to understand and improve the situation of smallholder producers in remote areas on both the grounds of equity and efficiency. Accordingly, the following areas of research have been suggested as needful in this respect:

1. Taking stock of the present status of the industry as regards the major production parameters of yields, areas, input usage etc.
2. Estimating costs of production and explaining differentials between producers.
3. Understanding the 'whole farm' economics of the small producers and designing strategies to help them best profit from nucleus estate/resettlement situations.
4. Addressing the issues of improving the marketing system and improving the supply of consumer goods to rubber producing areas.
5. Analysing the supply response of producers and determining the need for, and type of, price stabilisation scheme.

References

Blencowe, J.W. A development programme for the rubber industry. FAO/UNDP Project PNG 78/005.

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No. 1. Proceedings of the Eastern Africa-ACIAR consultation on agricultural research, Nairobi, Kenya, 19-22 July 1983. J.G. Ryan (ed.), 241 p., 1984.

No. 2. Proceedings of the international workshop on soils, Townsville, Qld., Australia, 12-16 September 1983. E.T. Craswell and R.F. Isbell (ed.), 189 p., 1984.

No. 3. Shrub legume research in Indonesia and Australia: proceedings of an international workshop, Ciawi-Bogor, Indonesia, 2nd February 1984. E.T. Craswell and Budi Tangendjaja (ed.), 42 p., 1985.

No. 4. Proceedings of the Nigeria-Australia seminar on collaborative agricultural research, Shika, Nigeria, 14-15 November 1983. S. Nuru and J.G. Ryan (ed.), 145 p., 1985.

No. 5. Evaluation of large ruminants for the tropics: proceedings of an international workshop held at CSIRO, Rockhampton, Queensland, Australia, 19-23 March 1984. J.W. Copland (ed.), 178 p., 1985.

No. 6. Soil erosion management: proceedings of a workshop held at PCARRD, Los Baños, Philippines, 3-5 December 1984. E.T. Craswell, J.V. Remenyi, and L.G. Nallana (ed.), 1985.

No. 7. Goat production and research in the tropics: proceedings of a workshop held at the University of Queensland, Brisbane, Australia, 6-8 February 1984. J.W. Copland (ed.), 1985.

No. 8. Tropical legume improvement: proceedings of a Thailand/ ACIAR planning and coordination workshop, Bangkok, 10-12 October 1983. G.J. Persley (ed.), 77 p., 1985.