ALLOCATION OF LABOUR IN SMALLHOLDER RUBBER FARMS IN A SELECTED RUBBER GROWING AREA IN SRI LANKA: A CASE STUDY

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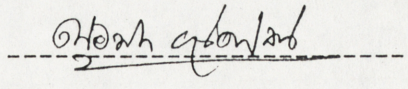
A dissertation submitted in partial fulfilment of the requirements for the degree of Master of Agricultural Development Economics in the Australian National University.

September, 1980.

DECLARATION

Except where otherwise indicated, this dissertation is my own work.



September, 1980.

H.D.B.H. Gunasekera

TO MY DEAREST PARENTS

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ABSTRACT

Investigations into the allocation of labour on smallholdings, with respect to rubber farming in combination with other crop farming activities, have been very limited in Sri Lanka. This study is aimed at examining how farm labour is allocated among different farming and non-farming activities of the mixed smallholder rubber farms in a selected rubber growing area in Sri Lanka. A case study approach is followed with a sample of 10 farms from 3 villages in the Hedigalla Rubber Extension Officers Division in Kalutara district.

Two methods of analysis are employed in this study: (a) simple tabular and graphical analysis and (b) whole farm analysis which is an application of the linear programming (LP) technique.

Simple tabular and graphical analysis gives insight into the existing farming situation of these farms and identifies the key factors which influence the labour use pattern. It also shows possible reasons for the inter- and intra-farm variations in labour use. Whole farm analysis using the LP technique generates optimal farm plans for two selected medium sized farms within the sample. Optimal farm plans are generated in respect of two different farming conditions: with and without rubber replanting.

Simple tabular and graphical analysis reveals that traditional technologies dominate in paddy farming activities among the case study farms. A variation in allocation of time for different paddy farming activities between, as well as within, the Maha and Yala seasons has been observed among these farms. Seasonality in expected labour use in paddy farming prevails in these farms. Also they show a relatively

high degree of variability in expected labour use per ha. with regard to paddy farming activities. This includes inter-farm variations in both Maha and Yala seasons as well as intra-farm variations between seasons within the same farms. Two types of variation in expected labour use in rubber tapping have been identified. They are: (i) variations in expected labour use within the individual farms between different months of the year, and (ii) variations in expected labour use between the individual farms within different months of the year. Also, except for felling and clearing the old rubber stand, the inter-farm variation in the expected labour use is relatively low for all the other rubber replanting activities among these farms.

LP solutions present a staggering of paddy planting and rubber replanting for both the farms selected for the whole farm analysis. However, the marginal opportunity cost (MOC) of not staggering the paddy crops is very low. The marginal value product (MVP) of labour for the farmer with less family labour is raised during peak periods. The MVP of cash remained low for both the farms under both replanting and non-replanting conditions. Inclusion of rubber replanting vectors has raised the cash surplus for both the farms considerably.

As a whole this study has been useful in indicating positive directions towards altering certain farming activities so as to accommodate new farming activities such as technologically improved paddy farming techniques and rubber replanting.

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CHAPTER 1

INTRODUCTION

1.1 Importance of the Rubber Industry in Sri Lanka

Rubber, which was introduced to Sri Lanka in 1876, has over the past 103 years developed into a major economic asset. It is the second largest export earner in the country. During the period 1958-1977 its share of the total export earnings varied within the range 14-22 per cent (Table 1.1). Also, the rubber industry accounts for around 10 per cent of the value of total agricultural production (EIU, 1979).

According to a recent aerial photo analysis, the total rubber area in Sri Lanka is about 210,465 ha (CDC,1979). This is nearly 12 per cent of the total land cultivated. Most of this rubber is grown in the wet zone or the south-west part of the country which is characterised by high population and adequate rainfall. The distribution of rubber lands by district is set out in Table 1.2.

The industry's contribution as a source of employment is estimated to be over 100,000 persons in the estate sector and nearly 150,000 in the smallholder sector (Jayasuriya, 1976).

Therefore, the rubber industry plays a major role in the economic life of Sri Lanka in terms of land use, provision of employment and earning of foreign exchange.

1.2 Importance of the Smallholder Sector in the Rubber Industry

Rubber is grown in large plantations as well as in smallholdings in Sri Lanka. The distribution of rubber holdings by planted area is given in Table 1.3.

The ownership of rubber lands has undergone a major change in the recent past. The Land Reform Law No. 1 of 1972 vested privately

TABLE 1.1

COMPOSITION OF EXPORTS OF SRI LANKA, 1958-1977

(Value in Million Rupees at current prices)

Year	Tea		Rubber		Various Coconut Products		Other Domestic Products		Re-Exports		Total Exports	
1958	1132	(66.2)	258	(15.1)	164	(9.6)	97	(5.7)	59	(3.4)	1711	(100)
1959	1046	(59.6)	298	(17)	244	(13.9)	104	(6)	62	(3.5)	1754	(100)
1960	1096	(59.8)	378	(20.7)	184	(10)	117	(6.4)	57	(3.1)	1832	(100)
1961	1115	(64.3)	260	(15)	202	(11.7)	104	(6)	52	(3)	1733	(100)
1962	1149	(63.6)	290	(16)	227	(12.6)	100	(5.5)	42	(2.3)	1808	(100)
1963	1140	(65.9)	257	(14.8)	198	(11.4)	110	(6.4)	26	(1.5)	1731	(100)
1964	1148	(61)	290	(15)	273	(15)	137	(7)	34	(2)	1876	(100)
1965	1210	(62)	304	(16)	275	(14)	127	(6)	33	(2)	1949	(100)
1966	1027	(60)	337	(20)	196	(12)	116	(7)	24	(1)	1700	(100)
1967	1061	(62)	282	(17)	167	(10)	121	(7)	59	(3)	1690	(100)
1968	1162	(57)	331	(16)	331	(16)	152	(8)	60	(3)	2035	(100)
1969	1062	(55)	431	(22)	221	(12)	161	(8)	41	(2)	1916	(100)
1970	1120	(55)	440	(22)	240	(12)	195	(10)	38	(2)	2033	(100)
1971	1144	(59)	307	(16)	280	(14)	199	(10)	17	(1)	1947	(100)
1972	1162	(60)	265	(14)	226	(14)	230	(12)	16	(1)	2009	(100)
1973	1261	(48.2)	592	(22.6)	145	(5.5)	487	(18.6)	21	(0.8)	2617	(100)
1974	1360	(39.2)	738	(21.3)	397	(11.4)	952	(27.4)	25	(0.7)	3472	(100)
1975	1932	(49.1)	654	(16.6)	397	(10.1)	941	(23.9)	10	(0.3)	3933	(100)
1976	2100	(43.6)	890	(18.5)	382	(7.9)	1430	(29.6)	14	(0.3)	4815	(100)
1977	3503	(52.8)	931	(14)	335	(5)	1846	(27.8)	23	(0.4)	6638	(100)

Note: Figures in brackets denote percentage of total exports.

Source: Central Bank of Ceylon, Annual Review, 1958-1977

TABLE 1.2

DISTRIBUTION OF RUBBER LANDS BY DISTRICTS

District	Extent (ha)
Kalutara	42,400
Kegalle	61,400
Ratnapura	38,100
Colombo	31,400
Galle	15,700
Matara	7,600
Kurunegala	5,900
Matale	2,800
Kandy	3,400
Moneragala, Badulla	1,765
Total	210,465

Source: CDC (1979).

TABLE 1.3

DISTRIBUTION OF RUBBER HOLDINGS BY SIZE

Type of Holding	Extent (ha)	Per Cent
Smallholdings:		
0 - 4 ha	64,192	30.5
Estates:		
4 -40 ha	48,828	23.2
40 ha and above	97,445	46.3
Total	210,465	100.0

Source: Constructed with the use of date from CDC (1979) and Rubber Controller's Department (1974).

owned rubber lands above 20 ha in the Land Reform Commission. This was followed by the Land Reform (Amendment) Law No. 39 of 1975 which vested all company owned rubber lands in the same commission. The distribution of rubber lands by ownership after these changes is indicated in Table 1.4. Tables 1.3 and 1.4 show the importance of the smallholder rubber sector in the rubber industry of Sri Lanka from the point of view of holding size and ownership.

TABLE 1.4

DISTRIBUTION OF RUBBER LANDS BY OWNERSHIP

Ownership	Extent (ha)	Per Cent
Smallholdings:		
0 - 4 ha	64,192	30.5
Other privately owned estates:		
4 - 20 ha	101,234	48.1
State Plantations Corporations & Janatha Estates Development Board	45,039	21.4
Total	210,465	100.0

Source: Constructed with the use of data from CDC (1979) and Rubber Trends (1979).

1.3 Justification for the Study and Objectives

Rubber smallholdings consist mainly of scattered individual farms. A large proportion of these actually consist of small mixed farm units where paddy, coconut, tea and other subsidiary crops are also grown (Barlow et al., 1975). In addition to farming their own land, some rubber smallholders are engaged in farming as well as non-farming activities outside their own farms. Also, even in the case of farmers farming their own land,

situations occur where farm family labour and/or non-family farm labour is used. In effect, one could say that specialisation in rubber hardly exists in smallholder rubber farms, and the manner in which labour is allocated among different farm and non-farm activities in addition to rubber farming is therefore of importance. Although the studies on the Sri Lankan rubber industry by Hansen (1969), Silva (1974), Barlow et al (1975) and Jayasuriya (1977) have dealt with the labour use in rubber smallholdings, they have not attempted to investigate the allocation of labour in rubber smallholdings with respect to rubber farming in combination with other crop farming activities.

An important aspect of farm labour utilisation is its availability during different periods of the year. In the mixed farm units of smallholder rubber farms, the types of crops grown, their age, and the time and amount of labour use in different cultural practices will have a substantial effect on the pattern of labour use. The availability of farm labour and the allocation of that labour could have an important relationship with the type of crops grown, the time periods of certain cultural practices and, in particular, the extent to which certain cultural practices are time-specific.

The objectives of the study arise from the above observations. They are as follows:

(a) to examine how farm labour is allocated among the farm and non-farm activities of the mixed smallholder rubber farms, across the year;

(b) to investigate the relationship between the labour allocation pattern in these farms and the different marginal value productivities of labour, during different time periods of the year;

(c) to study the relationship between the labour allocation pattern and (i) the type of crops grown, and (ii) the time-specific and non-time specific farming activities.

CHAPTER 2

THE FIELD SURVEY

2.1 Method of Data Collection adopted in the Survey

Forward planning and budgeting is an important technique, widely used in farm planning processes such as evaluation of alternative farm plans and resource allocation. In using this technique in relation to small peasant farms, the generally adopted practice has been to rely upon the basic input-output data, collected through continuously maintained historical farm records. However, some economists have recently attempted to develop an alternative means of data collection for forward budgeting, which does not involve maintaining detailed historical records. This alternative method in contrast with the detailed historical farm records, involves constructing statements of farmers' expectations about the output and inputs for different crops, based on the experience of the farmers (Barlow et al., 1979). Such statments could be elicited through a few interviews within a relatively short period of time rather than from a large number of historical farm records.

Although the "farmers' expectation" method, in contrast with the "continuous farm record keeping" method is less time and resource consuming, it has its own weaknesses. One major weakness which could arise if proper precautions are not taken, is the lack of accuracy of the data which it will provide. Despite the fact that perfectly accurate data could not be obtained from any means of data collection, availability of accurate data is essential for any socioeconomic research. The accuracy of the data collected from the "farmers' expectation" method could be improved:

(a) by getting well acquainted with the farmers. In the process of getting acquainted with the farmers, the interviewer could win the confidence of the farmers and establish a high degree of rapport with them,

so that they would be more likely to provide more accurate information; and, (b) then using a detailed questioning procedure which includes cross checking of the information collected.

By making a simplified realistic assumption that farmers are reasonably well aware of their input requirements and output levels for the various crops and livestock products they have been producing for a long period of time,[1] one could expect reasonably accurate data from the "farmers' expectation" method. Nevertheless, the possible upward or downward biases in input requirement and/or output level data which could arise in this method must be borne in mind. Such biases would generally appear to result in overestimation of inputs such as human labour and animal power, etc., and underestimation of output levels. Needless to say the only way of minimising such biases and obtaining more accurate data is to follow the precautions which have been described above.

The writer has used the "farmers' expectation" method as the principal method of data collection in the field survey for a number of reasons: unavailability of continuously kept historical farm records for smallholder rubber farms with regard to rubber farming as well as other farming activities; limited availability of resources and particularly of time for the present study; and reasonably adequate reliability of the method as a means of collecting the required data.

2.2 Objective of the Survey and the Sampling Procedure

The main objective of the field survey was to collect data pertaining to the expected labour use pattern, among the farm and non-farm activities of a sample of smallholder rubber farms, throughout the year, and for this purpose a "case study approach" involving a smaller number of farms was deliberately selected as a more appropriate method of carrying out this

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1 Nevertheless, one could always question the applicability of the "farmers' expectation" method in a situation where the respondents are completely new to farming.

study. A "case study approach" in contrast with a more general sample survey involving a larger sample has the great advantage of allowing more opportunity for in-depth investigation and appreciation of the social, economic and physical environment within which the activities under study are observed. It was felt that the "case study approach" would provide a greater understanding of the relatively complex process of labour allocation among different farming activities in the smallholder rubber farms selected for this study.

The field survey was carried out among a sample of smallholder rubber farmers in the second largest rubber growing district in Sri Lanka, namely Kalutara (see Figure 2.1), over a period of six weeks between December 1979 and January 1980. Among the rubber growing districts Kalutara has the largest number of rubber smallholdings (less than 4 ha in size). This is about 30 per cent of the total number of about 150,000 rubber smallholdings (Department of Rubber Controller, 1974).

The Agricultural Census of 1973 reported that of all the agricultural holdings[1] in Kalutara district, about 94 per cent are about 2 ha in size and about 91 per cent are operated by owner operators. Therefore, it was necessary to achieve a measure of representativeness of the sample farms, that these farms were less than 2 ha in size and owner operated. Farms

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1 An Agricultural Holding consists of all the land and/or livestock used wholly or partly for agricultural production irrespective of title, size, legal form or location and is operated under one management and as a technical unit. By technical unit is meant all that land which has the same management and the same means of production such as labour force, machinery and animals.

The basic unit of enumeration at this census was the "Agricultural Holding". The land comprising the agricultural holding consisted of one or more parcels, situated in one or more locations. Sometimes a part or parts of a holding may be situated in a different administrative unit. Such cases occur mostly in highly urbanised areas where some operators have large parts of their agricultural holdings located outside the administrative unit in which they are residing.

which have decided to undertake replanting of rubber in the near future, was another criterion to be considered in choosing the sample farms, since it was expected to consider rubber replanting also as one of the activities in studying the labour use pattern of the smallholder rubber farms.

The absence of a suitable sampling frame which would help to select a sample of farms with the abovementioned characteristics, did not allow the adoption of a sophisticated sample selection procedure in the field survey. The biases, inaccuracies and the limitations of the statistical information available from the Rubber Controller's Department register, Census and Statistics Department's Census of Agriculture - 1973, and Agricultural Productivity Committee 1974 Land Tenure Report, as sources of information to construct a proper sampling frame are discussed by Jayasuriya (1977) and CDC (1979). According to Jayasuriya (1977) and CDC (1979), the statistics maintained by the Rubber Controller's Department are derived from an unsatisfactory registration system, and are unreliable; again, the data available from the Census of Agriculture - 1973, and the Agricultural Productivity Committee 1974 Land Tenure Report do not contain any detailed information on holding size distribution below 4 ha. Under these circumstances it was decided to adopt an ad hoc procedure and it could be best described as a purposive sampling procedure.

2.3 Location of the Survey

In selecting an area for the field survey in Kalutara district, the criteria discussed in the foregoing subsection 2.2. i.e. farm size, operational status, and the farmers' decision to replant were taken into consideration. In addition to that, the ability of the extension officers in assisting in carrying out the survey including pre-conditioning the respondent farmers, and farmers' willingness to cooperate in the survey, in the area to be selected were also considered; because extension officers are the most important agents through which the interviewer could contact,

win confidence and communicate with the respondent farmers and also without proper cooperation of the respondents a field survey could not be carried out successfully.

The area selected for the survey, namely Hedigalla Rubber Extension Officer's Division in Kalutara district is located in the wet zone or the south-west part of Sri Lanka (see Figures 2.1 and 2.2) and it covers about 85 square kilometres. This area experiences two peak periods of rainfall corresponding with the monsoons of north-east and south-west. The periods which get north-east and south-west monsoonal rains are known as Maha[1] and Yala[2] seasons respectively. The average annual rainfall in the area under study (five years) is about 4,845 mm. However, the rainfall is not evenly distributed, there being markedly drier periods in January, February, July and August.

Paddy cultivation is the major farming activity next to rubber farming among the smallholder rubber farmers in the area. In addition to rubber and paddy, they cultivate coconut, cinnamon and other subsidiary crops.

The high rainfall in this area frequently interferes with rubber tapping and the average number of days of tapping per year are less than 200.

Paddy is grown both in Maha and Yala seasons under rainfed conditions. Most of the smallholdings in this area are semi-subsistence farm units, in which part of their produce (i.e. rice) is consumed domestically and the rest (i.e. rubber) is marketed. Also, these farms combine the features of a firm and a household, involving both production and consumption in the same economic unit, that is, a part of their inputs comes from the household and a part of their produce goes to the household.

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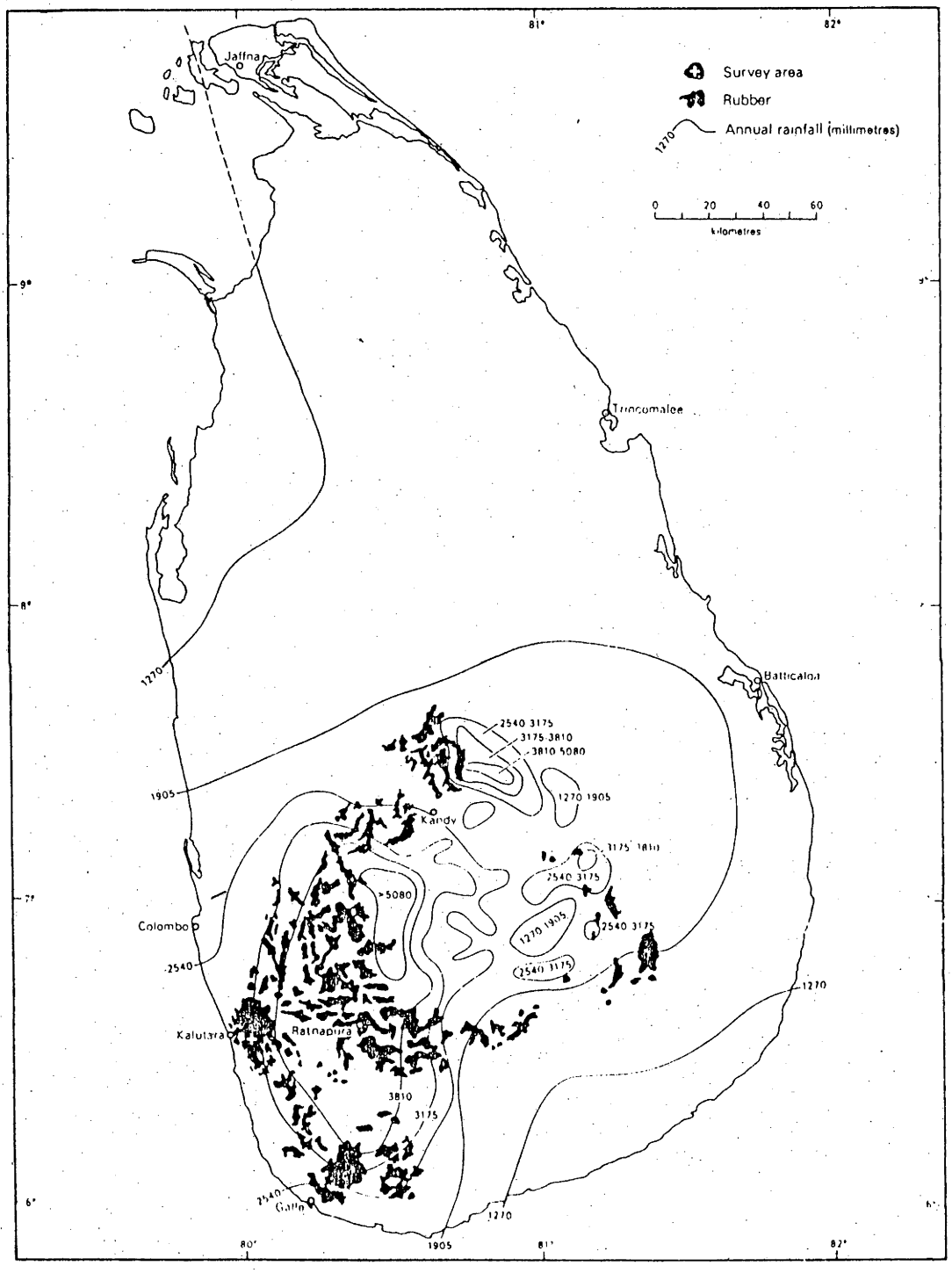
1 Maha season normally extends from about September-October to February.

2 Yala season normally extends from about March-April to August.

FIGURE 2.1

MAIN RUBBER GROWING AREAS IN SRI LANKA



Source: Barlow et al 1975.

2.4 Selection of the Rubber Smallholders to be Interviewed

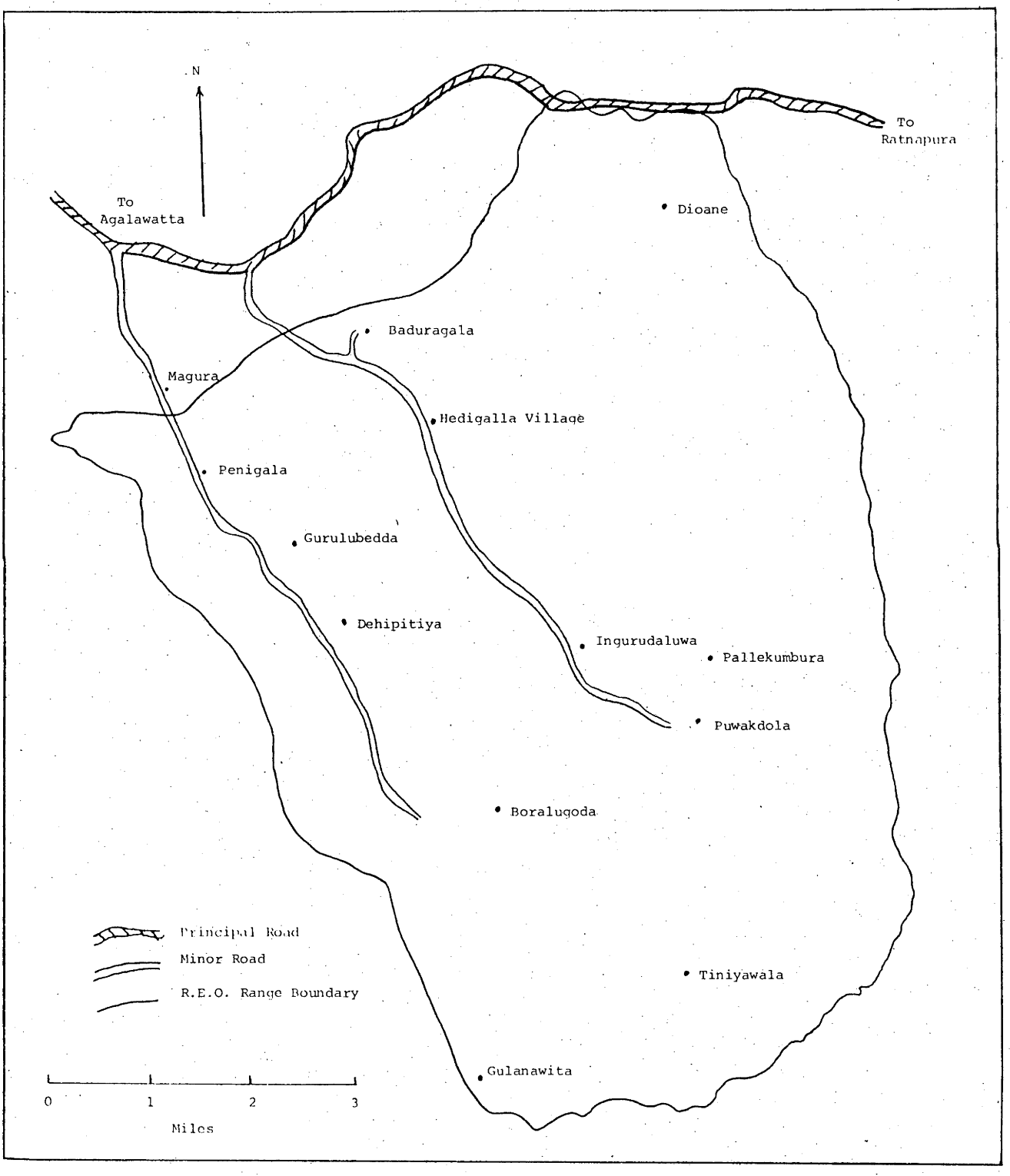
The rubber smallholders to be interviewed were selected with the help of the Hedigalla Rubber Extension Officer (REO) and a Technical Assistant of the Rubber Research Institute of Sri Lanka (RRISL). By considering the criteria described in the foregoing subsections, 20 rubber smallholders were initially selected from 3 villages in Hedigalla REO's division, namely Hedigalla colony, Gurulubedda and Ingurudaluwa (See Figure 2.2).

Due to the nature of his work, the REO knew many of the rubber smallholders, particularly the farmer-leaders in his area personally, and this made it possible to identify the future respondents. After 2-3 preliminary visits to the farmers initially selected, the most cooperative 10 farmers, which were those expected to be the most trustworthy and helpful in providing accurate data and information were chosen for the actual survey. The size of sample was mainly determined according to the time and resources available for this study. Through lengthy discussions with these 10 farmers regarding various topics including their day-to-day farming problems it was attempted to win their confidence gradually and to establish a high degree of rapport necessary for obtaining accurate information. Every effort was made to convince these farmers who were to be interviewed as to the purpose to which the information collected in this study would be put.

It is important to note here that the small sample of 10 farmers selected for interviewing could not be claimed as representative of the rubber smallholder population in the area surveyed. Nevertheless, it is expected that the study of these farmers would give some useful insights into their existing farming situation and how it could be altered to achieve the specific goals of these farmers. Such insights will undoubtedly have some relevance and applicability to similar type of other farms in the area surveyed.

FIGURE 2.2

AREA WHERE SURVEY WAS CARRIED OUT



2.5 Actual Interviewing of Case Study Farmers and a Brief Description of Data and Information Collected

A formal questionnaire as well as an informal schedule were used to interview the case study farmers in this survey. The questionnaire was field tested prior to the actual survey and modifications were made where necessary. On average 3-4 visits were made to each case study farmer in collecting the data and the other relevant information. Each interview took about 2-3 hours on average. In addition to the data collected through the formal questionnaire much information came up in the course of discussions with the case study farmers while interviewing them. When inconsistencies were detected in the responses made by the farmers, further questions were asked to clarify them.

The problems normally associated with oral interviews and the various types of biases in responses are well known (Naeem, 1971; Bhati, 1979). Care was taken to minimise the problems associated with interviewing and to verify the biases, at all stages of the survey.

Data and the other relevant information collected were as follows:

(a) Input and output data on the crops grown in the case study farms were collected through "activity statements" which indicate farmers' expectations about the output and inputs of the crops cultivated. These data are based on the farmers' experience.

(b) Information related to family structure and occupation of the farm family members, land use pattern and tenurial situation of the farms, household expenditure and non-farm activities were also gathered.

CHAPTER 3

FARM LABOUR INPUT IN PEASANT AGRICULTURE

Some of the important aspects related to availability and use of farm labour in peasant agriculture are discussed in this chapter.

Conventionally, 'labour' refers to "effort, mental or physical, applied during a certain time" for an economic purpose (ILO, 1969). Both availability and use of labour need to be treated as flows over a given period of time.

3.1 Different Types of Labour Available in Peasant Agriculture

Three basically different types of human labour could be identified in peasant agriculture in most of the less developed countries. They are family labour, hired labour and exchange labour. Characteristically, a high proportion of the labour force in peasantry consists of family labour. The farm family is the core of the family labour supply. Since most family members are regular workers on their farms, it is not easy to hire them just as and when required. Some, however, may have alternative employment and sources of income outside the farm.

Hired labour could be classified into regular, seasonal and casual. Regular hired labour works on the farm throughout the year while seasonal hired labour works only during a particularly demanding period. These two types follow a repetitive pattern in rendering their services from season to season. Casual hired labour is to meet the requirements of a particular season caused by such factors as weather or family circumstances. A delayed start of the rains may create pressures to complete plantings or a particular rainfall pattern may require unusually heavy weeding and in such situations casual labour could be used. However, casual hired labour will not be used routinely from season to season. Characteristically hired labour works either for a specified period or on a specified job (until it is completed) and is paid in cash and/or in kind which in certain

cases includes meals.

Intermediate between hired labour and family labour is exchange labour. This third type of labour may or may not be reciprocal. According to Connell and Lipton (1977) there are many tribal societies in Africa where it is not customary for a member of one family to perform wage labour for a member of some other family and instead work is exchanged according to customary definitions of reciprocity.

In Sri Lanka there is a system of reciprocal exchange of labour limited to rice farming which is known as attam. The crux of this exchange labour system is balanced reciprocity as it consists of a series of voluntary and informal contracts between sets of individuals which stipulate the duration, nature and the type of labour to be exchanged (Gunasinghe, 1976). The balanced nature of this system is emphasised by its absolutely binding nature. If a person has reaped the harvest in the field cultivated by another person, the latter must reciprocate and the reciprocation must be done without delay as the former may be reaping his harvest a couple of days later.

While family labour plays a predominant role in farming, other types of labour discussed above also occur in the area surveyed. Since the majority of the farmers are owner-operators, the landless agricultural labourers who work as hired labourers are very few. Thus, dependence on exchange labour is probably of more importance than it would be when more hired labour is available. Exchange labour is used only in paddy farming. However, hired labour is used in both paddy farming and rubber farming.

3.2 Factors Affecting the Availability of Farm Labour

The important factors which affect the availability of farm labour in peasant agriculture are as follows:

(a) the proportion of people of working age;

(b) the age at which children should be considered as potential labour;

(c) specialisation of tasks by sex or age group;

(d) the proportion of a work force (i.e. people of working age) who participate in work;

(e) the availability of hired labour and exchange labour;

(f) the extent of the time committed in non-agricultural activities or at school;

(g) nutritional constraints; and,

(h) the duration of work of each person in a certain period of time.

Connell and Lipton (1977) have pointed out that the proportion of people of working age in a peasant farming community could vary with the age and sex structure of the population in the community, the fertility and mortality rates, the laws on compulsory schooling and retirement, and the extent of their effective enforcement, and the customs of that particular region which may have been affected by the historical requirements of labour.

Hired labour is an additional resource and it could be properly added to the family labour availability. Timing is an important consideration when seasonal hired labour is used for, although the number hired may represent only a small fraction of total labour availability over the year, it may be a significant proportion of the total over the period of hire. Exchange labour could be an important means of supplementing family labour in situations where adequate hired labour is not available.

According to Collinson (1972), the significance of off-farm commitments for the availability of farm labour depends on the man-equivalent values of the missing individuals and the coincidence of the times of these commitments and the important agricultural periods.

Although quantification of the phenomenon of "nutritional constraints on the availability of farm labour" is complex, Richards (1939) and Fox (1953) have observed, among African farmers in Northern Rhodesia and in Gambia, that the capacity for physical effort is reduced by undernourishment.

3.3 Estimation of Availability of Labour

Availability of labour could be estimated by multiplying the number of participants by an assumed duration; and this requires some sort of an assumption regarding the standard work duration.

The duration of work of the participants could be estimated in months and weeks per year, days per week and hours per day over the period concerned. Different bases for the estimation of availability of labour could give rise to different variations in total working time available. Connel and Lipton (1977) say that when hired labour is employed, limited checks may allow a fairly homogeneous working day to be assumed; in the sense that the type of labour, lengths of day worked, and intensity of work do not vary much. However, for family labour no such assumptions could be made because it is unlikely that family labour is homogeneous in these terms. Moreover, it is important to bear in mind that family members may work longer hours and put more effort into their work than hired labour, particularly during the peak periods of farming.

3.4 Wages of Agricultural Labour

As in any other market, demand and supply interactions determine the wage rate of labour in agricultural labour markets. Basically, demand for agricultural labour is a function of the marginal productivity of labour while the supply is determined by the size and structure of the agricultural labour force.

However, there are some other factors which influence agricultural wages. On the demand side, factors such as increasing the irrigated area, higher cropping intensities and cultivation of higher yielding crop varieties could raise the demand for labour and thus push up the wage rate. The wage rate is likely to be affected also by the size of land holding. The relatively higher wage rates in the larger farms such as estate plantations are generally a result of strong trade union activities. The

larger the size of holding, the higher will be the demand for labour and the wage rate.

The proportion of landless labour households to the total rural households will influence wages on the supply side. A higher proportion of landless labour households to the total rural households means a larger supply of agricultural labour and a lower wage rate.

Apart from the factors discussed above, there are several other factors on the supply side which play an important role in agricultural wage determination. These include the availability and use of agricultural machinery, alternative employment opportunities and wage rates outside agriculture, cropping patterns and production uncertainties, etc.

An interesting phenomenon that can be observed in agricultural labour markets, is the seasonality in agricultural wage rates, which depict a definite seasonal trend in wages in accordance with the demand for labour at particular time periods during the year. The seasonal rise in the wage rates among the agricultural labour during the months of harvesting and threshing of wheat in Punjab, India (Grewal and Bal, 1974) is an example of this seasonality.

Although such seasonal changes in agricultural wage rates could not be seen in the area surveyed, a rise in wages seems to occur due to such factors as an occasional increase in the government guaranteed price for paddy. Moreover, an increase in the prices of consumer goods and services, and inflationary pressures resulting from the general economic conditions of the country as a whole, have also been influential in pushing up the nominal wage rates during the recent past.

3.5 Determinants of Farm Labour Use

There are four important factors which determine the use of labour in peasant agriculture: (a) the extent of crop land farmed and/or the number of livestock reared; (b) the operational sequence for each crop and/or

livestock type; (c) the timing of the operational sequence; and (d) the rates of work on each operation.

Collinson (1972) pointed out the following groups of independent sets of variables which influence the rate of work on each operation for a given crop. They are: (i) soil type, cropping history and plot size; (ii) tools, methods and group specialisation; and (iii) motivational, managerial, nutritional status differences between farmers and their families; and (iv) climatic variations over the area. While soil type has an independent influence on the degree and rate of cultivation work, cropping history may also influence the rate of work. The effect of the plot size on the rate of work is an interesting phenomenon known as the "scale effect". It is an "effect" which exaggerates the rate when data from small areas are multiplied up to a per hectare basis. In this case, Collinson (1972) explains that the overheads classed as work - getting to and from the farming plot, getting ready to work, getting ready to leave the plot - are just as high for a large as for a small plot. Thus, when bulked up to per hectare from small plots, the overhead elements tend to distort the work requirement. Group specialisation means the specialisation of certain operations by sex/age groups. Differences in motivations among farmers are reflected in the effort they make while at work on the farm. The conditions under which farm operations are carried out are influenced by managerial differences.

The area surveyed has a unique soil series called the Agalawatta Series. These soils are derived from granite rocks, a large percentage of which is hypersthene granite (Peries, 1970). However, variations in soil structure and texture among different farms could be expected, although detailed analysis was not carried out to investigate this. The topography of the area surveyed is generally undulating. Rubber and other tree crops such as coconut, cinnamon and jak etc., are grown on the slopes and highland

while paddy is cultivated in the valleys. The size of plot ranks among farms within the case study ranges from 0.1 to 1.0 ha. However the majority of the plots are less than 0.5 ha in size with a mean value of 0.4 ha. Group specialisation by sex is seen to a certain extent with regard to paddy farming operations. Land preparation is undertaken by men while women do paddy harvesting. In relation to rubber farming activities, no group specialisation is observed.

3.6 Seasonal Variation of Farm Labour Use

Seasonal variation in labour use in peasant agriculture is more striking and more regular than variation within and between individual days. Seasonality of farm labour use is related to the agricultural systems, especially cropping cycles and transhumant migration. Annual crops in particular tend to make greater demands for labour at busy periods or "work peaks" such as land preparation, planting and harvesting times, than at times of other operations. Land preparation, planting and harvesting are critical tasks which are closely related to the seasons and they must be completed within a limited period of time. Therefore the flexibility of time in completing these critical tasks within a certain period of time is relatively low when compared to that of other operations such as weeding, etc. "Seasonal" variations cover any annually regular recurrence between a few days and a whole year. In mono-cultural farming systems with sharp seasonal differences, only simple changes are common. However, peaked seasonal demands for agricultural labour may be smoothed out with the adoption of methods such as use of crop varieties of different maturing ages, staggering of plantings, and use of different crop combinations. One important point to note is that the seasonality of farm work causes seasonal variations in the opportunity cost of labour.

The seasonal nature of the demand for labour could be observed in the area surveyed in relation to certain paddy farming activities such as

planting and harvesting, which have to be completed within a short period of time.

3.7 Standardisation of Farm Labour

Variations in the strength and skills of men, women and children mean that their labour is not homogeneous. In such circumstances it would be realistic to treat different sex/age groups as separate resources. However, for certain tasks these different types of labour may be approximately perfect substitutes, in which case it would be appropriate to treat them as one resource. Connell and Lipton (1977) showed that in most farm operations, an hour of work by a male adult could not be expected to yield the same addition to output as an hour of work by a woman or child. However, Moerman (1968) argued that there is no single cut-off point between child and adult labour. Yet, it is well known that most farm management studies have chosen to weigh labour contribution rigidly according to a very limited number of divisions; but such procedures have been essentially arbitrary.

It has been pointed out by many researchers that the relative values of different sex/age groups will vary with the operation. For a Rajasthan village, Bishnoi (1966), considered only those persons between 14 and 60 years old, and set a full day's farm work for a man at 8 hours and for a woman at 4 hours. Sanghvi (1969) noted that women are more efficient than men at cotton-picking and less efficient on all other crops, but he standardised the work input of women at 75 per cent that of men. Njoku (1971) used a more complex weighting system with eight different categories (from very old men to female children) for different tasks on upland and partially mechanised farms in Sierra Leone. Heyer (1966) observed amongst the Kamba in Kenya, that over the age of 40 years women decline in efficiency and over 60 years all workers do. Bieze (1972) working with the Malawian farmers used a rating of 1.0 man equivalent for adult males

and hired labourers, 0.7 for other adults and females and 0.3 for children and relations of the farmers. Upton (1973) indicated that one scale of conversion commonly used is based on the assumption that the work done per hour by a woman is two-thirds, and that by a child under 15 years of age, is one-third of that done per hour by a man. However it is important to note that it is not easy to weigh accurately the productivity of workers of different age and sex groups.

3.8 Concluding Remarks

Some of the important aspects of farm labour input in peasant agriculture, including different types of labour available in peasantry, factors affecting the availability of farm labour, wages of agricultural labour, estimation of availability of labour, determinants of farm labour use, seasonal variation in labour use and standardisation of farm labour have been discussed in the previous sections of this chapter. In this discussion, a few important facts related to the area surveyed have been highlighted. They are as follows: Family labour and exchange labour seem to account for a major share of farming activities in the area surveyed, because of the fact that the majority of the farms are owner-operated. Nevertheless, the use of hired labour is not very low. It is difficult to identify any seasonal variation in the agricultural wage rates in this area. However, a general upward movement in the wages has been observed during the recent past and this could be due to such factors as an increase in the prices of the consumer goods and services, and the inflationary pressures etc., in general. Of all the aspects discussed, there is a controversy regarding standardisation of farm labour. As described elsewhere, there is one school of thought which advocates the use of different weights for different sex/age groups (Bishoi (1966), Heyer (1966), Sanghvi (1969), Njoku (1971), Bièze (1972), Upton (1973), Connell and Lipton (1977)), and another school which assumes that all farm

workers make equal contributions (Moerman, 1968). However it is realistic to assume that within the farm family, member-workers will engage in activities for which they are best fitted, and that the distribution of different types of labour is roughly equivalent between farms (See Table 3.1). An ideal example for this comes from paddy farming where men generally engage in land preparation while women do transplanting. In the present study a rating of 1.0 man-day-equivalent for adult males and 0.75 for adult females are used.

TABLE 3.1

DISTRIBUTION OF MALE AND FEMALE FAMILY LABOUR*

AMONG CASE STUDY FARMS

CATEGORY	FARM NUMBER									
	1	2	3	4	5	6	7	8	9	10
Males working full-time in the family farm	2	1	1	1	1	1	2	1	1	1
Females working full-time in the family farm	-	-	-	-	-	-	-	-	-	-
Males working part-time in the family farm	-	-	-	-	-	2	-	-	-	2
Females working part-time in the family farm	1	2	1	1	1	3	1	1	1	1

* 13-65 years old

CHAPTER 4

BASIC CHARACTERISTICS OF CASE STUDY FARMS

4.1 Population Characteristics

Population characteristics such as age and sex structure, family composition, labour force participation and educational level have an important bearing on the utilisation of factors of production such as land and capital.

Information on family size, labour force and labour participation on farms within the case study is summarised in Table 4.1. The average number of family members per farm household for the whole sample is 6.3 of which 3.5 are males and 2.8 are females. The average number of economically active members, defined to include all persons between 13 and 65 years of age inclusive, is 3.9 per farm household for the whole sample. The economically active males outnumber the economically active females in the sample.

The labour force ratio which is the ratio between the total number of economically active farm family members and the total number of farm family members is 61 per cent on average, but slightly higher for females. On average, about 33 and 47 per cent of the economically active farm family members work as full-time and part-time workers respectively.

The full-time labour participation ratio is the ratio between the total number of farm family members who work full-time in the family farms and the total number of economically active farm family members, whereas the part-time labour participation ratio is the ratio between the total number of farm family members who work part-time in the family farms and the total number of economically active farm family members. In all farms within the case study, only economically active males work as full-time farm family workers. The average full-time labour participation ratio is about 58 per cent while the average part-time labour participation

TABLE 4.1

FAMILY SIZE, LABOUR FORCE AND LABOUR ABSORPTION BY CASE STUDY FARMS

	Family Members per Farm Household (no.)				Labour Force Ratio (%) (2) ÷ 1	Full-time Labour Participation Ratio (%) (3) ÷ 2	Part-time Labour Participation Ratio (%) (4) ÷ (2)
	Total (1)	Economically Active[a] (2)	Full-Time Working[b] (3)	Part-Time Working[c] (4)			
Farm 1 Male	5	5	2	-	60	66	-
Female	2	2	-	1	50	-	100
Farm 2 Male	2	1	1	-	50	50	-
Female	2	2	-	2	100	-	100
Farm 3 Male	2	1	1	-	50	50	-
Female	3	1	-	1	33	-	33
Farm 4 Male	4	2	1	-	50	-	-
Female	2	1	-	1	50	-	100
Farm 5 Male	2	2	1	-	100	50	-
Female	1	1	-	1	100	-	100
Farm 6 Male	5	3	1	2	60	33	66
Female	4	3	-	3	75	-	100
Farm 7 Male	5	2	2	-	40	100	-
Female	3	1	-	1	33	-	100
Farm 8 Male	4	1	1	-	25	100	-
Female	1	1	-	1	100	-	100
Farm 9 Male	3	2	1	-	50	50	-
Female	6	4	-	1	66	-	25
Farm 10 Male	3	3	1	2	100	33	66
Female	4	1	-	1	25	-	100
Average per farm Male	3.5	2.2	1.2	0.4	58.5	58.2	11.2
Female	2.8	1.7	-	1.3	63.2	-	85.8

a - 13-65 years old
b - Working full-time in the family farm
c - Working part-time in the family farm

ratio is about 97 per cent for males and females combined.

Four out of the 10 case study farmers reported that when they do not have any work in their own farms and when part-time outside employment is available, they work outside.

Of the 10 case study farmers, only two have had formal education up to Grade 5. However, all the farmers are able to read and write. About 38 per cent of the total number of farm family members attend school.

4.2 Farm Land and Rental Arrangements

Returns to the farmers are, to an important degree, determined by the extent of land cultivated by them and the terms and conditions under which the land is farmed.

Information on farm size by case study farms and by different crops grown is illustrated in Table 4.2. The size of land owned and cultivated by the case study farmers varies from 1 ha. to 1.8 ha, with an average of 1.39 ha., while the size of the total land cultivated, both owned and rented by them ranges from 1.1 ha. to 2.3 ha., with an average of 1.6 ha.

Basically, all the case study farmers are owner operators. However, six of them have rented paddy land. Rental arrangements vary, with two farmers paying 1/4 of the harvest, another two paying 1/3 of the harvest, and one farmer paying 1/2 of the harvest to their respective landlords, while the remaining one paying a fixed rental of Rs 6.00 per season to the Government.

Since these tenants receive no collateral help in any form from landlords, possible reasons for different types of rental arrangements could be the variations in quality of land and/or the different types of personal relationship between the landlords and the tenants such as being either friends, neighbours or relatives, etc.

TABLE 4.2

CROPS GROWN AND TENURE ARRANGEMENTS ON CASE STUDY FARMS

Farm Number	Owned Land				Rented in Land	Total land Cultivated
	Paddy (ha)	Rubber (ha)	Other Crops (ha)	Total (ha)	Paddy (ha)	(ha)
1	0.2	1.0	0.1	1.4	0.4	1.8
2	-	1.0	0.4	1.4	0.4	1.8
3	0.2	1.0	0.2	1.4	-	1.4
4	0.2	0.4	0.4	1.0	0.2	1.2
5	0.1	0.8	0.2	1.1	-	1.1
6	0.3	0.8	0.2	1.3	0.3	1.6
7	0.2	1.3	0.2	1.7	-	1.7
8	0.4	1.3	0.1	1.8	-	1.8
9	0.2	1.2	0.4	1.8	0.5	2.3
10	0.2	0.5	0.3	1.0	0.3	1.3
Average per farm	0.2	0.93	0.26	1.39	0.21	1.6

4.3 Land Use and Cropping Patterns

In addition to the physical extent of land cultivated, land use intensity and the cropping patterns also influence, to a greater extent, the returns from farming.

Rubber is the major crop grown in terms of land use in the case study farms, while paddy comes next (see Table 4.2). The average size of rubber land and paddy land cultivated in the case study farms is 0.93 ha and 0.41 ha respectively. Rubber land and paddy land are situated close to the homestead of the case study farmers, as separate land parcels.

The distribution of rubber parcels within each case study farm by

agro-economically important groups and by major components of these groups is given in Table 4.3. According to this table only four case study farms have immature rubber. Except for one farm all the other case study farms have mature rubber area of 0.2 ha or above. The plant density in the mature rubber area varies from 167 to 600 trees per ha, while the planting material used both in immature and mature parcels is predominantly PB86.

Except for one case study farm, all the others have old rubber. However, old rubber in 3 farms is not tapped while in the rest it is tapped. The 3 farms in which old rubber is not tapped, reported that their old rubber does not yield any more and, thus, it is being set aside for replanting. The plant density in old rubber parcels ranges from 77 to 600 trees per ha for the whole sample. It is important to note that the plant density figures given here are based on the data from small areas which could be susceptible to a scale effect that exaggerates the rate when multiplied up to a per hectare basis. Most of the old rubber parcels are planted with clonal seedlings. The category of old rubber in Table 4.3 is a classification based on the case study farmers' treatment, according to which rubber gives low yields and is to be replanted soon, whether it is currently tapped or not, is old rubber. The case study farms which have old rubber are reported to have had the intention of replanting a part or whole of the old rubber. The extent of rubber land to be replanted varies from 0.2 to 1 ha, in the case study farms, with an average of 0.5 ha.

"Cropping index", which is important with respect to annual crops rather than the perennials, shows the extent cultivated over the year as a percentage of total cultivable land area. An index of 100 would indicate the full exploitation of all cultivable land in one season while anything over 100 would indicate the extent of double or multiple cropping of the same land during the year. A "cropping index" of 200 for paddy

TABLE 4.3

DISTRIBUTION OF RUBBER PARCELS OF EACH CASE STUDY FARM

BY AGRO-ECONOMICALLY IMPORTANT GROUPS

AND BY MAJOR COMPONENTS OF THESE GROUPS

Farm No.	Immature Rubber			Mature Rubber (Tapped)				Old Rubber (Tapped)				Old Rubber (Not tapped)				
	Area (ha)	Age (Yr)	Variety	Area (ha)	Age (Yr)	Variety	Trees/ ha	Area (ha)	Age (Yr)	Variety	Trees/ ha	Area (ha)	Age (Yr)	Variety	Area to be Replanted (ha)	Total Rubber Area (ha)
1	0.3	4	PB86	0.2	9	PB86 & Clonal Seedlings	600	-	-	-	-	0.5	26	PB86	0.5	1.0
2	-	-	-	1.0	19	PB86	400	-	-	-	-	-			0.8	1.0
3	-	-	-	0.2	22	PB86	310	-	-	-	-	0.8	40	Clonal Seedlings	0.8	1.0
4	-	-	-	0.2	20	PB86	325	0.2	20	PB86	350	-	-	-	0.2	0.4
5	0.6	3	PB86	-	-	-	-	0.2	40	Clonal Seedlings	200	-	-	-	0.2	0.8
6	-	-	-	0.4	14	Clonal seedlings	188	0.4	14	Clonal seedlings	188	-	-	-	0.4	0.8
7	-	-	-	0.3	15	Clonal Seedlings	500	1.0	-	Clonal Seedlings	-	-	-	-	1.0	1.3
8	0.5	2	PB86	0.4	18	Clonal seedlings	500	-	-	-	-	0.4	28	Clonal seedlings	0.4	1.3
9	-	-	-	0.3	12	PB86	167	0.9	28	Clonal Seedlings	77	-	-	-	0.6	1.2
10	0.2	4	PB86 & RRIC mixed clones	0.2	10	RRIC36	540	0.1	24	PB86 & Clonal Seedlings	600	-	-	-	0.1	0.5
Average per farm	0.16	-	-	0.32	-	-	-	0.32	-		-	0.13	-	-	0.5	0.93

farming is reported in the case study farms. This implies the cultivation of paddy, in all the case study farms, both in the Maha and Yala seasons.

Details of the crops, other than rubber and paddy, grown in the case study farms are summarised in Table 4.4. This table illustrates the mixed nature of farming practised in the case study farms, where crops such as coffee, banana, kitul, coconut, jak, cinnamon, mango, aricanut and passion-fruit, etc., are grown in the homestead. Coconut which is consumed domestically is the most common crop in the homesteads, although some case study farms reported the cultivation of cash crops such as cinnamon and coffee. The extent of the homestead in the case study farms varies from 0.1 ha and 0.4 ha with an average of 0.26 ha.

TABLE 4.4

DETAILS OF THE CROPS GROWN IN HOMESTEADS

OF THE CASE STUDY FARMS

Farm No.	Area of the home-stead (ha)	Number of trees grown per homestead								
		Coffee	Banana	Kitul	Coco-nut	Jak	Cinna-mon	Mango	Arica-nut	Passion-fruit
1	0.2	4	15	5	20	-	-	-	-	-
2	0.4	-	8	-	30	15	100	-	-	-
3	0.2	-	5	-	13	2	-	3	-	-
4	0.4	5	15	-	8	-	-	-	10	-
5	0.2	-	4	1	10	2	-	-	2	-
6	0.2	2	10	2	7	-	100	5	3	-
7	0.2	-	5	-	27	2	-	-	-	20
8	0.1	-	-	-	2	-	-	-	-	4
9	0.4	3	12	-	12	5	-	-	-	-
10	0.3	-	6	-	8	5	-	-	-	-
Average per farm	0.26	-	-	-	-	-	-	-	-	-

4.4 Farm Incomes and Expenses

There are limitations in the estimation of farm incomes and expenses from data gathered in an interview survey at one point in time. Admitting such limitations, the current annual income levels and expenses of the case study farms are estimated with the use of information and data provided by them (see Tables 4.5 and 4.6). Of the 10 case study farms, six reported having off-farm incomes (agricultural and non-agricultural) in addition to on-farm (agricultural) incomes. Nevertheless, according to Table 4.5 the major source of farm family income of all the case study farms is on-farm agricultural activities, which contribute more than 50 per cent of the farm family incomes. The annual income from the on-farm (agricultural) activities of the case study farms ranges from Rs 2,100.00 to Rs 4,800.00 with an average of Rs 3,370.00, while the annual income from both on-farm and off-farm activities varies from Rs 2,400.00 to Rs 5,400.00 with an average of Rs 4,225.00.

According to Table 4.6, more than 55 per cent of the total annual expenditure of all the case study farms is on food items. Expenditure on clothing, health and other items such as entertainment, religious and social activities, repairing the houses etc., accounts for about one quarter of the total annual expenses. The total annual expenses of the case study farms range from Rs 2,600.00 to Rs 6,160.00 with an average of Rs 4,680.00. Some case study farmers may have provided overestimated data on expenditure items and underestimated data on revenue items. This factor, besides other things such as total land cultivated per farm and family size per farm household, could also have accounted for the higher expenditure levels which is apparent from Tables 4.5 and 4.6 exceed the income levels of certain case study farms.

TABLE 4.5

CURRENT ANNUAL INCOME LEVELS OF THE CASE STUDY FARMS ESTIMATED AT 1979 PRICES BY SOURCE OF INCOME[1]

Farm Number	Total Land Cultivated (ha)	Income From On-Farm (Agricultural) Activities (Rs)	Income From Off-Farm (Agricultural & non-Agricultural) Activities (Rs)	Total Farm Family Income (Rs)
1	1.8	2400	-	2400
2	1.8	4800	-	4800
3	1.4	2100	1800	3900
4	1.2	3600	-	3600
5	1.1	3600	1800	5400
6	1.6	3000	780	3780
7	1.7	3600	1200	4800
8	1.8	3300	-	3300
9	2.3	4800	1800	6600
10	1.3	2500	1200	3700
Average per farm	1.6	3370	858	4228

1. All figures are given in gross terms. Lack of necessary data prevented the inclusion of net values or gross margins.

TABLE 4.6

CURRENT ANNUAL EXPENDITURE OF THE CASE STUDY FARMS

ESTIMATED AT 1979 PRICES BY VARIOUS CATEGORIES OF EXPENSES

Farm Number	Total Land Cultivated (ha)	Expenditure on Food Items (%)	Expenditure on Clothing (%)	Expenditure on Health Facilities (%)	Expenditure on Education (%)	Miscellaneous Expenses (%)	Total Farm Family Expenses (Rs)
1	1.8	59	12	13	8	8	3580
2	1.8	78	5.1	8	0.9	8	6160
3	1.4	74	8	12	1	5	2600
4	1.2	79	8	6	-	7	6060
5	1.1	79	7	6	-	8	3790
6	1.6	80	6.3	6.3	1.1	6.3	4550
7	1.7	67	9	7	3	14	5360
8	1.8	87	5	4	-	4	4000
9	2.3	74	6	8	2	10	4900
10	1.3	84	6	4	1	5	5800
Average per farm	1.6	76.1	7.24	7.43	1.7	7.53	

CHAPTER 5

METHOD OF ANALYSIS

Two methods of analysis are employed in this study:

(a) simple tabular and graphical analysis, and

(b) whole farm analysis which is an application of the linear programming (LP) technique.

5.1 Simple Tabular and Graphical Analysis

In this analysis, the allocation of farm labour among time-specific and non-time-specific farming activities of the case study farms is examined by employing cross-tables, histograms and simple graphical illustrations of labour use pattern and rainfall etc. This analysis is essentially descriptive and is used to illustrate the existing farming situation.

5.2 Whole Farm Analysis

Whole farm analysis attempts to optimise economic benefits of a farming system in the context of all the economic activities of the farmer. These include farmer's household and off-farm activities in addition to his agricultural enterprises. In this analysis, the farm household model takes into consideration the relationships between all the productive processes through their dependence on a common resource base including labour as an important element. Here the LP technique is used firstly to model the existing farming situation of the case study farms and then to investigate the relationship between the labour allocation pattern in these farms and the marginal value productivities of labour through the year. And secondly, it is used to determine what possibilities there are of altering the pattern of farm operations (including replanting of rubber) so that family labour is used optimally within the farmer's goals of producing consumption goods and generating cash surplus.

5.2.1 LP Technique in Whole Farm Analysis[1]

As a formal mathematical technique LP selects the mix of the levels of activities from the set of all feasible activities, in such a way that a specific objective function, usually the cash surplus, is maximised without violating the resource constraints.

When represented mathematically, the whole farm analysis technique using LP notation is:

Maximise $$\Pi = \sum_{j=i}^{n} c_j x_j$$

subject to $$\sum_{j=i}^{n} a_{ij} x_j \leq r_i \quad (i = 1,2,\ldots,m)$$

and $$x_j \geq 0 \quad (j = 1,2,\ldots, \ldots,n)$$

where c is a row vector of income surpluses generated from unit levels of the set of activities available to the farm. Here a surplus is defined as a return over all cash costs,

x is a column vector of the number of unit levels of the set of activities,

a is a matrix of coefficients representing the amount of restricted resources used by the unit levels of the activities, and

r is a column vector of the available amount of the restricted resources.

An iterative procedure is followed in solving the above problem.

A broad outline of the LP model used in this study is given in Table 5.1. Each activity in this model must be specified in terms of the surplus c_n it is expected to produce, and the requirements a_{ij} it has for all important resources r_i.

The limitations of the basic LP technique have been discussed extensively by Hardaker (1975) and Anderson et al. (1977). To a large extent its

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1 This subsection is largely based on Barlow, et al. (1979).

limitations are attributed to the assumptions on which the LP technique is built. The assumption of linearity in the objective function and in the constraints does not allow lumpy, indivisible inputs and fixed initial costs of certain activities to enter into the model; additivity assumes that each activity and limiting factor is independent of all others; divisibility of choice variables allows them to enter into the solution at any fractional level; non-negativity does not permit any activity to be produced at non-negative levels; and the assumption of perfect knowledge ignores possible variability in the input-output coefficients.

TABLE 5.1

A BROAD OUTLINE OF THE LP MODEL

Surpluses per unit of activity, C				Activity Levels
	C_1	C_2	C_n	
Restricted resource availabilities, r	Input - Output Coefficients for each activity			X
	a_1	a_2	a_n	
r_1	a_{11}	a_{12}	a_{1n}	x_1
r_2	a_{21}	a_{22}	a_{2n}	x_2
:	:	:	:	
r_m	a_{m1}	a_{m2}	a_{mn}	x_n

However, by making adjustments to the basic model some of these drawbacks could be eliminated. For instance, Hardaker (1975) has suggested that the problem of assuming certainty in LP could be rectified by over specifying the risk constraints concerned. An example given by him in

this respect involves the constraints relating to the provision of and requirements for food for farm household. He has suggested that uncertainty about the reliability of food supplies could be taken into account by inflating the minimum food requirement artificially, so that the risk involved in having a food deficiency is minimised. A possible variability in the input-output coefficients could be accommodated by paramatizing the yields and resource constraints concerned, so that a range of options is available for the decision maker.

LP imputes appropriate prices to all restricted resources, when it selects the particular combination of activities that maximises surplus. It computes the shadow prices of each activity and resource supply. These shadow prices are of two types. The first type is the value imputed to a scarce resource which represents the amount by which surplus would rise if an extra unit of that resource is used, that is,its marginal value product (MVP). The second type is the marginal opportunity cost (MOC) which is the amount by which the surplus would decrease if a unit of the activity excluded from the optimal plan is forced into the solution. It is important to bear in mind that changes in these shadow prices could be observed only within a relatively narrow limit. Large deviations in the use of resources would lead to changes in relative scarcity which drastically alter these prices.

5.2.2 Application of LP Technique in Similar Studies

In agriculture, although LP was originally used in large commercial farms in developed countries, it has also been used in less-developed countries to study the low resource farms. Heyer (1971) on peasant farms in Kenya; Thodey and Sektheera (1974) on multiple cropping programmes in Thailand; Amarasinghe (1974) on farming in settlement schemes in Sri Lanka; Hardaker (1978) on planning agricultural development in Tonga; Wardhani (1976)

on land settlement in Indonesia and Barlow et al. (1979) on rice farmers in Philippines have amongst others used the LP technique in less-developed countries.

CHAPTER 6

A DESCRIPTIVE ANALYSIS OF THE LABOUR USE PATTERN IN THE CASE STUDY FARMS

6.1 Aims of the Descriptive Analysis

The aims of this descriptive analysis are to gain insight into the existing farming situation of the case study farms and, in particular, to identify the key factors which influence the labour use pattern. The analysis is carried out in three sections: paddy farming; rubber farming; and other farming activities. In each section care is taken to identify the salient features of that farming category and then to analyse the timing of different farming activities and the related labour use patterns. An attempt is also made to explain the important factors which cause variations in the labour use pattern in each farming category.

6.2 Some Salient Features of Paddy Farming Among the Case Study Farms

The case study farmers cultivate paddy under rainfed conditions in both the Maha and Yala seasons. Thus, the successful production of paddy is largely dependent on the northeast and southwest monsoonal rains.

In the area surveyed, the sole source of power in land preparation is human labour. Ploughing is done exclusively with the use of mammoties. It is not possible to use hand tractors or buffaloes because much of the paddy land is swampy.

Despite the effort of the Department of Agriculture to popularise the use of new high yielding varieties of paddy which would be suitable for the area surveyed, all the case study farmers use traditional unselected local paddy varieties, such as herath banda and rata thawalu. The reasons given by the farmers for cultivating these traditional varieties included the low level of cash inputs and management required for these varieties, the suitability of these traditional varieties for the area and the high palatability of the rice. In this area the traditional method of

broadcasting is adopted widely. Almost all the case study farmers use some kind of fertilizer. However, they do not control pests, diseases or weeds as they do not think that such controls would have any significant impact on yield levels. Trampling by foot with the use of human labour is the method of threshing practised. A comparison of yields per hectare of paddy between the case study farms and Kalutara district in general indicates (Table 6.1), that the paddy yields of the former are relatively low. The reason is the adoption of low yielding traditional unselected varieties and poor cultural practices. All the case study farms consume the total paddy output within the farm-household units. However, in addition they also have to buy from outside to meet the total consumption requirements.

6.3 Labour Use Pattern in Paddy Farming Among the Case Study Farms

The time specific field operations in paddy farming can be classified into the following activities:

(1) Clearing the bunds: Clearing and repairing of bunds, and cleaning of channels.

(2) Ploughing 1: first ploughing.

(3) Ploughing 2: second ploughing, harrowing, puddling and levelling.

(4) Fertilizing 1 and Sowing: final levelling, basal application of fertilizer and broadcast-sowing.

(5) Fertilizing 2: first top dressing of fertilizer

(6) Fertilizing 3: second top dressing of fertilizer, and,

(7) Harvesting and Threshing: reaping, spreading, bundling of sheaves, transfer of sheaves to the threshing floor, threshing and winnowing, etc.

Land preparation is a combination of activities (1), (2) and (3).

TABLE 6.1

COMPARISON OF PER HECTARE YIELDS OF PADDY,

BETWEEN CASE STUDY FARMS AND KALUTARA DISTRICT
(kg)

	Maha Season	Yala Season
Case Study Farms	727.75	615
Kalutara District	1598.04	1369.17

Note: Yield figures in Kalutara District refers to 1976.

Source: Field Survey (1979).
Department of Census and Statistics (1979).

The normal crop year in the area studied starts from week 35 (27 August) and ends in week 34 (26 August) (see Appendix Table 1).

The average expectations of the week of commencement of time specific activities in paddy farming for each case study farm were obtained during the field survey, and are presented in Table 6.2. These values may have been influenced to a certain extent by the farmers' previous year's experience, although care was taken to minimise this by appropriate questioning procedures. The periods within which the time specific paddy farming activities could be expected to occur in these farms are indicated in Table 6.2 by the time range of the different average expectations given by these farms. However, the ideal case would have been the time range of expectations of the time of commencement for farming activities for each separate farm. This could have been calculated from the range of expectations of each farm. Unfortunately, the absence of relevant data has prevented this.

The most important fact which is apparent from Table 6.2 and Figure 6.1 is that the degree of flexibility of time for different paddy farming activities could vary between as well as within, the Maha and Yala seasons.

TABLE 6.2

THE AVERAGE EXPECTATIONS OF THE WEEK OF COMMENCEMENT

OF TIME SPECIFIC ACTIVITIES IN PADDY FARMING

AMONG THE CASE STUDY FARMS

(January 1-7 = week 1)[a]

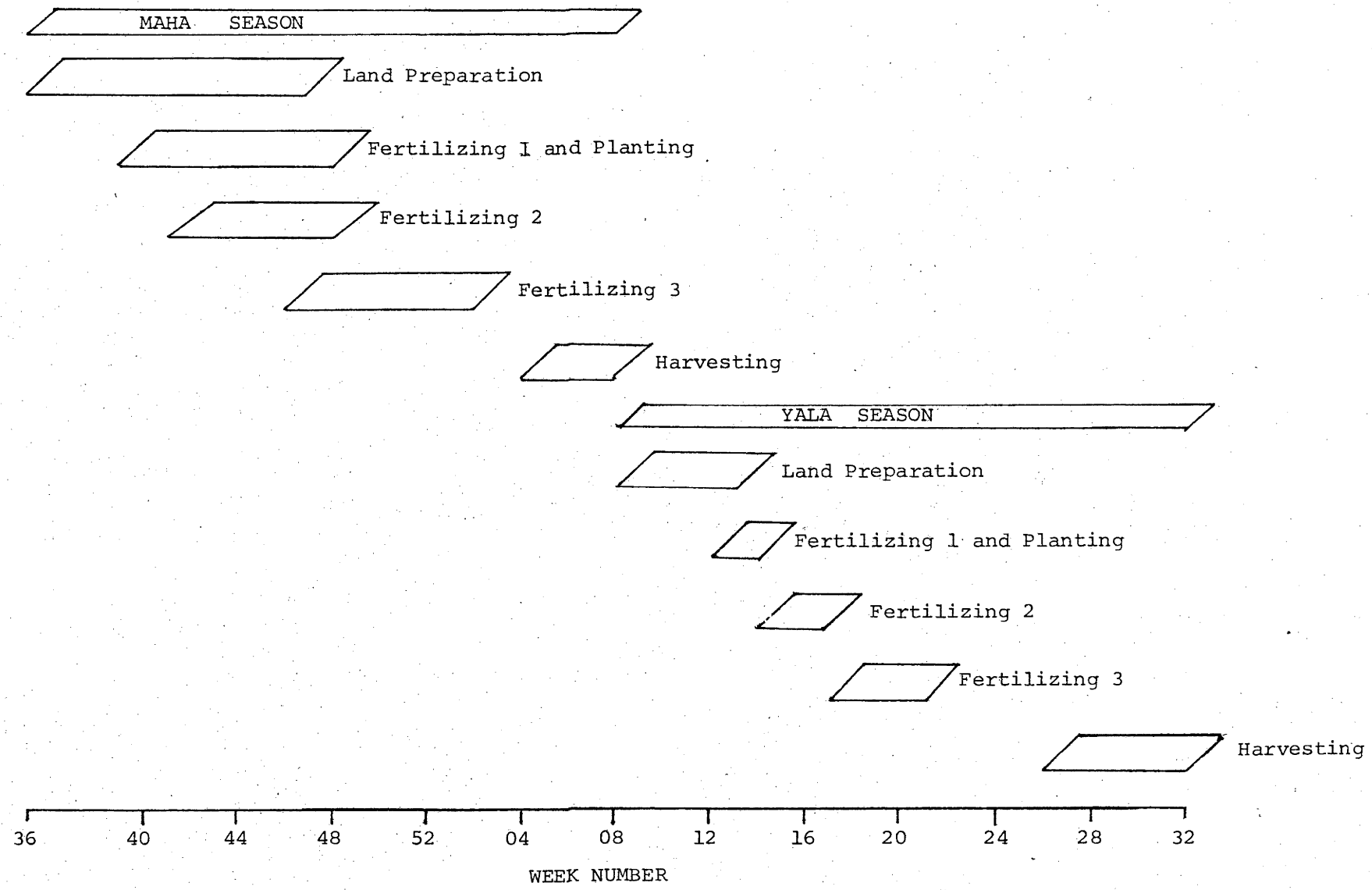
Activity	Farm Number										Time Range (Wk.No.)	Duration of Time Range (Wks.)
	1	2	3	4	5	6	7	8	9	10		
Maha Season:												
1. Cleaning the bunds	40	37	44	40	37	39	36	40	39	39	36-44	
2. Ploughing 1	41	38	45	41	38	40	37	41	40	40	37-45	12
3. Ploughing 2	43	41	47	43	40	43	39	43	43	43	39-47	
4. Fertilizing 1 & Sowing	44	42	48	44	41	44	40	44	44	44	40-48	9
5. Fertilizing 2	47	45	-	47	-	46	42	-	48	-	42-48	7
6. Fertilizing 3	51	-	02	-	47	-	-	49	52	49	47-02	8
7. Harvesting & Threshing	06	06	08	05	05	05	05	07	07	06	05-08	4
Yala Season:												
1. Cleaning the bunds	10	10	10	09	09	09	09	09	09	09	09-11	
2. Ploughing 1	11	11	11	10	10	10	10	10	10	10	10-11	5
3. Ploughing 2	13	13	13	12	12	12	12	12	12	12	12-13	
4. Fertilizing 1 & Sowing	14	14	14	13	13	13	13	13	13	13	13-14	2
5 Fertilizing 2	17	17	-	16	-	15	15	-	17	-	15-17	3
6. Fertilizing 3	21	-	20	-	19	-	-	18	21	18	18-21	4
7. Harvesting & Threshing	30	31	30	32	31	31	30	31	30	30	30-32	3

[a] See Code of Cropping Weeks in Appendix Table 1.

FIGURE 6.1

SEASONAL SEQUENCE OF TIME-SPECIFIC PADDY FARMING ACTIVITIES

AMONG CASE STUDY FARMS



Comparison of the degree of flexibility of time for different paddy farming activities between seasons, shows that, in the Maha season there is a greater degree of flexibility of time than in the Yala season. For instance, land preparation in the Maha season is done from the 36th week up to the 47th week, i.e. within a range of 11 weeks, whereas in the Yala season the time range within which the same activity is done is only 4 weeks, i.e. from the 9th week up to the 13th week. This pattern of greater time flexibility of activities in the Maha season when compared to the Yala season is common for all the paddy farming activities which are considered in this discussion (see Table 6.2). A major reason for these differential time flexibilities of paddy farming activities in the Maha and Yala seasons, is given in an illustrative form in Figure 6.2. Out of the two peak periods of rainfall which the area surveyed experiences, the Yala season (March/April-August) has a heavier rainfall than the Maha season (September/October-February) (see Figure 6.3). Often heavy rainfall interferes with rubber tapping. According to the survey of the case study farms, a greater proportion of the total expected labour use in rubber farming (excluding rubber replanting) is for tapping, as compared to the other activities such as fertilizer application, weeding and tapping panel treatment (see Table 6.3). According to Figure 6.4, which illustrates the expected number of tapping days per month over a year, the number of tapping days is lower in the Yala season (March/April-August) than in the Maha season (September/October-February). Therefore, in the Yala season, farmers will have less restrictions in terms of availability of time in using farm labour for paddy farming.

In other words, in the Maha season, farmers will have to stagger their paddy farming activities more than that in Yala season, because the release of farm labour from rubber tapping to paddy farming is restricted to a great extent by the higher number of tapping days in the Maha season.

TABLE 6.3

EXPECTED USE OF LABOUR IN TAPPING AND OTHER ACTIVITIES CONCERNING RUBBER FARMING (EXCLUDING RUBBER REPLANTING) AMONG THE CASE STUDY FARMS

(man-day-equivalents/ha/year)

Activity	Farm Number									
	1	2	3	4	5	6	7	8	9	10
Tapping	302.5	135	299.5	212.5	265	77.5	175	72.5	67.03	537
Other Activities[a]	20	12	16	15	36	9	36	6	8	12

[a] Other Activities include weeding, fertilizing, soil and water conservation and tapping panel treatment etc.

Staggering of the Maha season paddy farming activities involves a relatively longer period of time for completion of those activities.

Another reason for the relatively longer period of time within which Maha season paddy farming activities are expected to be carried out, could be the relatively large amount of expected total labour requirement per hectare (see Table 6.4). This higher labour requirement may well be accounted for by a thorough cleaning and repairing of bunds in Maha season that reduces the land preparation work in the Yala season.

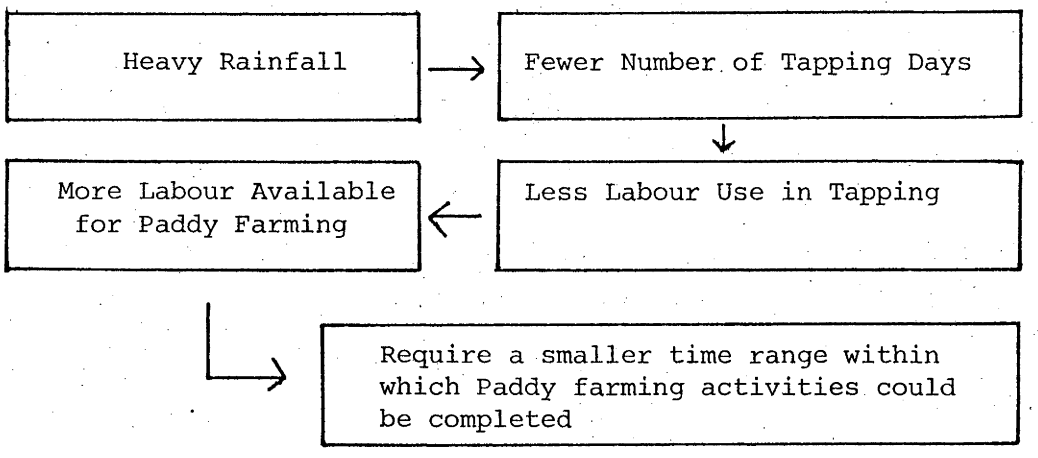
It is interesting to note that almost all the farmers make sure they complete planting of paddy in the Yala season before the second week of April (i.e. week 15) which very often coincides with the Sinhalese New Year in Sri Lanka. This factor could also have some bearing on the relatively smaller degree of flexibility of time for paddy farming activities in Yala season.

A close look at the degree of flexibility of time for different paddy farming activities within the Maha and Yala seasons (see Table 6.2) indicates that in both seasons, the activities which follow land preparation, have

FIGURE 6.2

RELATIONSHIP BETWEEN RAINFALL, NUMBER OF TAPPING DAYS AND THE DEGREE OF FLEXIBILITY OF TIME FOR PADDY FARMING ACTIVITIES IN MAHA AND YALA SEASONS

Yala Season



Maha Season

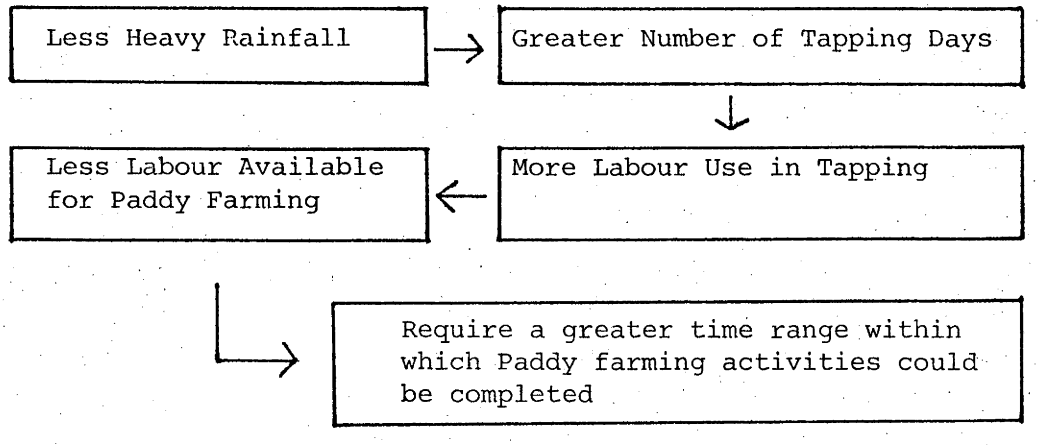
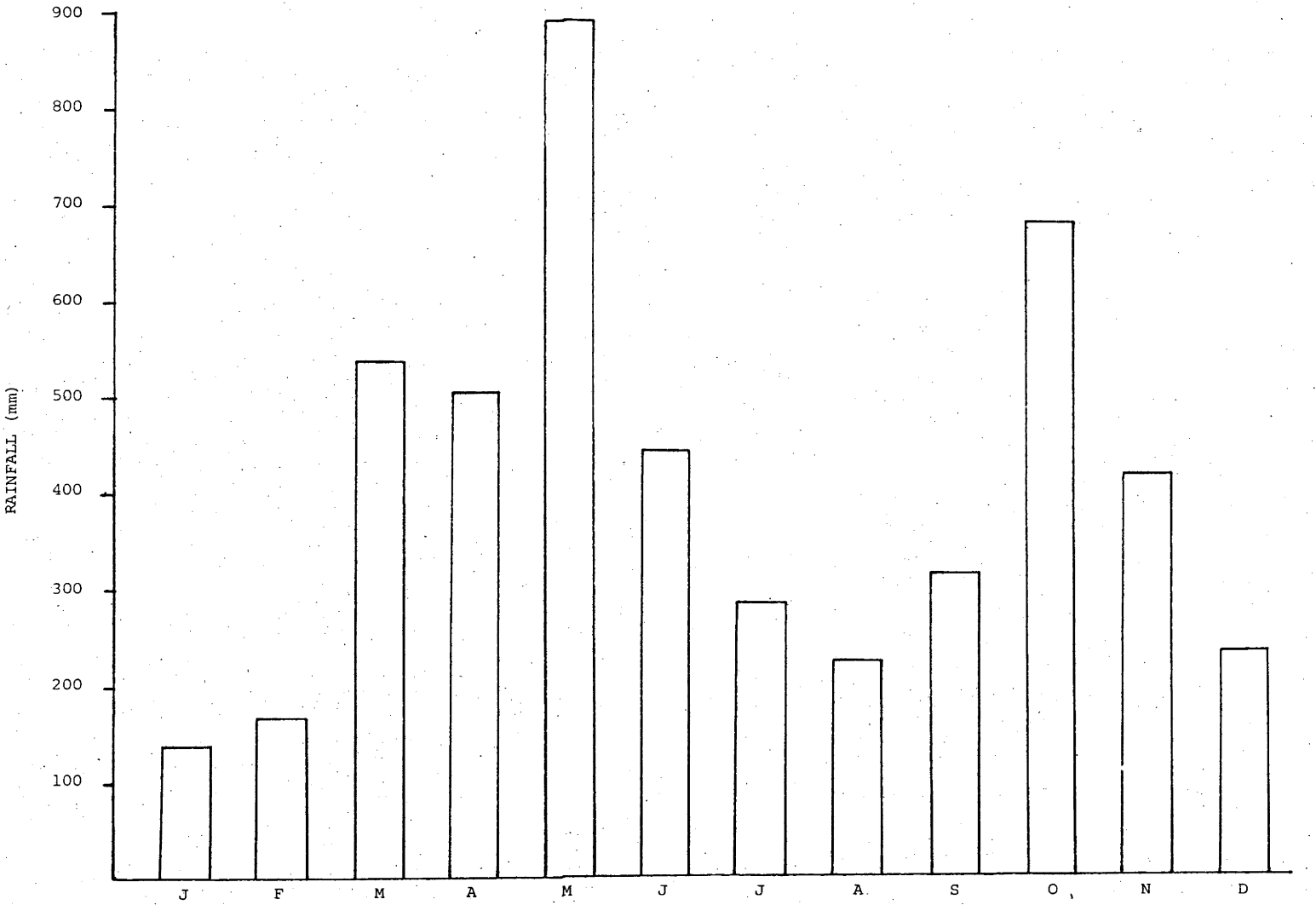


FIGURE 6.3

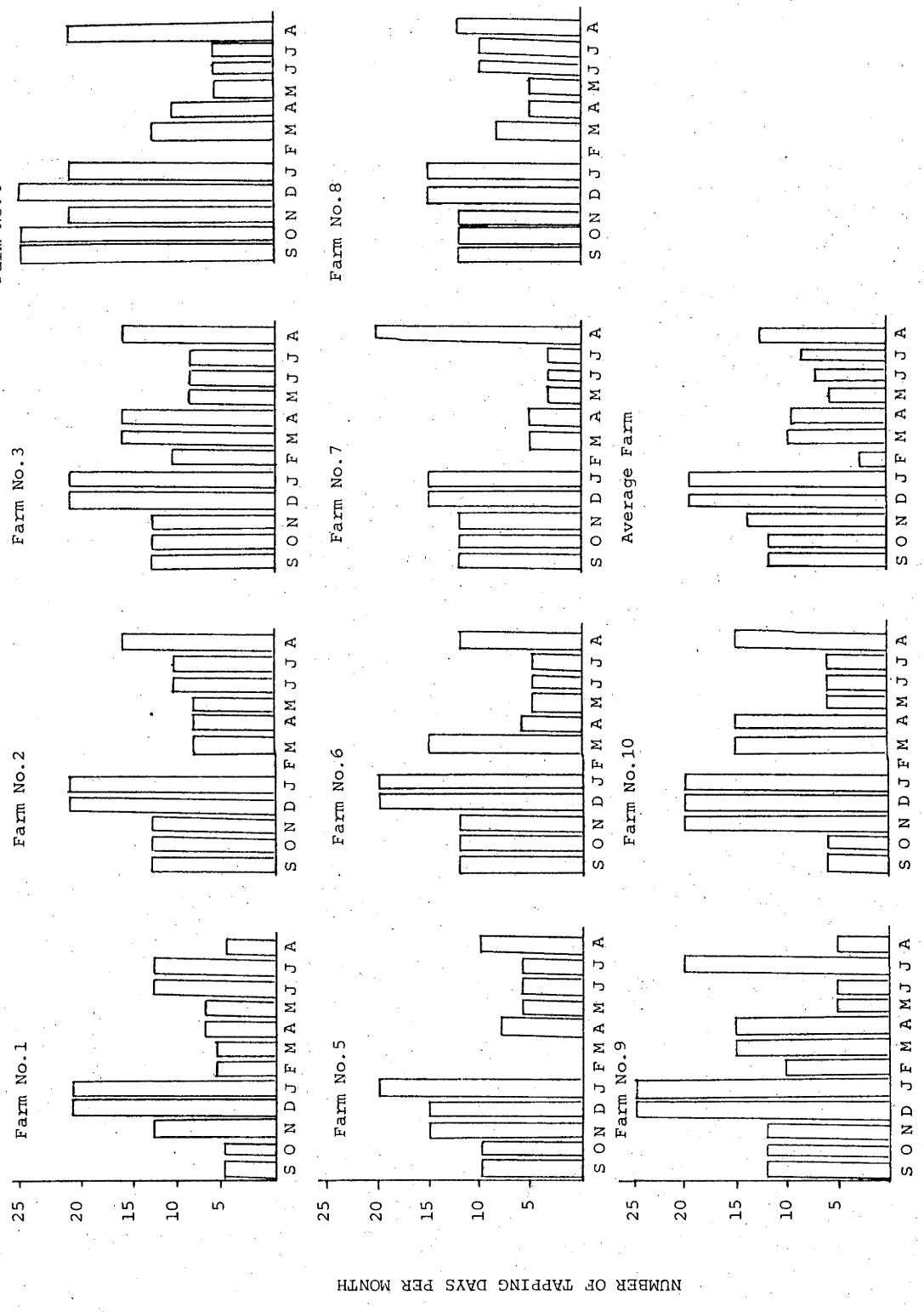
ANNUAL AVERAGE RAINFALL DISTRIBUTION IN HEDIGALLA REO'S DIVISION
FOR FIVE YEARS (1975-1979)



Source: RRISL (1979)

FIGURE 6.4

EXPECTED NUMBER OF TAPPING DAYS PER MONTH OVER A YEAR FOR INDIVIDUAL CASE STUDY FARMS



varying durations of range of time. It is important to note here that, once planting has been carried out there is relatively little flexibility available regarding the subsequent activities. This is because the subsequent activities such as application of fertilizers have to be completed after a certain specific time period of planting. In addition to such rigidities involved in carrying out activities which follow land preparation and planting there are other possible reasons for the varying lengths of time for paddy farming activities within seasons. These could be: (i) the competitive nature of the demand for labour both by paddy farming and rubber farming resulting in variations in the availability of labour in different time periods; (ii) the influence of inter-monsoonal rainfall which determines the time of completing certain paddy farming activities; and, (iii) the variations in the time of availability of certain inputs such as fertilizers.

Seasonality in the expected labour input for paddy production per farm basis, for all the case study farms, is shown in Figure 6.5. As described elsewhere, the paddy holdings in the case study farms vary in size from 0.1 ha to 0.7 ha. As it is evident from Figure 6.5 the expected labour input for paddy production increases with the increase of extent of paddy land. Four seasonal peaks could be identified with regard to expected labour requirements. The highest peaks would be in the periods between weeks 5 and 8, and weeks 30 and 32 which correspond to the Maha season harvesting and threshing and the Yala season harvesting and threshing respectively. Next to these two peaks would be the period between weeks 36 and 47, during which land preparation, sowing and fertilizing are done for the Maha season. Labour peaks for the Yala season land preparation, sowing and fertilizing which take place between weeks 9 and 13 would be relatively lower.

In this study, a considerable degree of variability in expected labour use per hectare with regard to different activities in paddy farming is

apparent among the case study farms. This variability could be observed within the seasons as well as between the Maha and Yala seasons (see Table 6.4).

The expected use of labour per hectare among the case study farms by Maha and Yala paddy farming activities is given in Table 6.4. This table illustrates:

(a) an inter-farm variation in the expected labour use in paddy farming per hectare between the case study farms in both the Maha and Yala seasons, and

(b) an intra-farm variation in the expected labour use per hectare between the Maha and Yaha seasons within the same farms.

Inter-farm variations in expected use of labour for each activity are given by the standard deviation values in Table 6.4. These values show that, except for land preparation and harvesting and threshing, the inter-farm variation is relatively low for all the other activities, in both the seasons. However, the total expected labour use for paddy farming among these farms varies from 85.00 to 245.00 mandays equivalent with a mean value of 133.15 mandays equivalent in Maha season, while in in Yala season it ranges from 81.25 to 225.00 with a mean value of 125.35. Thus, a high inter-farm variation could be observed in total expected labour use in both the seasons among these farms.

Intra-farm variation in expected labour use between seasons shows that except for land preparation, the expected labour use for other activities is the same for both Maha and Yala seasons within the same farm.

Also, as is evident from Table 6.4, more than 75 per cent of the total labour expected to be used for paddy farming will be allocated for land preparation, and harvesting and threshing by all the case study farms, irrespective of the season.

FIGURE 6.5

SEASONALITY IN THE EXPECTED LABOUR INPUT FOR PADDY PRODUCTION AMONG CASE STUDY FARMS

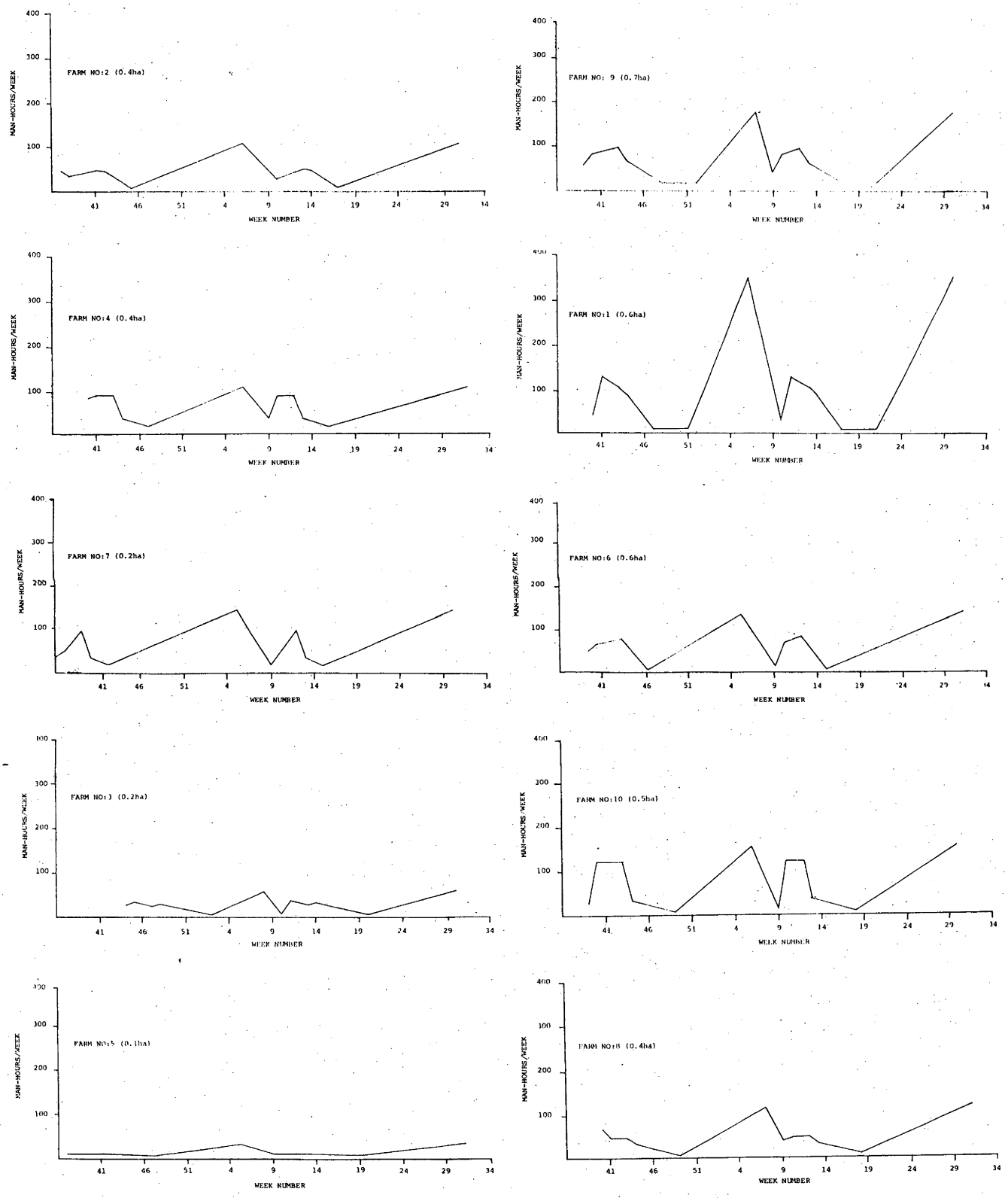


TABLE 6.4

EXPECTED USE OF LABOUR PER HECTARE AMONG THE CASE STUDY FARMS

BY MAHA AND YALA PADDY FARMING ACTIVITIES

(man-days-equivalent/ha)

	1		2		3		4		5		6		7		8		9		10		Mean	Standard Deviation
Maha Season:																						
1. Land preparation	56.5	(37.3)	40.0	(45.1)	50.0	(48.8)	80.0	(62.7)	30.0	(35.2)	120.0	(49.0)	110.0	(47.8)	50.0	(51.3)	41.40	(35.0)	66.0	(57.9)	64.39	30.18
2. Fertilizing 1 & sowing	18.3	(12.3)	15.0	(16.9)	16.25	(15.9)	10.0	(7.8)	10.0	(11.8)	35.0	(14.3)	20.0	(8.7)	10.0	(10.3)	11.40	(12.7)	8.0	(7.0)	15.39	7.97
3. Fertilizing 2	1.6	(1.0)	1.25	(1.4)	-	-	5.0	(4.0)	-	-	5.0	(2.0)	10.0	(4.4)	-	-	2.90	(3.2)	2.0	(1.8)	3.96	3.08
4. Fertilizing 3	1.6	(1.0)	-		1.25	(1.2)	-	-	5.0	(5.9)	-	-	-	-	2.5	(2.6)	2.90	(3.2)	-	-	2.65	1.47
5. Harvesting & threshing	73.3	(48.4)	32.50	(36.6)	35.0	(34.1)	32.5	(25.5)	40.0	(47.1)	85.0	(34.7)	90 0	(39.1)	35.0	(35.8)	31.40	(34.9)	38.0	(13.3)	49.27	23.60
TOTAL	151.3	(100.0)	88.75	(100.0)	102.5	(100.0)	127.5	(100.0)	85.0	(100.0)	245.0	(100.0)	230.0	(100.0)	97.5	(100.0)	90.00	(100.0)	114.0	(100.0)	133.15	58.67
Yala Season:																						
1. Land preparation	53.2	(35.9)	32.5	(40.0)	40.0	(43.2)	65.0	(57.8)	30.0	(35.2)	100.0	(44.4)	100.0	(45.3)	42.5	(47.2)	38.50	(44.2)	64.0	(44.2)	56.57	25.80
2. Fertilizing 1 & sowing	18.3	(12.4)	15.0	(18.5)	16.25	(17.6)	10.0	(9.0)	10.0	(11.8)	35.0	(15.6)	20.0	(9.1)	10.0	(11.1)	11.40	(11.1)	8.0	(13.2)	15.39	7.97
3. Fertilizing 2	1.6	(1.1)	1.25	(1.5)	-	-	5.0	(4.4)	-	-	5.0	(2.2)	10.0	(4.5)	-	-	2.90	-	2.0	(3.3)	3.96	3.08
4. Fertilizing 3	1.6	(1.1)	-	-	1.25	(1.4)	-	-	5.0	(5.9)	-	-	-	-	2.5	(2.8)	2.90	(2.8)	-	(3.3)	2.65	1.47
5. Harvesting & threshing	73.3	(49.5)	32.5	(40.0)	35.0	(37.8)	32.5	(28.8)	40.0	(47.1)	85.0	(37.8)	90.0	(40.9)	35.0	(38.9)	31.4	(38.9	38.0	(36.0)	49.27	23.60
TOTAL	148.0	(100.0)	81.25	(100.0)	92.5	(100.0)	112.5	(100.0)	85.0	(100.0)	225.0	(100.0)	230.0	(100.0)	90.0	(100.0)	87.2	(100.0)	112.0	(100.0)	125.35	54.81

Note: Figures in brackets denote percentage of total expected labour use.

Tables 6.5 and 6.6. illustrate the pattern of different types of labour expected to be used by the case study farms in Maha and Yala seasons. All these farms use family labour in some amount, ranging from 20 to 100 per cent in Maha season (see Table 6.5) and from 22 to 100 per cent in Yala season (see Table 6.6) across the farms. The relative importance of exchange and hired labour in paddy farming is also evident from these two tables. The use of exchange labour ranges from 33 to 80 per cent in Maha season and from 36 to 78 per cent in Yala season across the farms. The use of hired labour among these farms varies from 12 to 77 per cent in Maha season and 13 to 75 per cent in Yala season across the farms. It should be realized that, due to the seasonal nature of paddy cultivation and the peak demand for labour during land preparation and harvesting, the use of a certain amount of hired labour and exchange labour becomes necessary among these farms.

The following three possible reasons could be identified to explain the inter-farm variations in expected labour use in paddy farming which has been described above.

Firstly, the differences in effort made within a given period of time by different types of labour in farming activities. This means the differences in efficiency between different types of labour or between different individuals within the same type of labour. One could possibly say that a family labour unit may make more effort than a hired or exchange labour unit in a certain farming activity. Accordingly, varying proportions of different types of labour used by different case study farms could have caused the inter-farm variations in the expected labour use per hectare among these farms.

Secondly, the variations in soil texture and structure between different farms could have obvious repercussions on the mechanical resistance of the soils and on the expected labour use requirement for the paddy farming

TABLE 6.5

PATTERN OF DIFFERENT TYPES OF LABOUR EXPECTED TO BE USED BY CASE STUDY FARMS IN MAHA SEASON PADDY FARMING

Farm Number	Total Area Under Paddy (ha)	Number of Plots	Expected Number of Man-Days-Equivalent to be Used Per Hectare			
			Family Labour	Hired Labour	Exchange Labour	Total
1	0.6	2	59.7 (39)	-	91.6 (61)	151.3 (100)
2	0.4	1	20.0 (23)	68.75 (77)	-	88.75 (100)
3	0.2	1	67.5 (66)	35 (34)	-	102.5 (100)
4	0.4	2	25.0 (20)	-	102.5 (80)	127.5 (100)
5	0.1	1	85 (100)	-	-	85 (100)
6	0.6	2	90 (37)	-	155 (63)	245 (100)
7	0.2	1	100 (44)	130 (56)	-	230 (100)
8	0.4	1	32.5 (33)	65.0 (67)	-	97.5 (100)
9	0.7	2	32.8 (37)	57.2 (63)	-	90 (100)
10	0.5	2	100 (88)	14 (12)	-	114 (100)

Note: Figures in brackets denote percentage of total expected labour use.

TABLE 6.6

PATTERN OF DIFFERENT TYPES OF LABOUR EXPECTED TO BE USED

BY CASE STUDY FARMS IN YALA SEASON PADDY FARMING

Farm Number	Total Area Under Paddy (ha)	Number of Plots	Expected Number of Man-Days-Equivalent to be Used per Hectare			
			Family Labour	Hired Labour	Exchange Labour	Total
1	0.6	2	56.4 (38)	-	91.6 (62)	148.0 (100)
2	0.4	1	20.0 (25)	61.25 (75)	-	81.25 (100)
3	0.2	1	57.5 (62)	35 (38)	-	92.5 (100)
4	0.4	2	25.0 (22)	-	87.5 (78)	112.5 (100)
5	0.1	1	85 (100)	-	-	85.0 (100)
6	0.6	2	90 (40)	-	135 (60)	225.0 (100)
7	0.2	1	90 (41)	130 (59)	-	220 (100)
8	0.4	1	32.5 (36)	57.5 (64)	-	90.0 (100)
9	0.7	2	32.8 (38)	54.4 (62)	-	87.2 (100)
10	0.5	2	98 (87)	14 (13)	-	112 (100)

Note: Figures in brackets denote percentage of total expected labour use

activities. Thirdly, differences in terms of tenurial status among these case study farms may also have contributed to a cartain extent to the variation in expected labour use in paddy farming between different farms. As described earlier, the intra-farm variations in expected labour use between seasons is apparent with regard to land preparation (see Table 6.4). This is due to the relatively large amount of labour which is required for Maha season land preparation when compared with that of Yala season.

In addition to the seasons explained above, the following factors could also have some effect on the variations in expected labour use among the case study farms. Firstly, it is apparent that these farms operate in small areas of paddy (see Table 6.5). Thus it is possible that labour use requirement from small areas are susceptible to a scaling effect which exaggerates the rate and gives an upward bias when multiplied up to a per hectare basis. Secondly, it is shown in Table 6.5 that 50 per cent of the farmers cultivate more than one plot of paddy. This means that aggregation of the labour use requirements for more than one plot and then its multiplication up to a per hectare basis could also lead to an upward bias.

6.4 Labour Use Pattern in Rubber Farming Among the Case Study Farms

As discussed in Chapter 4, rubber occupies a large proportion of the total land cultivated by the case study farms. The labour intensive nature of the rubber crop has been widely recognised in all the standard works on rubber cultivation (Teo, 1976).

The major field operations in rubber farming could be classified into the following activities:

(1) Establishment of the crop: felling and clearing, lining and holing, filling holes and planting;

(2) Maintenance of the Crop: Weeding, fertilizing, and pest and disease control, and

(3) Harvesting of the Crop: tapping rubber trees and collecting the

latex.

Labour input in establishment and maintenance of the rubber crop during the earlier periods will have a strong influence on current output, and the variations in these inputs are likely to be highly correlated to managerial skills (Teo, 1976). Once the crop reaches the mature stage (it takes about 6-7 years to reach this stage depending on the clonal type, management practices, weather conditions, etc), the major maintenance activities are reduced to fertilizer application, weeding and disease control. In the case of most of the smallholder rubber farmers, the rubber crop does not receive much frequent attention in terms of maintenance during the mature stage of the crop, except for an occasional dose of fertilizers and/or a sporadic round of weeding. Nevertheless, the physiology of the crop is such that it does allow extraction of latex even under very poor maintenance conditions, but at the expense of the life span of the crop. Thus, the most important labour input on mature rubber is in the form of tapping the trees and collection of latex, which involves both male and female labour.

6.4.1. Pattern of Labour Use in Rubber Tapping [1]

Expected use of labour per hectare in rubber tapping among the case study farms by different months of the year is given in Table 6.7.

It is important to note here that the number of case study farmers expected to tap during the month of February is very few. This is because of the annual defoliation of rubber trees which is known as "wintering", that occurs around February/March. Usually rubber trees are not tapped during the wintering period, since it depresses yield, ranging from 10 to 30 per cent of normal yield (Teo, 1976).

Table 6.7 illustrates two important variations in the labour use pattern in rubber tapping among these farms. Firstly, it shows that there is a variation in expected labour use in tapping between the case study farms in different months of the year. Secondly, it sets out the variation

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1 Time spent on marketing of rubber is not incorporated here due to lack of relevant data on that aspect.

TABLE 6.7

EXPECTED USE OF LABOUR PER HECTARE IN RUBBER TAPPING

AMONG THE CASE STUDY FARMS BY DIFFERENT MONTHS OF THE YEAR

(Man-Days-Equivalent/ha/month)

Month	Farm Number										Mean	Standard Deviation
	1	2	3	4	5	6	7	8	9	10		
January	50.0	20.0	37.5	25.0	50.0	12.5	25.0	9.375	10.4	75.0	31.47	21.4
February	15.0	-	28.0	-	-	-	-	-	4.16	-	15.72	11.93
March	15.0	8.0	28.0	15.0	-	9.375	8.33	5.0	6.25	56.0	16.77	16.29
April	17.5	8.0	28.0	12.5	20.0	3.75	8.33	3.125	6.25	56.0	16.35	16.01
May	17.5	8.0	15.0	7.5	15.0	3.125	5.0	3.125	2.08	22.0	9.83	7.01
June	30.0	10.0	15.0	7.5	15.0	3.125	5.0	6.25	2.08	22.0	11.59	8.97
July	30.0	10.0	15.0	7.5	15.0	3.125	5.0	6.25	8.33	22.0	12.22	8.43
August	12.5	15.0	28.0	25.0	25.0	7.5	33.33	7.5	2.08	90.0	24.59	25.16
September	12.5	12.0	22.5	31.25	25.0	7.5	20.0	7.5	5.0	22.0	16.53	8.81
October	12.5	12.0	22.5	25.0	25.0	7.5	20.0	7.5	5.0	22.0	15.9	7.82
November	30.0	12.0	22.5	25.0	37.5	7.5	20.0	7.5	5.0	75.0	24.2	20.78
December	60.0	20.0	37.5	31.25	37.5	12.5	25.0	9.375	10.4	75.0	31.85	21.72
Mean	25.20	12.27	24.95	19.31	26.5	7.04	15.90	6.59	5.58	48.81		
Standard Deviation	15.68	4.38	7.78	9.47	11.73	3.50	9.95	2.13	2.93	27.29		

in expected labour use in tapping within the individual farms between different months of the year. These variations in expected labour use are indicated by the standard deviation values in Table 6.7. The two sets of standard deviation values show that between farm variation is greater than the within farm variations over time.

Two important possible reasons for the inter-farm variation in expected labour use in tapping in different months of the year could be:

(i) the variation in number of rubber trees per hectare, and

(ii) the variation in number of tapping days per month in different months (see Table 6.8).

Number of trees per hectare, at a given point of time, is dependent on the planting density, topography of the rubber land, age of the crop and climatic factors such as wind. The number of tapping days per month is determined by the tapping system, rainfall, and the availability of labour. Variations in the efficiency of expected labour use in tapping among different case study farms and the differences in the distance between rubber holdings and farm houses may also have some effect on the variation in expected labour use in tapping between these farms.

On the other hand, a possible reason for the intra-farm variation in expected labour use in tapping in different months could be the variation in number of tapping days per month in different months of the year (Table 6.8). The total rubber area under tapping in each farm is small and in some cases it is in more than one plot (see Table 6.8). Expected labour use data from such small areas are susceptible to a "scaling effect" which overestimates the rate when multiplied up to a per hectare basis. Also aggregation and multiplication of labour data from more than one plot to a per hectare basis could also lead to an overestimation. Thus, these factors may also have contributed to a certain extent to the variations in expected later use in tapping among the case study farms which have been discussed above.

TABLE 6.8

NUMBER OF TAPPING DAYS PER MONTH AND NUMBER OF RUBBER

TREES UNDER TAPPING PER HECTARE AMONG THE CASE STUDY FARMS

Farm Number	Total Rubber Area Under Tapping (ha)	Number of Plots	Number of Tapping Days/Month												No. of trees per ha.
			Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
1	0.2	1	20	6	6	7	7	12	12	5	5	5	12	20	600
2	1.0	1	20	-	8	8	8	10	10	15	12	12	12	20	400
3	0.2	1	20	10	15	15	6	8	8	15	12	12	12	20	310
4	0.4	2	20	-	12	10	6	6	6	20	25	25	20	25	338
5	0.2	1	20	-	-	8	6	6	6	10	10	10	15	15	200
6	0.8	2	20	-	15	6	5	5	5	12	12	12	12	20	188
7	1.3	2	15	-	5	5	3	3	3	20	12	12	12	15	500
8	0.8	2	15	-	8	5	5	10	10	12	12	12	12	15	438
9	1.2	2	25	10	15	15	5	5	20	4	12	12	12	25	100
10	0.3	2	20	-	15	15	6	6	6	15	6	6	20	20	560

6.4.2 Pattern of Labour Use in Rubber Replanting

As in all productive processes which involve assets whose productivity declines over time, in rubber farming the productivity of rubber trees also diminishes with aging and thus, the necessity for replanting arises.

The important field operations involved in rubber replanting could be classified into the following activities:

(1) Felling and Clearing: This is the method of eradication of the old stand of rubber. It involves cutting and felling of the old rubber trees, and subsequent removal of the root system and clearing the cut trees.

(2) Lining and Holing: This involves lining the rubber holding and cutting the planting holes.

(3) Filling the cut holes: and,

(4) Planting.

The recommendations given by the RRISL (Peries, 1970) in rubber replanting could be briefly described as follows:

For effective elimination of root diseases caused by fungi, the felling and clearing should be started about three years before replanting. And lining should begin early in the year prior to replanting, i.e. in February-March. Holes should be cut and left exposed for some time and be filled by January of the year of planting. At a time when a period of wet weather could be expected, planting should be undertaken. In the main rubber growing areas in the south-west part of Sri Lanka, the latter half of May and the beginning of June is usually the best time for planting in the south-west monsoon season. In a normal year October and November are also favourable months for planting. Although the importance of a nitrogenous cover, especially in the first few years of growth of the rubber trees has been clearly established in Malaysia, there are no experimental data available under Sri Lankan conditions to assess the economics

of maintaining a pure legume crop under rubber. It is generally accepted in Sri Lanka, for the present, that clean weeding is not necessary in rubber farming. Yet an area of two feet around the plant must be kept free of grass and covers.

However, as will be explained in the following discussion, the timing of different field operations in rubber replanting expected to be carried out by the case study farmers, is quite different from that which has been recommended by the RRISL.

Of the ten case study farmers, 5 reported their intention to replant in May/June and the rest in the October/November period. The week of commencement of different activities in rubber replanting among the case study farmers is given in Tables 6.9 and 6.10. It is apparent from these tables that except for planting, the other activities in rubber replanting are not expected to be carried out in strictly specific time periods. This is quite contrary to what has been observed in paddy farming, where almost all the activities are time specific.

Timing of different rubber replanting activities among these farms is dependent on the availability of farm labour and capital, other farming and/or non-farming activities and the climatic factors such as rainfall. If farmers have to rely solely or predominantly upon family labour for rubber replanting, the availability of family labour plays a major role. The effect of the availability of capital is much greater if the farmers have to depend upon a considerable proportion of hired labour for replanting activities. Other farming and/or non-farming activities, particularly paddy farming activities, and withdrawal of both family and hired labour from rubber farming to other farming activities also have a bearing on the timing of rubber replanting activities. As for any other farming activity, the effect of climatic conditions, particularly of rainfall on the timing of rubber replanting activities is crucial.

TABLE 6.9

THE WEEK OF COMMENCEMENT OF DIFFERENT ACTIVITIES IN RUBBER REPLANTING AMONG THE CASE STUDY FARMS WHO INTEND TO REPLANT IN MAY/JUNE

(January 1-7 = Week 1)[a]

Activity	Farm Number				
	3	5	6	7	9
1. Felling & Clearing	36	03	08	49	16
2. Lining & Holing	47	12	17	04	17
3. Filling Holes	12	15	18	08	21
4. Planting	20	21	20	19	22

[a] See Code of Cropping Index in Appendix Table 1.

TABLE 6.10

THE WEEK OF COMMENCEMENT OF DIFFERENT ACTIVITIES IN RUBBER REPLANTING AMONG THE CASE STUDY FARMS WHO INTEND TO REPLANT IN OCT/NOV

(January 1-7 = Week 1)[a]

Activity	Farm Number				
	1	2	4	8	10
1. Felling & Clearing	11	18	06	20	17
2. Lining & Holing	17	27	20	25	25
3. Filling Holes	33	32	37	29	43
4. Planting	40	46	43	45	45

[a] See Code of Cropping Index in Appendix Table 1.

Table 6.11 gives the expected use of labour per hectare among the case study farms by different rubber replanting activities.[1] According to this table, the expected total labour use per hectare for rubber replanting among these farms varies from 124.0 to 292.5 mandays equivalent with a mean value of 215.58. Inter-farm variations in expected use of labour for each rubber replanting activity is given by the standard deviation values in Table 6.11. These values show that, except for felling and clearing, the inter-farm variation is relatively low for all the other activities. Nevertheless, a standard deviation value of 68.46 mandays equivalent per hectare, denotes that there is a considerably high degree of variability in expected total labour use in rubber replanting between the case study farms. Also, according to Table 6.11, a greater proportion of the expected total labour use in rubber replanting will go for felling and clearing. If felling and clearing, lining and holing, and filling holes are combined together, then they account for more than 90 per cent of the total labour expected to be used for rubber replanting among all the case study farms.

Expected use of different types of labour by case study farms in rubber replanting is illustrated in Table 6.12. According to this table all these farms use family labour in some amount ranging from 36 to 100 per cent, across the farms.

Eight case study farms report the use of hired labour in addition to family labour. The use of hired labour in replanting varies from 36 to 64 per cent across the farms. There are only two farms which depend solely on family labour for rubber replanting.

In an attempt to explain the inter-farm variations in expected labour use for rubber replanting, the following reasons are considered to be reasonably valid.

Firstly, the varying number of old rubber trees per hectare and the

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1. This ensures that the replanting assumption is for a standard (recommended) plant density.

TABLE 6.11

EXPECTED USE OF LABOUR PER HECTARE AMONG THE CASE STUDY FARMS

BY DIFFERENT RUBBER REPLANTING ACTIVITIES

(Man-Days-Equivalent/ha)

Activity	FARM NUMBER										Mean	Standard Deviation
	1	2	3	4	5	6	7	8	9	10		
1. Felling & Clearing	160.0 (64)	112.5 (56)	75.0 (48)	115.0 (59.0)	100.0 (40.4)	50.0 (33.3)	80.0 (41.5)	200.0 (68.5)	50.0 (40.3)	210.0 (60.8)	115.25	57.52
2. Lining & Holing	38.0 (15)	42.5 (21)	37.5 (24)	30.0 (15.4)	70.0 (28.3)	42.5 (28.5)	50.0 (26.0)	47.5 (16.2)	42.5 (34.4)	50.0 (14.6)	45.05	10.69
3. Filling Holes	40.0 (16)	42.5 (21)	37.5 (24)	35.0 (18.0)	70.0 (28.3)	50.0 (33.3)	55.0 (28.5)	37.5 (12.8)	25.0 (20.0)	60.0 (17.4)	45.25	13.40
4. Planting	4.0 (3)	2.5 (1)	3.75(2.4)	5.0 (2.5)	5.0 (2.0)	2.5 (1.6)	4.0 (2.0)	2.5 (0.8)	3.2 (2.5)	15.0 (4.3)	4.75	3.72
5. Weeding & Maintaining the Nitrogenous cover	8.0 (2)	2.5 (1)	2.5 (1.6)	10.0 (5.1)	2.5 (1.0)	5.0 (3.3)	4.0 (2.0)	5.0 (1.7)	3.3 (2.6)	10.0 (2.9)	5.28	2.99
TOTAL	250.0(100)	202.5(100)	156.25(100)	195.0(100)	247.5(100)	150.0(100)	193.0 (100)	292.5(100)	124.0(100)	345.0(100)	215.58	68.46

Note: Figures in brackets denote percentage of total expected labour use.

TABLE 6.12

PATTERN OF DIFFERENT TYPES OF LABOUR EXPECTED TO BE USED BY CASE STUDY FARMS IN RUBBER REPLANTING

Farm Number	Total Area to be Replanted (ha)	Number of Plots	Expected Number of Man-days-Equivalent to be used per hectare		
			Family Labour	Hired Labour	Total
1	0.5	1	128.0 (51)	122.0 (49)	250.0 (100)
2	0.8	1	77.5 (38)	125.0 (62)	202.5 (100)
3	0.8	1	66.25 (42)	90.0 (58)	156.25 (100)
4	0.2	1	70.0 (36)	125.0 (64)	195.0 (100)
5	0.2	1	112.5 (45)	135.0 (55)	247.5 (100)
6	0.4	1	150.0 (100)	-	150.5 (100)
7	1.0	1	73.0 (38)	120.0 (62)	193.0 (100)
8	0.4	1	187.5 (64)	105.0 (36)	292.5 (100)
9	0.6	1	64 (52)	60 (48)	124 (100)
10	0.1	1	346 (100)	-	345 (100)

Note: Figures in brackets denote percentage of total expected labour use.

differing ages of the trees in the holdings to be replanted (see Table 4.3) of the case study farms can cause a variation in the expected use of labour in different activities, particularly in felling and clearing.

Secondly, differences in the soil texture and structure, and topography of land between different holdings to be replanted can have varying effects on the mechanical resistance of the soils and the ease with which trees can be uprooted and holes cut. These differing physical properties of the holdings could lead to a variation in the expected labour use in activities such as felling and clearing, and holing.

Thirdly, differences in the efficiency of labour in terms of efforts made within a given period of time between different types or within the same type but between different individuals could also account for a variation in the expected labour use in replanting among different farms.

According to Table 6.12, some of the case study farmers intend to replant smaller areas of rubber. The expected labour use data for rubber replanting have been gathered in relation to these small areas and thus this data could be susceptible to a scale effect which overestimates the rate and gives an upward bias when multiplied up to a per hectare basis. This upward bias could also be a contributory factor to the variation in expected labour use in rubber replanting among these farms.

6.5 Other Farming Activities in the Case Study Farms

In addition to the time specific farming activities which have been discussed in reference to the labour use pattern in the foregoing analyses, the case study farmers do practise the following non-time specific farming activities according to the amount of time they have.

One major operation which comes under non-time specific activities is weeding of rubber land. Although they weed once or twice a year, they have no fixed time period for it. However, these farmers make sure that they weed their rubber lands during the drier months of the year, i.e. in January and

August.

As described elsewhere, very few smallholders apply fertilizers to their mature rubber. Only two case study farms report the application of fertilizers.

Tapping panel treatment is done by these farmers once a month or once in two months without having a fixed time period.

As indicated before, in their home gardens, these farmers grow crops such as coffee, banana, kitul, coconut, jak, cinnamon, mangoe, aricanut and passionfruit etc. They attend to these crops whenever they have time, but such attention is not very time specific.

Detailed information regarding the expected use of labour and cash inputs in home gardening is not available for the case study farms. However, the case study farmers report that home garden products are predominantly consumed within the households. This indicates the relative importance of the non time-specific activities of which home gardening is a major one.

Labour use per hectare on paddy or rubber implicitly attaches an imputed value to labour for each crop considered. This could be regarded as a trade off between commercial farming (eg. rubber farming) and semi-subsistence or subsistence farming (eg. paddy farming) since the latter is partly or wholly consumed domestically. The relative share of farm labour to each crop is a trade off between the subjective valuation attached by the farmer to consumption goods vs. cash income. Although this distinction is important, lack of relevant data has prevented from going into details of it.

CHAPTER 7

THE WHOLE FARM ANALYSIS

7.1 The Whole Farm Model

A broad outline of the whole farm model used in this analysis is given in Table 7.1. In this LP model the farm household is examined as a whole entity with a common resource base from which alternative enterprises of crops and different planting time periods can be selected to fulfil the objectives of farming. Here, the modelling process will select a mix of farming activities which satisfies the farmer's goals of producing consumption goods and maximises cash surplus subject to the major constraints of land, labour and capital. The model itslef is an expansion on the matrix given in Table 5.1.

The normal crop year in the area studied starts from fortnight 18 (27 August) and ends in fortnight 17 (26 August) (see Appendix Table 2). However, the model covers one and a half years of operation for the case study farm household units. This period comprises 40 fortnightly periods ranging from the beginning of fortnight 18 (27 August) to the end of fortnight 5 (11 March) of the second crop year (see Appendix Table 3). The reason for selecting one and a half years is to accommodate two rubber replanting operations, one which has a planting time in October and the other in May.

Fortnightly time periods are used in this model for the following reasons. Firstly, the major resources of the case study farms considered in this model such as land and labour are not likely to act as a constraint within weekly time periods. But they are frequently a constraint within fortnightly time periods. Secondly, labour and other important input data for rubber tapping were collected on monthly basis in the field survey. If this monthly data were to be decomposed into much smaller time periods biases would be likely to occur. Finally, exchange labour is an important

TABLE 7.1

OUTLINE OF THE WHOLE FARM MODEL

	Rubber Production (ha)	Rubber Sales (metric tonnes)	Paddy Production (ha)	Paddy Harvesting (metric tonnes)	Paddy Purchasing (metric tonnes)	Paddy Consumption (metric tonnes)	Rubber Replanting (ha)	Other earnings (Rs)	Household Expenditure (Rs)	Hired Labour (Rs/fortnight)	Cash Savings (Rs/fortnight)	Cash Surplus (Rs/fortnight
Land fortnightly (ha)	+Aij	O	+Aij	O	O	O	+Aij	O	O	O	O	O
Labour fortnightly (hr)	+Aij	+Aij	+Aij	+Aij	O	O	+Aij	O	O	-Aij	O	O
Cash Supply fortnightly (Rs)	+Aij	-Aij	+Aij	O	+Aij	O	$\pm$Aij	-Aij	+Aij	+Aij	$\pm$Aij	+Aij
Other Earnings maxima (Rs)	O	O	O	O	O	O	O	+Aij	O	O	O	O
Paddy Balance (metric tonnes)	O	O	O	-Aij	-Aij	+Aij	O	O	O	O	O	O
Paddy Consumption Minima (Metric tonnes)	O	O	O	O	O	+Aij	O	O	O	O	O	O
Household Expenditure minima (Rs)	O	O	O	O	O	O	O	O	+Aij	O	O	O
Paddy Transfer (metric tonnes)	O	O	-Aij	+Aij	O	O	O	O	O	O	O	O
Rubber Transfer (metric tonnes)	-Aij	+Aij	O	O	O	O	O	O	O	O	O	O
Surplus per unit of activity	O	O	O	O	O	O	O	O	O	O	O	C_n

component in labour input, and usually has to be reciprocated within a fortnight. Defining fortnightly periods allows for the use of exchange labour without explicit provisions being made for it through the addition of special vectors in the model.

The various activities of the model are given across the top of Table 7.1. A unit of different activities will have differing requirements of the various restricted resources, which are given in the left hand side of Table 7.1. The utilization of each major resource is defined on a fortnightly basis.

The requirement for each restricted resource by a unit of a given activity is expressed by a coefficient, Aij, in the relevant row vector. In the model these coefficients are on a per hectare basis, and can have a positive (+) or a negative (-) sign, or sometimes be zero. A(+) sign denotes that resources are used by the relevant activity; a (-) sign implies that the activity involved contributes to the row vector; and zero means it does not have any effect on the row vector concerned. The surplus for all activities is denoted by C_n. The total of the individual surpluses generated by all the units of cash surplus vectors specified in the final solution is the total surplus CX, which is maximised in the LP process. This cash surplus is net of input costs and household expenditure.

7.2 The Activities in the Model

The first set of vectors (Table 7.1) is for rubber production. Rubber production which is defined in hectares uses up land, labour and cash supply and contributes rubber yields to the rubber transfer row. Thus, rubber production vectors have a +Aij for land, labour and cash supply rows, and a -Aij for the rubber transfer row. The surplus C_n per unit of rubber production is zero, because the yield from which the surplus can be generated is taken up by the rubber transfer row vectors.

The second set of vectors is for rubber sales which is defined in metric tonnes. Rubber sales column vectors take out the crop from the rubber transfer row vectors, use labour and add the value of rubber sold to the cash supply rows. Thus, rubber sales vectors have a +Aij for labour and rubber transfer rows and a -Aij for the cash supply rows. Here the surplus per unit of rubber sales activity is zero.

The third set of vectors is those for paddy production which is defined in hectares. Paddy production uses up land, labour and cash supply, and contributes the paddy output to the paddy transfer rows. Therefore, paddy production vectors have a +Aij for land, labour and cash supply rows and a -Aij for the paddy transfer rows. The surplus per unit of paddy production is zero, since the yield from which the surplus can be generated is taken up by the paddy transfer vector rows. The paddy output contributed by the paddy production activity is the yield net of the landlord's share if the paddy land is rented by the case study farmers.

The fourth set of vectors is the paddy harvesting defined in metric tonnes. Paddy harvesting column vectors take out the crop from the paddy transfer row vectors, use labour in harvesting and contribute the yield resulted to the paddy balance rows. Thus, paddy harvesting vectors have a +Aij for labour and paddy transfer rows and a -Aij for the paddy balance rows. The surplus per unit of paddy harvesting activity is zero.

The fifth set of vectors is the paddy purchasing defined in metric tonnes. Paddy purchasing vectors use up cash and contribute quantities of paddy to the paddy balance rows. Among the case study farmers paddy purchasing vectors have a +Aij for cash supply rows and a -Aij for paddy balance rows. The surplus per unit of paddy purchasing activity is zero.

The sixth set of vectors contains those for paddy consumption, defined in metric tonnes of paddy consumed in the case study farm household. Paddy consumption vector takes quantities of paddy out of the paddy balance

rows. The paddy consumption minima are set at a level to satisfy the minimum consumption requirements of the particular case study farm household. This is necessary, as all the case study farmers use all the paddy they produce for domestic consumption and also purchase from outside to fulfil the total domestic consumption requirements. Here the paddy consumption vector has a +Aij for paddy balance and paddy consumption minima rows. The surplus per unit of paddy consumption activity is zero.

The seventh set of vectors includes rubber replanting which is defined in hectares. It uses land, labour and cash supply. A rubber replanting subsidy given by the government adds cash supply to the rubber replanting vectors. Thus it has a +Aij for land, labour and cash supply rows, and a -Aij for cash supply rows. The surplus per unit of rubber replanting activity is zero.

The eighth set of vectors is the other earnings defined in Rs. This vector adds cash to the cash supply rows in those fortnights where such earnings are expected. Thus, this activity has a -Aij for the cash supply row and a +Aij for the other earnings maxima row. The surplus per unit of other earnings activity is zero.

The nineth set of vectors is those for household expenditure defined in Rs. This activity takes the total amount of cash expenditure expected in each fortnight from the cash supply rows. Therefore, household expenditure activity has a +Aij for cash supply and household expenditure minima rows. The surplus per unit of household expenditure activity is zero.

The tenth set of vectors includes hired labour defined in Rs. This activity adds to labour time in particular fortnights, and uses cash supply since payment for hired labour is needed. Therefore, hired labour activity has a +Aij for labour rows and a -Aij for cash supply rows. The surplus per unit of hired labour activity is zero.

The eleventh set of vectors is the cash savings defined in Rs. Cash savings vectors transfer extra cash from one fortnight to a succeeding fortnight during the year. Thus, it has a +Aij and a -Aij for cash supply rows.

Lastly, the cash surplus vectors allow cash which is not needed in the profit maximising combinations of activities to be set aside as a surplus in any of the 40 fortnightly periods of the defined one and a half years term for which the model is built.

7.3 Activity Analysis and Crop Production Vectors

Basic physical data for the specification of input requirements and average expected output levels of the crop production activities, included in the whole farm model, are based on "activity analysis". An activity analysis is defined as a catalogue, overtime, of the recorded inputs and output levels pertaining to a given crop on a given plot in a given period of time (Barlow et al. 1979). Table 7.2 illustrates an activity analysis for the Maha season paddy crop on plot 1 for Farmer 1.

The following steps are involved in determining the crop production vectors from activity analysis. Firstly, all activity analyses that refer to a given crop production technology are grouped. Secondly, for each selected group of activity analyses, a suitable set of vectors to cover the range of planting time periods and performances is defined.

Table 7.3 shows the set of paddy production vectors defined to cover the range represented by the group of activity analyses for the Maha season paddy crop on plot 1 of Farmer 1. In vector A, land preparation begins with fixing of bunds in fortnight 18, and the crop is harvested in fortnight 1. In vector E, at the other end of the range, bunds are fixed in fortnight 22 and harvesting takes place in fortnight 5. Three other vectors are defined between these extremes. Average labour input requirements are given for each operation on a per hectare basis. The yield

dependent inputs of harvesting processes are indicated on a per metric tonne basis. And they are linked in the model to crop production vectors by separate transfer vectors (see Table 7.1). Thus the set of vectors illustrated in Table 7.3 presents in a more orderly fashion the range of timings and performances represented by the relevant groups of activity analysis.

TABLE 7.2

AN ACTIVITY ANALYSIS

Farmer : No. 1

Crop : Maha Season Paddy

Area : 0.6 ha.

Fortnight Number[a]	Operation	Labour hr/ha	Seed kg/ha	Fertilizer kg/ha	Yield kg/ha
18	Fixing bund	66			
19	Ploughing 1	213			
20	Ploughing 2	173			
20	Fertilizing 1 & Sowing	146	85	127	
22	Fertilizing 2	13		64	
24	Fertilizing 3	13		64	
1	Harvesting & Threshing	520			1128

[a] See Code of Cropping Fortnights in Appendix 3.

TABLE 7.3

THE SET OF PADDY PRODUCTION VECTORS FOR MAHA SEASON

PADDY ON PLOT 1 OF FARMER 1

Operations	Fortnight Number[a]					Hours/ha.
	A	B	C	D	E	
Fixing Bunds	18	19	20	21	22	66
Ploughing 1	19	20	21	22	23	213
Ploughing 2	20	21	22	23	24	173
Fertilizing 1 & Sowing	20	21	22	23	24	146
Fertilizing 2	22	23	24	25	26	13
Fertilizing 3	24	25	26	1	2	13
Harvesting & Threshing	1	2	3	4	5	520

	kg/ha
Seed	85
Fertilizer	255
Yield	1128

[a] See Code of Cropping Fortnights in Appendix Table 3.

It should be noted here that inadequacy of relevant data prevented the incorporation of factors such as the number of holidays that farmers would enjoy, troughs and peaks of demand for cash expenses in the farms and the 'rainy day' constraint imposed on the rubber tapping activity etc., in the LP model.

CHAPTER 8

WHOLE FARM ANALYSIS OF TWO CASE STUDY FARMS

Similar cropping patterns are followed by all the case study farms in their crop production activities. These consist of seasonal paddy cultivation and perennial rubber farming. As described in Chapter 4, the size distribution of total farm land cultivated by the case study farmers is within a range of 1.1 to 2.3 hectares with a standard deviation of 0.35 hectares (see Table 4.2). The majority of the farms are between 1.2 and 1.8 hectares inclusive in extent with a mean value of 1.6 hectares. Also the distribution of male and female labour is roughly equivalent among these farms (see Table 3.1). Thus, it may not be unrealistic to assume that the majority of these farms are homogeneous in terms of their major resource availability and cropping pattern. This being the case, only two farms have been selected for the whole farm analysis. Analysis of more than two farms has been constrained largely by the limited time available for this study. The two farms selected for the whole farm analysis are medium in size. One of these farms is run by a farmer called Sirisena and the other one by a farmer called Piyasena.

8.1 Aims of the whole Farm Analysis

The aims of the whole farm analysis of the two case study farms selected are twofold. Firstly, an attempt is made to examine the existing farming situation of these farms with special reference to allocation of farm labour. Secondly, the allocation of labour in these farms is re-examined after introducing rubber replanting activities into the existing system. Moreover, the relationship between the marginal value productivity of labour and the labour allocation pattern, the staggering of different crop production activities, and the shadow price of other major resources are also studied.

8.2 Basic features of the Two Farm-Households

The basic features of the two farm-households selected for the whole-farm analysis are briefly set out in Tables 8.1 and 8.2. Both households

depend essentially on farming for their livelihood. Both have similar size farms of 1.8 hectares which consist of lowland and upland parcels. Paddy and rubber are the major crops grown in these farms, although subsidiary crop cultivation is done in each household's homestead. Sirisena's homestead is larger than that of Piyasena's; Piyasena owns his farm fully while Sirisena rents part of his paddy land.

Sirisena has a family of seven members. Four of his children are school going; only the eldest son helps him in the farm. Sirisena, his wife and their eldest son can contribute an estimated 192 man-hours per fortnight to their farm. Piyasena's family is smaller. His three children attend school and his wife assists in farming. It is estimated that they can contribute 92 man-hours per fortnight for their farming activities. These estimates of labour input do not necessarily imply that all of this labour will be available within the farm. One should bear in mind that these farmers may not be wanting to put all their labour as estimated, into farming, if their preferences for leisure or any other activities besides farming have greater opportunity cost. However, in the field survey, such preferences for leisure, or any other activities such as social and/or religious commitments, were not elicited from these farmers.

The household expenses of Sirisena and Piyasena are Rs 3,580.00 and Rs 4,000.00 per annum respectively. Since a greater proportion of the staple diet (rice) of these farm-households is produced within the farms, most of the household expenditure accounts for other essential food items, clothing, health, entertainment, religious and social activities and repairing the houses, etc.

With the resource endowments illustrated in Tables 8.1 and 8.2 and the vectors of different activities described in Chapter 7 as given, the optimum solutions were obtained for both the farms, and they are discussed in the following sub-sections.

TABLE 8.1

BASIC FEATURES OF SIRISENA'S FARM HOUSEHOLD

Land	Parcel Number					
	1	2	3	4	5	Homestead
Area (ha)	0.2	0.4	0.3	0.2	0.5	0.2
Class[a]	L	L	U	U	U	U
Tenure[b]	O	R	O	O	O	O
Crop	Paddy	Paddy	Immature Rubber	Mature Rubber	Old Rubber	Subsidiary Crops

Total Area (ha): 1.8

Household:

Availability of family labour hrs/fortnight	:	192.00
Household expenditure Rs/year	:	3580.00
Domestic consumption of paddy metric tonnes/year	:	1.029
Liquid Cash, fortnight 18 (Rs)	:	400.00
Subsidy available for rubber replanting Rs/ha	:	9263.00

[a] L = Lowland; U = Upland

[b] O = Owned; R = Rented

TABLE 8.2

BASIC FEATURES OF PIYASENA'S FARM HOUSEHOLD

Land	Parcel Number				
	1	2	3	4	Homestead
Area (ha)	0.4	0.5	0.4	0.4	0.1
Class[a]	L	U	U	U	U
Tenure[b]	O	O	O	O	O
Crop	Paddy	Immature Rubber	Mature Rubber	Old Rubber	Subsidiary Crops

Total Area (ha): 1.8

Household:

Availability of family labour hrs/fortnight	: 96.00
Household expenditure Rs/year	: 4000.00
Domestic consumption of paddy metric tonnes/year	: 0.800
Liquid Cash, fortnight 18 (Rs)	: 350.00
Subsidy available for rubber replanting Rs/ha	: 9263.00

[a] L = Lowland: U = Upland

[b] O = Owned

8.3 Optimal Solutions for the Two Farm-Households With the Existing Farming Situation

With respect to paddy cultivation the LP solutions specify staggering of planting of certain paddy crops for both the farms, utilizing all the paddy land available. In Sirisena's farm, staggered planting has been prescribed for (i) all the Maha paddy crops except for the second year's owned crop, and, (ii) for Yala season owned paddy crop (see Table 8.3). In the case of Piyasena's farm, planting of all the paddy crops has been staggered in the

solution (see Table 8.4). However, the "expected" paddy cultivation plans elicited from both the farmers do not have any staggering of planting.

Of the three major resources required for paddy farming namely, land, labour and capital, land is fixed and the use of cash inputs such as fertilizers, insecticides and weedicides is very limited in both the farms. Thus, the availability and demand for farm labour should be carefully examined in any attempt to explain the possible reasons for the staggered planting of paddy prescribed by the LP solution.

As described elsewhere, the availability of family labour in Sirisena's farm is greater than that in Piyasena's farm. As shown in Figure 8.1, family labour available in Sirisena's farm is not fully utilized except for fortnights 21, 2, 15 of the first year and fortnight 20 of the second year. Also, according to the LP solution, the shadow price of this family labour is zero throughout the farming period considered. This implies that family labour is more than adequate for farming activities, since the farm-family members of Sirisena's farm do not report their involvement with any off-farm work.

It should be mentioned here that the relative prices and availabilities of the basic resources required for paddy farming have brought about this staggered planting in the solution. The optimum solution selected by the LP technique first utilizes all the relevant resources available within the farm intensively, before prescribing hiring or purchasing from outside. Also it is interesting to note here that the model always attempts to select production vectors which take place when the MVP of labour is lower. Thus, in the case of Sirisena's farm where family labour is relatively abundant, one could see that, the staggered planting in certain seasons given in the LP solution, would spread out the use of family labour while intensively using it in such a way as to avoid the occurrence of sharp labour peaks or troughs.

TABLE 8.3

OPTIMAL SOLUTION OF PADDY PRODUCTION VECTORS (WITHOUT RUBBER REPLANTING IN THE FARMING SYSTEM) FROM WHOLE-FARM MODEL

SIRISENA'S FARM

Plot Number, Season of Cultivation, Tenure Status and Total Extent	Paddy Production Vectors
Plot 1, Maha Season (1st year) Owned, (0.20 ha.)	Rata Thawalu* (19-02 to 20-03): 0.20 ha.
Plot 2, Maha Season (1st year) Rented, (0.40 ha.)	Rata Thawalu (19-02 to 21-04): 0.40 ha.
Plot 1, Yala Season (1st year) Owned, (0.20 ha.)	Rata Thawalu (05-15 to 06-16): 0.20 ha.
Plot 2, Yala Season (1st year) Rented, (0.40 ha.)	Rata Thawalu (05-15): 0.40 ha.
Plot 1, Maha Season (2nd year) Owned, (0.20 ha.)	Rata Thawalu (19-02): 0.20 ha.
Plot 2, Maha season (2nd year) Rented, (0.40 ha.)	Rata Thawalu (18-01 to 21-04): 0.40 ha.

TABLE 8.4

OPTIMAL SOLUTION OF PADDY PRODUCTION VECTORS (WITHOUT RUBBER REPLANTING IN THE FARMING SYSTEM) FROM WHOLE-FARM MODEL

PIYASENA'S FARM

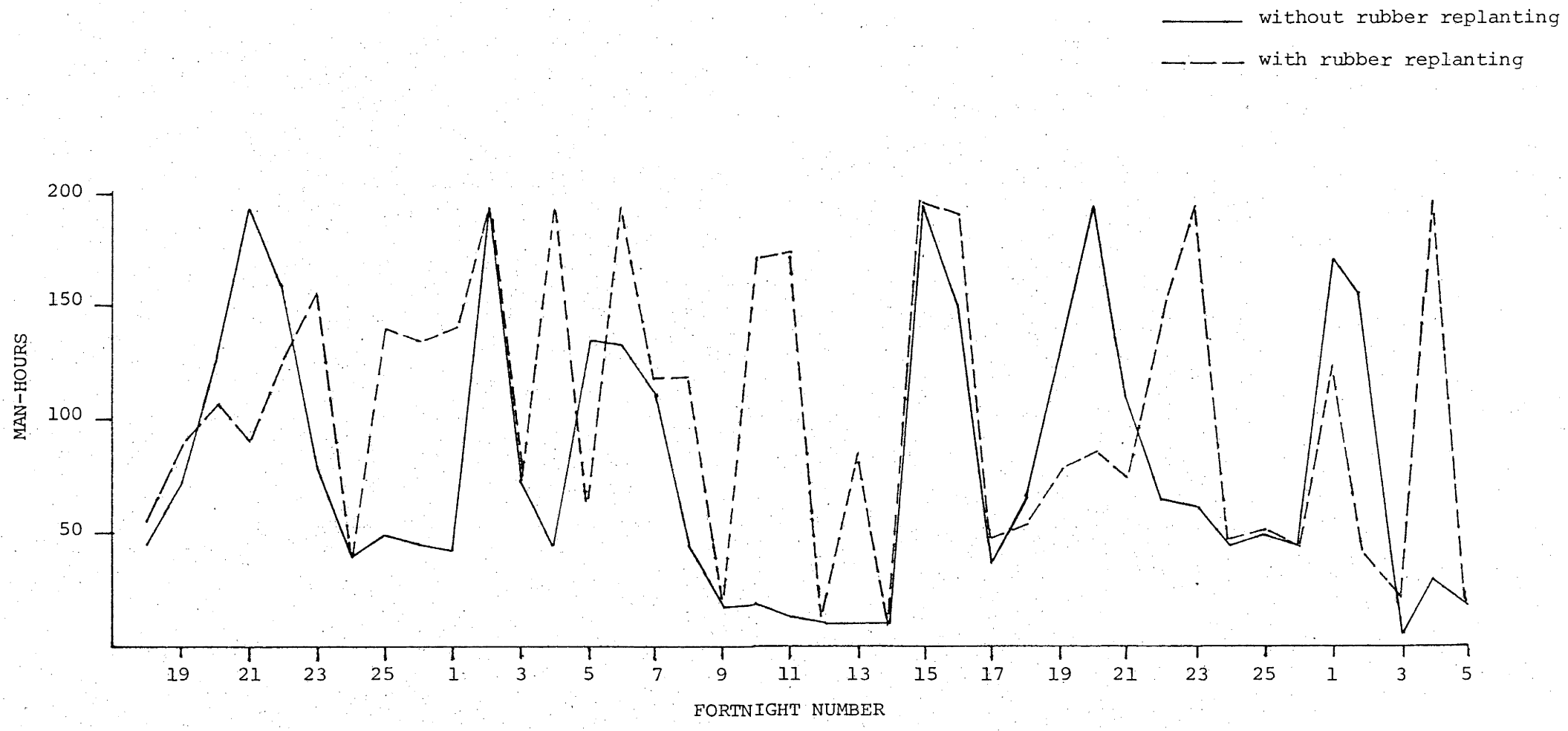
Plot Number, Season of Cultivation, Tenure Status and Total Extent	Paddy Production Vectors
Plot 1, Maha Season (1st year) Owned, (0.40 ha.)	Herath Banda * (18-01, 19-02, 20-03, 21-04, to 22-05): 0.40 ha.
Plot 1, Yala Season (1st year) Owned, (0.40 ha.)	Herath Banda (05-15 to 06-16): 0.40 ha
Plot 1, Maha Season (2nd year) Owned, (0.40 ha.)	Herath Banda (18-01, 19-02, 20-03 to 22-05): 0.40 ha.

* Rice varieties.

FIGURE 8.1

USE OF FAMILY LABOUR IN SIRISENA'S FARM,

WITHOUT AND WITH RUBBER REPLANTING



Also, the type of labour used in rubber tapping - the only rubber farming activity included in the model - is exclusively family labour in both farms. As extensively described elsewhere (see Chapter 6, sub-section 6.3) the demand for labour by rubber tapping is relatively higher in the Maha season (September/October to February) than in the Yala season (March/April to August). This is because of the larger number of tapping days in the Maha season than in the Yala season (see Table 6.11). Consequently, one could expect greater competition for farm labour by paddy farming and rubber farming in the Maha season than in the Yala season. It is apparent that staggering of paddy planting is greater in the Maha season than in the Yala season on both farms (see Tables 8.3 and 8.4). Thus, the relatively more staggered planting of Maha season paddy, prescribed in the LP solution for Sirisena's farm would ease the competitive nature of the demand for family labour generated both by paddy farming and rubber farming, while maintaining the rubber tapping activities and the paddy farming activities in all the land available in the Maha season.

According to the LP solution for Piyasena's farm, the shadow price of family labour in his farm is not equal to zero throughout the cropping period considered. Family labour in fortnights 18, 19, 20, 21, 22, 23, 01, 05, 06 and 16 of the first year and the fortnights 18, 19, 20, 21, 22, 23 and 24 of the second year have positive shadow price levels (see Figure 8.2). Fortnights 18 to 23 of the first year, and the second year coincide with the time periods within which Maha season and Yala season land preparation and planting of paddy could be done respectively. Also, the LP solution specifies a complete utilization of family labour, and the employment of a certain amount of hired labour during these fortnights (see Figure 8.3). Out of all the paddy crops in Piyasena's farm (see Table 8.3), the Maha season paddy crops are staggered to a greater extent, when compared with those of the Yala season and with the staggering of Sirisena's Maha paddy crops.

FIGURE 8.2

SHADOW PRICE OF FAMILY LABOUR IN PIYASENA'S FARM

WITHOUT AND WITH RUBBER REPLANTING

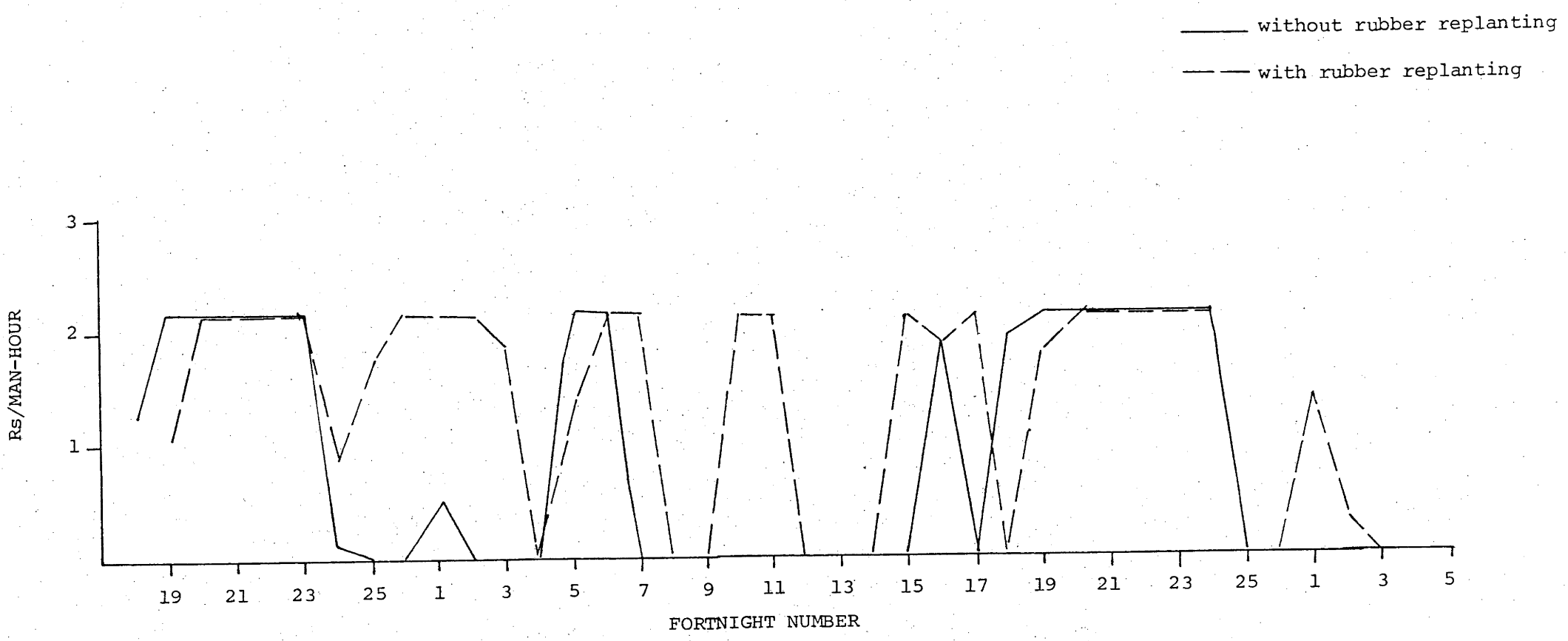
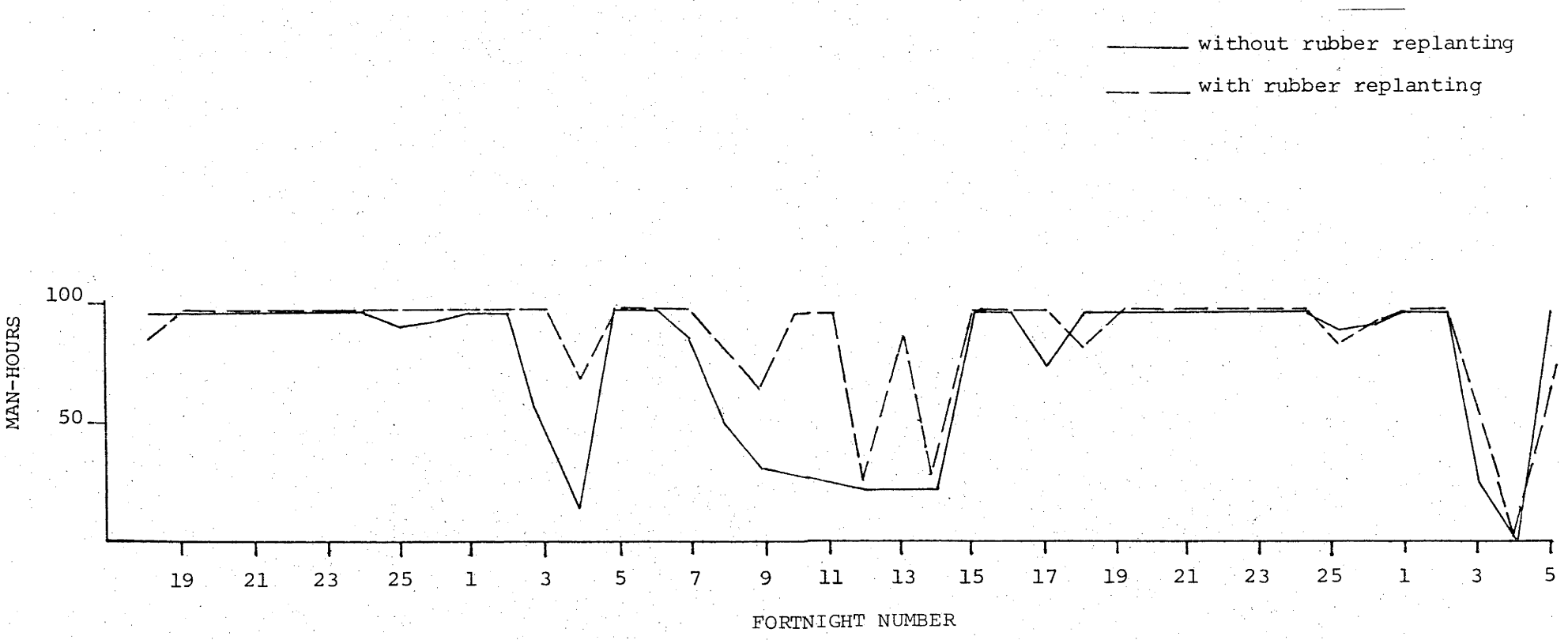


FIGURE 8.3

LABOUR USE (FAMILY AND HIRED LABOUR) IN PIYASENA'S FARM,
WITHOUT AND WITH RUBBER REPLANTING



In the actual situation, Piyasena expects to use 1500 hours of hired labour for land preparation and planting activities in paddy farming in all the seasons considered. As explained before his expected plan for paddy farming does not have any staggering of paddy crops. However, the timing of paddy crops, given in the LP solution (See Table 8.3) has effectively reduced the use of hired labour to 460 hours and intensified the use of family labour by spreading it out with the help of staggered planting (see Table 8.5). Also as described in respect to the staggering of Maha season paddy crops of Sirisena's farm, the staggered planting of Piyasena's Maha paddy crops would reduce the competitive nature of the demand for family labour created by paddy farming and rubber farming while maintaining both rubber tapping and paddy cultivation in all the land available in the Maha season.

According to the LP solutions for both farms, the MOC of not staggering the paddy crop is very low. Probably this could be due to the expected use of relatively small amount of hired labour which accordingly involves limited cash inputs in paddy farming activities.

With regard to rubber tapping, the extent of the rubber land prescribed to be tapped in the LP solution is equal to what both farmers have specified in their expected rubber farming plans (0.2 ha. for Sirisena and 0.4 ha. for Piyasena).

As explained before, neither farm fully utilizes the estimated family labour available within the farms over the cropping period considered. However, a part of the estimated family labour in these farms will be used in farming activities which are not time specific (see Chapter 6, sub-section 6.5). These have not been included in the LP model due to lack of adequate data. Nevertheless one could assume that if there is any family labour which is not utilized within these farms, it may be used for leisure or any other activity (for example, social and religious activities etc.). However,

since this aspect of farm family labour use was not elicited in the field survey, it is not possible to reach any inferences regarding it.

Cash surplus and MVP of cash and land are also generated by the LP model. Sirisena's farm has a maximum cash surplus of RS 268.00. As explained elsewhere, all the paddy produced in both the farms is consumed within the farm-households. The only cash-income generating farming activity is rubber tapping. Thus, his farm has a cash surplus of RS 1240.00 per hectare. In the case of Piyasena's farm, the LP solution generates a maximum surplus of Rs 416.00 or a cash surplus of Rs 1040,00 per hectare. According to the LP solutions, the shadow price of cash has the value of Rs 1.00 per rupee in both farms throughout the period under consideration. This could be due to the limited use of cash inputs such as fertilizers, insecticides, weedicides, and hired labour, etc., in these farms. Also it is interesting to note here that there would not be an acute shortage of cash in these farms, mainly because of the continuous flow of cash in relatively adequate quantities from rubber tapping.

8.4 Optimal Solutions for the Two Farm-Households When Rubber Replanting is Introduced into the Existing Farming Situations

The LP solution obtained for both the farms, after introducing rubber replanting vectors into the existing farming situation, specify a splitting of replanting of rubber in both the farms (see Tables 8.5 and 8.6). This staggering of rubber replanting over a relatively longer period of time in both the farms has been brought about by the relative prices and the availabilities of the resources needed, particularly of farm labour.

Two important changes in paddy farming activities have taken place with the introduction of rubber replanting in both farms. Firstly, the staggering of paddy planting in the Maha season has changed. In Sirisena's farm, the beginning of the first year's Maha season owned paddy crop cultivation activities has been advanced from fortnight 19 to fortnight 18, and the

beginning of the second year's Maha season rented paddy crop cultivation activities has been delayed from fortnight 18 to fortnight 21. Moreover, the second year's Maha season owned paddy crop has been split into two (see Tables 8.3 and 8.7). In the case of Piyasena's farm, the extent of staggering the first year's Maha season paddy crop has been reduced (see Tables 8.4 and 8.8).

TABLE 8.5

OPTIMAL SOLUTION OF RUBBER REPLANTING VECTORS

FROM WHOLE-FARM ANALYSIS

SIRISENA'S FARM

Plot Number, Tenure Status Total Extent to be Replanted	Rubber Replanting Vectors
Plot 1 Owned (0.50 ha.)	Clonal Rubber (25-16, 02-17, to 10-03): 0.50 ha. (0.1ha, 0.2ha 0.2ha)

TABLE 8.6

OPTIMAL SOLUTION OF RUBBER REPLANTING VECTORS

FROM WHOLE-FARM ANALYSIS

PIYASENA'S FARM

Plot Number, Tenure Status Total Extent to be Replanted	Rubber Replanting Vectors
Plot 1 Owned (0.40 ha.)	Clonal Rubber (25-16, 02-17, 06-26 to 10-03): 0.40 ha. (0.08ha,0.12ha,0.15 ha 0.05ha)

TABLE 8.7

OPTIMAL SOLUTION OF PADDY PRODUCTION VECTORS (WITH RUBBER REPLANTING IN THE FARMING SYSTEM) FROM WHOLE-FARM MODEL

SIRISENA'S FARM

Plot Number, Season of Cultivation Tenure Status and Total Extent	Paddy Production Vectors
Plot 1, Maha Season (1st year) Owned, (0.20 ha.)	Rata Thawalu (18-01 to 19-02): 0.20 ha.
Plot 2, Maha Season (1st year) Rented, (0.40 ha.)	Rata Thawalu (19-02 to 21-04): 0.40 ha.
Plot 1, Yala Season (1st year) Owned, (0.20 ha.)	Rata Thawalu (05-15 to 06-16): 0.20 ha.
Plot 2, Yala Season (1st year) Rented, (0.40 ha.)	Rata Thawalu (05-15): 0.20 ha.
Plot 1, Maha Season (2nd year) Owned, (0.20 ha.)	Rata Thawalu (18-01 to 21-04): 0.20 ha.
Plot 2, Maha Season (2nd year) Rented, (0.40 ha.)	Rata Thawalu (21-04 to 22-05): 0.40 ha.

TABLE 8.8

OPTIMAL SOLUTION OF PADDY PRODUCTION VECTORS (WITH RUBBER REPLANTING IN THE FARMING SYSTEM) FROM WHOLE-FARM MODEL

PIYASENA'S FARM

Plot Number, Season of Cultivation Tenure Status and Total Extent	Paddy Production Vectors
Plot 1, Maha Season (1st Year) Owned, (0.40 ha.)	Herath Banda (18-01, 21-04, to 22-05): 0.40 ha.
Plot 1, Yala Season (1st year) Owned, (0.40 ha.)	Herath Banda (05-15 to 06-16): 0.30 ha.
Plot 1, Maha Season (2nd Year) Owned, (0.40 ha.)	Herath Banda (18-01, 19-02, 20-03, to 22-05): 0.40 ha

Secondly, the area of paddy land under cultivation in the Yala season has declined in both the farms. In Sirisena's farm, it has dropped from 0.6 ha. to 0.4 ha. whereas in Piyasena's farm it has come down to 0.3 ha. from 0.4 ha. (see Tables 8.3, 8.4, 8.7 and 8.8). Staggering of rubber replanting in both the farms shows (see Tables 8.5 and 8.6, and Figure 8.4), that different replanting strategies overlap each other between fortnights 5 and 16. Thus, the demand for farm labour by rubber replanting would be relatively higher during this period. This could be the reason for cultivation of a reduced area of Yala paddy land in both farms between fortnights 5 and 16 which coincide with the Yala season paddy cultivation period.

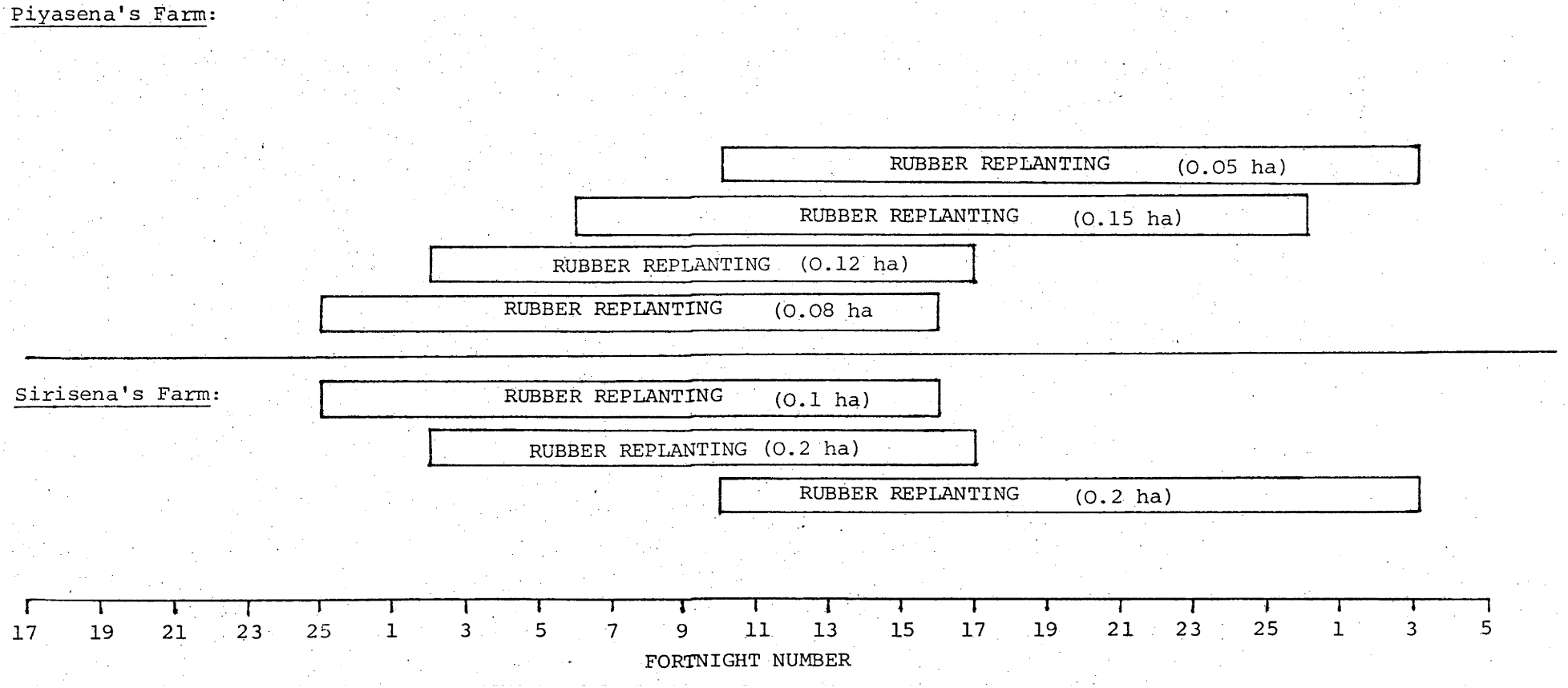
Changes in the staggering of paddy cultivation as described earlier may have led to a reallocation of farm labour within the farms so as to accommodate rubber replanting activities. Although Sirisena reported his intention to use hired labour for his replanting activities, the LP solution has allocated family labour in his farm in such a way that it does not have to hire any labour from outside. In the case of Piyasena's farm, the model has reallocated family labour in such a way that he has to employ hired labour in addition to his family labour, as expected, but in lesser quantities.

The extent of rubber land that both farmers have indicated their intention to tap has not changed in the LP solutions. The LP solution specifies 0.2 ha. of rubber land to be tapped in Sirisena's farm and this is equal to his expectation. In the case of Piyasena's farm the solution prescribes 0.4 ha. of rubber land to be tapped, which is also equal to his expectation.

The effect of the introduction of rubber replanting on labour use shows that in both the farms total family labour utilization has increased substantially (see Figures 8.1 and 8.2). Also labour use has been spread

FIGURE 8.4

STAGGERING OF RUBBER REPLANTING IN SIRISENA'S FARM AND IN PIYASENA'S FARM



out over time to even out labour peaks and troughs.

The shadow price of family labour in Sirisena's farm remains zero throughout the cropping period, implying that there is more than adequate family labour for use within the farm. However, in the case of Piyasena's farm, where family labour is relatively scarce, the shadow price of family labour has varied over time, depending on demand. As can be seen from Figure 8.3, the introduction of rubber replanting has raised the MVP of family labour in fortnights 25, 26, 1, 2, 3, 10, 11 of the first year and fortnights 15, 17, 1 and 2 of the second year. Fortnights 25, 26, 2, 3, 10 and 11 of the first year coincide with the time periods within which May/June rubber replanting activities could be done. In the second year, fortnights 17, 1 and 2 represent the time periods of land preparation activities of the October/November rubber replanting.

It is interesting to note here that the rubber replanting vectors were not forced into the existing farming system when they were incorporated in the LP model. Nevertheless, their selection in the solution of both the farms implies that it is economical for these farms to replant the old rubber land since rubber replanting vectors contribute a certain amount of cash to the farming system through a rubber replanting subsidy.

According to the solution, the maximum cash surplus generated by the LP model, for both the farms has increased considerably. Sirisena's farm has a maximum cash surplus of Rs 3924.00 while Piyasena's farm generated a cash surplus of Rs 2289.00. The reason for this relatively high surplus could be the high rubber replanting subsidy which amounts to Rs 9263.00 per ha., received by these farms. Although this subsidy includes payments on cash inputs such as barbed-wire for fencing etc., farmers hardly used such cash inputs in replanting.

The limited use of cash inputs such as agro-chemicals in paddy farming, hired labour and material inputs (e.g. barbed-wire etc.) in rubber replanting

has been reflected in the low shadow price of cash in both the farms. They have a very low shadow price of Rs 1.00 per rupee throughout the cropping period considered.

Here, one could question the usefulness of a short period LP model when dealing with a crop such as rubber which has a long gestation period. However, the foregoing analysis has been able to denote some possible directions of staggering of rubber replanting, which is important from the point of view of those farmers who grow several other crops in addition to rubber.

CHAPTER 9

SUMMARY AND CONCLUSIONS

The smallholder rubber sector occupies an important place in the rubber industry of Sri Lanka, in terms of holding size, ownership and production. However, investigations into resource allocation, particularly with regard to labour input in rubber smallholdings, have been very limited. In this study the allocation of farm labour is investigated in a sample of ten smallholder rubber farms with respect to both rubber and other crop farming activities. The size distribution of total land cultivated in these farms is within a range of 1.1 to 2.3 ha. with a standard deviation of 0.35 ha. And the majority of these farms are between 1.2 and 1.8 ha.

Two methods of analyses are employed in this study: (a) simple tabular and graphical analysis, and (b) whole farm analysis which is an application of the LP technique. Simple tabular and graphical analysis were used to gain insight into the existing farming situation of these ten case study farms, and in particular to identify the key factors which influence the labour use pattern. Two medium sized case study farms were selected for the whole farm analysis. Here the LP technique was used to generate optimal farm plans under two different conditions, namely without rubber replanting and with rubber replanting. These optimal farm plans specified a mix of farming activities and an allocation of resources that would satisfy the farmer's goals of producing certain consumption goods, and maximising cash surplus under a given set of resource restrictions.

9.1 Tabular and Graphical Analysis

The findings of the simple tabular and graphical analysis could be summarised as follows:

Firstly, the case study farms employ traditional technologies in paddy farming activities. These involve the use of traditional unselected local paddy varieties, limited use of material inputs such as fertilizers and low management levels, which in turn are reflected in their low paddy yields.

Secondly, there is a variation in the degree of flexibility of time for different paddy farming activities between, as well as within, the Maha and Yala seasons among these farms. There is a greater degree of flexibility of time in the Maha season than in the Yala season. The following reasons have been identified to explain this variation.

(i) Primarily, paddy farming and rubber farming compete with each other for farm labour within these farms. Heavy rainfall during the Yala season interferes considerably with rubber tapping, making the release of farm labour from rubber tapping to paddy farming easier. This makes the staggering of paddy farming activities in the Yala season not very essential. Thus, a greater time flexibility in paddy farming during the Yala season is not necessitated. However, in the Maha season, the relatively less heavy rainfall does not interfere with the rubber tapping. Thus, there will be more restrictions in terms of availability of farm labour for paddy farming in the Maha season. This makes the staggering of paddy farming activities in the Maha season necessary.

(ii) A larger amount of farm labour is needed in the Maha season paddy farming than in the Yala season. This is because of the high labour requirement for a thorough cleaning and repairing of bunds in the Maha season. This makes the time period, within which Maha season paddy farming activities are carried out longer than that in the Yala season.

(iii) Sinhalese New Year in Sri Lanka coincides with the second week of April (i.e. week 15). Farmers complete their Yala season paddy planting before the New Year. This factor could also affect the relatively smaller degree of flexibility of time for the Yala season paddy farming.

The degree of flexibility of time for different paddy farming activities within the Maha and Yala seasons is smaller, once paddy is planted. There is relatively little flexibility available with regard to the subsequent activities, since the subsequent activities such as fertilizer application etc., have to be completed after a certain specific time period of planting.

Thirdly, seasonality in expected labour use in paddy farming among the case study farms has been identified. Of the four seasonal labour use peaks observed, the highest peaks would correspond to the Maha season harvesting and threshing, and the Yala season harvesting and threshing. Next to these two peaks would be that which corresponds to the Maha season land preparation, sowing and fertilizing. Labour peaks for land preparation, sowing and fertilizing in the Yala season would be relatively low.

Fourthly, a relatively high degree of variability in expected labour use per hectare was observed among these farms with regard to paddy farming activities. This included inter-farm variations in both seasons as well as intra-farm variations between seasons within the same farms. The following reasons were identified to explain the inter-farm variations in expected labour use:

(i) Differences in effort expended within a given period of time by different types of labour in farming activities.

(ii) Variations in soil texture and structure between different farms which have obvious repercussions on the mechanical resistance of the soils and on the labour use requirements.

(iii) Differences in tenurial status among these farms.

(iv) Upward biases caused by the multiplication of the expected labour use data from small, multiple plots to per hectare basis.

Fifthly, two types of variation in expected labour use in rubber tapping have been observed. They are: (a) variation in expected labour

use between the case study farms in the same months of the year, and, (b) variation in expected labour use within the individual farms between different months of the year. The analysis of these variations explained that between farm variation is greater than the within farm variations over time. The most important reasons for the inter-farm variations in expected labour use in tapping in different months of the year are: (i) the variation in number of rubber trees per hectare, and (ii), the variation in number of tapping days per month in different months of the year. A possible reason for the intra-farm variation in expected labour use could be the variation in number of tapping days per month in different months of the year. Another partial cause may be the aggregation and multiplication of the expected labour use data from multiple plots to per hectare basis.

Sixthly, it has been observed that the case study farmers do not expect to carry out all the rubber replanting activities except planting in strictly specific time periods.

Seventhly, it has been demonstrated that timing of different rubber replanting activities among the case study farms is dependent on the availability of farm labour and capital, other farming and/or non-farming activities and the climatic factors, such as rainfall.

Eighthly, it has been shown that, except for felling and clearing the old rubber stand, the inter-farm variation in the expected labour use is relatively low for all the other rubber replanting activities among the case study farms. It should be noted here that the techniques used in felling and clearing on all these farms are the same. Yet, a considerably high degree of variability in expected total labour use in rubber replanting is observed between the case study farms. The following factors were identified in explanation of this inter-farm variability in labour use:

(i) Variation in the density of old rubber trees and the differing ages of the trees in the holdings to be replanted on the case study farms.

(ii) Differing physical properties of the holdings such as soil texture and structure, topography of land.

(iii) Differences in labour efficiency in terms of effort made within a given period of time between different types or within the same type but between different individuals.

(iv) Upward biases caused by the multiplication of the expected labour use data from small, multiple plots to per hectare basis.

Lastly, it has been observed that these farms do practise non-time specific farming activities such as weeding and fertilizing of rubber land, tapping panel treatment, home gardening, etc., according to the amount of time they have.

9.2 Whole Farm Analysis

The findings of the whole farm analysis without rubber replanting vectors could be summarised as follows:

Firstly, staggering of paddy planting has been prescribed for both the farms, utilizing all the paddy land available. However, the Maha season staggering is greater than that in Yala season. In Sirisena's farm, which is relatively labour abundant, the staggered paddy planting would spread out the use of family labour while intensively using it, and thereby avoiding sharp labour peaks and troughs. In the case of Piyasena's farm, which is relatively labour scarce, and which employs a considerable amount of hired labour, the staggered paddy planting has effectively reduced the use of hired labour and intensified the use of family labour. Also, the more staggered planting of Maha season paddy in both the farms, would reduce the competitive nature of the demand for family labour created by

paddy farming and rubber farming while maintaining both rubber tapping and paddy cultivation in the Maha season.

Secondly, the MOC of not staggering the paddy crops in both the farms is very low. This could probably be due to the expected use of a relatively small amount of hired labour which accordingly involves limited cash inputs in paddy farming activities.

Thirdly, the MVP of family labour in Sirisena's farm is zero throughout the farming period considered. This is because of the relative abundance of family labour in his farm. In Piyasena's farm, the MVP of family labour is raised and hired labour is employed in peak periods. However, the raised MVPs of family labour are equal to or lower than the average wage rate of the hired labour in the area surveyed.

Fourthly, the extent of the rubber land prescribed to be tapped in the LP solution is equal to what both farmers have specified in their expected rubber farming plans.

Fifthly, the shadow price of cash is low in both the farms implying the limited use of cash inputs such as fertilizers, insecticides, weedicides and hired labour, etc. Nevertheless, it should be noted here that there would not be an acute shortage of cash in these farms since a continuous flow of cash in relatively adequate quantities is guaranteed from rubber tapping throughout the period considered.

The findings of the whole farm analysis with rubber replanting vectors could be summarised as follows:

Firstly, the relative prices and the availabilities of the resources needed, particularly farm labour, have brought about a staggering of rubber replanting over a relatively longer period of time in both the farms.

Secondly, certain changes have taken place in regard to paddy cultivation activities in both the farms. The staggering of paddy planting in the Maha season has been altered. Also the area of paddy land under

cultivation in the Yala season has declined. These changes may have led to a reallocation of farm labour within these farms so as to accommodate the rubber replanting activities. Also, the optimal farm plan has allocated family labour in Sirisena's farm in such a way that it does not have to hire any labour from outside for rubber replanting activities. In Piyasena's farm the reallocation of family labour has reduce the expected use of hired labour. Introduction of rubber replanting has increased the expected total family labour use substantially and has spread it out over time to even out labour peaks and troughs in both the farms.

Thirdly, the extent of rubber land that both farmers have indicated their intention to tap has not changed in the optimal farm plans.

Fourthly, the MVP of family labour in Sirisena's farm is zero throughout the farming period considered, implying that there is more than adequate family labour for use within the farm. In Piyasena's farm, where family labour is relatively scarce, the MVP of family labour is raised in peak periods, but it does not exceed the average wage rate of hired labour in the area surveyed.

Fifthly, inclusion of the rubber replanting vectors in the optimal farm plans for both farms showed that it is economical for these farms to replace the old stand of rubber trees with new plants, since rubber replanting contributes a considerable amount of cash to the farming system through a rubber replanting subsidy.

Sixthly, the cash surplus generated for each farm has increased considerably, mainly because of the high rubber replanting subsidy received by these farms. It is observed that farmers hardly use the total subsidy for rubber replanting activities.

Seventhly, the availability of cash in relatively adequate quantities from rubber tapping and the limited use have been shown in the low shadow price of cash in both the farms.

The generalisations which could be deduced from the findings discussed above are as follows:

Farming activities adopted by these farmers involve the use of high levels of a relatively abundant resource-family labour. Thus, one could suggest that, and this is implied in the optimal solution, farm plans to modify or improve farming systems so as to increase economic gains, should involve intensive use of family labour. However, one needs to find out the extent to which these farmers are actually prepared to use their family labour more intensively.

Weather factors, particularly rainfall, play a major role in farming activities among these farms. Rubber tapping is more susceptible to the effect of rainfall than paddy farming.

Traditional technologies dominate the paddy farming activities in the area surveyed. The economic gains obtained from these technologies are relatively low when compared with those from improved technologies. Attitudes of the farmers towards improved technologies such as use of high yielding seed varieties, better water management, use of pesticides, are not promising at present. However, intensification of agricultural extension activities, farm credit facilities, agro-chemical supplies, high yielding seed paddy distribution etc., may be able to change the present picture, so that these farmers might accept the improved technologies in paddy farming. This could lead to a rise in economic benefits to these farmers.

The paddy varieties grown at present by these farmers are long-aged varieties. However, new technologies in paddy farming involve short-aged high yielding varieties. If short-aged paddy varieties could be introduced to these farms they would help to spread out the labour utilization and thereby to avoid sharp labour peaks and troughs. This would release farm labour for other farming activities such as rubber tapping, rubber replanting, cash cropping in the home gardens, with less difficulties.

Under the existing farming system, it is necessary to split and stagger certain paddy crops as well as rubber replanting so as to ensure a smooth flow of paddy farming, rubber tapping and replanting activities with an extensive use of family labour and reduced employment of hired labour.

Finally, it could be said that this study has been useful in denoting the possible directions of altering certain farming activities particularly staggering of paddy farming and the interactions with those of rubber replanting. These directions could be useful if one expects to plan the introduction of new technologies.

APPENDIX TABLE 1

CODE OF CROPPING WEEKS WHICH COVERS A NORMAL CROP YEAR IN THE AREA SURVEYED

Week	Actual Dates	Week	Actual Dates
35	27 Aug - 2 Sep	09	26 Feb - 4 Mar
36	3 Sep - 9 Sep	10	5 Mar - 11 Mar
37	10 Sep - 16 Sep	11	12 Mar - 18 Mar
38	17 Sep - 23 Sep	12	19 Mar - 25 Mar
39	24 Sep - 30 Sep	13	26 Mar - 1 Apr
40	1 Oct - 7 Oct	14	2 Apr - 8 Apr
41	8 Oct - 14 Oct	15	9 Apr - 15 Apr
42	15 Oct - 21 Oct	16	16 Apr - 22 Apr
43	22 Oct - 28 Oct	17	23 Apr - 29 Apr
44	29 Oct - 4 Nov	18	30 Apr - 6 May
45	5 Nov - 11 Nov	19	7 May - 13 May
46	12 Nov - 18 Nov	20	14 May - 20 May
47	19 Nov - 25 Nov	21	21 May - 27 May
48	26 Nov - 2 Dec	22	28 May - 3 Jun
49	3 Dec - 9 Dec	23	4 Jun - 10 Jun
50	10 Dec - 16 Dec	24	11 Jun - 17 Jun
51	17 Dec - 23 Dec	25	18 Jun - 25 Jun
52	24 Dec - 31 Dec	26	26 Jun - 1 Jul
01	1 Jan - 7 Jan	27	2 Jul - 8 Jul
02	8 Jan - 14 Jan	28	9 Jul - 15 Jul
03	15 Jan - 21 Jan	29	16 Jul - 22 Jul
04	22 Jan - 28 Jan	30	23 Jul - 29 Jul
05	29 Jan - 4 Feb	31	30 Jul - 5 Aug
06	5 Feb - 11 Feb	32	6 Aug - 12 Aug
07	12 Feb - 18 Feb	33	13 Aug - 19 Aug
08	19 Feb - 25 Feb	34	20 Aug - 26 Aug

APPENDIX TABLE 2

CODE OF CROPPING FORTNIGHTS WHICH COVERS A NORMAL CROP YEAR IN THE AREA SURVEYED

Fortnight	Actual Dates	Fortnight	Actual Dates
18	27 Aug - 9 Sep	05	26 Feb - 11 Mar
19	10 Sep - 23 Sep	06	12 Mar - 25 Mar
20	24 Sep - 7 Oct	07	26 May - 8 Apr
21	8 Oct - 21 Oct	08	9 Apr - 22 Apr
22	22 Oct - 4 Nov	09	23 Apr - 6 May
23	5 Nov - 18 Nov	10	7 May - 20 May
24	19 Nov - 2 Dec	11	21 May - 3 Jun
25	3 Dec - 16 Dec	12	4 Jun - 17 Jun
26	17 Dec - 31 Dec	13	18 Jun - 1 Jul
01	1 Jan - 14 Jan	14	2 Jul - 15 Jul
02	15 Jan - 28 Jan	15	16 Jul - 29 Jul
03	29 Jan - 11 Feb	16	30 Jul - 12 Aug
04	12 Feb - 25 Feb	17	13 Aug - 26 Aug

CODE OF CROPPING FORTNIGHTS WHICH COVERS ONE AND A HALF NORMAL CROP YEARS IN THE AREA SURVEYED

Fortnight	Actual Dates	Fortnight	Actual Dates
18	27 Aug - 9 Sep	12	4 Jun - 17 Jun
19	10 Sep - 23 Sep	13	18 Jun - 1 Jul
20	24 Sep - 7 Oct	14	2 Jul - 15 Jul
21	8 Oct - 21 Oct	15	16 Jul - 29 Jul
22	22 Oct - 4 Nov	16	30 Jul - 12 Aug
23	5 Nov - 18 Nov	17	13 Aug - 26 Aug
24	19 Nov - 2 Dec	18	27 Aug - 9 Sep
25	3 Dec - 16 Dec	19	10 Sep - 23 Sep
26	17 Dec - 31 Dec	20	24 Sep - 7 Oct
01	1 Jan - 14 Jan	21	8 Oct - 21 Oct
02	15 Jan - 28 Jan	22	22 Oct - 4 Nov
03	29 Jan - 11 Feb	23	5 Nov - 18 Nov
04	12 Feb - 25 Feb	24	19 Nov - 2 Dec
05	26 Feb - 11 Mar	25	3 Dec - 16 Dec
06	12 Mar - 25 Mar	26	17 Dec - 31 Dec
07	26 Mar - 8 Apr	01	1 Jan - 14 Jan
08	9 Apr - 22 Apr	02	15 Jan - 28 Jan
09	23 Apr - 6 May	03	29 Jan - 11 Feb
10	7 May - 20 May	04	12 Feb - 25 Feb
11	21 May - 3 Jun	05	26 Feb - 11 Mar

QUESTIONNAIRE USED IN FIELD SURVEY

Farmer's Name: Village:

G.S. Division: R.E.O. Division:

DATE:

1. FAMILY STATUS AND OCCUPATIONS

Relationship	Age	Education	Self-employed and/or employed outside

2. LAND USE

Crop	Owned Area	Rented in Area	Share Cropped Area

3. PADDY CROP

	Plot 1			Plot 2		
	Area	Variety	Age	Area	Variety	Age
Yala						
Maha						

Output:	Plot 1	Plot 2
Yala		
Maha		
Total		

Amount of Paddy consumed/year:

Amount of Paddy sold/year :

Amount of Paddy kept for seed/year:

4. RUBBER CROP

Plot 1				Plot 2			
Area	No. of Trees	Clone	Age	Area	No. of Trees	Clone	Age

Immature:

Mature:

Old:

5. TAPPING, COLLECTION AND MANUFACTURING OF RUBBER

Month	Area	No. of Tapping days/month	Most Likely yield/day	Tapping system

6. OTHER CROPS

Crops Grown:

Output:

Disposal:

Notes:

7. CROP ACTIVITY STATEMENT

Crop: Area: Season:

Operation	Expected Time	Labour Use and wages	Input Requirements and prices

8. HOUSEHOLD EXPENDITURE

Purpose	Expenditure
(a) Food	
(b) Clothing	
(c) Health	
(d) Education	
(e) Housing	
(f) Religious and Social activities	
(g) Others	

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